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use normal, plain font (12-point Times New Roman) number all pages consecutively. indent or space paragraphs. Articles should be arranged in the following order. *Title, Abstract, Introduction, Materials and Methods, Results, Discussion, Conclusions, Acknowledgements, References, Tables and Legends to Illustrations.*

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Should not exceed 300 words and should be presented under the following subheadings: Objectives, Materials and Methods; Results; Conclusions (For Reviews: Objectives; Data; Sources; Study selection; Conclusions). These subheadings should appear in the text of the summary. Provide a short, nonstructured, 1-paragraph abstract that briefly summarizes the problem encountered and treatment administered for clinical report.

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-identify the limitations of the present study, and suggest areas for future research.

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ARAŞTIRMA / RESEARCH

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Cumhuriyet Dental Journal: 2018; 21(4)
Doi: 10.7126/cumudj.433716 *RESEARCH ARTICLES*

THE COMPARISON OF SHEAR BOND STRENGHT OF DIFFERENT BULK-FILL COMPOSITES TO A BIOACTIVE DENTINE SUBSTITUTE

Farklı Bulk-Fill Kompozitlerin Bir Bioaktif Dentin Substratına Makaslama Bağlanma Dayanımlarının Karşılaştırılması

Murat ÜNAL

Makale Kodu/Article Code ***:*** *433716*

Makale Gönderilme Tarihi ***:*** *13.06.2018*

Kabul Tarihi ***:*** *09.07.2018*

ABSTRACT

Objective: The aim of this research was to compare shear bond strength(SBS) of various bulk-fill composites (BFC) to Biodentine(BD) with different time intervals.

Materials and Methods: 300 cyclindrical acrylic blocks with a hole (4 mm diameter a 2 mm height) were prepared. The holes were filled with BD and after bonding application, 5 different BFC groups (Tetric EvoCeram Bulk Fill, Filtek Bulk Flow, Beautifil Bulk, Filtek Bulk Fill Posterior and SDR) were divided into 10 main groups in 2 mm and 4 mm height, and these 10 main groups were divided into 3 subgroups according to three different waiting times (12 min, 24 hour and 2 week). After then, SBSs measured and the fractured surfaces were examined. Statistical analyzes were performed with Kolmogorov-Simirnov, Tukey HSD and One-way ANOVA tests.

Results: There was found statistically significant difference in all BFC groups between 12 minutes, 24 hours and 2 weeks ($p<0.05$). Significant differences were found between the 2 mm and 4 mm Filtek Posterior BFCs ($p<0.05$). However, there was not significant differences in the other BFC groups ($p>0.05$).

Conclusion: In all BFC groups, there was significant difference found between the groups waited for 12 min and,24 h and 2 weeks. In clinically, we may prefer to use BFC at a height of 4 mm, onto BD with after 1 day of waiting time

Keywords: Bulk-fill Composite, Biodentine, Shear Bond Strength

ÖZ

Amaç: Araştırmanın amacı farklı Bulk-fill kompozitlerin (BFK) Biodentine (BD) farklı zaman aralıklarında bağlantı dayanımlarını karşılaştırmaktır.

Gereç ve Yöntemler: Çalışmada, 300 adet akrilik blok, ortası boşluk olacak (2mm kalınlık ve 4mm yükseklikte) şekilde hazırlanmıştır. Bu boşluk kısım, BD ile doldurulmuş ve 5 farklı BFK, BD üzerine 2mm ve 4mm yüksekliklerde (her bir grup 10 örnekten oluşacak şekilde) bağlanarak, üç farklı bekleme süresine göre 3 alt gruba ayrılmıştır (12 dk., 24 sa ve 2 hafta). Daha sonra bağlantı dayanım değerleri ölçüldü ve kırık yüzeyler incelendi. İstatistiksel analizler Kolmogorov-Simirnov, Tukey HSD ve One-way ANOVA testleri ile yapıldı.

Bulgular: Tüm BFK gruplarında 12 dakika, 24 saat ve 2 hafta bekletilmiş gruplar arasında anlamlı fark bulundu ($p<0,05$). 2 mm ve 4 mm Filtek Posterior BFK'ler arasında anlamlı fark bulunurken ($p<0,05$), diğer BFK gruplarında anlamlı farklılık bulunmadı ($p>0,05$).

Sonuç: Tüm BFC gruplarında 12 dakika, 24 saat ve 2 hafta bekletilmiş gruplar arasında anlamlı fark bulundu. Klinik olarak BD üzerine 4mm yükseklikte BFK uygulaması yapılacaksa, 1 gün beklemeyi tercih edebiliriz.

Anahtar Kelimeler: Bulk-fill kompozit, Biodentine, Makaslama Bağlantı Dayanımı

Cumhuriyet University, Faculty of Dentistry, Department of Pediatric Dentistry, Sivas, Turkey

INTRODUCTION

Vital pulp treatments includes all treatments that reduce pulp injuries by protecting the pulp from toxic, mechanical and thermal effects, which is aimed to treat reversible pulp injuries and to cover the pulp with a suitable material; and also, trigger reperative dentin formation.[1] For this purpose, a wide variety of materials such as calcium hydroxide, zinc-oxide ogenol, formocresol, gluteraldehyde, bonding systems, collagen fibers and cytokines have been used to date.[2,3] Calcium hydroxide, among these materials, is the most commonly used due to having properties as the induction of reperative dentin formation, being antibacterial, cheap and easy to manipulate.[2] However, calcium hydroxide has a great deal of disadvantages such as; resorption over time, microleakage into these resorbed areas, fractures and cracks during restorative procedures due to being thin and weak, causing necrotic tissue because of its high alkalinity, causing necrosis and degeneration in the pulp, leading to internal resorption in direct pulp capping and amputation treatments.[4,5] Due to these mentioned factors, new and alternative substances were needed in vital pulp treatments.

MTA has been accepted as a reference material for pulp treatments because of its high success rates (90-100%) in clinical, radiological and histopathological studies. Nevertheless, despite its positive properties, MTA has the disadvantages of long hardening time, high resolution throughout the hardening process, and the coloring potential of tooth tissues and difficult manipulation.[6] In order to overcome these drawbacks, various calcium silicate cements have been developed, and Biodentine (BD) is the most recent of these cements.

BD contains tri- and dicalcium silicate as main materials, calcium carbonate as the filler, and zirconium dioxide as the radio-opacity provider.[7,8] Liquid form consists of distilled water, calcium chloride and a water-soluble polymer. Calcium chloride acts as an accelerator to expedite the hardening process of the material.[9] The mixing of BD's powder and liquid allows the ionic exchange and polymerization leading to the formation of a solid network over time. The product of the reaction consists of a cemental phase containing tricalcium silicate, and a radio-opasity provider phase containing zirconium oxide. Reported that calcium carbonate acts as a nucleation site for formation of the reaction, thereby increasing hydration and producing more dense microstructure.[7,10] The most important advantages of BD over MTA are easier clinical use, high viscosity, caused less discoloration, short curing time (12 min) and better physical properties.[11] However, when literature review was performed, it was obvious that shear-bond strenght(SBS) values of BD to resin-based materials were found to increase more after 1 day.[12]

In nanocomposites, when the thickness of the resin composite material placed in the cavity exceeds 2 mm, reported in studies that it adversely affects the polymerization, and so the physical properties and the clinical life span of the restoration.[13-16] For this reason, BFC materials have been developed recently in order to apply composites to cavity in large quantities, and to reduce the application time.[17] These BFCs have advantages of lower viscosity than conventional resin composites, and less polymerization shrinkage than flowable composites.[18-20] Bis-GMA, aliphatic urethane dimethacrylate, partial aromatic dimethacrylate or highly branched methacrylate monomers are added to the organic matrix portion of the BFCs. This addition to the matrix and monomer structure reduces the polymerization shrinkage of the material by 70%, and improves the translucency of the resin, resulting in deeper stratification of the light required for polymerization, and increase in the conversion rate.[14] BFCs shorten the working time because they are applied in bulks to the cavity at once. Thus, it is known that they increase the comfort of both dental physicians and patients.

In this research, we examined the SBS values of these two different (2mm and 4mm) thicknesses of BD and we aimed to compare SBSs of 5 different BFCs placed at two different thicknesses (2 mm and 4 mm) after 3 different time periods of BD retention (12 min, 24 h and 14 days).

MATERIALS AND METHODS

Preparation of Acrylic Blocks;

A total of 300 acrylic blocks containing a central hole with a 4 mm diameter a 2 mm height were prepared. Biodentine (Septodent, Saint-Maur-des-Fosses Cedex, France) was mixed according to the manufacturer's instructions (as described below) and acrylic blocks were fully filled with Biodentine (BD).

Placement of BD into Acrylic Blocks;

BD was prepared according to the manufacturer's directions as explained below;

-The capsule containing BD powder was opened and placed on the capsule carrier which was also included in the box,

-Later its own the liquid containing pipette was opened, and 5 drops were poured into the capsule,

-Powder capsule was closed back and placed in amalgamator (ADM 9002, MedidentGbR, Treffurt, Germany) to mix, and stirred for 30 seconds,

-After stirring, the capsule was opened to ensure that BD was mixed homogenously.

-BD in the capsule was placed into the 4 mm diameter spaces on acrilic blocks by plastic spatulas, which were included in the box of the product, and was gently condensed. All the samples in the study, BD was placed into acrylic blocks by being prepared as mentioned above.

Separation of Bulk-Fill Composites(BFCs) into Groups;

Single Bond Universal [(SBU) (3M Espe, St. Paul, MN, USA)] adhesive system was applied to the BD surface of samples prepared in total with Self-Etch (SE) technique as described below in accordance with the user's instructions after 3 different waiting times (12 minutes, 24 hours and 2 weeks) (all specimens stored at 37ºC with 100% humidity during the waiting time).

SBU-SE application;

The adhesive was applied to the BD surface with the help of a disposable bond brush for 20 seconds of scrubbing, and gently air-dried for 5 seconds by using the air-water spray until no movement on the adhesive occurred. Polymerization was achieved by irradiating LED curing light (Elipar S10, 3M ESPE, St. Paul, MN, USA) for 10 seconds.

After bonding application, 5 different BFC [TetricEvo (TE), Filtek Bulk Flow (FF), BEAUTIFIL(BE), Filtek Bulk Fill Posterior (FP) and SDR)] groups were divided into 10 main groups in 2 mm and 4 mm thickness, and these 10 main groups were divided into 3 subgroups (n = 10 was accepted in all groups). (Table 1)

The each of 10 experimental groups were divided into 3 subgroups as follows in table 1.

Table 1: Classification of experimental test groups

Thickness / Waiting TtiTimes / Composites	2mm			4mm		
	12 Min	24 Hours	2 Weeks	12 Min	24 Hours	2 Weeks
Tetric Evo (TE)	G1a	G1b	G1c	G2a	G2b	G2c
Filtek Bulk Flow (FF)	G3a	G3b	G3c	G4a	G4b	G4c
Beautiful (BE)	G5a	G5b	G5c	G6a	G6b	G6c
Filtek Bulk Fill Posterior (FP)	G7a	G7b	G7c	G8a	G8b	G8c
SDR	G9a	G9b	G9c	G10a	G10b	G10c

All BFC materials were placed on a BD at the heights stated above, with the aid of a Teflon mold, 2 mm in diameter, 2 mm and 4 mm in heights. BFC materials in all the groups were polymerized by irradiating with LED light curing device for 40 sec. All materials used in this research shown in Table 2.

Table 2. The materials used in this study

Brand Name(Manufacturer)	Type of resin Bulk fill composite	Matrix Composition	Inorganic filler content (wt%, vol%)
Tetric EvoCeram Bulk Fill (Ivoclar Vivadent, Schaan, Lichtenstein)	High viscosity bulk-fill resin composite	UDMA, Bis-EMA, EBPADMA	Barium aluminium silicate glass, ytterbium triluoride, 80.0 wt%, 61.0 vol%
Filtek Bulk Flow (3M ESPE St Paul, MN, USA)	Low viscosity bulk-fill resin composite	Bis-GMA, Bis-EMA, UDMA	Silane treated ceramic, ytterbium fluoride filler, 64.5 wt%, 42.5 vol%
Beautifil Bulk (SHOFU Kyoto, Japan)	High viscosity bulk-fill giomer	Bis-GMA, UDMA, Bis-MPEPP, TEGDMA	Fluoro-silicate glass, 87.0 wt%, 74.5 vol%
Filtek Bulk Fill Posterior (3M ESPE St Paul, MN, USA)	High viscosity bulk-fill resin composite	AromaticUDMA, UDMA, 1,12-dodecane-dimethacrylate	non-agglomerated/non-aggregated silica filler, non-agglomerated/non-aggregated filler, aggregated zirconia/silica cluster filler, ytterbium trifluoride filler, 76.5 wt%, 58.4 vol%
SDR (DENTSPLY Caulk, Milford, DE, USA)	Low viscosity bulk-fill resin composite	Modified UDMA, Bis-EMA, TEGDMA	Barium-alumino-fluoro-silicate glass, Strontium alumino-fluoro-silicate glass, 68.0 wt%, 44.0 vol%
	Composition		
Single Bond Universal (3 M ESPE, St. Paul, MN, USA)	10-MDP phosphate monomer, Vitrebond copolymer, HEMA, BISGMA, dimethacrylate resins filler, silane, initiators, ethanol, water		
Biodentine (Septodent, Saint-Maur-des-Fosses Cedex, France)	Powder: Tri-calcium silicate, di-calcium silicate, calcium carbonate and oxide filler, iron oxide, zirconium oxide radiopacifier Liquid: calcium chloride acceleratorhydrosoluble polymer water reducing agent.		

Shear Bond Strength (SBS) Test

The polymerized specimens were stored in 100% relative humidity at 37ºC for 24 hours. For SBS testing, the specimens were secured in a holder placed on the platen of the testing machine and then sheared with a knife-edge blade on a universal testing machine (LF Plus, LLOYD Instruments, AmatekInc, UK) at a cross head speed of 1.0 mm/min. SBS in Mpa was calculated by dividing the peak load at failure with the specimen surface area.

Fracture Analysis

Fractured test specimens were examined under a stereomicroscope (Stemi DV4: Carl Zeiss, Gottingen, Germany) at a magnification of 25×. Specimen fractures were classified as follows: cohesive failure within BD or composite, adhesive failure that occurred at the BD-composite interface; or mixed failure when 2 modes of failure happened simultaneously (Table 4). Fracture analysis was performed by a single observer who was completely uninformed about the experimental groups. In figure 1 are shown the adhesive, cohesive and mix fracture pictures.

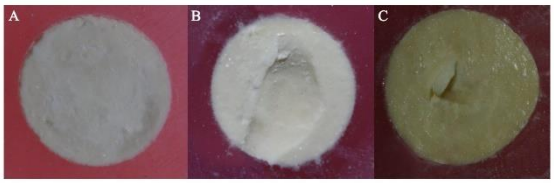

Fig 1. Steriomicroscopic imaging of the failure modes. (A) Adhesive failure (B) Cohesive failure (C) Mix failure.

For the SEM analyses, samples randomly selected from the 12-min, 24-hour and 2 week groups of the failure specimens. The failure surfaces were sputter-coated with gold using a SputterCoater, and specimens were analyzed with an SEM [TESCAN MIRA 3 XMU (Brno, Czech Republic)].

In statistical method, the data, obtained in our study, were loaded with SPSS 22.0 program, and determined by Kolmogorov-Smirnov test whether the data are in normal distribution. In the research, t-test (IndependentSamples t-test) was used in two-group comparisons, yet ANOVA (F) test was more preferable for more than 2 group comparisons to determine any possible differences between groups.

Thereafter, the Tukey HSD multiple comparison test was applied to determine any further differences between the groups. The significance level was set at $p < 0.05$ for all the tests.

RESULTS

In both 2 mm and 4 mm groups of TE, FF, BE, FP, and SDR (Table 2), BFC groups, the fracture values obtained from BD awaited for 12 min, 24 h and 2 w are statistically compared; the difference between the groups of 12 min and 24 h and 2 weeks was statistically significant ($p<0.05$), yet the difference between the groups of BD kept for 24 h and 2 w was statistically insignificant ($p>0.05$). Similarly, effects of thickness differences (2 mm and 4 mm) on fracture values of TE (G1 and 2), FF (G3 and 4), BE (G5 and 6), and SDR (G9 and 10) BFCs

were examined, and the difference between the groups was found to be statistically insignificant ($p>0.05$), while the difference between the FP (G7 and 8) BFC groups was statistically significant ($p<0.05$). (Table 3) All fracture analyzes results are given in Table 4.

Table 3. SBS values [Mean(SD)] between Biodentine and Bulk-fill composites

BD Waiting Time ntervals	G1 (Tetric evo 2mm)	G2 (Tetric evo 4mm)	G3 (FILTEK FLOW 2mm)	G4 (FILTEK FLOW 4mm)	G5 (Beautifil 2mm)	G6 (Beautifil 4mm)	G7 (FILTEK POSTERIOR 2mm)	G8 (FILTEK POSTERIOR 4mm)	G9 (SDR 2mm)	G10 (SDR 4mm)
12 min	5,49(0,69)^{a}	4,31(1,05)^{c}	4,19(1,12)^{e}	3,62(0,99)^{g}	4,79(0,62)^{i}	3,92(0,79)^{k}	7,18(0,67)^{m}	5,91(0,95)^{o}	5,65(82)^{r}	4,93(0,69)^{t}
1 day	9,81(1,25)^{b}	8,95(1,28)^{d}	8,77(1,54)^{f}	7,96(1,43)^{h}	10,31(0,78)^{j}	9,24(1,37)^{l}	14,98(2,22)^{n}	12,68(1,27)^{p}	11,17(1,01)^{s}	10,15(0,60)^{u}
2 w	9,50(1,29)^{b}	9,18(1,09)^{d}	7,89(1,04)^{f}	7,23(1,30)^{h}	9,73(0,93)^{j}	8,76(1,00)^{l}	14,18(1,88)^{n}	11,86(1,44)^{p}	10,84(0,74)^{s}	9,82(0,50)^{u}
Comparison of BFC applications at different (2 mm and 4 mm) thicknesses	p=0.211		p=0.260		p=0.163		*p=0.041		p=0.178	

*Statistically significant difference within in the bottom row ($p<0.05$).
-Shear bond strength values are shown as Mean(SD). All the groups were evaluated separately within themselves and different lower-case letter represents statistical significant difference within each column.

Table 4. Fracture failure types of the groups

Fracture types Total	G1 (Tetric evo 2mm)	G2 (Tetric evo 4mm)	G3 (FILTEK FLOW 2mm)	G4 (FILTEK FLOW 4mm)	G5 (Beautifil 2mm)	G6 (Beautifil 4mm)	G7 (FILTEK POSTERIOR 2mm)	G8 (FILTEK POSTERIOR 4mm)	G9 (SDR 2mm)	G10 (SDR 4mm)
Adhesive=29	1	3	6	4	2	1	3	2	3	4
Cohesive=203	26	21	20	21	25	24	21	21	22	17
Mix=54	3	6	4	5	3	5	6	7	5	9

Figure 2 represents SEM images of BFC after waiting times, 12 min (Fig 2a), 24 h (Fig 2b) and 2 w (Fig 2c).

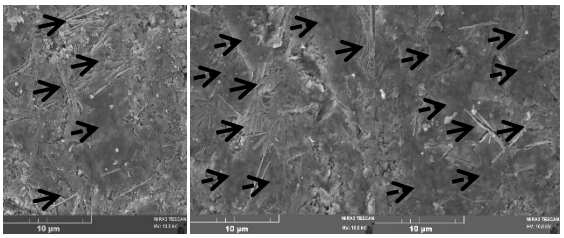

Figure 2. SEM images of Biodentine after waiting times for 12 min.; (a) 12 min., (b) 1 day, (c) 2 week.

As seen from (a) to (c), the polymerizaton increases by cross-linking and surface smoothening. The characteristic polymer surface can be found more at 24 h and 2 w. In Figure 1 (a), the unpolymerized surface is obvious by particle like morphology and some smoothened areas were formed due to the natural quick usability of BD. The unpolymerized regions may be responsible from the low mechanical properties associated with fast degradation for the long term use. The black arrows show the polymerized and crosslinked regions. The smooth areas as seen by dashed arrows decrease the roughness by increasing polymerization time. The unpolymerized regions with high roughness and particle like morphology may also cause faster peeling of the resin and deformation. This may result in differentiation of tooth color and cosmetic problems.

DISCUSSION

Biodentine (BD) contains tri- and dicalcium silicate as parent materials, calcium carbonate as a filler improving its mechanical properties, and zirconium oxide as a radio-opacity provider.[7] BD also has more advanced antibacterial properties and lower cytotoxic effects when compared to MTA.[21] BD has high alkaline pH values which causes an inhibitory

effect on microorganisms; therefore, the alkali environment, formed by BD, provides the disinfection of surrounding hard and soft tissues.[22] In a study related to the biocompatibility of BD, Laurent *et al.*[23] reported that, regardless of concentration, BD did not have a cytotoxic or genotoxic effect on pulp fibroblasts; consequently, did not cause modification in the function of these cells when used as a base material or pulp capping agent. About *et al.*[24] reached to the conclusion that BD stimulates dentin regeneration by inducing odontoblast differentiation from pulp progenitor cells in studies examining the activity of BD on activation, differentiation of pulpal progenitor cells and dentin regeneration in human dental cultures.

BD also has higher microhardness, bending resistance and compressive strength than other calcium silicate-based cements, and more similar physical property to the dentine.[25] Kaup *et al.* [26] reported a statistically significant increase in SBSs values of BD to dentin between the groups of waited 2 and 7 days, yet no statistically significant difference was apparent between the groups of waited 7 and 14 days; Jang *et al.*[27] assessed the hardening times of MTA, Bioaggregate and BD, and compared the compressive strengths after awaited BD for 1, 3 and 7 days; as a result, the groups showed similar compressive strength values which resulted in no statistically significant difference between the groups.

In the study conducted by Kaup *et al.*[26] evaluated the SBSs of BD, ProRoot MTA, GIC and composite resins to dentin on permanent teeth; self-etch (SE) adhesive system was applied to the dentin only in the composite resin group, while no application was performed in the other groups. Samples were separated into different time groups of 2, 7 and 14 days before conducting SBS test, and stored at 37.5 °C in 100% humidity. As a result, among all the materials tested, Pro Root MTA gave the lowest SBS values. A statistically significant increase was observed in the SBS values of BD to dentin between 2 and 7 days. Hashem *et al.*[28] reported that the bond strength values of BD to composite resin at the beginning were lower in the studies that evaluated the microshear bond strength of BD groups which were kept for different durations, and these bonding values reached to the values of conventional glass ionomer cements(GICs) only 24 hours later; therefore, the research stated that BD should be allowed 2 weeks for maturation before the final restoration.

Reported that BD takes the form of a hydrated calcium silicate gel with poor physical-mechanical properties as a result of the initial hardening reaction which lasts approximately 12 minutes, and in this stage hardening occurs only on the surface. Besides, the BD maturation through the crystallization of the calcium silicate hydrate gel texture takes about two weeks; therefore, the material must take at least 2 weeks to achieve final hardening and maximum physical-mechanical properties.[29] However, while considering the results of our study, no statistically significant difference on the SBS values of BFCs between BD, kept for 24 hours and 2 weeks, was found.

Cantekin and Avcı[30] investigated the SBS values between the applications of methacrylate-based composite, silorane-based composite and GIC with different adhesive systems on BD and MTA, where BD samples were kept for 15 min and MTA samples for 96 hours at a 37ºC and 100% humidified medium. As a result, the highest SBS values were found in methacrylate-based composite resin-BD group and the lowest SBS values were observed in the GIC-MTA group. In this study, despite that methacrylate-based composites indicated statistically significant higher SBS values in the group bonded to BD rather than the group bonded to MTA, other restorative materials exhibited similar SBS values when bonded to both BD and MTA. In addition, the methacrylate-based composites showed higher

statistically significant SBSs to BD and MTA than other restorative materials. It is concluded that resin-based composites (methacrylate based) are the best choice of restoration to clinically apply on BD.

SBU, which we used in our study, has been marketed as a new type of adhesive, which is classified as Universal and can be applied with both SE and Etch-and-Rinse (ER) techniques [31]. Reported by the manufacturers that using either bonding techniques does not reduce the bonding efficiency, and these adhesive systems can also be used for the selective acidification of the enamel margins.[32] From a marketing standpoint, the universal adhesives are highly innovative products that offer clinicians freedom of application for use in the ER, SE, or selective enamel etch mode without sacrificing binding effectiveness.[33-36] SBU, used in our study, contains 10-methacryloloxydil dihydrogen phosphate (10-MDP). Universal adhesive, containing 10-MDP, may also reduce the total binding activity by also containing HEMA as a mono functional resin monomer, which competes with 10-MDP for calcium binding, reducing the amount of 10-MDP-Ca bonds.[36] The 10-MDP structure contains a polymerizable methyl-methacrylate group, and a phosphate group responsible for ionic interaction with calcium.[34] Theoretically, 10-MDP may be considered to bind to calcium in BD and provide chemical bonding in addition to micromechanical binding.[28] It is unknown whether a chemical bond is formed between BD and composite resin. However, it has been theoretically stated that the functional monomers (10 MDP, 4-MET) used in the adhesive systems can chemically bond to the calcium in the structure of BD, so that chemical bonding additional to micro-mechanical binding can be established.[26-28] Odabas *et al.*[36] evaluated the dentin bonding strengths of composite to BD groups, awaited for 12 minutes and 24 hours, using total-etch, 2-step SE, and 1-step SE adhesive systems, which showed higher SBS values than the total-etch groups; in addition to these results, the highest SBS values were obtained with 2-step SE adhesive systems in the 24 hour period awaited groups. On a meta-analysis by Rosa *et al.*[35] reported that acid application in mild acidic universal adhesive agent (Single Bond Universal) did not affect dentin bonding strength, and no difference in dentin bonding strength between ER and SE applications was observed.

Hashem *et al.*[28] measured micro-SBSs of composites with BD, GIC and RMGIC, by using SBU adhesive system on the modes of SE and ER models after early (0, 5, 20 minutes and 24 hours) and late (2 weeks, 1 and 6 months) aging of composites. As a result, similar to our work, they reported that the application of the SBU adhesive system by SE and ER methods did not create a statistically significant difference in the micro-SBS values. A statistically significant increase in micro-SBS values was detected in the late aging groups in BD compared to early aging groups, also the highest micro-SBS values were obtained in the 24 hour group. SE adhesive systems; it can be preferred both in terms of time and in practice, since it is easy to apply.

The most common type of fracture in our study was cohesive fracture within BD; Contrarily, the least common fracture type was adhesive fracture. Cohesive fractures in BD show that adhesion forces between composite-adhesive-BD are stronger than the cohesive forces within BD itself. El-Kalla and Garcia-Godoy[37] indicated that cohesive fractures occur more frequently in both dentin and restorative material may be caused by the low internal durability of the material or higher bonding strength than the durability in material.

The breakthrough, observed in our study, shows the fractures being mostly cohesive reflecting the strength of cohesive forces within the BD structure rather than the actual bonding strength between the material and adhesive resin. Declared that the stress distribution between the dentin and composite resin was not

homogeneous due to the use of specimens with large surface area in conventional bonding strength tests, which usually results in the cohesive type failure of the material itself.[38] One of the reasons for the tendency towards cohesive failure observed in our study is assumed to be this non-homogeneous stress distribution.

Flury *et al.*[14] conducted a study using four different BFCs (Tetric Evoceram, Filtek, SDR, x-trafil) and one conventional resin composite (Filtek supreme xt) which were bonded on permanent tooth dentin in different thicknesses (2mm, 4mm and 6mm); subsequently, compared their SBS values. When the results of the study examined, the SBS value differences of BFCs between the thicknesses of 2 mm and 4 mm were not statistically significant ($p > 0.05$). Considering these results, when the bonding strength values of Tetric Evoceram, Filtek, SDR BFCs were evaluated in 2 mm and 4 mm of thicknesses to BD, the difference was statistically insignificant ($p > 0.05$) in our study, as well. Analyzing the results of our study, when connection strengths of FP BFCs in 2 mm to 4 mm were statistically compared, a significant difference was found ($p < 0.05$). Our opinion is that this difference was caused by the difference in content of this BFC.

BD, which has indication in many areas of dentistry, with improved physical properties, short curing time, easy manipulation and good biological properties, can be regarded as a good alternative material for MTA.[39,40] In the direction of data obtained in our study, we came to think that the restoration of the BFC to be placed on the BD material has a positive effect on the bonding strength after awaiting for 24-hour, which may increase the long-term success of the restoration. Furthermore, BFCs could be placed in the cavity with a single step applying 4 mm in thickness with SE technique; reducing the number of steps will be extremely valuable in Pediatric Dentistry, by also reducing the technical sensitivity, duration of application and the risk of saliva contamination especially when working with the children who can not be cooperated. This research was conducted in vitro, which does not provide a possibility to fully reflect the oral environment (occlusal stresses, blood-saliva contamination, etc.) to the study. Therefore, in order to investigate the clinically performance of the BD and BFC materials, in vitro studies must be accompanied and supported by clinical studies. In clinically, we may prefer to use BFC at a height of 4 mm,onto BD with after 1 day of waiting time.

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Doi: 10.7126.cumudj.401248 *RESEARCH ARTICLES*

THE EVALUATION OF THE SURFACE MICRO-HARDNESS VALUES IN DIFFERENT DEPTH OF RESIN BLOCKS

Rezin Blokların Farklı Kesitlerindeki Yüzey Mikrosertlik Değerlerinin Değerlendirilmesi

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ABSTRACT

Objective: The aim of this study was to investigate the polymerization depth and hardness of each 2 mm layer of resin blocks.

Materials and Methods: Two composite resin block materials (Cerasmart, GC Corp., Tokyo, Japan and Lava Ultimate, 3M ESPE, St. Paul, MN, USA) and one hybrid resin block material (Vita Enamic, Vita Zahnfabrik H. Rauter GmbH, Bad Säckingen, Germany) were included in the present study. Using a diamond saw (Exakt 300 cl Apparatebau, Norderstedt, Germany), 10×10×2 mm blocks were prepared from the upper surface to the lower surface, under water-cooling. All specimens were abraded by using 500,1200,2500 grid SiC abrasive papers (Exakt 400 cs Apparatebau, Norderstedt, Germany), under water-cooling. After storage in distilled water at 37 °C for 24 hours, Knoop hardness test was performed using a hardness testing machine (Buehler MMT 3 digital micro hardness tester, Lake Bluff, IL, USA) (500 gf, 10s).

Results: There was a statistically significant difference between the materials in terms of surface hardness ($p<0.05$). The highest hardness value was obtained on Vita Enamic block, whereas the lowest group was the Cerasmart. The surface hardness values were Vita Enamic> Lava Ultimate >Cerasmart, respectively. No difference was found among slices of 2 mm thickened specimens of each material's blocks ($p>0.05$)

Conclusion: The hardness measurements of the layers of blocks were similar.

Key Words: CAD/CAM, composite resin blocks, microhardnes

ÖZ

Amaç: Bu çalışmanın amacı rezin blokların 2 mm'lik her katmanındaki polimerizasyon derinliklerinin ve sertliklerinin araştırılmasıdır.

Gereç ve Yöntemler: Mevcut çalışmada iki farklı marka kompozit rezin blok (Cerasmart, GC Corp., Tokyo, Japoya ve Lava Ultimate, 3M ESPE, St. Paul, MN, ABD) ve bir hibrit rezin blok (Vita Enamic, Vita Zahnfabrik H. Rauter GmbH, Bad Säckingen, Almanya) kullanıldı (n=5). Bir elmas testere ile su soğutması altında (Exakt 300 cl Apparatebau, Norderstedt, Almanya) blokların üst yüzeyinden alt yüzeyine doğru 10×10×2 boyutlarında horizontal kesitler alındı (Exakt 300 cl Apparatebau, Norderstedt, Almanya). Örnekler su altında sırasıyla 1000, 1500, 2500 grit zımpara kullanılarak polisajlandı (Exakt 400 cs Apparatebau, Norderstedt, Almanya). Örneklerin Knoop yüzey sertlik ölçümü 37° C'lik distile suda 24 saat süreyle bekletildikten sonra bir mikrosertlik test cihazı (Buehler MMT 3, Lake Bluff, IL, ABD) kullanılarak yapıldı (500 gf, 10s).

Bulgular: Materyallerin sertlik ölçümleri arasında istatistisksel olarak anlamlı bir fark vardır ($p<0,05$) En yüksek sertlik değeri Vita Enamic blok, en düşük Cerasmart materyalinde ölçülmüştür. Yüzey sertliğinin derecesi sırasıyla Vita Enamic> Lava Ultimate >Cerasmart şeklindedir. Bloklarının 2 mm kalınlığındaki kesitleri arasında fark bulunmadı ($p> 0,05$).

Sonuç: Blok katmanlarının sertlik ölçümleri benzerdir. Blokların tüm katmanları, oklüzal kuvvetlere karşı koyacak kadar serttir.

Anahtar Kelimeler: CAD/CAM, kompozit rezin blok, mikrosertlik

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INTRODUCTION

Dental materials are widely used in all areas of routine dental practice. There are mainly two methods for their application Firstly, dental biomaterials are placed into living tissues, such as teeth, to fill the space. Furthermore inlay, onlay, crown and bridge restorations are manifactured using a variety of materials to recover the morphology and functioning of the teeth.

These materials can be dissolved by the saliva and they may also have cytotoxic potential due to residual monomers after curing.

During the last decade, a remarkable increase has been seen in the use of computer–aided design and manufacturing (CAD/CAM) in dentistry. For this purpose, various methods have been developed to obtain ceramic and polymer or composite resin hybrid materials.

These commercial dental CAD/CAM blocks have been frequently used to utilize single step restorations in dentistry. Two main types of esthetically pleasing CAD/CAM processed dental materials were used for indirect dental restorative purposes; glass-ceramic/ceramics and resin composites.

Although glass-ceramics/ceramics blocks have some advantages such as aesthetic appearance (attractiveness), biocompatibility, low fracture toughness, high resistance to failure against different chemicals, but have some disadvantages such as high stiffness and low strength to chewing force.[1,2,3]

Single tooth restorations produced using ceramic materials showed an overall failure rate of approximately 22% after 4 years in service.[4] Dense ceramics are characterized by high hardness and wear resistance values; however, they cannot withstand elastic deformation because of their Young modulus, which is higher than dental tissues.[5] According to a recent studies using this ceramic materials indicated a flexural strength of greater than 100 MPa, obtained with a three point bending test.[6,7] The obtained flexural strength value is higher than the critical value proposed by International Organization for Standardization (ISO) 6872 for single unit restorations.[8]

Resin blocks have a higher modulus of resilience than ceramic blocks therefore they cause less wear on the opposing teeth.[9,10] Moreover, due to the young modulus of resin blocks are closer to dentin, the risk of fracture and chipping is lower.[1,9-12] Additionally, they are easier to repair and polish than glass-ceramics.[13-17] Industrial production of these blocks under high temperature and high pressure has led to a higher conversion degrees (85%) and higher volume fraction filler.[5,18,19]

These high-density polymer resin blocks are polymerized under controlled and standardized industrial conditions with high pressure and high temperature. The production and structure of resin blocks are different and they are polymerized under different temperature and pressure condition.[20] Vita Enamic is composed of a porous ceramic network (86%), which is then infiltrated with a polymer by capillary action. Hybrid blocks containing nanoceramic particles bound in the polymeric matrix either nanofillers (Lava Ultimate; 3M ESPE, St. Paul, MN, USA) or nanohybrid fillers (Cerasmart; GC Corp., Tokyo, Japan).

The polymerization of resin composite material under HP/HT (High Pressure/High Temperature) resulted with superior properties in comparison with those of their photo-polymerized counterparts in vivo conditions. Curing depth of composite resins intraoral are limited, no greater than 2 mm thick should be placed to ensure complete polymerization. the depth of cure of the composite resins affect the composition of residual monomers and their surface hardness.[21]

In most CAD / CAM systems restorations can be produced from prefabricated blocks by milling using bur, only diamond or diamond

discs. In this technique, 90% of the blocks are removed to achieve the desired restoration scheme. Different depth of layers of the resin blocks are used during to produce a restoration.

In this study the null hypothesis was there would be no significant differences in the surface hardness of different depth of various CAD/CAM composite resin blocks fabricated under HP/HT conditions.

MATERIALS AND METHODS

Two composite resin block materials and one hybrid resin block material were included in this study. The CAD/CAM block materials evaluated in this study were Cerasmart (CER; GC Corp., Tokyo, Japan; A3 LT/14), Lava Ultimate (ULT; CAD-CAM restorative; 3M ESPE, St. Paul, MN, USA; A3-HT/14L) and Vita Enamic (VIT; Vita Zahnfabrik H. Rauter GmbH, Bad Säckingen, Germany; A3C/I14) (Table 1).

Table 1: Materials tested and their compositions.

Type	Brand	Code	Manufacturer	Shade/Size	Monomer	Filler Composition	Fillerwt (%)
Composite resin block	Cerasmart	CER	GC Corp., Tokyo, Japan	A3 LT/14	Bis-MEPP, UDMA, DMA	Silica (20 nm), barium glass (300 nm)	71
Composite resin block	Lava Ultimate	ULT	3M ESPE, St. Paul, MN, USA	A3-HT/14L	Bis-GMA, UDMA, Bis-EMA, TEGDMA	SiO2 (20 nm), aggregated SiO2-Al2O3-ZrO2 (200–600 nm) cluster (1–6 µm)	80
Hybrid ceramic block	Vita Enamic	VIT	Vita Zahnfabrik H. Rauter GmbH, Bad Säckingen, Germany	A3C/I14	UDMA, TEGDMA	Feldspar ceramic enriched with aluminum oxide	86

Bis-GMA: Bisphenol A diglycidylether methacrylate; UDMA: Urethane dimethacrylate; Bis-EMA: Bisphenol A polyethethylene glycol diether dimethacrylate; TEGDMA: Triethylene glycol dimethacrylate; Bis-MEPP:2,2-Bis (4-methacryloxypolyethoxyphenyl) propane;

Square specimens (n=5/material) of approximate dimensions 10×10×2 mm blocks were sectioned (5 slices/block) from commercially available CAD-CAM materials using a diamond saw (Exakt 300 cl Apparatebau, Norderstedt, Germany) with water cooling. All specimens were abraded followed by 500, 1200, 2500 grid using SiC abrasive paper (Exakt 400 cs Apparatebau, Norderstedt, Germany). After storage in distilled water at 37 °C for 24 hours the Knoop hardness test was performed using a hardness testing machine (Buehler MMT 3 digital micro hardness tester, Lake Bluff, IL, USA) using a load of 500 gf and a loading time of 10s. The hardness of different depth of 2 mm thickened slices of evaluated materials was measured for each of 5 repeated blocks and nine indentations were applied in specific locations for each slice (Fıgure 1).

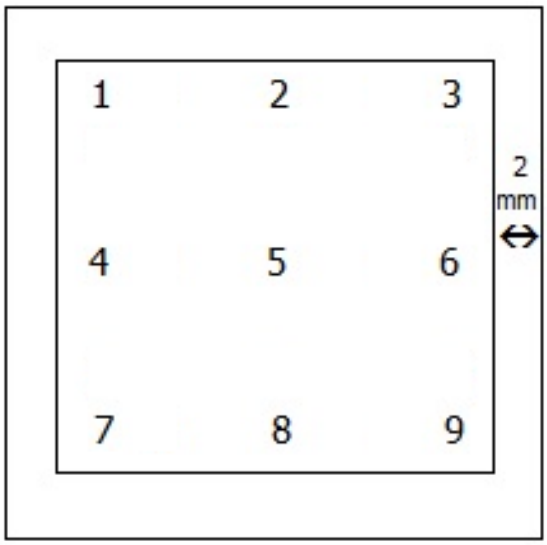


Figure 1: Indentations for each slice

Statistical analyses

Statistical analyses were performed using SPSS v. 21.0 (IBM Corp., Armonk, NY, USA). The normality assumption for micro-hardness data tested by using Shapiro-Wilk test, the assumption was not confirmed. Therefore, the non-parametric Kolmogorov-Smirnov test was conducted to evaluate micro hardness of materials and also different slices of blocks. Adjusted pairwise comparisons were further performed to evaluate inter-group differences among groups with value of statistical significance α=0.05. The mean values, standard deviations, medians, and minimum, maximum values of materials and five slices of each material were given as descriptive statistics.

RESULTS

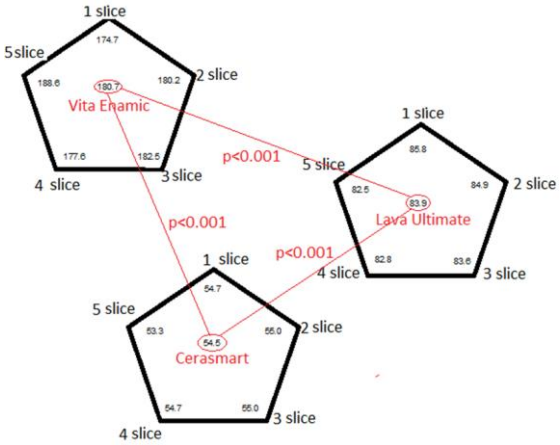
The highest hardness value was obtained from Vita Enamic block material, while the lowest was obtained from the Cerasmart. The obtained values were shown in Table 2.

Table 2: Descriptive Statistics for hardness

CAD/CAM Material	N	Mean	Std. Deviation	Median*	Min	Max
Cerasmart	225	54.5	4.1	54.1[a]	43.7	71.6
Vita Enamic	225	180.7	29.1	176.0[b]	122.7	295.7
Lava Ultimate	225	83.9	6.6	83.2[c]	69.5	113.2

*Identical superscript letters indicate that are not significantly different (Adj. Sig; p>0.05)

The post hoc test revealed a significant difference among all the tested materials (p<0.05) with the following ranking: Vita Enamic> Lava Ultimate> Cerasmart. No difference was found among slices of 2 mm thickened specimens of each material's blocks (p>0.05) (Graph 1).



Graph 1: Clustring groups and descriptive Statistics of the hardness of different depth of 2 mm thickened slices of Vita Enamic, Lava Ultimate and Cerasmart

DISCUSION

The surface hardness testing is useful for evaluating the properties of composites in relation to the depth of polymerization.[22,23,24]

Brinell, Knoop, Barcol, Rockwell and Vickers are the most commonly used test methods for surface hardness measurements of composite resin based restorative materials used in dentistry. The choise of the hardness test to be applied depends on the materials and the hardness value expected from the material.

Knoop hardness test is the most commonly used method for evaluating polymeric materials, such as resin composites, because it uses a rhombic diamond tip and reduces the effect of elastic recovery after removal of the tip.[25] For this reason we have decided to use the Knoop hardness test to determine the hardness of CAD/CAM composites.

Vita enamic has the highest hardness value due to the both filler amount and ceramic content. Lava ultimate and cerasmart contain similar components but the content of inorganic fillers is approximately 80% in Lava Ultimate and 71% in GC cerasmart.

The hardness is measured higher than cerasmart because of the filler content of the Lava ultimate. Hardness order is similar in other studies, conducted with the materials used in the present study.[26,27,28] But it is unclear from which region the hardness test was conducted in these studies.

In the present study, although there is no statistical difference, hardness values are different in different layers of the same block. (P>0.05). The null hypothesis is accepted. There isn't significant differences in the surface hardness of different depth of various CAD/CAM composite resin blocks. When the SEM images of the conducted studies are taken into account, the filler and ceramic distributions and shapes of the resin blocks are not homogenous, so the hardness results may vary in different regions of the blocks.[25,28] These results shows that the hardness is not only affected by the inorganic filler content but also by the filler size, the filler form and the polymeric matrix.

Knoop hardness test method are used to evaluate the bright and smooth surface specimens. Therefore, the hardness measurements of the specimens were not performed on the top layer of the resin blocks because of their roughness in the present study.

In the Lava Ultimate groups, a cloud-like shadow formed around the rhombic diamond on the microscopic image.

It is estimated that this view is due to fracture of feldspar ceramic filler. It is thought that these ceramic fillers have increased

hardness but also increased in the possibility of fracture and chipping.

Lack of this study no thermocycling done in the samples. If the thermocycling was done, the results could be different from the samples with more water absorption.

CONCLUSION

The hardness measurements of the layers of blocks were similar. All layers of blocks are hard enough to resist defamation by occlusal forces.

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Doi: 10.7126/cumudj.428957 *RESEARCH ARTICLES*

ULTRASONOGRAPHIC EVALUATION OF MANDIBULAR ELEVATOR MUSCLES TO ASSESS EFFECTS OF ATTRITION-TYPE TOOTH WEAR ON MASTICATORY FUNCTION

Atrizyon Tipi Diş Aşınmasının Çiğneme Fonksiyonu Üzerine Etkisini İncelemek Amacıyla Mandibular Elevator Kasların Ultrasonografik Değerlendirilmesi

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ABSTRACT

Objectives: Occlusal alterations may result in changes in the functional performance of masticatory muscles. This study was planned to evaluate mandibular elevator muscles of patients with dental attrition by using ultrasonography (USG).

Materials and Methods: 30 physiologically dental attrition subjects, aged 35–65 years, were clinically examined by tooth wear index (TWI). Patient group (TWI scores of 2–4) and age-matched controls (TWI scores of 0–1) underwent ultrasonographic analysis to assess the thickness of anterior temporalis, superficial masseter muscles, bilaterally, during clench and rest positions.

Results: The mean thickness of masseter and temporal muscles for rest and clench positions and the ratio between thickness of clench and rest position (C/R) were evaluated. Muscle thickness had a higher mean value in the tooth wear group. However, the only significant differences were in the C/R ratio for left side of masseter (p=0.04) and temporal muscles (p=0.03). Although, there was a negative correlation between TWI scores and the muscle C/R ratio for the tooth wear group. A significant positive correlation was found between age and TWI in both groups.

Conclusion: The contraction capacity of the chewing muscles and the attrition mutually interact. This study showed an associate on between the severity of occlusal tooth wear and the C/R of chewing muscles. Although dental attrition can occur due to increased jaw muscle activation, and it can also cause a reduction in the contraction capacity of mandibular elevator muscles.

Keywords: Attrition, masticatory muscle, masseter muscle, ultrasonography**.**

ÖZ

Amaçlar: Okluzal değişiklikler çiğneme kaslarının fonksiyonel performansında değişikliklere neden olabilir. Bu çalışma ultrasonografi (USG) ile dental atrizyonu olan hastaların mandibular elevator kaslarını değerlendirmek amacıyla planlanmıştır.

Gereç ve Yöntemler: 35–65 yaşları arasında 30 adet fizyolojik atrizyonu olan hasta, diş aşınma indeksi (TWI) kullanılarak klinik olarak incelendi. Hasta grubu (2–4 TWI skorları) ve yaş eşleştirilmiş kontroller (0–1 TWI skorları), anterior temporal ve yüzeysel masseter kaslarının, bilateral olarak, diş sıkma ve dinlenme pozisyonları sırasında kalınlığını değerlendirmek amacıyla ultrasonografik analizi yapıldı.

Bulgular: Dinlenme ve diş sıkma pozisyonları için masseter ve temporal kasların ortalama kalınlığı ve diş sıkma ile dinlenme pozisyonu (C / R) arasındaki oran değerlendirildi. Kas kalınlığı, atrizyon grubunda daha yüksek bir ortalama değere sahipti. Bununla birlikte, tek anlamlı fark masseter kasın sol tarafında C / R oranında (p = 0,04) ve temporal kaslarda (p = 0,03) bulundu. Bununla birlikte, TWI skorları ile atrizyon grubu için kas C / R oranı arasında negatif bir korelasyon vardı. Her iki grupta yaş ve TWI arasında anlamlı pozitif korelasyon bulundu.

Sonuç: Çiğneme kaslarının kasılma kapasitesi ve atrizyon karşılıklı olarak etkileşmektedir. Bu çalışmada, okluzal diş aşınmasının şiddeti ile çiğneme kaslarının C/ R' si arasında ilişki bulunmuştur. Çiğneme kaslarının aktivitesinin artması nedeniyle atrizyon meydana gelebilir ve bu da mandibular elevatör kasların kasılma kapasitesinde azalmaya neden olabilir.

Anahtar Kelimeler: Atrizyon, çiğneme kası, masseter kası, ultrasonografi.

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INTRODUCTION

The masticatory apparatus is a very complex mechanism comprising the jaw bones, muscles, ligaments and teeth. If any one component in this mechanism should fail, it can cause harmful complications in other components.[1] Tooth wear is regarded as the loss of dental hard tissue due to chemical and/or mechanical factors without bacterial activity.[2] It is a multifactorial, complex phenomenon consisting of three basic mechanisms: abrasion, erosion and attrition. Abrasion is the pathological wear of dental structures by extreme mechanical irritation. Erosion involved the loss of tooth surface by way of electrochemical or chemical activity.[3] Attrition is generally a primary physiological adjustment mechanism of masticatory functions caused by friction between reciprocal tooth surfaces or restorations. Attrition is thought to be irreversible and progressive; and should be anticipated as a part of the natural ageing process.[4] Nevertheless, attrition remains the most frequent kind of tooth wear.[5] When attrition sets in, left untreated, it can result in the total breakdown of the masticatory system.[6,7]

Some etiological factors of tooth wear as follows: abnormal occlusal strengths, premature contacts in occlusion, bruxism, excessive loading of the teeth and hyperactivity of the masticatory muscles. Attrition-related tooth wear commonly affects the jaw elevator muscles, reducing the strength of contraction and disturbing their functional efficiency.[8] Therefore, it is essential to understand the morphological and functional muscle changes in subjects with severe attrition-related tooth wear.

MRI and CT scanning are the most widely used techniques to measure jaw muscle cross-sectional thickness and volumes. CT scanning, however, shows only cumulative biological effects, while MRI has only limited use because of its cost and availability.[9-11] Concerning the structural examination of muscles, ultrasonography (USG) has been shown to be beneficial in the confirmation of structural deviations in muscle tissue, such as hypertrophy, muscular contracture, injury and alterations in superficial soft tissue.[12,13] The technique is non-invasive, simple, reproducible, low cost, easily accepted by patients and uses non-ionized radiation.[14] In previous studies performed by using USG, positive correlations were reported between USG thickness values of the masseter muscle and the magnitude of bite force. Therefore, USG is an essential tool for analysing the functional efficiency of jaw elevator muscle contraction during dental clenching by measuring muscle thickness.[15]

To investigate the adaptive changes in the masticatory muscles of cases with attrition-related tooth wear, a study was planned to determine jaw elevator muscle thickness during clench and rest and to calculate Clench/Rest ratio of the muscles (defined as 'contraction activity') by USG in mature age groups with dental attrition and controls.

MATERIALS AND METHODS

The data was collected in the Department of Dentomaxillofacial Radiology at the Dentistry Faculty of Erciyes University from patients who applied to the oral diagnosis clinic for routine clinical examination in 2016, while conforming to the criteria of The Helsinki Declaration, ICH *Guideline for Good Clinical Practice*. Informed consent was obtained from each subject at the initiation of the study prior to confirmation of their suitability for the study. The subjects were free to withdraw from the study at any time and for any reason without prejudice. The protocol was approved by the Local Ethical Committee of the Erciyes University (protocol no 2016/585).

Inclusion and exclusion criteria of the experimental and control groups

Thirty patients with severe tooth wear and exposed occlusal dentine, 20 women and 10 men (mean age=46.7±11 years), comprised the experimental subject. Two oral radiologists

(DGB and FA; with 4 years of experience) were made that clinical examination. In an effort to classify the severity of tooth wear, the Tooth Wear Index (TWI) of Smith and Knight was used[16]:

0; No loss of enamel surface characteristics on the buccal, lingual occlusal, incisal and cervical surfaces (B/L/O/I/C).

1; Loss of enamel surface on the B/L/O/I and minimal loss of cervical contour

2; Loss of enamel exposing dentin for less than one third of the B/L/O/I, loss of enamel just exposing dentine on the incisal surface and defect less than 1 mm depth on the cervical surface.

3; Loss of enamel exposing dentine for more than one third of the B/L/O, loss of enamel and substantial loss of dentine, but not exposing pulp or secondary dentine on the incisal surface and defect less than 1-2 mm depth on the cervical surface.

4; Complete loss of enamel, pulp exposure and exposure of secondary dentine on the B/L/O, pulp exposure or exposure of secondary dentine on the incisal surface, defect more than 2 mm depth, pulp exposure or exposure of secondary dentine on the cervical surface.

Patients with tooth wear levels TWI 2-4 were included in the (TW) group. Subjects in the study needed to satisfy the following criteria for inclusion:

1. The presence of widespread advanced occlusal surface tooth wear with multiple sites of exposed occlusal dentine and/or pulp (TWI on occlusal/incisal surface 2–4), but normal buccal, lingual and cervical surfaces.
2. The presence of at least one tooth with reciprocally normal occlusion in posterior groups (each premolars and molars region) of both sides (at least 10 teeth/arch in total).

Subjects were excluded from the study on the basis of the following criteria:

1. Patients with parafunctional activities (e.g. bruxism, according to patient anamnesis and clinical examination).
2. Patients with unilateral chewing (patient anamnesis, presence of unilateral painful caries cavitation inhibiting chewing at this side, unilaterally missing posterior teeth).
3. Prior prosthetic treatment in which more than one tooth was restored.
4. Patients presenting with more than one tooth in dire need of repair or with deep caries cavitation.
5. Absence of canine teeth for canine-protected occlusion.
6. Unhealthy adults with chronic medication use that would affect muscular tension, oral micro flora or salivary flow rate.

Age–gender matched controls equalled the number experimental subjects (mean age =47.7±10 years), with the same inclusion and exclusion criteria, although without signs of advanced tooth wear (TWI 0–1, no wear on buccal, lingual or cervical surfaces). Two groups were similar for dentition status and number of teeth. All subjects underwent clinical examination involving the exploration of occlusal surface integrity and observation of the amount of exposed occlusal surface dentine in order to establish whether they satisfied both the inclusion and exclusion criteria.

Principles of the ultrasonography

The thicknesses of the masseter (Fig 1) and anterior portion of the temporalis (Fig 2) were assessed bilaterally by ultrasonography (Aplio 500 ToshibaTM, Otawara, Japan; 7-18 MHz linear transducer), and measures were taken directly over the image at the moment of its acquisition, with an approximation of 0.1 mm. The locations analysed by USG were determined by palpation[17,18], asking the subjects to clench their teeth with maximal effort in accordance with the following orientations: masseter, a level halfway between the zygomatic arch and gonial angle; and anterior portion of the temporalis muscle, in front of the anterior border of the hairline.[19]

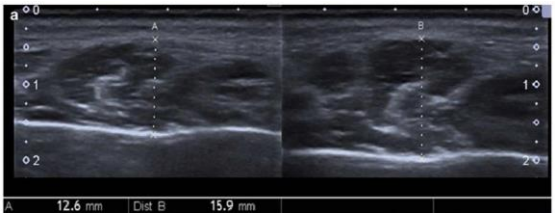

Figure 1. The measurements of masseter muscles during rest and clench.

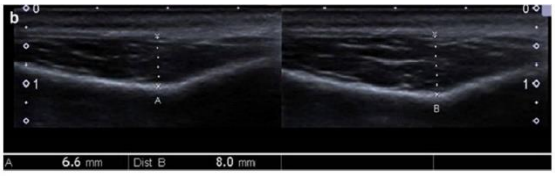

Figure 2. The measurements of temporal muscles during rest and clench.

Throughout the records, the probe was positioned perpendicular to the direction of the muscle fibres. An airtight inert gel was applied on the skin surface and the transducer was moved until optimized images had been obtained. The examination was made with the muscles resting (i.e. relaxed) and in the maximum intercuspal position (i.e. maximum clenching) for both left and right sides. During the examination, the subject remained seated, relaxing against the backrest with their head unrestricted. The muscle thickness was measured from the widest part of the muscles. On the USG image, the distance between the most inner surface and the outermost surface of the muscles was measured. [12] All the examinations were carried out by the same person (GO; oral radiologist experienced on USG imaging for 2 years). Three acquirements were performed in each muscle situation (relaxed and maximum clenching), with an interval of 2 min between each acquirement for the subjects to rest their muscles after dental clenching. The thickness of each side was estimated as the mean value of the three repetitions.

Statistical analyses

Statistical analyses were conducted with SPSS for Windows SPSS® v. 16.0 (IBM Corp., New York, NY; formerly SPSS Inc., Chicago, IL). The measurements were evaluated using the independent and paired samples t-test to compare the means of all values between patients and controls. Values of $p<0.05$ were considered to indicate statistical significance.

RESULTS

There were 60 subjects enrolled in the study: 30 subjects presenting with severe attrition-related tooth wear and 30 controls. Groups comprised same number of females (*n*=20) and males (*n*=10). Patient and control groups did not differ by age. Table 1 presents the distribution of subjects according to age, gender and TWI scores in both patients with tooth wear and control groups. Among the subjects included in this study, the most frequent tooth wear score was TWI-2 (40%).

Table 1: The distribution of subjects according to age, gender and TWI scores.

subjects	Tooth wear			Control		
	mean age	TWI 2	TWI 3	mean age	TWI 0	TWI 1
Male (n=10)	45.1	8	2	44.2	3	7
Female (n=20)	47.5	16	4	49.4	11	9
Total	46.7	24	6	47.7	14	16

Masseter and temporal muscle thickness during rest and clench positions and the C/R thickness ratio was evaluated. The mean values and standard deviations of these thickness, rates and comparisons of patients and controls are illustrated in Table 2 according to gender. Mean muscle thickness values were higher in the tooth wear group. However, significant differences were only found in C/R ratio for the left side of the masseter (*p*=0.04) and temporal muscles (*p*=0.03). Among females, there were significant differences in right masseter muscle thickness during clench and the C/R ratio for left masseter muscle. Furthermore, significant differences were found in the C/R ratio for the right side of masseter and left side of the temporal muscles in males.

Table 2. The mean value of masseter and temporal muscles during rest and clench and clench/rest ratio according to gender with corparisons between groups

muscle	position	gender	Right			Left		
			Tooth wear	Control	*p* value	Tooth wear	Control	*p* value
Masseter	Relax	Male	11.06 ± 0.17	10.11 ± 1.88	0.13	12.24 ± 1.52	12.85 ± 0.94	0.29
		Female	10.04 ± 2.27	9.41 ± 0.96	0.26	10.2 ± 2.4	10.5 ± 1.68	0.65
		Total	**10.38 ± 1.90**	**9.64 ± 1.35**	**0.91**	**10.88 ± 2.33**	**11.2 ± 1.84**	**0.46**
	Clench	Male	13.88 ± 0.57	14.69 ± 2.7	0.36	15.5 ± 1.07	15.86 ± 1.79	0.59
		Female	14.16 ± 2.42	12.87 ± 1.21	0.04*	14.1 ± 2.32	13.56 ± 1.97	0.43
		Total	**14.07 ± 1.99**	**13.48 ± 2.00**	**0.25**	**14.56 ± 2.08**	**14.32 ± 2.18**	**0.66**
	Clench/Relax	Male	1.55 ± 0.04	1.45 ± 0.07	<0.001*	1.27 ± 0.08	1.23 ± 0.06	0.19
		Female	1.42 ± 0.14	1.37 ± 0.1	0.17	1.4 ± 0.12	1.29 ± 0.09	0.004*
		Total	**1.47 ± 0.14**	**1.40 ± 0.10**	**0.38**	**1.36 ± 0.12**	**1.27 ± 0.09**	**0.04***
Temporal	Relax	Male	7.26 ± 0.68	7.02 ± 0.74	0.46	7.38 ± 1.12	7.21 ± 1.12	0.574
		Female	7.15 ± 1.42	7.12 ± 0.41	0.92	7.91 ± 1.73	7.78 ± 0.83	0.76
		Total	**7.19 ± 1.21**	**7.09 ± 0.53**	**0.68**	**7.73 ± 1.56**	**7.59 ± 0.96**	**0.67**
	Clench	Male	8.2 ± 0.96	8.16 ± 0.45	0.9	8.3 ± 1.15	8.74 ± 1.03	0.38
		Female	8.27 ± 1.72	8.05 ± 0.44	0.57	8.77 ± 1.97	8.93 ± 1.4	0.77
		Total	**8.25 ± 1.49**	**8.08 ± 0.44**	**0.56**	**8.61 ± 1.73**	**8.86 ± 1.27**	**0.52**
	Clench/Relax	Male	1.22 ± 0.07	1.16 ± 0.08	0.26	1.23 ± 0.11	1.18 ± 0.06	0.04*
		Female	1.25 ± 0.07	1.13 ± 0.06	0.27	1.25 ± 0.09	1.21 ± 0.07	0.23
		Total	**1.23 ± 0.77**	**1.13 ± 0.71**	**0.87**	**1.24 ± 0.09**	**1.19 ± 0.08**	**0.03***

Table 3 illustrates a left–right comparison in patients with tooth wear according to gender. The mean left muscle thickness values in both genders were higher than for the right. Significant differences were found in thickness between rest (p=0.01) and clench positons (p=0.04) for the temporal muscles between both sides. Furthermore, there were significant differences in the thickness of the masseter muscles in males and temporal muscles in females (p<0.05).

Table 3. The mean value of masseter and temporal muscles thickness of tooth-wear group during rest and clench and clench&rest ratio according to gender with comparisons between sides

muscles	***position***	**Right**	**Left**	***p* value**
Masseter	**Relax**	10.38 ± 1.90	10.88 ± 2.33	0.12
	Clench	14.07 ± 1.99	14.56 ± 2.08	0.17
	Clench/Relax	1.37 ± 0.14	1.36 ± 0.12	0.75
Temporal	**Relax**	7.19 ± 1.21	7.73 ± 1.56	0.01*
	Clench	8.25 ± 1.49	8.61 ± 1.73	0.04*
	Clench/Relax	1.14 ± 0.77	1.11 ± 0.09	0.25
side	***position***	**Masseter**	**Temporal**	***p value***
Right	**Clench/Relax**	1.37 ± 0.14	1.14 ± 0.77	<0.001*
Left	**Clench/Relax**	1.36 ± 0.12	1.11 ± 0.09	<0.001*

A gender comparison of mandibular elevator muscles' thickness during rest and clench positions and TWI scores are can be found in Table 4. Statistically significant differences were found in the C/R ratio for both left and right sides of the masseter muscles for males and females in the tooth wear group (p<0.05). Although, there were significant differences between the genders in the control group for left and right masseter muscle thickness during clench, there were no such significant differences in the patient group. In addition, there was a significant difference in TWI scores between males and females in the tooth wear group (p<0.001).

Table 4: The p value of masseter and temporal muscles and TWI scores for males and females during relax and clench position and clench/relax ratio and also comparisons between genders.

muscles	*positions*	*gender*	Right		Left	
			Tooth wear	Control	Tooth wear	Control
			p value	*p* value	*p* value	*p* value
Masseter	**Relax**	*Male*	0.17	0.18	0.02	<0.001*
		Female				
	Clench	*Male*	0.71	0.01*	0.08	0.004*
		Female				
	Clench/ Relax	*Male*	0.001*	0.05	0.006*	0.06
		Female				
Temporal	**Relax**	*Male*	0.82	0.62	0.38	0.12
		Female				
	Clench	*Male*	0.9	0.53	0.48	0.7
		Female				
	Clench/ Relax	*Male*	0.37	0.17	0.53	0.07
		Female				
TWI			**Tooth wear**	***p* value**	**Control**	***p* value**
		Male	2.6 ± 0.51	<0.001*	0.40 ± 0.51	0.31
		Female	2 ± 0		0.60 ± 0.5	

*correlation is significant at the 0.01 level (2-tailed)

Table 5 presents the correlation between TWI scores and C/R ratios for the mandibular elevator muscles. The negative correlation between C/R ratio of masseter muscles of patients with tooth wear and TWI scores were significant. There was no significant correlation in the control group. Table 5 also illustrates the significant positive correlation between age and TWI in both groups.

Table 5.The correlation values of TWI scores with clench/rest ratio of muscles and age

variable	*side*	TWI	
		Tooth wear	**Control**
Masseter (C/R)	**right**	-0.420*	-0.023
	left	-0.425*	-0.148
Temporal (C/R)	**right**	-322	-117
	left	-296	-312
age		0.623*	0.562*

*correlation is significant at the 0.05 level (2-tailed)

DISCUSSION

Attrition-related tooth wear is a visible sign of physiological functional tooth wear. Such functional tooth wear is usually apparent by means of functional distortion in the masticatory system because increased muscular functioning causes increased tooth wear.[1] At the same time, progressive tooth wear also changes the occlusion itself, thus affecting muscular

functions.[8] Therefore, understanding the functional and morphological changes in the masticatory muscles of patients with attrition-related tooth wear is important for understanding alterations in the masticatory apparatus of dental attrition cases.

Attrition-related tooth wear occurs as a natural result of the ageing progress.[3] The present study found a significant positive correlation between TWI scores and age in both experimental and control groups. This result is compatible with the findings of Oginni *et al.*[20] and Yadav[1], Seligman *et al.*[21], Egermark-Ericksson[22], Richmond *et al.*[23], but Clark *et al.*[24] did not find any relationship between age and degree of attrition. In the present study, it was also found that males had higher attrition scores than females. This result is consistent with those of Oginni *et al.*[20]

With advanced tooth wear, the number of occlusal contacts has a tendency to occur larger in maximum intercuspation. As tooth wear increases, the occlusal surface of the related tooth can become completely flat. Flat tooth surfaces, therefore, expose a larger area to occlusal contacts. In this position, the mandibular elevator muscles must be capable of generating maximal masticatory strength. According to Oginni *et al.*[20], if the tooth wear becomes more severe, the stain and stress on the masticatory muscles and TMJ during chewing increases. In accordance with this, Bakke [25] reported a significant positive correlation between strength generated during chewing and the number of occlusal contacts. This result supports the outcome of this study that the mean thickness value of muscles during clench is higher in tooth-wear group.

There are studies in the literature showing that USG can be used to determine muscle activity. In the study of Andrade *et al.*[26] EMG activity and muscle thickness with real-time USG of masseter and anterior temporalis muscles in children was recorded. A positive correlation was found between the ultrasonographic thickness of the masseter muscle and the EMG amplitude. Strini *et al.*[27] evaluated the maximal bite force, EMG and muscle thickness of the masseter, temporalis and sternocleidomastoid muscles of patients with temporomandibular joint diseases and compared the three methods. The results of three methods were similar to the controls and TMD patients and the authors suggest that USG can also be used to assess muscle activity. Georgiakaki *et al.*[28] found a strong association between the average muscle mass of the masseter muscle and mean EMG activity and stated that USG could be used as a tool for assessing masseter muscle functional capacity through full effort in healthy individuals.

The findings of this study suggest that the thickness of the chewing muscles increases with tooth wear, but contraction activity (C/R ratio) is not affected positively due to tooth wear. We found a negative correlation between TWI scores and C/R ratio of masseter muscle. In accordance with the results of the present study, in a study conducted with EMG Sierpinska *et al.*[8] stated that mandibular elevator muscles demonstrate significantly inferior muscular activity at maximal clench in advanced tooth wear patients as compared to healthy controls; although the reasons for this were not clear. They also found a significant negative correlation between elevator muscle activity and TWI.

CONCLUSIONS

During clinical examination, patients presenting with numerous teeth with advanced tooth wear will likely also have increasingly thick chewing muscles due to the increased contraction necessary to maintain active mastication. On the other hand, the findings of this study show a reduction in the C/R ratio of muscles with increased TWI scores. The findings of this study indicate that advanced attrition-related tooth wear in mature adults limits the masticatory functions by not only reducing the edges of teeth, but also decreasing

the contraction capacity of the chewing muscles. To avoid this, clinicians should endeavour to restore teeth with attrition-related tooth wear before reducing masticatory activity. USG helps to analyse the influence of tooth wear severity on the masticatory apparatus and provides a sophisticated approach to attrition-related tooth wear. This study is important that is the first USG study to focus on dental attrition effects in relation to the mandibular elevator muscles.

Author Disclosure Statement

None of the authors have any competing financial interests to disclose.

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SEARCHING THE EFFECT OF ANODIZATION PROCESS AS A SURFACE TREATMENT

Yüzey İşlemi Olarak Uygulanan Anodizasyonun Etkilerinin Araştırılması

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ABSTRACT

Objective: The aim of this study was to compare the effect of anodization and air-particle abrasion surface treatments on shear bond strength between Ni-Cr and ceramics.

Material and Methods: 30 cylindrical Ni-Cr specimens (7x10 mm) were divided into three groups according to the surface treatments [control group (no-treatment), air-particle abrasion group (110 µm Al_2O_3 at 75 psi from 20 cm for 30 seconds), and anodization group]. One sample from each group was evaluated by using SEM. Ceramics with a dimension (5x3 mm) built-up on specimens and shear bond strength tests were performed by using universal testing machine with a 1 mm/min crosshead speed. Stereomicroscope was used to evaluate the failure mode of specimens. One-way ANOVA with post-hoc Tukey's test was used to analyze the differences in shear bond strength values.

Results: The shear bond strength of air-particle abrasion (21.35∓4.64) was higher than anodization group (20.92∓4.85) however, no statistically significant difference was detected (p=0.893). Both groups showed higher bond strength than control group (8.02∓1.47) (p<.05).

Conclusion: The evaluation of the surface treatment methods showed that the anodization process can be used in order to increase the metal-ceramic bond strength.

Keywords: Air-particle abrasion, anodization, Ni-Cr, platinum, shear-bond strength.

ÖZ

Amaç: Bu çalışmanın amacı, anodizasyon ve kumlama yüzey işlemlerinin Ni-Cr ve seramik arasındaki makaslama bağlantı dayanımı üzerine etkilerini karşılaştırmaktır.

Gereç ve Yöntem: 30 adet silindir şeklinde Ni-Cr örnek (7x10 mm) uygulanan yüzey işlemlerine göre üç gruba ayrıldı [kontrol group (hiç işlem görmedi), kumlama grubu (110 µm Al_2O_3, 75 psi basınçla, 20 cm uzaklıktan, 30 saniye süresince) ve anodizasyon grubu]. Her gruptan birer örnek alınarak SEM analizleri gerçekleştirildi. Hazırlanan örneklerin üzerine 5x3 mm boyutlarında seramikler pişirildi ve makaslama bağlantı dayanım testleri universal test cihazında kafa hızı 1mm/dk olacak şekilde gerçekleştirildi. Örneklerin kopma şekillerinin tespitinde stereomikroskop kullanıldı. Makaslama bağlantı dayanım değerlerinin analizinde One-way ANOVA ve post-hoc Tukey's testleri kullanıldı.

Bulgular: Kumlama grubunun makaslama bağlantı dayanımı (21,35∓4,64) anodizasyon grubuna (20,92∓4,85) göre yüksek olarak bulunmasına rağmen her iki grup arasındaki farklılık istatistiksel olarak önemli bulunmamıştır (p=0.893). Her iki grupta kontrol grubuna göre (8,02∓1,47) yüksek bağlantı dayanımına sahip olduğu tespit edilmiştir (p<0,05).

Sonuç: Yüzey uygulama metotlarının değerlendirilmesi sonucunda anodizasyon uygulamasının metal-seramik bağlantısının artırılması için kullanılabilecek bir yöntem olduğunu tespit edilmiştir.

Anahtar kelimeler: Kumlama; anodizasyon; Ni-Cr; platin; makaslama bağlantı dayanımı.

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INTRODUCTION

In prosthetic restorations, in order to mimic the natural appearance of the tooth, all ceramic restorations have been using with an increasing demand.[1] Although more aesthetic results can be obtained with full ceramic applications, due to the high production costs, the sensitive cementation procedure, and unsuitability to apply in every case, metal-ceramic restorations still the most frequently used fixed partial denture which have long term clinical success. Noble metal alloys have good biocompatibility, superior bond strength with ceramic and mechanical properties, besides the increased cost of this material limits the usage.[2] Despite the difficulty of manipulation because of the harder structure and need for higher temperature for casting, Ni-Cr and Cr-Co are the most preferred alloys due to its cost-effectiveness.[3]

The most susceptible area of metal-ceramic fixed partial denture to fracture is the metal ceramic interface, which plays a curial role for life span of the restoration.[4] In order to improve the bond strength between metal-ceramic, air-particle abrasion (APA), laser, and acid-etching applications have been using.[5–7] APA is the most common method among them, which increases surface roughness of substructure by creating micropores and undercuts to boost mechanical interlocking.[8] It is easy to perform and the obtained metal-ceramic bond strength is sufficient which is mentioned 25 MPa according to the ISO standard.[9] The increased particle size of Al_2O_3 with an increasing pressure and application time has potential to increase the surface roughness however, bond strength increase is not parallel to surface roughness increase.[10] Besides, Gilbert *et al.*[11] mentioned that the particles embedded into the metal surface could contaminate the metal substructures and deteriorate the metal-ceramic bond strength and could cause allergic reactions and decrease the corrosion resistance.

The anodization process, an electronic passivation technique, attracted a noteworthy interest due to its ease of application and the reproducibility of the obtained results.[12] In recent years anodization has been using as a surface treatment for titanium implants in order to make rougher surface to enhance osteointegration.[13] In this process, the material used as an anode dissolve in an electrolytic medium and encapsulate the material used as a cathode. After covering the material, its surface properties change and acts as the material used in coating process (anode). Besides, this technique forms an oxide layer on metal surface in a controlled way. The oxide layer on metal surface plays a crucial role on metal ceramic bond strength which forms chemical adhesion with oxides of ceramics[14] while the excessive amount of this layer decreased the metal ceramic bond strength.[15] The anodization process is used to increase material's the corrosion resistance and surface roughness however, its effect on metal-ceramic bond strength is unclear.

The purpose of the present study was to compare the effects of anodization and APA on shear bond strength (SBS) between Ni-Cr substructure and ceramic. The present study is a novel approach in prosthetic dentistry. The null hypothesis tested was that the anodization would not be as effective as sandblasting on metal-ceramic bond strength.

MATERIAL AND METHODS

30 Ni-Cr metal cylinders (System KN, Adentatec, Köln, Germany) with a diameter 7 mm and height of 10 mm were used for testing as they were produced. The composition of the metal is depicted in Table 1. The specimens' surfaces were polished with P0001-220 silicone polisher (NTI silicone, Kerr, CA, USA). They were randomly divided into three groups according to the surface treatments [control group (no treatment), air-particle abrasion (APA) with 110 μm Al_2O_3 (Metoxides, Dortmund, Germany) at 75 psi from 20 cm for

30 seconds and anodization] (n:10). In APA group, specimens were ultrasonically cleaned with distilled water for 10 min than dried at room temperature after surface treatment. One specimen from each group was examined under scanning electron microscopy (SEM) (LEO 440, Zeiss, Jane, Germany).

Table 1. The composition of metal alloy (%)

Ni	**Cr**	**Mo**	**Si**	others
61.9	25	11.5	1.4	<0.1

In anodization group, one side polished 10 Ni-Cr samples were ultrasonically degreased consecutively in acetone, 2-propanol and deionized water for 30 min, and then dried in a nitrogen stream. The samples were etched in ethylene glycol containing 0.4 wt.% NH_4F (Sigma Aldrich, Darmstadt, Germany) and 5 wt % water content by using a two-electrode electrochemical cell Ni-Cr as a cathode and a platinum gauze as a counter electrode (anode). 30 V voltage was applied, and the electrolyte temperature was at 25 ^{0}C. After anodization, the prepared samples were thoroughly washed with a large amount of distilled water and methanol to remove precipitations.

Shear bond strength tests

Ceramic application (Ceramco3, Denstply, Hanau-Wolfgang, Germany) was performed by using a custom-made metal mold which has cylindrical holes (diameter 5, thickness 3 mm) than fired (Multimat Easy, Denstply, Hanau Wolfgang, Germany) according to manufacturers' instructions which is shown in Table 2. All specimens were stored in distilled water for 24 h at 37 C^0. Shear bond strength tests were performed by using universal testing machine (Lloyd LF Plus, Ametek Inc, Leicester, UK) with a 1 mm/min crosshead speed. Stereomicroscope (Stemi DV4, Zeiss, Jane, Germany) at x30 magnification was used to evaluate the failure mode of specimens. The failure modes were classified as follows:

Type A: Adhesive failure (on the interface)

Type C: Cohesive failure (within ceramics)

Type AC: Combined failure.

Table 2. Firing schedule

	Pre-drying		**Firing**	
	Temperature (^{0}C)	Time (min)	Heating rate (^{0}C/min)	Firing temperature (^{0}C)
Opaque	650	3	70	970
Dentin	650	3	50	950

Statistical analysis was performed using the SPSS 22.0 (SPSS Inc., Illinois, USA). One-way ANOVA with post-hoc Tukey's test was used to analyze the differences in shear bond strength values. The significance level was set at p<.05 for statistical procedures.

RESULTS

The mean shear bond strengths, standard deviations and failure modes for all groups are depicted in Table 3 and Figure 1. In terms of bond strength there was no significant difference between the surface treatment groups (p=0.893).

Table 3. Shear bond strength, standard deviation and failure mode

	SBS (MPa) and SD	**Adeshive**	**Cohesive**	**Mix**
Control	8,02∓1,47^a	8		
Sandblasting	21,35∓4,64^b	3	2	3
Anodization	20,92∓4,85^b	6	2	

Shear bond strength (SBS); standard deviation (SD). $^{(a)(b)}$The values with same superscript mean no statistically significant difference (p=0.893)

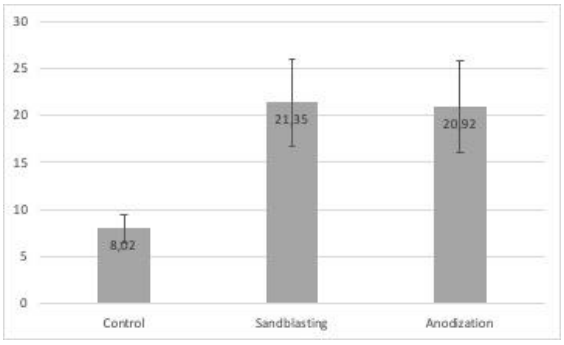

Figure 1. Shear bond strength and standard deviation.

An analysis of the failure mode, adhesive and cohesive failures were observed in both groups however combined failure mode was only observed in sandblasting group.

The scanning electron microscopic (SEM) images of untreated, sandblasted and anodized samples are presented in Figure 2. According to

the SEM images, the anodization process appears to be more effective on the surface.

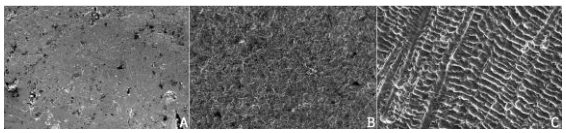

Figure 2. SEM images of the samples (A) non-treated surface. (B) air-particle abraded surface (C) anodized surface

DISCUSSION

This study aims to compare the effects of sandblasting which is the most common and scientifically proven method and anodization which has not been investigated on metal-ceramic bond strength. The results obtained from the tests suggested that the difference between sandblasting and anodization groups was not significantly different ($p>.05$). Therefore, the hypothesis which advocate the application anodization would not enhance metal ceramic bond strength, was not accepted.

This research was conducted on nickel-based alloy which rarely shows allergic reactions. This decision was made according to the research of Sipahi *et al.*[4] in which shear bond strength between different metals and different ceramics were investigated and Ni-Cr gave the highest bond strength value. Furthermore, supporting the Sipahi' s results, Akova *et al.*[16] investigated the bond strength of cast and laser sintered Ni-Cr and Co-Cr metals, they mentioned that the highest metal-ceramic bond strength was obtained with cast Ni-Cr but no significant different was detected between cast Co-Cr. Although different results were obtained in different studies,[17-18] Ni-Cr was preferred due to consistency of data in terms of standard deviation in Sipahi's research.[4]

The effect of airborne-particle abrasion on metal surface in order to achieve mechanical interlocking to obtain higher metal-ceramic bond strength was proven in many research.[19-20] The application of APA increases the surface energy and wettability of the metal substructures, which means the improvement of the adhesion between metal and ceramic.[21] While the benefits of sandblasting were mentioned in so many publications, the parameters preferred in each study were different.[3,19,22] In this research, the APA parameters were determined from our previous research in which all sandblasting parameters were tested and mentioned the most effective parameters on surface roughness was 110μm Al_2O_3 at 75 psi from a distance of 20 mm for 30 min.[10]

The platinum was used as an anode to cover the Ni-Cr because of the corrosion resistance and biocompatibility. Producing platinum framework by casting is difficult because of the high melting point and the need of argon atmosphere. However, by anodization process using the platinum it is aimed to get rid of allergic properties and corrosion tendencies of nickel-containing metals.

There is no publication on the investigation of anodization on metal-ceramic bond strength. The results evaluation of recent study with other studies which investigated the metal-ceramic bond strength is difficult, since different methods were used as surface treatments. Most studies were focused on the effect of sandblasting,[24] chemical etching[25] or acid etching[20,26] on metal-ceramic bond strength. Working mechanism of all these surface treatments to obtain surface roughness is removing the material on the surface of the applied sample. However, in anodization process roughness was obtained by adding (encapsulating) materials on the samples, not removing.

In literature, different bond strength values after the application of APA were obtained in different studies.[17,22,19] Such a result may be attributed to the use of different grain size of Al_2O_3 or the difference of the surface treatments' application time. Fonseca *et al.*[19] who evaluated the effect of different surface treatments on the bond strength between resin cement and a base metal alloy performed the APA procedure after polishing the surface of the specimens with 150, 400, 600 grid silicon

carbide papers. However, Yurdanur *et al.*[27] applied the surface treatment after the casting process without any polishing procedure and then investigated the bond strength with the ceramic. However, the obtained results did not only indicate the effect of surface treatment on bond strength but also includes the effect of roughness of casting process. In this study, like Fonseca, the surface of the samples was polished in order to compare only the effects of the applied surface treatments.

The structural compatibility means a strong and durable bond between metal and ceramic. Initially, the chemical bond forms between oxide and metal which than concluded a chemical adherent oxide bond between ceramic and oxide layer. However, the overproduction of the oxide layer on metal surface forms poor metal-ceramic bond.[23] Adhesive failure modes suggesting the weaker bond strength at metal-opaque interface. In anodization group of this study, the vast majority of the specimens were failed in adhesive mode whereas in the sandblasting group, the great majority of the specimens were failed in mix and cohesive mode. Such a result can be interpreted to the weakness of the connection of Ni-Cr and platinum oxide layer after anodization.

CONCLUSION

Within the limitations of this study, it can be concluded that the anodization is a viable method for increasing the metal ceramic bond strength.

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THE EFFECTS OF DIFFERENT PLATELET-RICH CONCENTRATES ON EXTRACTION SITE HEALING

Farklı Plateletten Zengin Konsantrelerin Çekim Alanı İyileşmesi Üzerine Etkileri

Esra ERCAN

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ABSTRACT

Objective: Some physiological changes may occur following tooth extraction, and symptoms during the post-extraction period may affect the patient's quality of life. Many techniques have been developed to promote soft/hard tissue healing. Accordingly, this study compared the early soft tissue healing characteristics of extraction sites treated with leukocyte-and-platelet-rich fibrin (L-PRF), titanium-prepared platelet-rich fibrin (T-PRF), and untreated control sites.

Materials and Methods: This study included 42 single-rooted teeth. The extraction sites were treated with L- or T-PRF. Extraction sockets left to heal spontaneously were defined as control sites. The Landry Wound Healing Index (LWHI) and H_2O_2 bubbling test results for the complete wound epithelization (CWE) rates were recorded 1 and 2 weeks postoperatively. All patients were asked to record a visual analogue scale (VAS) value for pain and the number of analgesics taken during the 2 days after extraction.

Results: The LWHI improved significantly in all groups 2 weeks postoperatively compared with 1 week (p<0.05). However, there was no difference among the three groups in each week. The CWE ratios were 7.1%, 53.3%, and 69.2% in the control, L-PRF, and T-PRF groups at 1 week, respectively. The CWE rate of the control group was significantly lower than in both test groups. (p<0.05) At 2nd weeks, both test groups showed 100% CWE compared with 35.7% in the controls. The VAS score 1 day postoperatively was significantly higher in the controls than in both test groups. (p<0.05) There was no significant difference among the groups at day 2. There was also no significant difference among the groups in the number of analgesics taken.

Conclusion: Within the limitations of this study, both T-PRF and L-PRF, which are completely autologous biomaterials, similarly enhanced wound epithelization and reduced postoperative discomfort at extraction sockets.

Key Words: tooth extraction, platelet-rich fibrin, wound healing

ÖZ

Amaç: Diş çekimi sonrası, yara iyileşmesi döneminde görülen bazı durumlar hastaların yaşam kalitesini olumsuz etkileyebilmektedir. Hem diş çekimi sonrası yara iyileşmesini desteklemek, hem de hastaların yaşam kalitesini artırmak amacı ile birçok teknik geliştirilmiştir. Bu nedenle bu çalışmanın amacı, lökosit-trombositten açısından zengin fibrin (L-TZF), titanyumla hazırlanan trombositten zengin fibrin (T-TZF) ile tedavi edilmiş çekim soketleri ile ve tedavi edilmemiş kontrol bölgelerinin erken yumuşak doku iyileşmesini karşılaştırmaktır.

Gereç ve Yöntem: Çalışmaya toplam 42 tek köklü diş dahil edildi. Rastgele olarak belirlenen, L-TZF (n=15) ve T-TZF (n=13) uygulanan alanlar test bölgeleri olarak belirlenirken, kendiliğinden iyileşmeye bırakılan çekim soketleri kontrol grubu (n=14) olarak değerlendirmeye alınmıştır. Landry Yara İyileşme İndeksi (LYİİ) skorları ve yaranın tamamen epitelizasyonun (YTE) için H_2O_2 kabarcık testi sonuçları işlem sonrası 1 ve 2. haftalarda kaydedildi. Ayrıca hastadan, çekimden sonraki 2 gün boyunca VAS skalasını işaretlemesi ve aldığı analjeziklerin sayısını kaydetmesi istendi.

Bulgular: İkinci haftada 1. haftaya göre tüm gruplarda LYİİ skorları istatistiksel olarak anlamlı derecede yüksekti. (p *<0,05*) Ancak üç grup arasında anlamlı fark yoktu. H_2O_2 kabarcık testi sonuçlarına göre, 1. haftadaki YTE oranı kontrol, L-TZF ve T-TZF grupları için sırasıyla %7,1, %53.3 ve %69.2 idi. Kontrol grubunun oranı, her iki test grubuna göre istatistiksel olarak anlamlı derecede düşüktü (p *<0,05*). 2. haftadaki test gruplarının her ikisi de %100 YTE göstermişti, ancak bu oran kontrol grubunda sadece %35,7 idi. VAS skoru, 1. günde, kontrol grubunda her iki gruptan da istatistiksel olarak anlamlı derecede yüksekti (p *<0,05*). 2. günde gruplar arasında anlamlı fark yoktu. Alınan analjezik sayısı bakımından gruplar arasında anlamlı bir fark yoktu.

Sonuç: Tamamen otolog biyomateryaller olan T-TZF ve L-TZF, çekim soketlerinde yara epitelizasyonu arttırarak ameliyat sonrası hisedilen rahatsızlığı azaltır.

Anahtar Kelimeler: diş çekimi, trombositten zengin fibrin, yara iyileşmesi

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INTRODUCTION

The alveolar process is a tooth dependent tissue that develops in conjunction with the eruption of the teeth.[1] After tooth extraction, physiological changes start in the soft and hard tissues. The resorption process is responsible for the dimensional changes that occur after tooth extraction. The amount of hard tissue resorption differs considerably between subjects. Therefore, a reduction of up to 50% of the original bone width can occur after tooth extraction. This decrease is greater in the buccal area than in the lingual/palatal areas, partly because the buccal bone is thinner.[2,3] Tooth extraction and implant placement in aesthetic areas are of particular importance in such cases. The dimensional change is most common in the first 3 months, but may continue until the end of the first year after extraction.[4] Symptoms such as pain, bleeding, and swelling may affect soft tissue healing and the patient's quality of life after tooth extraction.[5] Many techniques and materials have been proposed to promote soft and hard tissue healing and preserve tissue volume after extraction.[6-10] With our increased knowledge of bone regeneration and advances in biotechnology, new biologically active biomaterials have been developed to overcome the disadvantages of autogenous and non-autogenous materials, such as first- and second-generation platelet concentrates.[11] In the first-generation platelet concentrate, platelet-rich plasma (PRP) is obtained by adding chemical additives (e.g., bovine thrombin and calcium chloride) to manipulate the clotting process, resulting in a product with an unnaturally short life, quick resorption, and poor regenerative properties. Leukocyte- and platelet-rich fibrin (L-PRF) is obtained from the patient's own blood, without adding any anticoagulant, during natural clot formation. L-PRF membranes consist of high-density cross-linked fibrin networks and viable platelets and leukocytes. This bioskeleton releases growth factors, adhesion molecules, and pro- and anti-inflammatory cytokines for up to 7 days.[12, 13] This modulates the inflammatory process, increasing angiogenesis and tissue regeneration.[14] It is a preferred active biological product because it is inexpensive, easy to obtain, completely autogenous, and has beneficial biological properties in post-extraction socket protection. Titanium-based PRF (T-PRF) is promising, especially in soft and hard tissue augmentation, due to its fibrin structure, which is tighter than that of L-PRF, and it is prepared in Grade IV titanium tubes.[15,16] When T-PRF was applied to secondary wound areas in the mouth, it produced faster epithelization, less postoperative bleeding, and better wound healing than spontaneous healing.[17] T-PRF also has osteoinductive properties similar to those of bone and preserves tissue volume.[17,18] Rapid, complete soft tissue healing after tooth extraction minimizes surgical complications and enables subsequent implant placement. Therefore, this study compared the soft tissue healing of human tooth extraction sites using L-PRF, T-PRF, and a non-grafted control after 2 weeks.

MATERIALS AND METHODS

This study was done in accordance with the Helsinki Declaration of 1975 (revised in 2000). The study protocol was approved by the Clinical Research Ethics Commitee of Kanuni Education and Research Hospital. (protocol number: 2018/03)

The participants were over 18 years of age, in good general health, and required a single tooth extraction and subsequent replacement with an implant in anterior or premolar sites. Patients were excluded if they had any systemic disease that affected wound healing (e.g., diabetes or scleroderma); had undergone radiotherapy, chemotherapy, or bisphosphonate therapy; were pregnant; were current smokers; or had poor oral hygiene and motivation.

The study included 42 teeth, which were divided into three study groups: the control

group (n=14) underwent natural socket healing after tooth extraction without applying any material; the L-PRF group (n=15) had L-PRF added to the socket following tooth extraction; and the T-PRF group (n=13) had T-PRF added to the socket following tooth extraction.

Exclusion criteria for the extraction sockets were the presence of a tooth or an oro-antral connection, or a radiographically diagnosed endodontic lesion larger than 5 mm.

Protocols used during and after tooth extraction

Eligible teeth were extracted gently under local anesthesia without elevating a flap. Granulation tissue was removed and the socket was washed with sterile saline after tooth extraction. In the test groups, L-PRF or T-PRF membranes obtained from the patient's own blood were firmly placed in the extraction socket and sutured with a polypropylene 4-0 horizontal mattress suture. In the control group, no additional material was placed, and the socket was sutured similarly. The suture was removed after 1 week. Patients were advised to record their pain level using a visual analogue scale (VAS) and the number of analgesics taken for 2 days after tooth extraction. The Landry wound healing index (LWHI) and H_2O_2 epithelization test were performed after 1 and 2 weeks.

Landry Wound Healing Index

The LWHI evaluates the extraction region based on tissue color, response to touch, marginality of the incision line, and extent of the area. The rating is from 1=very poor to 5=excellent.

1. **Very poor**: ≥50% of the gingiva is red; touch causes bleeding; granulation tissue is present; the incision margin is not epithelialized, with loss of epithelium beyond the incision margin; and suppuration is present.
2. **Poor**: ≥50% of the gingiva is red; touch causes bleeding; granulation tissue is present; the incision margin is not epithelialized; and connective tissue is exposed.
3. **Good**: ≥25 to <50% of the gingiva is red; there is no bleeding on palpation; there is no granulation tissue; and no connective tissue is exposed at the incision margin.
4. **Very good**: <25% of the gingiva is red; there is no bleeding on palpation; there is no granulation tissue; and no connective tissue is exposed at the incision margin.
5. **Excellent**: All tissues are pink; there is no bleeding on palpation; there is no granulation tissue; and no connective tissue is exposed at the incision margin.

Wound epithelization

Complete wound epithelization (CWE) was evaluated clinically using the H_2O_2 bubbling test, which is based on the principle that if the epithelium is discontinuous, H_2O_2 will diffuse into the connective tissue and catalase will act on the H_2O_2 to release water and oxygen, producing bubbles in the wound. The area to be evaluated was dried and 3% H_2O_2 was sprinkled on the wound using a syringe. The appearance of bubbles suggested that the surgical site was not completely epithelialized. If there were no bubbles, it was assumed that CWE had occurred. The rate of CWE was calculated as follows:

CWE (%) = number of sites with CWE (+) × 100 / total number of sockets.

L-PRF and T-PRF Preparation Procedures

Venous blood from the patient was rapidly transferred to tubes that did not contain an anticoagulant to trigger platelet activation and fibrin polymerization. The tube was then centrifuged at 2700 rpm for 12 min (Nuve NF 200; Ankara, Turkey). This resulted in three layers in the tube: serum at the top, PRF in the middle, and erythrocytes at the bottom. The PRF in the middle layer was squeezed between sterile moistened sponges and the membrane was separated from the serum. A glass tube was used to prepare L-PRF and a Grade IV

titanium tube to prepare T-PRF. Two L-PRF or T-PRF membranes were used for each socket.

Statistical analysis

The data were analyzed using IBM SPSS Statistics for Windows 22.0 (IBM Corp., Armonk, NY, USA). Qualitative data are presented as numbers, percentages, and the mean and standard deviation. The conformity of the measured data to the normal distribution was evaluated with the Kolmogorov-Smirnov/Shapiro-Wilk test. Numerical variables were compared among the three independent groups using the Kruskal-Wallis test when the distribution was not normal. Numerical variables were compared between two dependent groups with Wilcoxon's test when the distribution was not normal. The chi-square test was used to analyze the differences between categorical variables in independent groups. Statistically, $p<0.05$ was considered significant.

RESULTS

The study enrolled 32 non-smoking patients (mean age 43.74±9.36 years) in whom single-rooted teeth were extracted for periodontal reasons (57.1%), caries (21.4%), endodontic reasons (14.3%), or trauma (7.1%).

Table 1 shows the LWHI. The values were significantly better for all groups at 2 weeks compared with 1 week ($p<0.05$). However, there was no difference among the three groups in each week, despite better results with T-PRF.

Table 1. Landry Wound Healing Indexes

Groups	1st Week	2nd Week	*p*
Control	3.21±0.69	4.36±0.49	*<0.05*
L-PRF	3.53±0.64	4.53±0.52	*<0.05*
T-PRF	3.69±0.48	4.69±0.48	*<0.05*
p	*NS*	*NS*	

Values are presented as mean±standard deviation.
Statistically significantly different between first and second week (p<0.05). (Wilcoxon's test)
Statistically non- significant among groups NS (p>0.05). (Kruskal-Wallis test)

Table 2 shows the results of CWE using the H_2O_2 test. Wound epithelization was completed in 7.1%, 53.3%, and 69.2% of the control, L-PRF, and T-PRF groups, respectively. The rate was significantly lower in the controls than in both test groups ($p<0.05$). At 2 weeks, both of the test groups showed 100% CWE compared with only 35.7% in the control group ($p<0.05$).

Table 2. H_2O_2 test results- Complete Wound Epithelization

Groups	1st Week	2nd Week
Control	7.1 %*	35.7%
L-PRF	53.3%	100 %
T-PRF	69.2%	100%
p	*<0.05*	

Values are presented as mean±standard deviation.
Statistically significantly different between first and second week (*p<0.05*) (Wilcoxon's test)
Statistically non- significant among groups NS (*p>0.05*). (Kruskal-Wallis test)

Table 3 gives the mean and standard deviation of the patients' VAS scores for pain.

Table 3. The VAS scores

Groups	1st day	2nd day
Control	5.5±1.5*	1.29±1.49
L-PRF	3.2±2.04	0.47±0.92
T-PRF	3.85±1.82	0.46±0.52
p	*<0.05*	*NS*

Values are presented as mean±standard deviation.
*Statistically significantly different among groups at first day (*p<0.05*) (Kruskal-Wallis test)
NS: Statistically non-significant among groups at second day (*p>0.05*) (Kruskal-Wallis test)

The VAS scores decreased gradually in all groups. On day 1, the score was significantly higher in the control group than in both test groups ($p<0.05$). There was no significant difference among the groups on day 2. The number of analgesics recorded did not differ significantly among the groups at any time (Table 4).

Table 4. The number of analgesics

Groups	1st day	2nd day
Control	1.43±1.09	0.36±0.74
L-PRF	0.87±0.83	0.07±0.29
T-PRF	0.77±0.44	0
p	*NS*	*NS*

Values are presented as mean±standard deviation.
NS: Statistically non-significant among groups ($p>0.05$) (Kruskal-Wallis test)

DISCUSSION

Bone resorption is inevitable after tooth extraction. Socket preservation after tooth extraction is crucial for successful, predictable dental implant treatment. Platelet concentrates stimulate soft and hard tissue healing via various mechanisms.[19] In our study, both test groups exhibited positive outcomes in terms of CWE and the VAS score in the early soft tissue healing period.

Wound epithelization is important in secondary wound healing. In natural socket healing, a secondary wound is formed, which may cause pain and discomfort until the connective tissue is completely covered by epithelium. The cells in platelet concentrates populate the surgical wound area; the fibrin matrix serves as a supporting matrix, and growth factors placed in the socket accelerate healing by stimulating angiogenesis, clot formation, and epithelization.[20,21] We used L-PRF and T-PRF membranes to fill the socket. Consequently, the area of secondary healing covered by the platelet concentrates showed a pattern similar to primary wound healing. Ustaoğlu *et al*.[17] observed the positive effect of these biomaterials on secondary wound healing in free gingival graft donor sites. The T-PRF membranes were used as palatal healing material and were superior to the control condition at 14 days in terms of CWE. Similar to our study, this effect was observed 1 and 2 weeks after tooth extraction.

Our study participants were non-smokers because cigarette smoking affects the normal healing of extraction sockets, especially via nicotine-released catecholamines, which inhibit epithelization.[22] For example, one study used L-PRF to promote healing after an extraction in smokers, but it did not reduce pain or improve socket closure.[23]

T-PRF is a third-generation PRF product. It has a firmer fibrin network and slower resorption time than L-PRF.[16] Ours is the first study to evaluate the effects of T-PRF in the early stage of soft tissue healing after an extraction, and T-PRF was superior to the control in terms of CWE and VAS scores. The CWE rate was nearly 70% for the T-PRF group and 53.3% for the L-PRF group, although the difference was not significant. The high ratio of the T-PRF group was attributed to the dense, stable fibrin matrix, which serves as a scaffold for cell proliferation.

The VAS scores of the patients after extraction were significantly higher in the controls than in both test groups. Following extraction, patients have pain, bleeding, and swelling. The main reported advantages of using autologous platelet concentrates are better soft tissue epithelization and less pain, swelling, and inflammation.[24-26] These may be related to reduced food stagnation in the extraction socket, reduced postoperative bleeding, and the anti-inflammatory and anti-microbial activity of the platelet concentrates.[27-29]

CONCLUSION

Both T-PRF and L-PRF enhanced wound epithelization and reduced postoperative patient discomfort. They served as a stable fibrin matrix. The long-term effects of these biomaterials on soft and hard tissues should be evaluated in split-mouth clinical studies with more participants.

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KNOWLEDGE, ATTITUDE AND PRACTICES OF ORAL AND MAXILLOFACIAL SURGEONS REGARDING BEHAVIOR GUIDANCE TECHNIQUES FOR MANAGING CHILD PATIENTS

Ağız, Diş ve Çene Cerrahisi Uzmanlarının Çocuk Hastalarda Uygulanan Davranış Yönlendirme Tekniklerine İlişkin Bilgi, Tutum ve Uygulamaları

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ABSTRACT

Objectives: The aim of this study was to evaluate the knowledge, attitude, and practices of oral and maxillofacial surgeons regarding behavior guidance techniques that reduced fear and anxiety for children.

Materials and Methods: In this cross-sectional study, the participants were oral and maxillofacial surgeons who treat pediatric dental patients in the private and public clinics in Turkey. The questionnaires were applied through an electronic form via a website. The results were evaluated using IBM SPSS Statistics 22 for statistical analysis. A p-value of <0.05 was accepted as statistically significant.

Results: 60% of the participants were specialist trainees, 9% were doctoral students, 16% were oral and maxillofacial surgeons and 15% were lecturers in the department of oral and maxillofacial surgery of various universities. 45% of the participants said they could always take responsibility of working on a pediatric patient, while 33% of them stated that they frequently treated child patients, and 22% of them sometimes took this responsibility. 55% of the participants said they had been trained in behavior guidance techniques for children. The result showed that 93% of the surgeons used tell-show-do, 69% used voice control, 27% used nonverbal communication, 73% used positive reinforcement, 61% utilized distraction techniques, 59% used presence-absence of parents, 15% used hand-over-mouth, 36% used sedation, 36% used restrain/protective stabilization, 46% used general anesthesia, and 2% had used hypnosis method.

Conclusion: This study showed that the oral and maxillofacial surgeons working in public and private clinics have a high awareness of behavior guidance techniques while the level of this awareness varies among surgeons according to age, gender, workplace, work experience, and training.

Keywords: Behavioral guidance techniques, awareness, pediatric patients, oral and maxillofacial surgeon

ÖZ

Amaç: Bu çalışmanın amacı, kamu ve özel kliniklerde çocuk hastalara tedavi hizmeti veren ağız, diş ve çene cerrahlarının korku ve kaygıyı azaltan davranış yönlendirme tekniklerine ilişkin bilgi, tutum ve uygulamalarını değerlendirmektir.

Gereç ve Yöntemler: Bu kesitsel çalışmada, katılımcılar Türkiye'deki özel ve kamu kliniklerinde çocuk hastaları tedavi hizmeti veren ağız ve çene cerrahlarıdır. Anketler bir web sitesi üzerinden elektronik form aracılığıyla uygulandı. Çalışmada elde edilen bulgular IBM SPSS Statistics 22 (IBM SPSS, Türkiye) programı kullanılarak değerlendirildi. Anlamlılık p<0,05 düzeyinde değerlendirildi.

Bulgular: Katılımcıların %60'ı uzmanlık öğrencisi, %9'u doktora öğrencisi, %16'sı ağız diş ve çene cerrahı, %15'i üniversitede ağız diş ve çene cerrahisi bölümünde öğretim üyesiydi. Hekimlerin %45'i her zaman çocuk hastada çalışma sorumluluğunu alabildiğini söylerken, %33'ü sık sık, %22'si bu sorumluluğu bazen aldığını belirtti. Katılımcıların %55'i çocuklarda davranış yönlendirme teknikleri hakkında eğitim aldığını belirtti. Katılımcıların kullandıkları davranış yönlendirme teknikleri sorulduğunda, %93'ünün anlat-göster-uygula, %69'unun ses kontrolü, %27'sinin sözsüz iletişim, %73'ünün pozitif destekleme, %61'inin ilgiyi dağıtma, %59'unun ebeveyn varlığı-yokluğu, %15'inin ağzın elle örtülmesi, %36'sının çocuğun sabitlenmesi, %36'sının sedasyon, %46'sının genel anestezi ve %2'sinin hipnoz yöntemini kullandığı tespit edildi.

Sonuç: Bu çalışmanın sonuçları, çene cerrahlarının davranış yönlendirme teknikleri konusundaki farkındalığının yüksek olduğunu ve bu farkındalığın yaş, cinsiyet, çalışma yeri, çalışma deneyimi ve eğitime göre bireysel farklılık oluşturduğunu göstermektedir.

Anahtar kelimeler: Davranış yönlendirme teknikleri, farkındalık, pediatrik hasta, ağız diş ve çene cerrahı

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INTRODUCTION

Dental procedures, such as tooth extraction or treatment, cause a great deal of fear and anxiety among the majority of child patients. Especially, painful dental procedures cause anxiety and worsen children's behavior.[1] For this reason, children who have had previous tooth extraction feel more pain, fear, and discomfort. These emotions can cause serious difficulties during the procedure by resulting in non-collaborative behaviors during subsequent dental appointments.[1,2]

On the other hand, it has been shown that as children become more familiar and experienced with dental procedures, they adapt and cooperate more easily. The experience gained in previous dental appointments helps the child get accustomed to dental procedures and identify the non-threatening aspects of dental appointments.[3] In addition, in some children, the choice of the dentist's persuasive approach can affect the behavior of the child positively, enabling cooperation between the physician and the child.

Oral and maxillofacial surgeons are expected to manage pediatric surgical procedures effectively with the knowledge and skills they acquire during dental school education. However, ensuring safe and effective treatment during dental procedures often requires changing the behavior of the child. The purpose of guiding behaviors during treatment of children is to provide an environment that will facilitate the child's acceptance of treatment, especially in cases of frightening and anxiety-causing procedures such as tooth extraction. Providing these conditions depends on the practitioner's experience and skills in using appropriate behavior guidance techniques.[4,5] Behavioral guidance techniques include communication, fear and anxiety relief, providing quality dental care, establishing a reliable relationship between the dentist, the child and the parent, and to encourage the child to positively approach the dental treatment.[6]

The aim of this study was to evaluate the knowledge, attitude, and practices of oral and maxillofacial surgeons regarding behavior guidance techniques that reduced fear and anxiety for children.

MATERIALS AND METHODS

The study protocol was approved by the Mersin University Non-invasive Clinical Research Ethics Committee (2018/48). This cross-sectional study was performed between January 1 and July 1, 2018, and the participants were oral and maxillofacial surgeons who treat pediatric dental patients in the oral and maxillofacial surgery clinics in Turkey. The questionnaires were applied through an electronic form via a website and the participants were informed about the study at the beginning of the survey.

Oral and maxillofacial surgeons working at the universities, Oral and Dental Health Centers (ODHCs), private practices or private clinics providing pediatric treatment services, or specialist or doctoral students studying in this field were included in the study.

Surveys were prepared as electronic forms. In order to prevent non-specialists from participating in the survey, 211 oral and maxillofacial surgeons, who were contacted through e-mail, were asked to fill in the surveys.

The results were evaluated using IBM SPSS Statistics 22 (SPSS IBM, Turkey) for statistical analysis. Chi-square test, Fisher's Exact Chi-square test, Continuity (Yates) correction and Fisher Freeman Halton test were used to compare qualitative data as well as the descriptive statistical methods (frequency). A p-value of <0.05 was accepted as statistically significant.

RESULTS

100 out of 211 oral and maxillofacial surgeons answered the questionnaire. The participation rate was 48%. 27% of the oral and maxillofacial surgeons participating in the survey were

female and 73% were male. 60% of the participants were specialist trainees, 9% were doctoral students, 16% were oral and maxillofacial surgeons, and 15% were lecturers in the department of oral and maxillofacial surgery of various universities. 68% of the participants were between the ages of 23-30, 25% between the ages of 31-40, and 7% between the ages of 41-50. 87% of the participants had a work experience of 1-5 years, 8% had 5-10 years, and 5% had 10 or more years. 87% were working in the faculty of dentistry of different universities, 7% were in private practice or clinics, and 6% were working in ODHCs (Table 1).

Table 1: Demographics distribution of participants

		n	%
Sex	Female	27	27
	Male	73	73
Title	Specialist students at the university	60	60
	Doctoral students at the university	9	9
	Oral and maxillofacial surgeon	16	16
	Lecturer at the university	15	15
Age	20-30	68	68
	31-40	25	25
	41-50	7	7
Working experience	1-5 years	87	87
	5-10 years	8	8
	10 years and over	5	5
Type of practice	Private practices or private clinics	7	7
	Oral and Dental Health Centers	6	6
	Faculties of Dentistry	87	87

45% of the participants said they could always take responsibility of working on a pediatric patient, while 33% of them stated that they frequently treated child patients, and 22% of them sometimes took this responsibility. 55% of the participants said they had been trained in behavior management techniques for children.

While 79% of oral and maxillofacial surgeons thought that they needed family permission to conduct behavioral guidance, 25% of them stated that they always used behavior guidance techniques for child patients.

When we asked about the behavior guidance techniques used by the surgeons, they used; 93% used tell-show-do, 69% used voice control, 27% used nonverbal communication, 73% used positive reinforcement, 61% utilized distraction techniques, 59% used presence-absence of parents, 15% used hand-over-mouth, 36% used sedation and restrain/protective stabilization, 46% used general anesthesia, and 2% had used hypnosis method.

98% of the respondents gave a "no" answer when asked "Are all of the behavior management techniques appropriate for every child?" question. When asked, "Would you prefer not to talk at all if the child is quiet and cooperative during the treatment?" 7% of the respondents answered “always”, 17% stated “often”, 33% said “sometimes”, 43% responded “never”.

When the participants were asked "Do you allow the child to talk or ask questions during treatment?", 19% answered “always”, 53% said “often”, 27% stated “sometimes”, 1% responded as “never”.

When asked "Do you stop the treatment when the child feels uncomfortable?", 23% of the respondents answered “always”, 41% responded “often”, and 36% said “sometimes”.

When they were asked "Do you prefer to give a gift or a prize if the child behaves in a cooperative manner during treatment?", 5% answered “always”, 27% “often”, 58% “sometimes”, 10% responded “never” (Table 2).

Table 2: The distribution of responses to the survey questions

		n	%
Taking the responsibility of working in a child patient when needed	Always	45	45
	Often	33	33
	Sometimes	22	22
	Never	0	0
Training in behavioral guidance techniques in children	Yes	55	55
	No	45	45
Purpose in behavioral guidance techniques;	To increase child's alignment	11	11
	To establish and strengthen surgeon-child relationship	22	22
	Efficient and short-term treatment	6	6
	Reduce worry	1	1
	All	60	60
The need to get family approval to conduct behavioral guidance	Yes	79	79
	No	21	21
Use of behavior guidance techniques in children	Always	25	25
	Often	30	30
	Sometimes	44	44
	Never	1	1
Used behavior guidance techniques for child patients	Tell-show-do	93	93
	Voice control	69	69
	Nonverbal communication	27	27
	Positive reinforcement	73	73
	Distraction techniques	61	61
	Presence-absence of parents	59	59
	Hand-over-mouth	15	15
	Restrain/protective stabilization	36	36
	Hypnosis	2	2
	Sedation	36	36
	General anesthesia	46	46
	None	0	0
Are all of the behavior management techniques appropriate for every child?	Yes	2	2
	No	98	98
Would you prefer not to talk at all if the child is quiet and cooperative during the treatment?	Always	7	7
	Often	17	17
	Sometimes	33	33
	Never	43	43
Do you allow the child to talk or ask questions during treatment?	Always	19	19
	Often	53	53
	Sometimes	27	27
	Never	1	1
Do you stop the treatment when the child feels uncomfortable?	Always	23	23
	Often	41	41
	Sometimes	36	36
Do you prefer to give a gift or a prize if the child behaves in a cooperative manner during treatment?	Always	5	5
	Often	27	27
	Sometimes	58	58
	Never	10	10

There was no statistically significant difference in the frequency of dentists for taking responsibility of pediatric dental patients with regards to gender (p>0.05). Although more female dentists (70.4% of female participants) stated that they received education on behavioral guidance techniques in children compared to male surgeons (49.3% of male participants), the difference was not statistically significant (p>0.05). There was no statistically significant difference between male and female participants with respect to the belief that family members should obtain permission from the family to conduct behavioral guidance (p>0.05). On the other hand, there was a statistically significant difference between the frequency of use of behavior guidance techniques in children with respect to gender (p=0.001), where the female surgeons were significantly more likely to use behavior guidance techniques (51.9%) than males (15.1%).

The rate of use of voice control by female physicians (88.9%) was significantly higher than that of males (61.6%) (p=0.018). The rate of use of parental presence/absence by female surgeons (92.6%) was also significantly higher than that of males (46.6%) (p=0.000). Nevertheless, there was no statistically significant difference in the rates of use of other behavior-orienting techniques between the participants with different genders (p>0.05).

There was a statistically significant difference between the frequencies of "not talking at all if the child patient is quiet and cooperative" (p=0.008), where the rate of the male dentists who prefer to not talk often (23.3%) was significantly higher than that of females (0%) (Table 3).

Table 3: Assessment of responses to questionnaires according to sex

		Female n (%)	Male n (%)	P
Taking the responsibility of working in a child patient when needed	Always	13 (48.1%)	32 (43.8%)	[1]0.253
	Often	11 (40.7%)	22 (30.1%)	
	Sometimes	3 (11.1%)	19 (26%)	
Training in behavioral guidance techniques in children	Yes	19 (70.4%)	36 (49.3%)	[2]0.098
	No	8 (29.6%)	37 (50.7%)	
Purpose in behavioral guidance techniques;	Increase your child's alignment	1(3.7%)	10 (13.7%)	[3]0.161
	To establish and strengthen surgeon-child relationship	3 (11.1%)	19 (26%)	
	Efficient and short-term treatment	2 (7.4%)	4 (5.5%)	
	Reduce worry	0 (0%)	1 (1.4%)	
	All	21 (77%.8)	39 (53.4%)	
The need to get family approval to conduct behavioral guidance	Yes	20 (74.1%)	59 (80.8%)	[2]0.646
	No	7 (25.9%)	14 (19.2%)	
Use of behavior guidance techniques in children	Always	14 (51.9%)	11 (15.1%)	[3]0.001*
	Often	7 (25.9%)	23 (31.5%)	
	Sometimes	6 (22.2%)	38 (52.1%)	
	Never	0 (0%)	1 (1.4%)	
Used behavior guidance techniques for child patients	Tell-show-do	27 (100%)	66 (90.4%)	[4]0.185
	Voice control	24 (88.9%)	45 (61.6%)	[2]0.018*
	Nonverbal communication	11 (40.7%)	16 (21.9%)	[2]0.103
	Positive reinforcement	24 (88.9%)	49 (67.1%)	[2]0.054
	Distraction techniques	18 (66.7%)	43 (58.9%)	[2]0.634
	Presence-absence of parents	25 (92.6%)	34 (46.6%)	[2]0.000*
	Hand-over-mouth	6 (22.2%)	9 (12.3%)	[4]0.224
	Restrain/protective stabilization	10 (37%)	26 (35.6%)	[2]1.000
	Hypnosis	1 (3.7%)	1 (1.4%)	[4]0.469
	Sedation	7 (25.9%)	29 (39.7%)	[2]0.298
	General anesthesia	14 (51.9%)	32 (43.8%)	[2]0.625
Are all of the behavior management techniques appropriate for every child?	Yes	1 (3.7%)	1 (1.4%)	[4]0.469
	No	26 (96.3%)	72 (98.6%)	
Would you prefer not to talk at all if the child is quiet and cooperative during the treatment?	Always	3 (11.1%)	4 (5.5%)	[3]0.008*
	Often	0 (0%)	17 (23.3%)	
	Sometimes	8 (29.6%)	25 (34.2%)	
	Never	16 (59.3%)	27 (37%)	
Do you allow the child to talk or ask questions during treatment?	Always	7 (25.9 %)	12 (16.4%)	[3]0.171
	Often	10 (37%)	43 (58.9%)	
	Sometimes	10 (37%)	17 (23.3%)	
	Never	0 (0%)	1 (1.4%)	
Do you stop the treatment when the child feels uncomfortable?	Always	9 (33.3%)	14 (19.2%)	[1]0.321
	Often	10 (37%)	31 (42.5%)	
	Sometimes	8 (29.6%)	28 (38.4%)	
Do you prefer to give a gift or a prize if the child behaves in a cooperative manner during treatment?	Always	1 (3.7%)	4 (5.5%)	[1]0.472
	Often	6 (22.2%)	21 (28.8%)	
	Sometimes	19 (70.4%)	39 (53.4%)	
	Never	1 (3.7%)	9 (12.3%)	

*[1]Chi-square test [2]Continuity (yates) correction [3]Fisher Freeman Halton Test [4]Fisher Exact Test *p<0.05*

There was a statistically significant difference (p=0.012) between participants from different age groups with respect to the rate of receiving education in behavior guidance techniques for children. 85.7% of the surgeons between the

ages of 41-50, 60.3% of the surgeons between the ages of 23-30, and 32% of the surgeons between the ages of 31-40 received an education on these techniques. There were also statistically significant differences (p=0.000, p=0.042, p=0.001) in using the voice control, distraction and use of hand over mouth technique with respect to age (Table 4).

Table 4: Assessment of responses to questionnaires according to age

		23-30 years	31-40 years	41-50 years	p
		n (%)	n (%)	n (%)	
Taking the responsibility of working in a child patient when needed	Always	31 (45.6%)	10 (40%)	4 (57.1%)	[1]0.504
	Often	23 (33.8%)	7 (28%)	3 (42.9%)	
	Sometimes	14 (20.6%)	8 (32%)	0 (0%)	
Training in behavioral guidance techniques in children	Yes	41 (60.3%)	8 (32%)	6 (85.7%)	[1]0.012*
	No	27 (39.7%)	17 (68%)	1 (14.3%)	
Purpose in behavioral guidance techniques;	Increase your child's alignment	9 (13.2%)	1 (4%)	1 (14.3%)	[2]0.207
	To establish and strengthen surgeon-child relationship	14 (20.6%)	8 (32%)	0 (0%)	
	Efficient and short-term treatment	6 (8.8%)	0 (0%)	0 (0%)	
	Reduce worry	0 (0%)	1 (4%)	0 (0%)	
	All	39 (57.4%)	15 (60%)	6 (85.7%)	
The need to get family approval to conduct behavioral guidance	Yes	51 (75%)	22 (88%)	6 (85.7%)	[2]0.356
	No	17 (25%)	3 (12%)	1 (14.3%)	
Use of behavior guidance techniques in children	Always	20 (29.4%)	2 (8%)	3 (42.9%)	[2]0.218
	Often	19 (27.9%)	8 (32%)	3 (42.9%)	
	Sometimes	28 (41.2%)	15 (60%)	1 (14.3%)	
	Never	1 (1.5%)	0 (0%)	0 (0%)	
Used behavior guidance techniques for child patients	Tell-show-do	65 (95.6%)	21 (84%)	7 (100%)	[1]0.137
	Voice control	53 (77.9%)	9 (36%)	7 (100%)	[1]0.00*
	Nonverbal communication	18 (26.5%)	5 (20%)	4 (57.1%)	[2]0.145
	Positive reinforcement	52 (76.5%)	16 (64%)	5 (71.4%)	[2]0.484
	Distraction techniques	37 (54.4%)	17 (68%)	7 (100%)	[1]0.04*
	Presence-absence of parents	40 (58.8%)	13 (52%)	6 (85.7%)	[1]0.310
	Hand-over-mouth	8 (11.8%)	2 (8%)	5 (71.4%)	[1]0.00*
	Restrain/protective stabilization	25 (36.8%)	10 (40%)	1 (14.3%)	[1]0.515
	Hypnosis	1 (1.5%)	1 (4%)	0 (0%)	[1]0.540
	Sedation	25 (36.8%)	9 (36%)	2 (28.6%)	[1]1.000
	General anesthesia	31 (45.6%)	14 (56%)	1 (14.3%)	[1]0.165
Are all of the behavior management techniques appropriate for every child?	Yes	2 (2.9%)	0 (0%)	0 (0%)	[1]1.000
	No	66 (97.1%)	25 (100%)	7 (100%)	
Would you prefer not to talk at all if the child is quiet and cooperative during the treatment?	Always	5 (7.4%)	2 (8%)	0 (0%)	[2]0.749
	Often	13 (19.1%)	4 (16%)	0 (0%)	
	Sometimes	22 (32.4%)	9 (36%)	2 (28.6%)	
	Never	28 (41.2%)	10 (40%)	5 (71.4%)	
Do you allow the child to talk or ask questions during treatment?	Always	11 (16.2%)	6 (24%)	2 (28.6%)	[2]0.672
	Often	36 (52.9%)	12 (48%)	5 (71.4%)	
	Sometimes	20 (29.4%)	7 (28%)	0 (0%)	
	Never	1 (1.5%)	0 (0%)	0 (0%)	
Do you stop the treatment when the child feels uncomfortable?	Always	13 (19.1%)	9 (36%)	1 (14.3%)	[2]0.432
	Often	29 (42.6%)	8 (32%)	4 (57.1%)	
	Sometimes	26 (38.2%)	8 (32%)	2 (28.6%)	
Do you prefer to give a gift or a prize if the child behaves in a cooperative manner during treatment?	Always	4 (5.9%)	1 (4%)	0 (0%)	[2]0.857
	Often	18 (26.5%)	7 (28%)	2 (28.6%)	
	Sometimes	40 (58.8%)	13 (52%)	5 (71.4%)	
	Never	6 (8.8%)	4 (16%)	0 (0%)	

[1]Fisher Freeman Halton Test *[2]Chi-square test * p<0.05*

Regarding the frequency of use of behavioral guidance techniques and the rates of use of these techniques in child patients, there was no statistically significant difference between the groups of surgeons with different working experience (p>0.05) (Table 5).

Table 5: Assessment of responses to questionnaires according to working experience

		1-5 years	5-10 years	10 years and over	p
		n (%)	n (%)	n (%)	
Taking the responsibility of working in a child patient when needed	Always	38 (43.7%)	6 (75%)	1 (20%)	[1]0.119
	Often	30 (34.5%)	0 (0%)	3 (60%)	
	Sometimes	19 (21.8%)	2 (25%)	1 (20%)	
Training in behavioral guidance techniques in children	Yes	48 (55.2%)	6 (75%)	1 (20%)	[1]0.201
	No	39 (44.8%)	2 (25%)	4 (80%)	
Purpose in behavioral guidance techniques;	Increase your child's alignment	10 (11.5%)	0 (0%)	1 (20%)	[2]0.876
	To establish and strengthen surgeon-child relationship	18 (20.7%)	2 (25%)	2 (40%)	
	Efficient and short-term treatment	6 (6.9%)	0 (0%)	0 (0%)	
	Reduce worry	1 (1.1%)	0 (0%)	0 (0%)	
	All	52 (59.8%)	6 (75%)	2 (40%)	
The need to get family approval to conduct behavioral guidance	Yes	68 (78.2%)	6 (75%)	5 (100%)	[1]0.731
	No	19 (21.8%)	2 (25%)	0 (0%)	
Use of behavior guidance techniques in children	Always	22 (25.3%)	2 (25%)	1 (20%)	[2]0.884
	Often	24 (27.6%)	4 (50%)	2 (40%)	
	Sometimes	40 (46%)	2 (25%)	2 (40%)	
	Never	1 (1.1%)	0 (0%)	0 (0%)	
Used behavior guidance techniques for child patients	Tell-show-do	81 (93.1%)	7 (87.5%)	5 (100%)	[1]0.635
	Voice control	63 (72.4%)	3 (37.5%)	3 (60%)	[1]0.083
	Nonverbal communication	23 (26.4%)	3 (37.5%)	1 (20%)	[1]0.875
	Positive reinforcement	66 (75.9%)	4 (50%)	3 (60%)	[1]0.228
	Distraction techniques	55 (63.2%)	2 (25%)	4 (80%)	[1]0.069
	Presence-absence of parents	53 (60.9%)	4 (50%)	2 (40%)	[1]0.536
	Hand-over-mouth	38 (43.7%)	6 (75%)	1 (20%)	[1]0.448
	Restrain/protective stabilization	30 (34.5%)	0 (0%)	3 (60%)	[1]0.082
	Hypnosis	19 (21.8%)	2 (25%)	1 (20%)	[1]0.104
	Sedation	48 (55.2%)	6 (75%)	1 (20%)	[1]0.293
	General anesthesia	39 (44.8%)	2 (25%)	4 (80%)	[1]0.253
Are all of the behavior management techniques appropriate for every child?	Yes	10 (11.5%)	0 (0%)	1 (20%)	[1]1.000
	No	18 (20.7%)	2 (25%)	2 (40%)	
Would you prefer not to talk at all if the child is quiet and cooperative during the treatment?	Always	6 (6.9%)	0 (0%)	0 (0%)	[2]0.328
	Often	1 (1.1%)	0 (0%)	0 (0%)	
	Sometimes	52 (59.8%)	6 (75%)	2 (40%)	
	Never	68 (78.2%)	6 (75%)	5 (100%)	
Do you allow the child to talk or ask questions during treatment?	Always	19 (21.8%)	2 (25%)	0 (0%)	[2]0.572
	Often	22 (25.3%)	2 (25%)	1 (20%)	
	Sometimes	24 (27.6%)	4 (50%)	2 (40%)	
	Never	40 (46%)	2 (25%)	2 (40%)	
Do you stop the treatment when the child feels uncomfortable?	Always	1 (1.1%)	0 (0%)	0 (0%)	[2]0.766
	Often	81 (93.1%)	7 (87.5%)	5 (100%)	
	Sometimes	63 (72.4%)	3 (37.5%)	3 (60%)	
Do you prefer to give a gift or a prize if the child behaves in a cooperative manner during treatment?	Always	23 (26.4%)	3 (37.5%)	1 (20%)	[2]0.920
	Often	66 (75.9%)	4 (50%)	3 (60%)	
	Sometimes	55 (63.2%)	2 (25%)	4 (80%)	
	Never	53 (60.9%)	4 (50%)	2 (40%)	

[1]Fisher Freeman Halton Test *[2]Chi-square test * p<0.05*

There was a statistically significant difference (p=0.01) between the participants from different institutions with respect to using the behavioral guidance techniques in children. 59.8% of university-affiliated surgeons and 42.9% of private practitioners or clinicians had been trained, however, the surgeons working in the ODHCs did not receive training.

There was a statistically significant difference between the frequencies of using tell-show-do technique among the participants who were employed at different institutions (p=0.005). While 96.6% of university-affiliated surgeons used this technique, 71.4% of those working in private practice and 66.7% of those working in ODHCs used this technique.

The frequencies of using the voice control techniques among surgeons employed in different institution types were statistically significantly different (p=0.005), where 73.6% of surgeon working in university, 66.7% of surgeons working in ODHCs, and 14.3% of the employees in private practice used this technique.

There was also a statistically significant difference between the frequencies of using the distraction technique between surgeons from different institutions (p=0.012). 83.3% of surgeons working in ODHC and 63.2% of surgeon working in university used this technique, while only 14.3% of those working in private practice utilized this technique.

In terms of the frequency of use of parental presence/absence technique, there was also a statistically significant difference between physicians from different institutions (p=0.045); While 66.7% of surgeons working in ODHCs and 62.1% of university employees were using this technique, only 14.3% of those working in private practice stated that they use this technique.

There was a statistically significant difference between the frequency of using the sedation technique by surgeons working in different types of institutions (p=0.004); where 85.7% of the employees in the private practice and 34.5% of the university employees used this technique, but none of the surgeons working in ODHCs used this technique (Table 6).

Table 6: Assessment of responses to questionnaires according to type of practice

		Private practices or private clinics	Oral and Dental Health Centers	Faculties of Dentistry	p
		n (%)	n (%)	n (%)	
Taking the responsibility of working in a child patient when needed	Always	3 (42.9%)	3 (50%)	39 (44.8%)	[1]0.830
	Often	2 (28.6%)	1 (16.7%)	30 (34.5%)	
	Sometimes	2 (28.6%)	2 (33.3%)	18 (20.7%)	
Training in behavioral guidance techniques in children	Yes	3 (42.9%)	0 (0%)	52 (59.8%)	[1]0.010*
	No	4 (57.1%)	6 (100%)	35 (40.2%)	
Purpose in behavioral guidance techniques;	Increase your child's alignment	1 (14.3%)	0 (0%)	10 (11.5%)	[2]0.020*
	To establish and strengthen surgeon-child relationship	3 (42.9%)	2 (33.3%)	17 (19.5%)	
	Efficient and short-term treatment	0 (0%)	0 (0%)	6 (6.9%)	
	Reduce worry	1 (14.3%)	0 (0%)	0 (0%)	
	All	2 (28.6%)	4 (66.7%)	54 (62.1%)	
The need to get family approval to conduct behavioral guidance	Yes	5 (71.4%)	5 (83.3%)	69 (79.3%)	[1]0.856
	No	2 (28.6%)	1 (16.7%)	18 (20.7%)	
Use of behavior guidance techniques in children	Always	0 (0%)	1 (16.7%)	24 (27.6%)	[2]0.794
	Often	3 (42.9%)	2 (33.3%)	25 (28.7%)	
	Sometimes	4 (57.1%)	3 (50%)	37 (42.5%)	
	Never	0 (0%)	0 (0%)	1 (1.1%)	
Used behavior guidance techniques for child patients	Tell-show-do	5 (71.4%)	4 (66.7%)	84 (96.6%)	[1]0.005*
	Voice control	1 (14.3%)	4 (66.7%)	64 (73.6%)	[1]0.005*
	Nonverbal communication	1 (14.3%)	3 (50%)	23 (26.4%)	[1]0.364
	Positive reinforcement	5 (71.4%)	5 (83.3%)	63 (72.4%)	[1]1.000
	Distraction techniques	1 (14.3%)	5 (83.3%)	55 (63.2%)	[1]0.012*
	Presence-absence of parents	1 (14.3%)	4 (66.7%)	54 (62.1%)	[1]0.045*
	Hand-over-mouth	1 (14.3%)	0 (0%)	14 (16.1%)	[1]0.830
	Restrain/protective stabilization	4 (57.1%)	2 (33.3%)	30 (34.5%)	[1]0.468
	Hypnosis	0 (0%)	1 (16.7%)	1 (1.1%)	[1]0.121
	Sedation	6 (85.7%)	0 (0%)	30 (34.5%)	[1]0.004*
	General anesthesia	6 (85.7%)	3 (50%)	37 (42.5%)	[1]0.093
Are all of the behavior management techniques appropriate for every child?	Yes	0 (0%)	0 (0%)	2 (2.3%)	[1]1.000
	No	7 (100%)	6 (100%)	85 (97.7%)	
Would you prefer not to talk at all if the child is quiet and cooperative during the treatment?	Always	0 (0%)	0 (0%)	7 (8%)	[2]0.464
	Often	2 (28.6%)	1 (16.7%)	14 (16.1%)	
	Sometimes	3 (42.9%)	4 (66.7%)	26 (29.9%)	
	Never	2 (28.6%)	1 (16.7%)	40 (46%)	
Do you allow the child to talk or ask questions during treatment?	Always	0 (0%)	0 (0%)	19 (21.8%)	[2]0.001*
	Often	6 (85.7%)	2 (33.3%)	45 (51.7%)	
	Sometimes	1 (14.3%)	3 (50%)	23 (26.4%)	
	Never	0 (0%)	1 (16.7%)	0 (0%)	
Do you stop the treatment when the child feels uncomfortable?	Always	0 (0%)	1 (16.7%)	22 (25.3%)	[2]0.413
	Often	5 (71.4%)	3 (50%)	33 (37.9%)	
	Sometimes	2 (28.6%)	2 (33.3%)	32 (36.8%)	
Do you prefer to give a gift or a prize if the child behaves in a cooperative manner during treatment?	Always	1 (14.3%)	1 (16.7%)	3 (3.4%)	[2]0.012*
	Often	5 (71.4%)	1 (16.7%)	21 (24.1%)	
	Sometimes	1 (14.3%)	2 (33.3%)	55 (63.2%)	
	Never	0 (0%)	2 (33.3%)	8 (9.2%)	

*[1]Fisher Freeman Halton Test [2]Chi-square test * p<0.05*

DISCUSSION

It is quite difficult to examine and treat child patients. For this reason, oral and maxillofacial surgeons may be reluctant to treat or take responsibility for young child patients. A survey conducted in Pakistan showed that 36.5% of dental surgeons always, 22% often, 38% sometimes and 3.5% never take responsibility for the treatment of pediatric patients (5). Findings from our study showed that 45% of surgeons always, 33% often, and 22% sometimes took this responsibility. We did not observe any surgeon who did not treat pediatric patients. The present study is the first study evaluating the knowledge, attitude, and practices of oral and maxillofacial surgeon regarding behavior guidance techniques in Turkey.

This study shows that the vast majority of the surgeons working in the oral and maxillofacial clinics in Turkey (99%), and 79% of all oral and maxillofacial surgeons always use behavior guidance techniques. Similarly, Ajlouni *et al.*[7] have reported that 85% of Jordanian pediatric dentists always use the behavior guidance techniques.

Use of the behavior guidance techniques is an integral part of the pediatric dentistry practice.[8] In our study, 25% of the oral and maxillofacial surgeon working in maxillofacial surgery clinics used behavioral guidance techniques in children at all times and the most frequently used behavioral guidance techniques were tell-show-do (93%), positive support (73%), voice control (69%), distraction (61%) and parental presence/absence (59%). McKnight-Han *et al.*[9] showed that 96% of general dentists used tell-show-do and 88% used voice control, while 100% of pediatric dentists used tell-show-do and 98% of them used voice control. Sharath *et al.*[10] and Grewal *et al.*[11] reported that the most commonly used behavioral guidance technique in India is tell-show-do. In the study conducted by Wali and colleagues,[4] the most popular techniques that

dental surgeons used to manage children were stated to be distraction (33.5%), voice control (30.5%), and tell-show-do (29.5%). In the same study, 34% of the dental surgeons reported that they allowed the parents of the pediatric patients in their clinic during treatment.[4] In one study conducted in Israel, Peretz *et al.*[12] reported that dentists use tell-show-do and material reinforcement techniques more often than other behavior guidance techniques. Hypnosis (6%) was reported to be the least used method in the same study.[12] Hypnosis (2%) was also found to be the least used method in our study.

In the present study, there was a statistically significant difference between surgeons from different age groups with respect to control by voice, distracting, and using hand covering technique. In previously published studies, no significant difference was found between different age groups regarding any of the behavioral guidance techniques.[13,14]

We also determined that the pharmacological methods were also preferred by surgeons as behavior guidance techniques and that 36% of the surgeons used sedation and 46% used general anesthesia. There was no significant difference in sedation or general anesthesia use between male and female surgeons. Peretz *et al.*[12] observed that the use of general anesthesia was significantly more prevalent among male dentists than among females, and there was no significant difference between male and female dentists in terms of sedation use.

Wright *et al.*[15] reported that young dentists tend to use behavior guidance techniques more often than older dentists. In our study, it was observed that pediatric patients were treated mostly by young and university-affiliated surgeons (ages 23-30), and the behavioral methods were also used more often by younger (23-30 years), less experienced and university-affiliated surgeons. The use of behavioral guidance techniques by younger and less experienced surgeons can be explained by the positive changes in the curriculum in the faculties of dentistry that has taken place over time and the availability of more course opportunities. The more frequent use of behavior guidance techniques by university-affiliated surgeons is considered to be due to the fact that the vast majority of the participants were working at universities and that the pediatric patients are frequently referred to university hospitals due to the presence of pediatric dental clinics.

In line with the previous studies,[15,16] we found that the rate of behavior guidance technique use among female surgeons was statistically significantly higher than males. On the contrary to our work, Kawia *et al.*[5] reported that male surgeons used these techniques more than females.

CONCLUSION

In general, the results of this study show that the oral and maxillofacial surgeons working in public and private clinics have a high awareness of behavior guidance techniques while the level of this awareness varies among surgeons according to age, gender, workplace, work experience, and training. Training programs should be planned for the oral and maxillofacial surgeons to improve their knowledge and skills in providing treatment for children.

Conflict of Interests

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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Doi: 10.7126/cumudj. 466559 *RESEARCH ARTICLES*

SPECTROPHOTOMETRIC EVALUATION OF TOOTH COLOR IN CHILDREN WITH MIXED DENTITION

Karma Dişlenme Dönemindeki Çocuklarda Diş Renginin Spektrofotometrik Analizi

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ABSTRACT

Objective: In this study, the aim is to evaluate the shade of colors of the permanent maxillary central incisor, primary canine, primary first molar, primary second molar and permanent first molar teeth in individuals in mixed dentition stage using Vita Classic and Vitapan 3D Master scale, according to the L*, a*, b* color system.

Materials and Methods: Our study was performed on a total of 57 child patients between 7-12 years old. Color shade measurements were performed using VITA Easyshade Compact (Vita Zahnfabrik, Germany) spectrophotometry device; and CIE L*, a*, b* values according the Vita Classic and Vitapan 3D Master scale were recorded.

Results: In light of the obtained data, it was found that the L* value of the permanent first molar was the lowest, the L* value of the primary canine was the highest ($p<0.001$). The a* value of the central incisor was the lowest, whereas the a* value of the permanent first molar was the highest ($p<0.001$). According to the data, when the b* values were compared, a statistically significant difference was detected only between the central incisor and primary first molar teeth ($p=0.005$).

Conclusion: It was found that in individuals at the mixed dentition stage, according to the Vita Classic scale, B2 tones were found more frequently in permanent teeth whereas A2 tones were more common in the primary teeth. C2 and D3 tones were not detected in both groups.

Key Words: Spectrophotometer, tooth color, primary teeth, mixed dentition

ÖZ

Amaç: Bu çalışmada, karışık dişlenme dönemindeki aynı bireye ait daimi maksiller santral kesici, süt kanin, süt birinci molar, süt ikinci molar ve daimi birinci molar dişlerin renklerinin Vita Classic ve Vitapan 3D Master skalası ile L*, a*, b* renk sistemine göre değerlendirilmesi amaçlanmıştır.

Gereç ve Yöntemler: Araştırmamız; 7-12 yaş arası toplam 57 çocuk hasta üzerinde yapılmıştır. Renk ölçümleri VITA Easyshade Compact (Vita Zahnfabrik, Germany) spektrofotometre cihazı ile yapılmış; Vita Classic ve Vitapan 3D Master skalasına göre renk ve CIE L*, a*, b* değerleri kaydedilmiştir.

Bulgular: Elde edilen veriler doğrultusunda daimi birinci molar dişin L* değeri en düşük, süt kanin dişin L* değerinin en yüksek olduğu saptanmıştır ($p<0,001$). Santral kesici dişin a* değerinin en düşük, daimi birinci molar dişin a* değerinin en yüksek olduğu belirlenmiştir ($p<0,001$). Verilere göre b* değerleri karşılaştırıldığında ise sadece santral kesici ve süt birinci molar dişler arasında istatistiksel olarak anlamlı fark bulunmuştur ($p=0,005$).

Sonuçlar: Karışık dişlenme dönemindeki bireylerde Vita Classic skalasına göre daimi dişlerde B2 ve süt dişlerde A2 tonları en fazla yüzdeliğe sahip olduğu bulunmuştur. C2 ve D3 tonları her iki grupta da hiç saptanmamıştır.

Anahtar Kelimeler: Spektrofotometre, diş rengi, süt dişi, karışık dişlenme

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INTRODUCTION

Color is a concept that arises when different wavelengths of light reach the retina of the eye, and perceived subjectively by the observer.[1,2] The perceived color is affected by numerous factors including the personal color perception skills, light conditions, effect of the background, achromatism, differences between the two eyes, eye strain and other psychological factors; and in order for the color to be perceived, there should be an interaction between three factors. These are: light, object, and the observer.[3,4]

Color perception is subjective and thus differs from one person to another. This issue is of particular importance in dentistry. In dentistry, there are two different ways to perform color selection: visual measurement and color measurement devices. Visual measurement is subjective and is affected by the environmental factors.[5] Color measurement devices are objective and provide numerical data to the user.[6]

Among the color systems developed to be able to define the color with standardized, numeric values are Munsell, Commission Internationale de l'Eclairage XYZ and Commision Internationale de l'Eclairage L*a*b* (CIE L* a* b*) systems.[7]

Munsell analyzes the color in three parameters: Hue, Chroma and Value. Hue is the name of the color, while chroma is the intensity of the color and value is the brightness of the color.[8]

In Commission Internationale de l'Eclairage (CIE L* a* b*) color system, there are 3 different axes to define color, which are L*, a* and b* [2]. L* axis is the parameter that indicates the lightness, darkness, black/white or brightness of the color. In this parameter, the color closest to black has the value 0, while the color closest to white has the value 100 L*. The axes a* and b* represent the chromatic values of the color. The horizontal axis a* indicates the redness (+) and greenness (-) of the color. If the value is positive, it indicates the degre of redness, if it is negative, it indicates the degree of greenness; whereas the horizontal axis b* indicates the yellowness (+) and blueness (-) of the color. If the value is positive, it indicates the degree of yellowness, if it is negative, it indicates the degree of blueness.[9,10]

In the Commission Internationale de l'Eclairage (CIE XYZ) color system, the colors are referred to by the main tristimulus values. These are referred as X, Y, Z coordinates. X indicates the tristimulus values of red, Y of green, and Z of blue.[11]

Human teeth consists of soft tissue (pulpa), and the surrounding hard tissues comprising dentin and enamel, and the thickness of dentin and enamel are among the most important factors that determine the tooth color. Enamel and dentin thickness are different for primary and permanent teeth.[12] Moreover, the size of the tubules, array direction, volume of the pulp chamber and the vitality of the pulp tissue are the other factors that determine tooth color. Color intensity of the dentine is lower due to the masking effect of the enamel. Since the thickness of the enamel is the lowest at the cervical line and highest at the incisor edge, the intensity is the highest at the cervical line due to the reflection of the dentine layer from below, and it decreases toward the incisor edge.[13]

Different from the permanent teeth, in primary teeth, the enamel contains more organic ingredients, is less mineralized and the distance between the enamel crystals is greater. Therefore, enamel layer of the primary teeth is more opaque than the permanent teeth.[10,14] Compared with the size of the crowns of the primary teeth, the volume of the crown pulps of the primary teeth is greater than the volume of the crown pulps of the permanent teeth. Moreover, the decrease in the pulp chamber in permanent teeth upon the formation of tertiary dentin leads to a more yellowish appearance of

the permanent teeth compared with the primary teeth. While the shade of the primary teeth are bluish white, the shade of the permanent teeth is yellowish. The more matte and bluish appearance of the primary teeth is a physiologic condition.[15] Since the enamel in the primary teeth has a more opaque structure, the teeth have a white color that is called "milk color" and appear more bright.[16]

The method used to determine the tooth color must be easy to apply and reproducible. For color selection, two methods are used, which are visual measurement and color measurement devices.[17] In dentistry, determining the color is mostly performed by comparing the permanent tooth color scales with the color of the tooth itself.[18] Tooth color and the scale are subjectively compared under the same light source. When choosing the color, the interaction between the light source, object and the observer is important. The most important of these factors is the light source. The perceived color of an object is affected by the type of light the object is exposed to, its relationship with the colored objects at the environment and the experience of the observer. Because of this, a tooth can appear to have different colors under different circumstances.[19] The most frequently used scales in the clinical studies are Vitapan Classic and Vita 3D Master scales. Vita Classic scale has 4 different color tones, A, B, C and D, and comprises 16 colors with different color intensities in each group. Vita 3D Master scale is divided into 5 different color groups and comprises a total of 26 colors. In the scale, the numbers 1, 2, 3, 4 and 5 in front of the letters indicate the group number decreasing depending on the brightness; and the letters M, R and L indicate the color hue. L indicates the yellow hue, M the middle of the yellow and red hues, and R indicates the red hue. The numbers 1; 2; 3; 1.5 and 2.5 after the letters incidate the color intensity.[20]

Color measurement devices are spectrophotometer, colorimeter and digital cameras.[21] Spectrophotometer measures the amount of visible energy reflected by an object and records it by identifying its value, chroma and hue values as a wavelength.[22] It is a correct, reliable and easy-to-use device used to measure and compare color in dentistry.[23]

Colorimeter measures the transmittence and tristimulus values at the red, blue and green regions in the visible spectrum. It takes measurements according to the CIE Lab units (L*, a*, b*) and the obtained values can be mathematically analyzed.[24]

The working principle of the digital cameras is to analyze the obtained photograph pattern in the computer that the camera is connected to. After the image of the object of interest is obtained using the digital camera, the connected computer expresses these values in terms of CIE Lab units (L*, a*, b*).[25]

In the current study, using VITA Easyshade Compact (Vita Zahnfabrik, Germany) spectrophotometer, the data obtained after performing the color measurements of the permanent maxillary incisor, permanent primary molar and primary canine, primary first molar, primary second molar teeth without any structural and formal abnormality in the same individual in the healthy children aged between 7-12 years and at the mixed dentition stage were evaluated.

MATERIALS AND METHODS

This study was performed on a total of 57 children aged 7-12 years, without any decayed tooth or restoration in the mixed dentition stage, and with left or right permanent maxillary central incisor, primary canine, primary primary molar, primary second molar and permanent first molar teeth, who were admitted to the Department of Pedodontics in Bezmialem University, Faculty of Dentistry, after obtaining the approval of the clinical research ethics committee. Before the color

measurement, it was checked whether fluoride gel or varnish was applied on the patient's teeth. Volunteering children participating in the study and their parents were informed about the study and its objective, and they were asked to sign an informed consent form. Before starting the color measurements, teeth which will be measured was brushed by the researcher without using any paste. Then, according to the company's instructions, color measurement was performed on the primary and permanent teeth at the same half of the maxilla using Vitapan 3D mastershade. All measurements were made by the same researcher, and to prevent cross-contamination, Vita Easyshade was disinfected after each measurements and for calibration, the probe was placed into the calibration area of the device that contains a ceramic chamber. The standard light necessary for measurement is generated by the lighting system at the probe and developed specifically for this purpose; thus, based on the company's recommendations, the light at the environment was ignored. The measurement was performed by selecting the single measurement option of the spectrophotometer and according to the instruction manual, by placing the probe in a way that enables it to contact horizontally with the central triad region at the vestibular surface of the teeth.

Measurement results were arranged according to both the Vitapan 3D Master color scale and the Vita Classic color scale, and the color distribution percentages were calculated according to these two color scales. CIE L*, a* and b* values and color values determined according to the Vita Classic and Vitapan 3D Master scale were recorded. Measurement results were collected according to Vita Classic color scale and Vita 3D Master color scale. Color distribution was calculated according to thsi scale.

RESULTS

In light of the data obtained from the individuals, percent color distribution of permanent and primary teeth according to Vitapan Classical scale are given in Table 1. A2 was found more than the other colours both in permanent and primary teeth.

Table 1. Percent color distribution of permanent and primary teeth

PERMANENT TEETH		PRIMARY TEETH	
A1	5.3	**A1 and A4**	9.2
A2	21.1	**A2**	21.5
A3	15.8	**A3**	16.2
A3.5	1.8	**A3.5 and B2**	4.8
B3	10.5	**B3**	11.4
C1	7.0	**C1 and C3**	5.3
C4	3.5	**C4**	6.6
		D4	5.7

CIE L*, a*, b* values of the teeth of individuals are seen in Table 2. According to the Kruskal-Wallis Test, L *, a *, b * values must have a $p<0.005$. A $p=0.005$ for L* and a* makes the value significant for us (Table 2).

Table 2. CIE L*, a*, b* values of the teeth of individuals

	L*	a*	b*
Chi-Square	92.671	91.827	14.669
p	0.000	0.000	0.005

To perform pairwise comparison, Dunn test was performed and the teeth were compared in terms of their L*, a* and b* values.

The groups were compared in terms of their L* values and it was found that there is a statistical significance ($p<0.001$). As a result of the Dunn test, a significant difference was detected between permanent molar-primary second molar, permanent first molar-central incisor, permanent first molar-primary first molar, permanent first molar-primary canine, primary canine-primary second molar, central incisor-primary canine, primary canine-primary first molar (Table 3).

Table 3. Comparison between the groups in terms of their L* values

L*	Permanent Central Incisor	Primary Canine	Primary 1st Molar	Primary 2nd Molar	Permanent 1st Molar
Median	81.300	85.600	81.800	79.000	71.100
Minimum	23.1	60.0	29.1	61.5	47.2
Maximum	87.3	93.6	91.2	86.5	84.6

• Median L* value of the primary second molar > median L* value of the permanent first molar

• The median L* value of the central incisor > median L* value of the permanent first molar

• The median L * value of the primary second molar > median L* value of the permanent first molar

• The median L* value of the primary canine > median L* value of the permanent first molar

• The median L * value of the primary canine > median L * value of the primary second molar

• The median L * value of the primary canine > median L * value of the central incisor

• The median L * value of the primary canine> median L* value of the primary first molar

When the groups were compared in terms of a* value, a statistical difference was detected ($p<0.001$). Dunn test was performed for pairwise comparisons and it was found that there is difference between central incisor-primary canine, central incisor-primary second molar, central incisor-primary first molar, central incisor- permanent first molar, primary canine-primary first molar, primary canine-permanent first molar (Table 4).

Table 4. Intergroup comparison in terms of the a * value

a*	Permanent Central Incisor	Primary Canine	Primary 1st Molar	Primary 2nd Molar	Permanent 1st Molar
Median	-0.900	0.300	1.500	1.200	1.600
Minimum	-2.8	-1.5	-0.6	-0.7	-1.0
Maximum	5.2	13.1	11.9	19.3	7.6

• Median a* value of the primary canine > median a* value of the central incisor

• Median a* value of the primary second molar > median a* value of the central incisor

• Median a* value of the primary first molar > median a* value of the central incisor

• Median a* value of the permanent first molar > median a* value of the central incisor

• Median a* value of the primary first molar > median a * value of the primary canine

• Median a* value of the permanent first molar > median a * value of the primary canine

When the groups were compared in terms of b* value, it was found that there is a statistical difference ($p = 0.005$). Dunn test was performed for pairwise comparison and it was found that there is difference between central incisor-primary first molar teeth (Table 5).

Table 5. Intergroup comparison in terms of the b* value

b*	Permanent Central Incisor	Primary Canine	Primary 1. Molar	Primary 2. Molar	Permanent 1. Molar
Median	20.400	20.200	22.600	21.700	20.200
Minimum	4.4	2.7	6.5	4.5	8.9
Maximum	32.3	41.2	42.2	33.7	32.5

• Median b* value of the primary first molar > median b* value of the central incisor

DISCUSSION

Human teeth is made up of enamel, dentin and soft tissues (pulp). Enamel and dentin layers are hard tissues that surround the soft tissue of the tooth.[8,12] The thickness of these layers have important effects on tooth color. Difference between the primary teeth and permanent teeth in terms of the thickness of their enamel and dentin layers lead to a difference in color between the primary and permanent teeth. Moreover, thicker aprismatic layer of the primary teeth than the permanent teeth, larger pulp chamber in the primary teeth than the permanent teeth, less mineralized enamel and higher organic content of the primary teeth make primary teeth more opaque compared to the permanent teeth. Due to its high opacity, the enamel of the primary teeth tends to reflect the light. The amount of light reflected from and absorbed by the teeth depends on the thickness and transmittence of the dentin and enamel layer, and therefore these tissues play

important role in determining the tooth color. Enamel tends to reflect the light.[10, 14]

In this study on the analysis of color values of the teeth, using the spectrophotometer for color measurement, the amount of the visible energy in the light reflected by the tooty surface was measured and its wavelength was calculated.

Based on the results of the study, it was found that permanent first molar has a darker color than the permanent central, primary canine, primary first molar and primary second molar teeth. Since the L* value of the permanent molar tooth is low and a* value is high, the tooth appears darker and more red. In this study, it was found that the primary canine tooth has much lighter color than the other teeth whose color values were measured. This is because the L* value of the primary canine is high and a* value is low (Table 3). The negative a* value (-0.900) of the central incisor suggests that this tooth is greenish in color (Table 4). Pop-Ciutrila *et al.*[12] reported that the permanent molar tooth is darker than the permanent central and canine teeth. This is because the L* value of the molar tooth is lower than the L* value of the other teeth analyzed and the data obtained are concordant with Pop-Ciutrila *et al.*[12]

In the study by Savaş *et al.*[26] in which the spectrophotometric color analysis of the permanent central teeth was performed based on their apical development, it was found that the most frequently observed tooth color in permanent central teeth is A2, and a statistically significant difference was detected between the dental root development and L* values.

There is no significant difference in terms of the b* values between the teeth of the individuals other than that between the primary first molar and permanent central incisors. Primary first molar teeth are more yellowish than the central incisors (Table 5).

In the individuals participating in the study, percent values according to the Vitapan Classic scale were analyzed and B2 color was found more commonly in permanent teeth while A2 was more common in the primary teeth. The colors C2 and D3 could not be detected (Table 1). These findings are not concordant with the results of the study performed by R. Meera *et al.*[27] According to the abovementioned study, the shade D2 has a higher percentage in the shade distribution of the primary teeth.[27] In the study by Öngül *et al.*[20], the shade distribution of the permanent central teeth according to the Vita Classical scale was B2, C2 and C3. In the study by Yılmaz *et al.*[28], it was reported that the shades A1 and B2 were more commonly observed in the permanent central teeth according to the Vita Classical scale.

When the shade of the primary and permanent teeth in children at the mixed dentition stage was evaluted, it was found that the primary canine tooth had a higher L* value than the other teeth. It was found that the a* value of the permanent first molar was higher than the other teeth. In the obtained data, a statistically significant difference was detected only between the primary first molar and central incisor in terms of the b* value.

CONCLUSION

In or study, it was found that the L* value of the permanent first molar teeth was the lowest, and the L* value of the primary canine tooth was the highest. While there is a significant difference between the teeth in terms of the a* value, there is a significant difference in terms of the b* value only between the primary first molar and permanent central incisor. While the distribution is mostly ranges between the shades A and B according to the Vita Classic scale, C2 and D3 could not be detected.

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Doi: 10.7126/cumudj.480461 *RESEARCH ARTICLES*

THE PLAQUE REMOVAL EFFECTIVENESS OF POWERED AND MANUAL TOOTH BRUSH IN CHILDREN: A PILOT STUDY

Çocuklarda Otomatik ve Manuel Diş Fırçalarının Plak Uzaklaştırma Etkinliği: Bir Pilot Çalışma

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ABSTRACT

Objective: Aim of this study was to compare the plaque-reducing effectiveness of powered and manual tooth brushing in a small group of children.

Materials and Methods: Ten children aged between 7 to 10 years old were included the study. Each child firstly used manual tooth brush (ORAL B Stages for children). After two weeks children were asked to use powered tooth brush (ORAL-B TRIUMPH 5000 SMART GUIDE) for two weeks. Turesky modification of the Quigley and Hein Plaque Index (TQHPI) and Approximal Plaque Index (API) scores were recorded every two weeks. Friedman test and Wilcoxon signed rank test were used for comparison the jaws and powered brush /manual brush. Significance at $p < 0.05$ were considered.

Results: The whole mouth TQHPI and API were significantly different at after Powered Tooth brushing ($p=0.005$, $p= 0.012$). Statistics determined the most significant relationship was observed between baseline-post powered brushing and between manual-powered brushing in both TQHPI and API values ($p=0.008^{**}$, $p=0.005^{**}$, $p=0.018^{*}$, $p=0.012^{*}$).

Conclusion: Considering the results of the pilot study; it shows that it is more effective in removing dental plaque in both automatic and manual tooth brushing. Therefore, powered tooth brush can also be recommended for children to increase the oral health.

Key Words: Powered Tooth Brush, Children, Oral Health

ÖZ

Amaç: Bu çalışmanın amacı bir grup çocukta otomatik ve manuel diş fırçalamanın dental plak uzaklaştırmadaki etkinliğini karşılaştırmaktır.

Gereç ve Yöntemler: Çalışmaya 7 ile 10 yaş arası 10 çocuk dahil edilmiştir. Her çocuk ilk önce 2 hafta süre ile manuel diş fırçası kullanmıştır (ORAL B Stages). İki hafta sonunda çocuklarda plak indeksleri ölçülmüştür. Sonrasında çocuklara iki hafta standart diş fırçalamaya devam etmeleri istenmiş ve bu iki haftanın sonunda çocuklardan otomatik diş fırçasına (ORAL-B TRIUMPH 5000 SMART GUIDE) geçmeleri söylenmiştir. Quigley ve Hein Plaque Index (TQHPI) ve Approximal Plaque Index (API) skorlarının Turesky modifikasyonu her iki haftada bir kaydedilmiştir. Otomatik fırça/manuel fırçaların karşılaştırılmasında Friedman testi ve Wilcoxon işaretli rank testi kullanılmış, anlamlılık $p < 0,05$ olarak kabul edilmiştir.

Bulgular: Tüm ağız dental plak ölçümü incelendiğinde otomatik ve manuel diş fırçalama arasında; TQHPI ve API'lerine göre istatistiksel olarak anlamlı farklılık belirlenmiştir ($p=0,005$, $p=0,012$). İstatistiksel analiz; başlangıç dental plak ölçümü ve otomatik fırça, manuel ve otomatik diş fırçası arasında ikili karşılaştırmalar yapıldığında TQHPI ve API'lerine göre ileri derecede anlamlı farklılık olduğunu göstermiştir ($p=0,008^{**}$, $p=0,005^{**}$, $p=0,018^{*}$, $p=0,012^{*}$).

Sonuç: Pilot çalışma sonuçları göz önünde bulundurulduğunda; otomatik ve manuel diş fırçalamanın ikisinin de dental plağın uzaklaştırılmasında etkili olduğunu göstermektedir. Bu sebeple çocuk hastalara otomatik diş fırçaları da önerilebilir.

Anahtar Kelimeler: Otomatik diş fırçası, Çocuklar, Ağız Sağlığı

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INTRODUCTION

Dental biofilms are the primary etiologic factors in the two most prevalent oral diseases, dental caries and periodontal diseases.[1, 2] It has long been recognized that the presence of dental plaque leads to gingivitis, periodontitis and is also capable of reducing the pH at the surface of enamel to the levels that can cause dissolution of the hydroxyapatite crystals and initiates caries.[3] The disease can gravely affect the quality of life of children as well as adult patients, furthermore, contracting the disease at an early age puts these children at greater risk of developing caries and periodontal disease in the future. As a result, many end up requiring general anasthesia to under go treatment for a disease that is completely preventable.[4] Mechanical methods for plaque control are still the most widely used and accepted.[1, 5] Plaque control is defined as plaque removal on a routine daily basis and preventing its reaccumulation on tooth surfaces. It is assumed that efficient bacterial plaque removal can be accomplished by brushing the teeth for two minutes twice a day, using a fluoridated toothpaste. However, patients tend to overestimate the time they spend on oral hygiene. Tooth- brushing times below the recommended 2 minutes are observed, especially when no time control is conducted. Unfortunately, effective mechanical methods of plaque control are relatively tedious, time consuming and, difficult to master in children.[1,6] There arises difficulty in oral hygiene maintenance so the oral hygiene methods may need to be simplified or modified to suit the individual situation.[4,5,7-10] Considering the characteristics of individuals, there might be advantages and disadvantages of the materials used in oral hygiene especially in brushing. Hand skills, manuplation, consuming time, having fun may be defining features for choosing the right methods and tools to encourage the children for brushing their teeth daily.

The pressure of the toothbrush head during toothbrushing seems to significantly affect the condition of the tissue in the oral cavity. According to some authors, manual toothbrushing entails the application of much higher pressure than the use of power brushes.[1, 11,12] Powered toothbrushes appear to be helpful in improving the oral health of physically or mentally handicapped individuals because these devices require minimal hand motion and coordination skills. Some models are designed with each bristle rotating individually and are effective plaque removers. Although previous comparative studies between powered and manual toothbrushes have led to somewhat equivocal results, however, a review study showed advantage in plaque removal and reduction in gingivitis was seen for oscillating/rotating design of power brush.[3]

Vibhute *et al.*[2] reported a meta analysis study and concluded that as no trial compared durability and reliability of using manual versus powered brushes, it is not possible to make clear recommendation of toothbrush superiority.

The aim of this study is to compare the efficacy of an electric toothbrush with that of a manual toothbrush in controlling plaque and gingivitis in a small group of children.

MATERIALS AND METHODS

Ten children (3 girls, 7 boys) aged ranged between 7 to 10 years old were included the study. A single investigator explained the objectives of the research to the participants and their parents and asked them to sign the informed consent form. Inclusion and exclusion criteria applied for all participants are reported in Table 1.

Table 1: Inclusion and exclusion criteria applied for the selection of participants

Inclusion criteria	*Exclusion criteria*
Good general health	Any systemic disease
Minimum 20 natural teeth	Any removable or fixed orthodontic appliance
Never used a sonic power tooth brush before	A present history of medications that are likely to affect oral health.
dmft/DMFT < 5	Bad oral health: caries, periodontal diseases or oral lesions, dmft/DMFT > 5
	physical, mental abnormality restricting free movement of the hands

This study was planned as a randomized, single examiner, 6 weeks clinical trial with three study visit which consisted of 2 phases of 2 weeks duration each. Participants were provided with manual tooth brush (Oral-B®: ORAL B Stages for children) and powered toothbrush (Oral-B®TRIUMPH 5000 SMART GUIDE). To rule out the effect of toothpaste both group were advised to use their daily toothpaste during the study period. Bass technique for the manual brushing was demonstrated and powered electric brush was shown how to use according to the instruction and manufacturer's recommendation. After demonstration, all the participants were asked to replicate demonstrated movements on an oral model. No specific interdental cleaning aids were recommended. Participants were advised to brush at least 2 minutes. The subjects were given to familiarize and adapt to the manual and powered toothbrushes and brushing techniques, before starting the study. The following appointment was planned at two weeks after. Each child firstly used manual tooth brush. After two weeks children were given an appointment to keep oral hygiene motivation and obtain washout without changing the manual toothbrush. After four weeks from the initial session, this session is also the baseline of the powered toothbrush session, participants were asked to use powered tooth brush for two weeks.

Initial visit: Participants received an oral examination of hard and soft tissues and GC Plaque ID Gel was used for disclosing plaque. PI values were recorded for the facial and interproximal surfaces of all the teeth following use of a disclosing agent applied with a cotton applicator. Plaque evaluation was performed using Turesky modification of the Quigley and Hein index (TQHPI)[13,14] and Approximal Plaque Index (API).[15] All scores were recorded as baseline values of the manual session and asked the participants to use manual toothbrush for two weeks.

First visit (After 2 weeks from initial): Intraoral examination was performed and plaque was disclosed as initial visit. PI values were recorded as after manual toothbrushing session Participants were asked to keep brushing by using manual toothbrush and sheduled next appointment for two weeks after.

Second visit (After 4 weeks from initial): For second session once again initial protocol of the plaque was performed at baseline for powered toothbrush and asked participants to brush with powered device for two weeks.

Third visit (After 6 weeks from initial): The second toothbrush was tested by using same initial assessment of plaque and new plaque score was recorded following the same procedure as above.

Data Analysis: All subjects were told to inform if any problem with manual or powered toothbrush in between study period. The subjects were examined at the baseline and end of 2 weeks. At the start of 2st phase, plaque scores were again reduced to baseline. Each time plaque and gingival status scores were recorded by a single investigator. At the end of 2 weeks, cross over was done. All measurements were performed by the same investigator. Entire mouth indexes were calculated using the following formula: index= total score/ number of examined surfaces.

Statistics: Data were statistically analyzed by using IBM SPSS Statistics 22 (IBM SPSS, Turkey). Friedman test and Wilcoxon signed rank test were used for comparisons at a significance at $p < 0.05$.

RESULTS

There were 10 children (7 boys, 3 girls) (mean age=8.30±1.06) participated at the beginning of the study. One subject dropped out after the first visit therefore, was not included in the results of this study. Another subject was unable to be present at the final phase of the study and was, hence, only included in a portion of the results.

Dental plaque index measurements were repeated 3 times; at baseline, after manual toothbrushing, and after powered toothbrushing. Table 2 and Table 3 shows the TQHPI and API Scores baseline and after assigned toothbrushing according to their own index scale.

Table 2: tqhpi scores at beginning and after assigned tooth brushing

SCORE	Beginning (%)	After Manual brushing (%)	After Powered brushing (%)
5	19,5	8,05	0,4
4	10,05	12,3	4,2
3	18,5	19,4	13,2
2	29,6	33,6	27,01
1	17,4	12,3	21,3
0	4,7	14,2	33,6

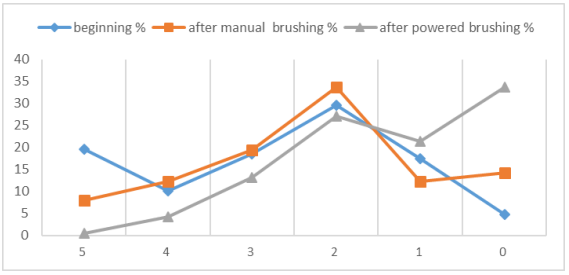

Fig1: TQHPI at beginning and after assiggned tooth brushing

Table 3 : API Scores At Baseline And After Assisgned Tooth Brushing

SCORES	Beginning (%)	After Manual Brushing (%)	After Powered Brushing (%)
1	88,8	83,4	56,4
0	11,2	16,6	43,6

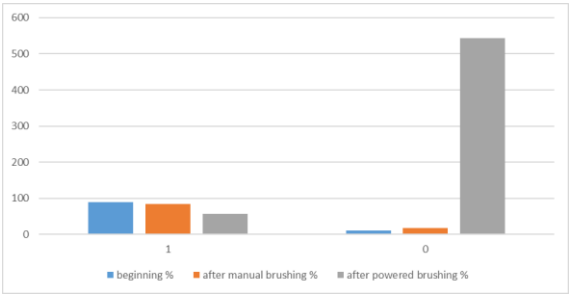

Fig 2: API at Beginning and After Assigned Tooth Brushing

The whole-mouth mean plaque scores for each toothbrush type are shown in Table 4. The whole mouth TQHPI and API were significantly different at after Powered Tooth brushing (p=0.005, p=0.012). Noticeable decrease was obtained in mean value at baseline and after powered tooth brushing. Powered toothbrush resulted in a larger reduction in plaque score when compared to the manual one. Despite the decline observed in the manual tooth brushing, this reduction is not statistically significant (p=0.173, p=0.345).

Table 4: Comparison of Whole Mouth Plaque Indices Among Assigned Toothbrushes

Assigned toothbrush	TQHPI at baseline mean±SD (median)	TQHPI 2 weeks follow up mean±SD (median)	p	API at baseline mean±SD (median)	API 2 weeks follow up mean±SD (median)	p
Manual toothbrush	2,71±0,8 (2,54)	2,25±0,81 (2,45)	**0.173**	0,88±0,17 (1)	0.83	**0,345**
Powered toothbrush	2,25±0,81 (2,45)	1,37±0,64 (1,34)	**0.005****	0,83±0,14 (0,78)	0,55	**0,012***

*Wilcoxon sign test **p<0.01 * p<0.05*

An evaluation was also performed to see if there were any differences among toothbrushes types at baseline and 6 weeks follow up. There was a statistically significant interaction between the toothbrush type and changes in TQHPI and API plaque score from baseline to the 2-week follow-up visit ($^{**}p<0.01$, $^{*}p<0.05$). (Table 5). Statistics determined the most significant relationship was observed between baseline-post powered brushing and between manual-powered brushing in both TQHPI and API values ($p=0.008^{**}$, $p=0.005^{**,}$ $p=0.018^{*}$, $p=0.012^{*}$).

Table 5: Interaction Between The Toothbrush Type and Baseline

	TQHPI (p)	API (p)
Beginning & Manual Brushing	0,173	0,345
Beginning & Powered Brushing	0,008**	0,018*
Manual Brushing & Powered	0,005**	0,012*

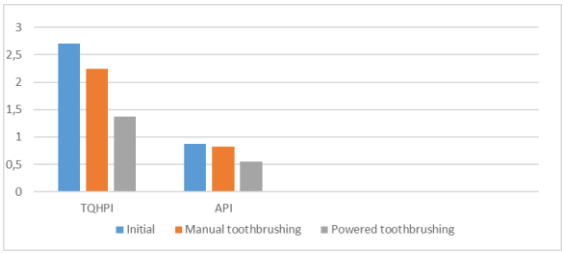

Fig 3: Plaque index reductions for the tested manual and powered toothbrushes

DISCUSSION

The prevetion procedure of oral hygiene depends on the ability and motivation of individual patients.[16] Both manual and power toothbrushes have increased the ability to remove plaque, although the effectiveness of manual toothbrush is still limited by manual dexterity and skill of the user.[1,17] Powered toothbrushes have partially overcome this limitation with the added advantage of simplifying the brushing technique and increasing the motivation to brush regularly.[5] In

our study we have evaluated the potential advantage of powered toothbrush over manual toothbrush in plaque control for children.

Turesky modification of the Quigley Hein Index (TQHPI) and Approximal Plaque Index (API) were used for plaque score with GC Plaque ID gel in the study. This clinical trial was designed to define the toohbrushing efficacy on not only smooth surface but also approximal surfaces. Therefore, no additional interdental oral hygiene tools were recommended. Re *et al.*[5], Silvermann *et al.*[19], Sheikh-Al-Eslamian *et al.*[18] used the same index to record the dental plaque. Yousaf *et al.*[3] studied with Silness- Löe plaque index, because it can be recorded easily and evaluated in a simple way. Furthermore, The Rustogi Modified Navy Plaque Index was used by Klukowska *et al.*[20] for analyzing of difficult to clean surfaces such as the gingival margin and approximate areas. It is more difficult to clean approximal and gingival margin areas to sustain gingival health by the ordinary brusher.[21, 22] A large research by Morris *et al.*[23] concluded that even when adults brushed immediately before an examination, a non disclosed plaque was seen on the one-third of the teeth. Reguarding this situation, it is much more difficult for children to remove dental plaque with manual brushes all the surfaces of tooth.

Sharma *et al.*[24] made their research for 4 weeks and concluded substantial improvements in plaque coverage and reported that both brushes had been well tolerated. Re et al designed the study for three appointments were sheduld one week apart and asked the participants to refrain from all oral hygiene measures 23-25 h prior to the appointment their teeth and brush teet at visit on site.[5] Silverman *et al.*[19] have studied for 6 weeks on 4 to 5 years old children by dividing the participants in to three groups according to the brush types and asked to brush their allocated toothbrushes at home fort he next 5 to 7 weeks. Goyal *et al.*[7] assigned the subjects by lottery method to one of two groups providing the groups to start brushing manual or powered tooth brush randomly for first three months and order was reversed for following three months. Jain et al compared the efficacy of powered and manual toothbrushes in controlling plague and gingivitis over a 6 week period. On 14th and 42nd days, significant results was shown by the subjects in the powered group.[6] The partcipants in our study firstly used manual toothbrush for two weeks and following two weeks they used powered one. Between manual and powered brushes washout sesssion were assigned. Therefore the trial was completed in six weeks.

There are overmuch clinical studies that have shown a relationship between oral hygiene status and the amount of dental plaque. In plaque control, both two brushes have significantly effect but powered toothbrush has better effect. Lazarescu *et al.* Jongenelis, Baab and Johnson,and Preber *et al.* had obtained similar results in their studies.[25,26,27,28] However, William *et al.*[29] resulted their studies as both brushes were equally effective in removing biofilm.

According to the Jain et al findings in oral hygiene score; no statistically significant difference was found between the manual toothbrush and powered toothbrush groups. However; Jain concluded that; powered toothbrushes offer an individual the ability to brush the teeth optimally to remove plaque and improve gingival health.[6] Silverman reported that the powered one performed significantly better in the 6 weeks trial for dental plaque removal.[19] In a study by Heasman, they observed lower plaque index in powered toothbrush users in comparison with manual toothbrush users especially at the inter proximal surfaces.[30]

Cochrane database showed that there was moderate quality evidence that powered toothbrushes provide a statistically significant benefit compared with manual toothbrushes with regard to the

reduction of plaque in both the short term and long term.[31]

In a review study by Robinson *et al.* reported that 42 studies were evaluated regarding powered and manual toothbrushes use and no significant difference was found in plaque removal between the powered toothbrushes with counter oscillation, side-to-side, circular ultrasonic or ionic movements, and manual toothbrush. However, Robinson added; powered toothbrushes with rotation oscillation movement acted more efficiently than manual toothbrushes.[32] According to meta-analysis by Vibhute and Vandana, there was no significant difference between the electric toothbrush and the manual toothbrush in plaque index. Although ionic and manual brushes showed statistically significant reduction of plaque index from baseline. Effect size of pooled data demonstrated a very large effect of using powered toothbrush for plaque removal as compared to manual toothbrush.[2] Similirly, we found reduction the plaque aqumulation not only smooth surfaces but also interproximal surfaces by using powered toothbrush.

CONCLUSION

In children without any previous experience of powered toothbrush and any training from parents, powered tooth brush showed more reduction in plaque compared to manual one. Considering the limitations of the study group, powered toothbrush might be recommended as effective and safe as manual toothbrush for children.

Bullet Points:

✓ To observe if the children who have just started to brush their teeth by their selves, use powered toothbrush as effective as manual toothbrush

✓ To find out if powered toothbrush do provide an effective dental plaque reduction a conventional manual toothbrush

✓ There is lack of comparative study on powered toothbrush versus manual toothbrush in children

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Doi: 10.7126/cumudj. 449340 *RESEARCH ARTICLES*

A COMPARISON OF THE WATER ABSORPTION AND WATER SOLUBILITY VALUES OF FOUR DIFFERENT COMPOSITE RESIN MATERIALS

Dört Farklı Kompozit Materyalinin Su Emilim ve Çözünürlük Değerlerinin Karşılaştırılması

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ABSTRACT

Objectives: The aim of this study was to compare the water absorption and water solubility of four different composte resin materials.

Materials and Methods: A total of 40 cylindrical discs were prepared and polymerised with light, as 10 from each group, each sample 2 mm in depth and 8 mm in diameter. The samples were kept for 24 hrs in a dessicator until a stable weight was reached. Then, the weight of each sample was measured on highly sensitive scales. To calculate the water absorption and solubility, measurements were made again with the sensitive scales at the end of 1, 7 and 30 days. The data obtained were evaluated with One-Way ANOVA variance analysis and the Friedman test.

Results: As a result of the statistical analyses, significant differences were determined between the composite resins in respect of water absorption on days 7 and 30 and in respect of solubility on day 30 only ($p<0.05$).

Conclusion: When the water absorption and water solubility of composite resins at the end of 30 days were evaluated statistically, it was observed that Ceram X One material showed the lowest values. This is related to the structure of the restorative material.

It can be concluded that the negative mechanical, physical and biological effects created by the water absorption and water solubility factors of restorative materials are important issues that should be taken into consideration.

Key Words: Composite resin, water absorption, water solubility.

ÖZET

Amaç: Bu çalışmanın amacı estetik amaçlı kullanılan dört farklı kompozit rezinin su emilimi ve sudaki çözünürlüklerinin karşılaştırılmasıdır.

Gereç ve Yöntemler: Çalışmada her kompozit grubundan 10 tane olmak üzere 2 mm derinliğinde 8 mm çapında toplam 40 adet silindirik disk hazırlandı ve ışıkla polimerize edildi. Örnekler sabit ağırlıklarına ulaşıncaya kadar 24 h desikator icinde bekletildi. Daha sonra tüm örneklerin ağırlıkları hassas terazi ile ölçüldü. 1, 7 ve 30. günlerin sonunda su emilimini ve çözünürlük sonuçlarını hesaplamak için hassas terazi ile tartımlar yapıldı. Elde edilen veriler ANOVA tek yönlü varyans analizi ve Friedman testleri kullanılarak değerlendirildi.

Bulgular: Yapılan istatistikler sonucunda kompozit rezinlerin su emiliminde 7. ve 30. günlerde, sudaki çözünürlüklerinde ise sadece 30. günde anlamlı farklılıkların olduğu saptanmıştır ($p<0,05$).

Sonuç: Kompozit rezinlerin 30 gün sonundaki su emilimi ve suda çözünürlüğü istatistiksel açıdan değerlendirildiğinde Ceram X One materyalinin en düşük değerleri gösterdiği görülmüştür. Bu da restoratif materyalin yapısı ile ilişkilidir.

Sonuç olarak restoratif materyallerin su emilimi ve suda çözünürlük faktörleri, mekanik, fiziksel ve biyolojik olarak olumsuz etkiler oluşturduğundan gözönünde bulundurulması gereken önemli konulardandır.

Anahtar kelimeler: Kompozit rezin, su emilimi, sudaki çözünürlük

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INTRODUCTION

Advances in adhesive dentistry have made it significantly easier for dentists to select the correct materials for clinical use. Restorative materials in combination with adhesive resins aiming to meet the aesthetic expectations of the patient, are frequently used especially in the restoration of dental caries, congenital defects, dental wear and crown fractures.[1]

Composite materials, which are currently widely used in aesthetic dentistry, were first developed by Dr R. Bowen in 1962. These materials, which were produced as an alternative to amalgam, have the advantages of strong adhesion to dental tissues, superior physical properties, can be easily shaped and have a broad colour scale, and there has been increasing use of these materials in the posterior region.[2]

However, in adition to these properties, there are several disadvantages that can affect the clinical life of composite resins, such as surface smoothness, microleakage, polymerisation freezing, fragility, discolouration, water absorption, wear, and low resistance to contraction and tension.[3,4]

A disadvantage of all composite resins is the water absorption property and that hydroscopic expansion occurs associated with water absorption within the mouth.[5,6] The water absorption and solubility of restorations are extremely important because composite resin-based filling materials in the interface region are usually in contact with the gingival region and fluid in the gingival groove.[7] As a result of this, fractures and discolourations are observed in the interface contours of composite resin restorations.

According to several studies, water absorption of restorative materials deteriorates the chemical structures and this is seen with an increase in surface smoothness of the materials.[8]

Increased weight related to water absorption and subsequent water solubility of the material (filling and monomers) occurs through two different mechanisms.[9] The water solubility factor that causes a change in the biological structures of restorations causes aesthetic loss and impairment of the marginal and surface properties.[10]

The type and volume of small parts of fillers in the structure of composite resins have an effect on water absorption and solubility.[11,12] With an increase in the amount of filler in the resin content, the water absorption and solubility decreases. In a study by Li[13] that investgated the effect of filler content on the resin structure, it was found that the water absorption values of composite resins with a high percentage of filler content were significantly lower than those of resins with a low filler content.

Ortengren *et al.*[14] reported that the deterioration of wear and mechanical properties in composite resins was associated with the dampness in the oral environment. This dampness created erosions and deteriorations in the resins as a result of hydrolysis and enzymatic hydrolysis reactions.

The aim of this study was to compare the water absorption and water solubility values of four different composite resins used for aesthetic purposes.

MATERIAL and METHODS

Preparation of the Samples

The aim of this study was to compare the changes in the water absorption and solubility values of four different composite resins over the period of one month (Table 1).

Table 1: The components of the composite types and the manufacturers

Composite Types	Content	Composite type	Manufacturer
Estelite Sigma Quick	Bis-GMA, Trietyline glikol dimetakrilat, silica-zirconium	Supra-nano Hibrit Composite	Tokuyama
G-Aenial	Silica, Strontium and Lanthanoid Fluoride containing, Fumed silica, Urethane dimethacrylate (UDMA), dimethacrylate co-monomers	MFR Hibrit Composite	GC
Clearfil Majesty	Silicone barium glass dust, silanized colloidal silica, Bisphenol A diglycidylmethacrylate (Bis-GMA), Hydrophobicaromatic dimethacrylate, di-Comphorquinone	Nano Hibrit Composite	Kuraray
Ceram.X One	Organic modified ceramic nano particles, nano fillers, conventional glass fillers	Nano Ceramic Composite	Dentsply

A total of 40 plastic cylindrical discs were prepared as 10 from each composite group, each sample 2 mm in depth and 8 mm in diameter. The restorative materials tested were G-Aenial GC Corporation, Tokyo, Japan), Estelite Sigma Quick (Tokuyama, Tokyo, Japan), Ceram X One (Dentsply, DeTrey, Konstanz, Germany) and Clearfil Majesty (Kuraray Medical, Okoyama, Japan). Using an oral spatula, each material was placed on the cylindrical discs prepared at equal sizes. To provide a smoth surface, pressure with cement glass was applied over a clear band. Then an LED light source (Guilin Woodpecker, China, 1100 mW/ cm²) was applied over the glasss for 20 secs, and after removing the glass and clear band, the light was applied again for 20 secs and polymerisation of the composites was achieved. All the samples were then polished with Soflex discs (3M ESPE, St. Paul, MN, USA).

Water Absorption and Solubility Test

All the samples were placed in glass bottles in the relevant groups of 10 for each material. The

ISO 4049:199416 test was used for this experiment. For the samples to reach a stable weight, they were kept in a dessicator at 37±1ºC for 24 hours. Then all the samples were weighed on scales sensitive to 10 micrograms (Chyo JL180, Chyo Balance Corp, Japan) and the weights were recorded as M1. After completion of the first measurements, the samples were placed in distilled water at 37±1ºC and left in an incubator for 24 hours, after which they were removed, dried with drying papers and weighed again with these second values recorded as M2a.

At the end of the 1st day, for the materials to regain a stable weight, the samples were again left in the dessicator for 24 hours. At the end of this period, the samples were measured again and recorded as M3. All the samples were then left in distilled water in an incubator for 7 days, after which they were removed, dried and weighed again (M2b). The same procedures were repeated at the end of 30 days and the values measured were recorded as M2c.

M1: The initial weights of the samples after removal from the desiccator (in µg)

M2: The weights of the samples after 1 day in distilled water after desiccator (M2a)

M2b: The weights of the samples after standing in distilled water for 7 days (in µg)

M2c: The weights of the samples after 30 days in distilled water (in µg)

M3a: The weights of the specimens after they were placed in the desiccator for the second time (in µg)

M3b: Weight of samples after second time desiccation (in µg)

Water absorption (µg/mm3) =

$$\frac{M2\ (a, b, c)\ (\mu g) - M3(a, b)\ (\mu g)}{V\ (mm3)}$$

Water solubility (µg/mm3) =

$$\frac{M1(\mu g) - M3(a, b)\ (\mu g)}{V\ (mm3)}$$

RESULTS

In the statistical evaluation of the water absorption of the composite resins, Anova One-Way Variance analysis and the Friedman test were used. No statistically significant

difference was determined between the resins in respect of the water absorption values on Day 1 (Table 2). (F=2.625 P=0.065, Kruskal Wallis Chi-Square=5.97 P=0.11 NS).

Anova One-Way Variance Analysis

In the comparison of the water absorption values of the resins according to the days, the Friedman test was used. The difference between the water absorption levels on Day 7 (F=11.051 P=0.000) and Day 30 (F=25.476 P=0.000) was determined to be statistically significant for the Clearfil Majesty, Estelite Sigma Quick, G-Aenial and Ceram X One composites. (Table 2)

Table 2. A comparison of the water absorption values of four different composite resin materials on Day 1, 7 and 30.

			N	Mean	Std. Deviation	P
DAY 1	CLEARFIL MAJESTY		10	,00000686	,000003938	p=0.065
	ESTELITE SIGMA QUICK		10	,00000448	,000001075	
	G-AENIAL		10	,00000607	,000004182	
	CERAM X ONE		10	,00000328	,000002253	
	Total		40	,00000517	,000003322	
	Model	Fixed Effects			,000003132	
DAY 7	CLEARFIL MAJESTY		10	,00001094	,000002735	p=0.000
	ESTELITE SIGMA QUICK		10	,00000975	,000002240	
	G-AENIAL		10	,00001472	,000002963	
	CERAM X ONE		10	,00000826	,000002528	
	Total		40	,00001092	,000003502	
	Model	Fixed Effects		,000002630	,00000	
DAY 30	CLEARFIL MAJESTY		10	,00001114	,000002922	p=0.000
	ESTELITE SIGMA QUICK		10	,00000806	,000003092	
	G-AENIAL		10	,00001502	,000001280	
	CERAM X ONE		10	,00000567	,000002439	
	Total		40	,00000997	,000004302	
	Model	Fixed Effects		,000002534	,00000	

On Days 7 and 30 the lowest water absorption values were determined in the Ceram X One group, and the highest values in the Clearfil Majesty composite samples (Figure 1). In the comparison of the water solubility values of the composite resins on Days 1, 7 and 30 a statistically significantly difference was determined only on Day 30 (Table 3).

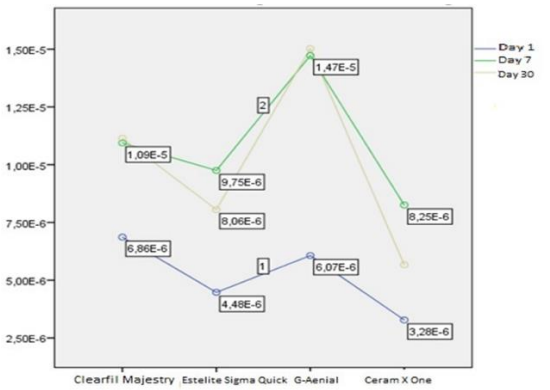

Figure 1. Changes in the water absorption values of the composite resins on Days 1, 7 and 30.

Table 3. The comparison of the water solubility values of the composite resins on Days 1, 7 and 30.

			N	Mean	Std. Deviation	P
Day 1	CLEARFIL MAJESTY		10	,00000209	,000001780	p=0.116
	ESTELITE SIGMA QUICK		10	,00000110	,000002362	
	G-AENIAL		10	,00000209	,000003364	
	CERAM X ONE		10	-,00000060	,000003219	
	Total		40	,00000117	,000002874	
	Model	Fixed Effects			,000002758	
Day 7	CLEARFIL MAJESTY		10	,00000627	,000002696	p=0.198
	ESTELITE SIGMA QUICK		10	,00000557	,000003187	
	G-AENIAL		10	,00000845	,000003191	
	CERAM X ONE		10	,00000657	,000003083	
	Total		40	,00000671	,000003120	
	Model	Fixed Effects			,000003046	
Day 30	CLEARFIL MAJESTY		10	,00000338	,000003354	p=0.000
	ESTELITE SIGMA QUICK		10	,00000288	,000002173	
	G-AENIAL		10	,00000756	,000002935	
	CERAM X ONE		10	-,00000189	,000003822	
	Total		40	,00000298	,000004533	
	Model	Fixed Effects			,000003130	

On the 30th day, the differences between the composite resins (Ceram X One, Clearfil Majesty, G-Aenial and Estelite Sigma Quick) in terms of water solubility were found to be statistically significant ($p < 0.05$).

In the evaluation of the water solubility values on Day 30 (F=15.262 P=0.000) the highest values were determined in G-Aenial composite and the lowest values in the Ceram X One composite samples (Figure 2).

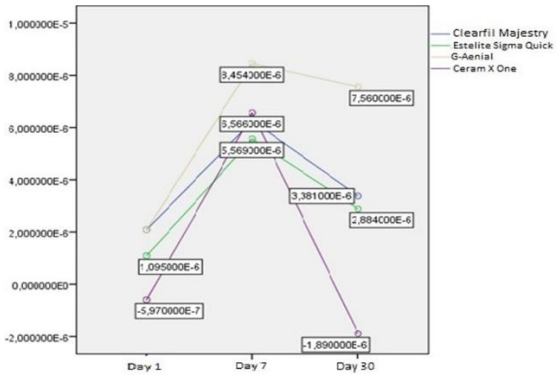

Figure 2. Changes in the water solubility values of the composite resins on Days 1, 7 and 30.

DISCUSSION

The water absorption and water solublity of composite resins is one of the most important problems affecting the physical, chemical and mechanical properties of composite resins.[15] Water absorption in restorations causes dimensional changes, fractures in the interface contours and especially discolouration, which leads to a significant degree of aesthetic loss. These negative effects lead to failure of the restoration.[14]

The entry of water molecules into the composite resin occurs in 3 ways. The first is that they penetrate gaps within the material.[16] The second way is diffusion to the spaces between the inorganic fillers and the third route is that they advance by directly flowing into the regions between the matrix and the fillers in the resin content.[12] The reason for the movement of water molecules in this study has been reported to originate from the resin matrix and filler structure.[17]

The behaviour of resin-based materials in water shows variations according to the characteristics of the composite. Previous studies have shown that the filler particles, the filler matrix and the bonding agent can change the water absorption values of resin.[5]

Composite resins with a higher filler ratio have lower water absorption. The polymerization time of the composite has a great effect on the water absorption values.[18] The application of the light for a shorter period than recommended causes inadequate polymerisation, which will have a negative effect on water absorption and solubility.[19]

Another factor which creates a reverse effect on water absorption and solubility is the generation of the composite. Water absorption values vary in resins containing solvents of different amounts.[20]

In addition, factors such as the waiting time of the material in water, surface properties, and the temperature and concentration of the water have an impact on water absorption.[14]

Kalachandra and Wilson[6] investigated the water absorption values of different composite materials and reported that filling particles and the structure of the bonding agent had an effect on the results.

Zaimoğlu and Sonat's[21] studies on this subject showed that the change in filler ratios and dimensions of composites had an effect on water absorption and solubility.

As in the current study, evaluations of water absorption and water solubility have been made in accordance with the ISO 4049 standard.[22] Iwami *et al.*[23] have showed that water absorption increases with an increase in weight and solubility creates a reduction in weight in their study.

The most important element affecting water absorption in composite resins is the organic matrix section. Water absorption by the organic matrix, even at a very small amount, has a negative effect on the physical properties of the resin.[24]

Several studies have examined the water absorption of restorative materials. In a study of 4 different composite resins by Palin *et al.*[25] the water absorption of Siloron monomer was found to be significantly lower than that of the other resins. The reason that the water absorption results of composite resins are different from each other is due to the

hydrophobic structure of monomers. In 2013, Boaro *et al.*[26] studied water absorption and reported that Siloran and Aelite posterior composites had lower values. In the current study, Ceram X One composite resin was seen to have the lowest water absorption and solubility values.

Water absorption causes swelling of composite resins, and the associated deterioration is irreversible (Powers and Wataha, 2008).[27] As the particles are finer in hybrid composites compared to microfiller composites, water absorption is lower. Therefore, hybrid compostes have generally been used in studies.

The amount of expansion occurring as a result of water absorption can be measured 15 mins after the start of polymerisation. Most composite resins achieve a balance in the first 7 days (Craig and Powers, 2002).[28] In our study, there was an increase in water absorption and water solubility values in the first 7 days. Researchers showed that water absorption values of all composites increased with time.[29] Braden[30] and Swart[31] supported this view in their study and stated that water absorption increased from day one to day 30. In the current study, measurements were taken and recorded at 24 hrs, 7 days and 30 days after polymerisation.

CONCLUSION

At the end of 30 days, Ceram X One showed the lowest values for water absorption and water solubility. This is due to the matrix and filler structure of the resin. Ceram X One differs from other materials due to nano ceramic particles and reduced resin content. These properties increase the ability of Ceram X One composite to be a compatible material.

The biocompatibility of composite resins in clinical use is extremely important. Therefore, it is necessary to eliminate the factors that can negatively affect the physical, mechanical and biological properties of the materials. Water absorption and solubility cause irreversible problems and is therefore a subject which should be carefully examined.

No conflict of interest.

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RADIOGRAPHIC INVESTIGATION OF THE RELATIONSHIP BETWEEN DENTAL MALOCCLUSIONS AND DENTAL ANOMALIES ON THE TURKISH POPULATION

Türk Popülasyonu Üzerinde Dental Maloklüzyonlar ve Diş Anomalileri Arasındaki İlişkinin Radyografik Olarak İncelenmesi

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ABSTRACT

Objectives: The aim of this study was to investigate the relationship between various dental anomalies and dental malocclusions / vertical growth patterns.

Materials and Methods: The study was carried out on panoramic radiographs of 756 patients with a mean age of 15.46 ± 4.52 years. 64.6% (n=488) of the total patients were female and 35.4% (n=268) were male. The panoramic radiographs of the patients were detected for the following dental anomalies: supernumerary tooth, agenesis, transposition, microdontia, dileseration and taurodontism. The obtained data were analyzed using chi-square or Fisher exact tests at a significance level of 5%.

Results: Impaction (14.4%) and microdontia (8.5%) were the most common anomalies. The prevalence of dental anomalies were the highest in skeletal Class III malocclusion (9.9%) and hypodivergent (11.6%) growth pattern ($p<0.05$).

Conclusion: The presence of an association between skeletal malocclusion/vertical growth pattern and dental anomalies was observed for tooth agenesis, impaction, transposition and taurodontism. Supernumerary tooth, microdontia and dilaceration were not significantly different among malocclusion groups.

Keywords: Dental anomalies; Dental Malocclusion; Growth Pattern.

ÖZ

Amaç: Bu çalışmanın amacı çeşitli dental anomaliler ile dental malokluzyonlar/dikey büyüme paternleri arasındaki ilişkiyi araştırmaktır.

Gereç ve Yöntemler: Çalışma, yaş ortalaması 15,46 ± 4,52 yıl olan 756 hastanın panoramik radyografileri üzerinde yapıldı. Hastaların %64,6'sı (n=488) kadındı ve %35,4'ü (n=268) erkekti. Hastaların panoramik radyografileri üzerinde aşağıda belirtilen diş anomalileri araştırıldı: süpernümerer diş, agenez, transpozisyon, mikrodonti, dileserasyon ve taurodontizm. Elde edilen veriler Ki-kare veya Fisher exact testleri kullanılarak % 5'lik anlamlılık düzeyinde analiz edildi.

Bulgular: Gömülü diş (%14,4) ve mikrodonti (%8,5) en sık rastlanan anomalilerdi. Dental anomalilerin prevalansı iskeletsel Sınıf III maloklüzyon (%9,9) ve hipodiverjan (%11,6) büyüme paterninde en yüksekti ($p<0,05$).

Sonuç: Diş agenezi, gömülü diş, transpozisyon ve taurodontizm için iskeletsel maloklüzyon / dikey büyüme paterni ve dental anomaliler arasında bir ilişki olduğu gözlendi. Süpernümerer diş, mikrodonti ve dilaserasyon maloklüzyon grupları arasında anlamlı olarak farklı değildi.

Anahtar Kelimeler: Dental Anomali; Dental Maloklüzyon; Büyüme Paterni.

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INTRODUCTION

Dental anomalies can be caused by a number of factors, including genetic, physical, chemical, environmental, and biological factors in the developmental stage.[1-3] Investigation of the incidence of dental anomalies may provide important information for phylogenetic and genetic studies and may help to understand variations within and between populations.[4, 5]Dental anomalies may also occur as part of a syndrome or disease, and detection may be important for diagnosis. For this reason, early diagnosis of dental anomalies is important from a therapeutic point of view.[4]

The number and the shape of the teeth and the anomalies in the tooth position may cause incompatibilities in maxillary and mandibular arch lengths and may prevent obtaining a proper occlusion during orthodontic treatment planning.[5,6] Dental anomalies may also impair orthodontic treatment and other dental treatments; therefore, the presence should be investigated before treatment and should be considered during treatment planning.[3,6,7]

In literature, the prevalence of dental anomalies has been investigated in many studies, but very few of these studies have examined the relationship between dental anomalies and malocclusions.[1,8] Therefore, in this study, it was aimed to investigate the relationship between various anomalies (supernumerary, agenesis, transposition, microdontia, dilaceration, taurodontism) and dental malocclusions.

Dental anomalies of number are supernumerary tooth and tooth agenesis. A supernumerary tooth is defined as an extra tooth or tooth-like structure in addition to 32 permanent teeth.[9] Tooth agenesis is defined as the congenital absence of tooth / dental germs in permanent teeth and is one of the most common tooth developmental anomalies.[10]

Dental transposition is defined as the displacement between two adjacent teeth in the same half-jaw.[11] Microdontia is defined as smaller teeth than normal.[12,13] Dilaceration means an abnormal twist during the development of the root.[14] Taurodontism is characterized by short, uncompleted roots that are formed as a result of prolonged pulp chamber and hertwig epithelial root sheath failure.[15]

The aim of this study was to determine the frequency and distribution of developmental anomalies in the permanent teeth of the Turkish orthodontic patient population with different skeletal malocclusions and vertical skeletal patterns.

MATERIALS AND METHODS

The study was carried out on panoramic radiographs of 756 patients who applied to Bolu Abant Izzet Baysal University, Faculty of Dentistry, Department of Orthodontics for orthodontic treatment between 2013 and 2018. The local ethics committee of Bolu Abant Izzet Baysal University approved the study. Patients between 12 and 25 years of age were included in this study. Patients with panoramic radiographs of bad quality, cleft lip/palate, syndromes, trauma, systemic disorders were excluded to correctly detect dental anomalies. The sample size was calculated based on a power analysis using G*Power Software version 3.1.9.2 (Universität Düsseldorf, Germany) at alpha error probability of 0.05. The power analysis showed that 273 samples were sufficient, while for more reliable results it was determined as 756.

The skeletal classification was made using ANB angle. Patients with ANB between 0-4, were classified as Class I, ANB>4 as Class II and ANB<0 as Class III.[16] The patients were classified according to their vertical growth pattern using SN-GoGn angle. Patients with SN-GoGn<32 were classified as hypodivergent, SN-GoGn=32 as normal and SN-GoGn>32 as hyperdivergent.[16]

The panoramic radiographs of the patients were detected for the following dental

anomalies: supernumerary tooth, agenesis (with the exclusion of third molars and inclusion of hypodontia and oligodontia), transposition, microdontia, dileseration and taurodontism. Radiographs were evaluated by an orthodontist who was blinded to the groups.

Statistical Analysis

The obtained data were analyzed with SPSS version 20.0 (Statistical Package for Social Sciences, SPSS Inc, Chicago, Ill.) using chi-square or Fisher exact tests at a significance level of 5%. The Kappa index was found to be. 83 and the intra-observer correlation was found to be. 84 in terms of reliability of the evaluations made.

RESULTS

64.6% (n = 488) of the total patients were female and 35.4% (n = 268) were male and the mean age was 15.46 ± 4.52 years. Table 1 shows the characterization and distribution of dental anomalies by sex. The prevalence of dental anomalies in 756 patients dental records was 26.9% (n = 203). There were significantly more dental anomalies in females (14%) than in males (12.8%) ($p<0.05$).

Table 1. Frequency of Dental Anomalies by Sex

	n (%)			
Dental Anomalies	**Females**	**Males**	**Total**	**P Value**
Total Of Dental Anomalies	106 (14)	97 (12.8)	203 (26.9)	0.000
Tooth Agenesis	21 (2.8)	16 (2.1)	37 (4.9)	0.310
Supernumerary	6 (1.2)	6 (0.8)	12 (1.6)	0.363
Microdontia	36 (4.8)	28 (3.7)	64 (8.5)	0.147
Impaction	48 (6.3)	61 (8.1)	109 (14.4)	0.000
Transposition	20 (2.6)	18 (2.4)	38 (5)	0.115
Dilaceration	13 (1.7)	20 (2.6)	33 (4.4)	0.002
Taurodontism	10 (1.3)	16 (2.1)	26 (3.4)	0.005

Impaction (14.4%) and microdontia (8.5%) were the most common anomalies. The most common dental anomaly was impaction, both in males (8.1%) and females (6.3%).

The teeth most affected by dental anomalies were shown in Table 2. Impaction was the most common in maxillary canines, while agenesis was the most common in maxillary incisive.

Table 2. Most Frequent Dental Anomalies and Their Most Affected Teeth

Dental Anomalies	**n (%)**	**Most Affected Teeth, n (%)**
Toot Agenesis	37 (4.9)	Maxillary Anterior 29(3.8) Mandibular Anterior 6(0.8) Mandibular Premolar 2(0.3)
Supernumerary	12 (1,6)	Maxillary Anterior 4(0.5) Mandibular Premolar 3(0.4) Mandibular Molar 3(0.4) Maxillary Molar 2(0.3)
Microdontia	64 (8.5)	Maxillary Anterior 62(8.2) Mandibular Anterior 2(0.3)
Impaction	109 (14.4)	Maxillary Canine 40(5.3) Mandibular Premolar 26(3.4) Mandibular Canine 23(3.0) Maxillary Premolar 14(1.9) Maxillary Molar 4(0.5) Maxillary Anterior 2(0.3)
Transposition	38 (5)	Mandibular Premolar21(2.8) Maxillary Premolar 6(0.8) Maxillary Canine 5(0.7) Mandibular Canine 3(0.4)
Dilaceration	33 (4.4)	Maxillary Anterior 14(1.9) Maxillary Premolar 9(1.2) Mandibular premolar 7(0.9) Mandibular Anterior 3(0.4)
Taurodontism	26 (3.4)	Mandibular Molar 23(3) Maxillary Premolar 3(0.4)

Table 3 shows the distribution of tooth anomalies according to skeletal malocclusions and growth patterns.

Table 3. Distribution of Dental Anomalies Among Skeletal Malocclusions and Growth Patterns

	Skeletal Malocclusion Pattern, n (%)				Growth Pattern, n (%)			
Dental Anomalies	**Class I**	**Class II**	**Class III**	**P Value**	**Hyperdivergent**	**Hypodivergent**	**Normal**	**P Value**
Total	68(9)	60(7.9)	75(9.9)	0.000	36(4.8)	88(11.6)	79(10.4)	0.000
Tooth Agenesis	13(1.7)	16(2.1)	8(1.1)	0.000	4(0.5)	13(1.7)	20(2.6)	0.000
Supernumerary	3(0.4)	2(0.3)	7(0.9)	0.454	3(0.4)	9(1.2)	0(0)	0.177
Microdontia	25(3.3)	13(1.7)	26(3.4)	0.849	6(3.8)	17(2.2)	41(5.4)	0.000
Impaction	32(4.2)	44(5.8)	33(4.4)	0.000	33(4.4)	52(6.9)	24(3.2)	0.032
Transposition	6(0.8)	17(2.2)	15(2)	0.000	15(2)	14(1.9)	9(1.2)	0.010
Dilaceration	7(0.9)	7(0.9)	19(2.5)	0.061	10(1.3)	14(1.9)	9(1.2)	0.215
Taurodontism	7(0.9)	0(0)	19(2.5)	0.002	10(1.3)	3(0.4)	13(1.7)	0.000

40.7% of the individuals in the study had Class I, 41.4% Class II, and 17.7% Class III 'malocclusion. According to the growth pattern, 22% of the patients were hypodivergans, 56.9% were normodiverts and 21.2% were hyperdivergent. The prevalence of dental anomalies were the highest in skeletal Class III malocclusion (9.9%) and hypodivergent (11.6%) growth pattern ($p<0.05$). Tooth agenesis was significantly more prevalent in Class II (2.1%)/ normodivergent (2.6%) patients, impaction was the most prevalent at Class II (5.8%)/hypodivergent (6.9%) patients. Transposition prevalence was significantly lower in Class I (0.8%) / normodivergent (1.2%) patients.

DISCUSSION

Some dental anomalies were linked to certain skeletal malocclusions, suggesting the similar genetic basics.[17] The presence of dental anomalies complicates the overall dental treatment, as well as orthodontic treatment. Therewithal, the patients referring to the Department of Orthodontics may have more dental anomalies resulting in esthetic concerns. There are numerous studies in the literature investigating the prevalence in different populations[18-25] and patient groups, as well as in Turkish population.[6,26-28] The results of these studies vary greatly due to differences in dental anomaly definitions, diagnostic criteria, environmental factors and ethnicity.[28] However, no previous study analyzed dental anomalies in Turkish patients with different skeletal malocclusion and growth patterns. Therefore, we aimed to investigate the prevelance of dental anomalies and their diversities between different sagittal malocclusions and vertical growth patterns.

Thongudomporn and Freer[29] investigated 111 orthodontic patients for dental anomalies and indicated that 74.77% of the patients had at least one dental anomaly with the most common as invagination. In their study on 900 orthodontic patients, Uslu *et al.*[6] found that 40.3% of patients exhibited at least one dental anomaly, with the most prevalent as agenesis (21.6%). Altug-Atac and Erdem[28] investigated 3043 orthodontic patients and they found that only 5.46% of the patients had dental anomalies, with the most prevalent ones as hypodontia and microdontia. Fernandez *et al.* (30) found a prevalence of 15.7% in their study that included 1047 orthodontic subjects, and impaction (14.4%) was the most prevalent dental anomaly in their study. We detected a total prevalence of 26.9% for dental anomalies in our study, with the most prevalent anomalies as impaction (14.4%) and microdontia (8.5%). The differences in these studies may be attributed to different populations and patient numbers the studies included.

While some studies did not found significant prevalence differences between sexes for dental anomalies[21], Fernandez *et al.*[30] indicated that dental anomaly prevalence was greater in males than in females and impaction and fusion were significantly different between sexes. The results of our study suggested that macrodontia, impaction, dilaceration and taurodontism was significantly different between sexes and these anomalies were also more frequent in males, in accordance with the study of Fernandez *et al.*[30], while female patients had more dental anomalies in total (14%).

Tooth agenesis prevalence was found to be between 0.3% and 10.1%.[31] In the present study, tooth agenesis prevalence was 4.9% and upper incisors were the most effected teeth by agenesis (3.8%), followed by lower incisors (0.8%) and lower premolars (0.3%) when the

third molars were not included. This finding was partially in accordance with the previous studies that showed the most affected teeth by agenesis are the second premolars and upper lateral incisors, respectively.[6,21,28]

Supernumerary teeth were observed in 12 patients (1.6%), which was between the range of the previous studies (0.3%-3.8%).[6,28,30] The most common area of supernumerary teeth in the literature was found to be the maxillary anterior site.[32] The most affected teeth in this study were upper incisors (0.5%), which was in accordance with the literature.

Microdontia prevalence was found to be between 1.5% and 2% in the literature[33], while we found a prevalence of 8.5%, with the most affected teeth as upper incisors (8.2%). Proffit[34] indicated that size anomaly of the maxillary lateral incisor is the most prevalent anomaly. Peg-shaped lateral incisors were also counted as microdontia and were not separately investigated in this study, which could be the reason why the prevalence was relatively higher than other studies.

Impaction prevalence was 14.4% in the study of Fernandez *et al.*[30], which was exactly the same as we observed in the present study. Prevalence rate of canine impaction was indicated as 3.58% in a Turkish population in a previous study[35], which was lower than the prevalence in our study. This difference may be due to the fact that patients with impacted teeth refer to orthodontist and gather at the department of orthodontics.

The prevalence of transposition (5%) and dilaceration (4.4%) in our study were similar to those described in the literature.[6,30] This difference can be attributed to different sample sizes and racial groups studied. A wide range of prevalence was given in the literature for taurodontism and our prevalence of taurodontism (3.4%) was within this range.[6,36]

The genes that have an influence on skeletal malocclusion may also influence certain dental anomaly occurance.[37] When associated with skeletal malocclusion and vertical growth patterns, a higher number of anomalies were found in skeletal Class III patients and hypodivergent patients, which was in accordance with the study of Fernandez *et al.*[30] Class III patients had the highest rate of anomalies, followed by Class I and Class II patients. Basdra *et al.*[37] previously showed that Class III patients had significantly higher dental anomalies than Class II div 1 patients. While Uslu *et al.*[6] found significant differences only for impaction and short roots and Fernandez *et al.*[30] for microdontia and tooth agenesis, we found multiple significant differences for anomalies among the groups. The difference could be due to the variability of patients with malocclusions.

Microdontia was associated with the skeletal Class III patients and tooth agenesis was associated with hypodivergent growth pattern previously.[30] According to our results, microdontia was also higher in Class III and II patients than in Class I. However, tooth agenesis was the highest in normal patients and hypodivergent patients were in the second order. In contrary to Uslu *et al.*[6], we found a higher rate of prevalence for impaction in Class II patients, which may also be associated with malocclusion variability. Taurodontism was not detected in any Class II patients and its rate was lower in hypodivergent patients that could be attributed to specific genetic mechanisms.

CONCLUSIONS

According to the results of the present study, the presence of an association between skeletal malocclusion/vertical growth pattern and dental anomalies was observed for tooth agenesis, impaction, transposition and taurodontism. Class III patients and hypodivergent vertical patterned patients had the most dental anomalies and dental anomaly prevalence. Supernumerary tooth, microdontia and dilaceration were not significantly different among malocclusion groups.

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Conflict of Interest

None declared.

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EFFECTS OF SIZE AND OPERATING MODE OF SONICALLY OSCILLATING FILES ON IRRIGANT EXTRUSION

Sonik Uçların Boyutunun ve Çalışma Modunun Irrigant Taşmasına Etkisi

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ABSTRACT

Objective: The purpose of this study was to evaluate the effects of size and oscillation frequency of sonic tips on irrigant extrusion during activation.

Materials and Methods: Twenty artificial maxillary molar tooth models were used in this study. The palatinal canal of each model was prepared up to final apical size of #40. Each specimen was mounted on a glass vial filled with saline solution to simulate a periapical lesion. The initial weights were measured using an analytical balance with 10^{-5} g accuracy. Then, a series of irrigations were conducted according to the size (15/.02, 25/.04, 35/.04) and operating mode/speed (low, medium, high) of the sonic tips. In control group, the irrigant was delivered by placing the needle tip at the access cavosurface, without the insertion and activation of the sonic tip. The mean weights of apically extruded irrigant were calculated by subtracting the mean initial weights from the final weights of test apparatus. Data were statistically analyzed by the Kruskal-Wallis and Siegel Castellan tests.

Results: The use of 15/.02 tips resulted in higher irrigant extrusion than the control only at high speed while the 35/.04 tips only at low speed ($p<0.05$). The 25/.04 tips presented higher extrusion than the control with all operating modes ($p<0.05$). At high speed mode, both the 15/.02 and 25/.04 tips were associated with higher irrigant extrusion than the 35/.04 tips ($p<0.05$).

Conclusion: Both the size and oscillation frequency of the sonic tips had significant effects on irrigant extrusion during sonically activated irrigation.

Keywords: apical extrusion, EndoActivator, irrigation, sodium hypochlorite, sonic activation

ÖZ

Amaç: Bu çalışmanın amacı irrigant aktivasyonu sırasında kullanılan sonik uçların boyutunun ve titreşim sıklığının irrigant taşmasına etkisini değerlendirmektir.

Gereç ve Yöntemler: Bu çalışmada 20 adet yapay üst molar diş modeli kullanıldı. Her bir modelin palatinal kanalı apikal çap #40 olacak şekilde genişletildi. Periapikal lezyonu taklit etmek için her bir diş modeli salin solusyonu ile dolu cam şişelere yerleştirildi. İlk ağırlıklar 10^{-5} g hassasiyetindeki hassas tartı ile ölçüldü. Sonrasında sonik ucun boyutu (15/.02, 25/.04, 35/.04) ve uygulama modu/hızı (düşük, orta, yüksek hız) esas alınarak irrigasyon protokolleri uygulandı. Kontrol grubunda irrigasyon herhangi bir sonik uç kullanmadan ve aktivasyon yapılmadan iğne ucunun giriş kavitesinin girişinde tutulması ile gerçekleştirildi. Apikalden taşan irrigantın ortalama ağırlığı, test düzeneğinin başlangıç ağırlığının ortalamasından, final ağırlığının ortalamasının çıkarılmasıyla hesaplandı. Veriler Kruskal-Wallis ve Siegel Castellan testleri analiz edildi.

Bulgular: Kontrol grubuna kıyasla, 15/.02 uçlar sadece yüksek hızda daha fazla irrigant taşmasına yol açarken, 35/.04 uçlar düşük hızda neden oldu ($p<0,05$). 25/.04 uçlar tüm hızlarda kontrol grubuna göre daha fazla irrigant taşması gösterdi ($p<0,05$). Yüksek hızda 15/.02 ve 25/.04 uçlar, 35/.04 uç kullanımına göre daha fazla irrigant taşmasına neden oldu ($p<0,05$).

Sonuç: Sonik aktivasyon sırasında kullanılan sonik ucun hem çapı hem de titreşim sıklığı irrigant taşmasını anlamlı ölçüde etkilemektedir.

Anahtar Kelimeler: apikal taşma, EndoActivator, irrigasyon, sodyum hipoklorit, sonik aktivasyon

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INTRODUCTION

One of the primary goals of root canal treatment is to clean and disinfect the root canal system via the mechanical and chemical effects of irrigants on the removal of microorganisms and tissue remnants.[1] However, while conventional irrigation with syringes has been accepted as an efficient method of irrigant delivery,[2] the mechanical flushing action created by this method is relatively weak and thorough cleaning of inaccessible canal extensions and irregularities in the root canal system is difficult to achieve.[3] Irrigant agitation has been recommended to facilitate the dispersion and replenishment of irrigants in the root canal system.[4] In this regard, sonic and ultrasonic devices have been extensively tested as irrigant agitation equipment.[2,4]

Low-frequency irrigation with sonic activation produces smaller shear stresses and generates greater back-and-forth tip movement than ultrasonic irrigation.[2] Sonic activation generates mechanical agitation at the tip of files, and sideway oscillation disappears when the movement of the sonic file is constrained, resulting in pure, longitudinal file oscillation.[2,4] This mode of action has been found to increase the tissue-dissolving activity of irrigants[5] and enhance root canal cleaning.[6] The EndoActivator System (Dentsply, Tulsa Dental Specialties, Tulsa, OK) is a sonically driven irrigant activation system that uses frequencies in the range of 160-190 Hz.[7] This device comprises a portable handpiece and disposable flexible noncutting polymer tips of three different sizes (15/.02, 25/.04, 35/.04) and is operated at three different modes/power settings (low speed, medium speed, high speed).[7]

Sodium hypochlorite (NaOCl) is accepted as the primary irrigant of choice because of its tissue-dissolving capability and strong antimicrobial properties.[8] However, it is extremely caustic in contact with vital tissue, and its extrusion through the apical foramen can cause severe pain, a burning sensation, and periapical tissue damage.[9] Therefore, a balance between safety and effectiveness should be maintained when irrigation is performed. The action of NaOCl should be restricted within the root canal system, but it should also penetrate the full extent of the canal to exert its favorable actions.[10]

The extent of extrusion has been reported to be related to several factors, including apical preparation size, irrigation technique, depth of needle insertion, and irrigant flow rate.[11,12] The size and oscillation amplitude of tips that are used for irrigant activation may also affect the amount of apical extrusion. However, the literature on the effects of size and operating mode of sonically oscillating files on irrigant extrusion is limited. Therefore, the purpose of this study is to evaluate the effects of size and oscillation frequency of sonic tips on the apical extrusion of NaOCl during sonic activation. The null hypothesis tested is that the size and oscillation frequency of the sonic tips do not affect the amount of extruded irrigant.

MATERIALS AND METHODS

Specimen Preparation

Twenty artificial maxillary molar tooth models with open access cavities (VDW, Munich, Germany) were used in this study. The buccal roots of each model were removed with burs (Edenta Ag Dental Products, Haupstrasse, Switzerland) and the coronal orifices of the buccal canals were sealed with a cyanoacrylate adhesive (Zapit, DVA, Anaheim, CA, USA). A size 15 K-file (Dentsply Maillefer, Ballaigues, Switzerland) was introduced into the palatinal canal until it was just visible at the apical foramen to facilitate working length (WL) determination. The WL was determined 1 mm short of this measurement. The palatinal canal of each model was prepared using ProTaper rotary files (Dentsply Maillefer) up to F4 mounted on a torque-controlled reduction handpiece (X-Smart, Dentsply Maillefer) at a

speed of 300 rpm and torque of 3 N/cm. Irrigation was performed with 2 mL of 2.5% NaOCl (Werax, İzmir, Turkey) between each instrument. After completion of the preparation, the canals were irrigated with 5 mL of 2.5% NaOCl and dried with paper points (Dentsply Maillefer).

Test Apparatus

Irrigant extrusion was determined using a glass vial model. The rubber stoppers of the glass vials were adjusted by a heated instrument to create a hole through the center for holding the specimen in upright position. Then, the specimens were inserted into the rubber stoppers and fixed to the stoppers from the cementoenamel junction using the cyanoacrylate adhesive. The vials were filled with 10 mL saline solution. The specimen–rubber stopper unit was fitted into the mouth of the vials by allowing the suspension of the apical part of the palatinal root within the vial. Each vial was vented with a sterile 27-gauge needle (Ultradent, South Jordan, UT, USA) alongside the rubber stopper to equalize the air pressure inside and outside the vial.

Irrigation Procedures

Aluminium foils were used to cover the vials to prevent the operator from viewing irrigant extrusion during the irrigation procedure. To ensure that any apical extrusion occurred was solely from the tested irrigation system, 30-G side-vented needle (Max-i-probe, Dentsply, Rinn, Elgin, IL, USA) was used to passively fill the canals with 2.5% NaOCl by placing the needle tip at the entrance of access cavity immediately before sonically activated irrigation. Then, a sonic tip of EndoActivator (Dentsply, Tulsa Dental Specialties, Tulsa, OK) was placed at 2 mm from the WL and activated while irrigant continued to be given from the canal orifice. A pumping action with 2-mm to 3-mm vertical strokes was also used to agitate the irrigant. A total of 4 mL irrigant was activated with the sonic device for 60 seconds. A series of irrigations were conducted on the same 20 specimens according to the tip size and operating mode (Table 1). A new polymer tip was used every 4 measurements. In control group, 4 mL of irrigant was delivered by placing the needle tip at the entrance of access cavity, without the insertion and activation of the sonic tip. During the delivery of the irrigant, a suction tip was placed near the access cavity for the aspiration of excess irrigant. Finally, each root canal was dried with paper points.

Table 1. The tip size and operating mode of the sonic device in the groups (n=20)

Groups	Tip Size	Operating Mode (Speed)
1 (Control)	-	-
2	15/.02	Low
3	15/.02	Medium
4	15/.02	High
5	25/.04	Low
6	25/.04	Medium
7	25/.04	High
8	35/.04	Low
9	35/.04	Medium
10	35/.04	High

Determination of Apically Extruded Irrigant

Before the irrigation procedures, each test apparatus (the glass vial-specimen-rubber stopper unit) was numbered and weighed using an analytical balance with 10^{-5} g accuracy (Radwag, Radom, Poland) thrice. The mean values were calculated and accepted as initial weight. After each irrigation procedure, aluminium foils were removed and each test apparatus was reweighed thrice. Then, the mean values were calculated and accepted as final weight. Apically extruded irrigant was calculated by subtracting the initial weight of the apparatus from the final weight. Because the same models were used repeatedly in all groups, each model was reestablished and weighed as described above, before starting a new group.

In the present study, a single operator performed the root canal preparation and irrigation procedures and a second operator who was blinded to the groups performed the weight analyses.

Statistical Analysis

Data were analyzed by the Kruskal-Wallis and Siegel Castellan tests. The level of significance was set at p = 0.05. All statistical analyses were performed using SPSS software (SPSS 22 for Windows, SPSS Inc., Chicago, IL, USA).

RESULTS

The descriptive statistics of the distribution of irrigant extrusion amount in the groups are shown in Table 2.

Table 2. Descriptive statistics of the distribution of irrigant extrusion amount in the groups

Groups		Mean (g)	Median	Minimum	Maximum
Control		0.001[a]	0	0	0.004
15/.02	Low	0.003[a,1,❖]	0.001	0	0.018
	Medium	0.013[a,1,2,❖]	0.004	0	0.127
	High	0.054[b,2,❖]	0.014	0	0.292
25/.04	Low	0.008[b,1,❖]	0.008	0	0.018
	Medium	0.025[b,1,2,❖]	0.008	0	0.164
	High	0.026[b,2,❖]	0.019	0	0.168
35/.04	Low	0.005[b,1,❖]	0.004	0	0.011
	Medium	0.004[a,1,❖]	0.002	0	0.014
	High	0.004[a,1,#]	0.003	0	0.009

[(a)(b)(1)(2)(·,·)]Different superscript letters indicate significant differences between each experimental group and the control. Different numbers indicate significant differences among the operating modes of each sonic tip. Different symbols indicate significant differences among the sonic tips at each operating mode.

Significant differences in the amount of extruded irrigant beyond the apex were observed among the groups ($p<0.05$). The use of 25/.04 tips resulted in higher irrigant extrusion than the control group with all operating modes ($p<0.05$). There were no significant differences between the control group and 15/.02 tips at low and medium speed ($p>0.05$), while 15/.02 tips resulted in higher irrigant extrusion than the control group at high speed ($p<0.05$). The use of 35/.04 tips presented similar irrigant extrusion to the control group at medium and high speed ($p>0.05$), while resulted in higher irrigant extrusion than the control group at low speed ($p<0.05$). The apical extrusion was significantly higher at high speed mode than low speed when the 15/.02 and 25/.04 tips were used ($p<0.05$). There were no significant differences in the extrusion amount among the opeating modes when the 35/.04 tips were used ($p>0.05$). At high speed mode, both the 15/.02 and 25/.04 tips were associated with higher irrigant extrusion than the 35/.04 tips ($p<0.05$), while there were no significant differences among different tips at low and medium operating modes ($p>0.05$).

DISCUSSION

Inadvertent NaOCl extrusion during root canal treatment and its sequelae have been reported in many case reports.[13-15] Although the minimum amount of extruded irrigant that may exert clinically significant effects remains unclear, the goal of work in this area is to minimize this incident. In the present study, the effects of size and oscillation frequency of sonic tips on the apical extrusion of NaOCl during sonic activation were evaluated and both parameters were found to be significant in irrigant extrusion. Therefore, the null hypothesis was rejected.

Based on the present findings, irrigant activation with 15/.02 and 25/.04 tips caused higher amounts of extrusion at the high-speed mode than at the low-speed mode. This result was expected as, in principle, a higher frequency causes a higher flow velocity.[16] In contrast to the present findings, a previous study in which only 15/.02 tips were used and the canals were prepared to an apical size of #35, compared the low- and high-power settings of the EndoActivator System in terms of irrigant extrusion and found no significant difference between them.[12] Different results among studies can be attributed to variability in the study designs, including apical preparation size, duration of irrigant agitation, and agitation type (intermittent or continuous).

In intermittent irrigation, the irrigant is delivered to the root canal by a syringe needle and then activated with the use of an oscillating instrument.[2] The continuous irrigation technique provides an uninterrupted supply of fresh irrigation solution in the root canal while reducing the time required for irrigant activation.[2] In the present study, sonic agitation was performed while the irrigant was delivered from the coronal canal orifice continuously as described in previous studies.[17,18] This described irrigation technique has shown to be effective in eliminating the microbial content of the root canals.[18]

According to the current results, the use of 35/.04 tips presented similar irrigant extrusion at three operating modes but resulted in less extrusion than the other sonic tips when operated at high speed. One explanation for this result can be a decrease in irrigant flow in the canal when 35/.04 tips are used. Although each canal was enlarged to an apical size of #40 to test all three available tips of the sonic system, the 35/.04 tips may have had less space around them for oscillation than the other tips. In a previous study, the 25/.04 and 35/.04 tips were tested in teeth with apical preparation sizes of #35 and #55, respectively, and no significant difference was found between them in terms of irrigant extrusion.[19] However, that result could be attributed to the apical preparation size rather than the size of the sonic tips. According to a recent study, the 15/.02 and 25/.04 tips of the same sonic system presented similar results in terms of root canal cleaning efficacy when operated at both low and high speed.[7] In that study, the 35/.04 tips could not be tested because the apical size of each model was enlarged to #30.[7] Although the 35/.04 tips were associated with less extrusion in the present study, this result should be interpreted with caution as these tips may lead to inferior canal cleaning compared with the other tips because of the decreased irrigant flow around them. Of note, the use of 35/.04 tips at high power setting was found to be more effective than other combinations in removing stained collagen from the canal surface and this result was attributed to increased energy applied to the irrigant as a result of greater tip rigidity.[20]

Several methods have been used to mimic periapical tissue resistance during irrigant extrusion *in vitro*. Although periapical tissues may act as a natural barrier to prevent apical extrusion *in vivo*, several studies have neglected the possible effect of periapical tissues by evaluating extrusion into vials full of air.[17,21,22] According to a previous study, the vial filled with water represented the clinical situation better than the vial completely filled with ambient air.[23] In the present study, a glass vial model filled with saline solution was used to determine apical extrusion similar to previous reports.[24-26] NaOCl accidents have been reported to generally occur in teeth with periapical pathology.[27] Although the exact amount of pressure in the apical area of teeth is unknown, the model used in the current study may simulate some degree of apical resistance of a periapical lesion.

Other factors considered earlier in the root canal treatment process, such as irrigation during root canal instrumentation, may affect the potential for apical extrusion. In the present study, the root canals were instrumented and irrigated between each instrument before being placed in the test apparatus to allow for direct comparison of the final irrigation procedures only. To minimize considerable variations between the groups and produce a reliable and comparable anatomic baseline, artificial tooth models were used in this study. Similar to previous studies, the same models were reused in all groups because no detectable degradation was expected with sonically activated irrigation.[12,23,28]

CONCLUSIONS

Within the limitations of this *in vitro* study, both the size and oscillation frequency of the sonic tips can be concluded to exert significant

effects on extrusion during sonically activated irrigation. Sonic activation with the 15/.02 tips at low and medium speed and with the 35/.04 tips at medium and high speed presented results comparable with those of the control in terms of irrigant extrusion. Clinically, selection of a technique that reduces the amount of apical extrusion should be a part of the decision-making process for the final irrigation system to apply. In this regard, the information obtained from the present study may contribute to future clinical applications of the technology. However, further research is required to evaluate whether these methods provide adequate cleaning effects during final irrigation of the root canal system.

Conflicts of interest

The authors declare no potential conflicts of interest with respect to the authorship and/or publication of this article.

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ÇÜRÜKSÜZ SERVİKAL BÖLGE DİŞ SERT DOKU KAYIPLARINDA UNIVERSAL ADEZİV KULLANILARAK YAPILAN RESTORASYONLARIN FDI KRİTERLERİNE GÖRE DEĞERLENDİRİLMESİ

Clinical Performance of Non-Carious Cervical Lesions Restored with a Universal Adhesive Assessed According to the FDI Criteria

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ÖZET

Amaç: Bu çalışmanın amacı çürüksüz servikal lezyonlarda, universal bağlayıcı ajanın farklı kullanım modlarının etkinliğinin karşılaştırılmasıdır.

Gereç ve Yöntemler: Çalışmaya ESOGÜ Diş Hekimliği Fakültesi Restoratif Diş Tedavisi Anabilim Dalı'na Mayıs 2015-Temmuz 2015 tarihleri arasında restorastonları tek hekim tarafından tamamlanmış hastaların arasından herhangi bir sistemik hastalığı olmayan, ağız hijyeni iyi, ağzında en az 20 dişi bulunan, en az 6 adet çürüksüz servikal lezyonlu dişi universal dentin bağlayıcı ajanın farklı kullanım modları ve nanohibrit kompozit materyal ile restore edilmiş 25 hasta seçilmiştir. Bu kullanım modları hem dentin hem de minenin asitlendiği total etch (TE), sadece minenin asitlendiği selektiv etch (SLE) ve sadece adezivin uygulandığı self etch (SE) modlarıdır. İlgili 246 restorasyon FDI kriterlerine göre 18 aylık süreçte değerlendirilmiştir. Her bir adeziv modun zamana bağlı tekrarlı skor değişkenleri Friedman analizi ve Dunn's ikili karşılaştırma testi ile değerlendirilmiştir. Kategorik mod değişkeni ile skorlar arasındaki ilişki Pearson Ki-Kare analizi ile değerlendirilerek $p<0,05$ bulunan sonuçlar istatistiksel olarak anlamlı kabul edilmiştir.

Bulgular: Yüzey cilası, yüzey renklenmesi, renk uyumu ve translusensi, estetik anatomik form, marjinal adaptasyon, post operatif hassasiyet, çürük rekürrensi, erozyon, abfraksiyon, diş bütünlüğü ve periodontal yanıt kriterlerinde 18 aylık süreç içerisinde modlar arasında anlamlı bir farklılık bulunmazken ($p>0,05$) marjinal renklenme, kırık ve retansiyon ve hastanın görüşü kriterlerinde 18 aylık süreç içerisinde modlar arasında anlamlı bir fark bulunmuştur ($p<0,05$). Estetik anatomik form, hastanın görüşleri ve diş bütünlüğü değerlendirmesinde ise her bir adeziv mod için aylar arasında anlamlı bir farklılık gözlenmezken ($p>0,05$) diğer kriterlerde zamana bağlı değişimler gözlemlenmiştir ($p<0,05$).

Sonuç: Restorasyonların klinik başarısı açısından TE ve SLE moduna göre en kötü skorlamalar SE moduna ait olmuştur. Ancak; universal adezivlerin performanslarının değerlendirilebilmesi için daha birçok çalışmaya ihtiyaç vardır.

Anahtar Kelimeler: Çürüksüz servikal lezyon, FDI kriterleri, universal adeziv.

ABSTRACT

Objectives: This study aimed to compare the different application modes of universal bonding agents on non-carious cervical lesions.

Materials and methods: Twenty-five patients without any systemic disease and with good oral hygiene, having at least 20 teeth and 6 non-carious cervical lesions treated using a universal adhesive and nano hybrid composite material were selected among the patients who were treated by a single operator at Department of Restorative Dentistry, Eskişehir Osmangazi University between January 2015-March 2015. For the restoration of the teeth, universal dentin adhesive was applied in 3 different modes, total etch (TE), selective-etch (SLE) and self etch (SE). The 246 restorations included in the study were evaluated according to FDI criteria at 18-month follow-up. Each bonding mode was analyzed by Friedman analysis and Dunn's binary comparison test. Relation between the categorical mode variate and the scores were analyzed by Pearson Chi-square analysis ($p=0.05$).

Results: There was no significant difference between the application modes at 18-month period regarding surface luster, surface staining, color match and translucency, esthetic anatomical form, marginal adaptation, post operative sensitivity, caries recurrence, erosion, abfraction, tooth integrity and periodontal response. Marginal discoloration, fracture and retention, and the patient's view criterias showed a significant difference in terms of the application modes at 18-month follow-up. Esthetic anatomic form, patient's view, and tooth integrity were not significantly different between evaluation periods ($p>0.05$).

Conclusion: SE mode showed significantly worse scores than that of TE and SLE modes. Further studies are needed to evaluate the clinical performance of universal adhesives.

Key Words: FDI criteria, non carious cervical lesion, universal adhesive

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GİRİŞ

Çürüksüz servikal lezyonlar; erozyon, atrizyon, abfraksiyon ve bunların olası etkileşimlerini içeren kompleks ve multifaktöriyel sebepli dişin sert doku kayıpları olarak adlandırılır.[1,2] Servikal bölgedeki bu tip diş sert doku kayıpları yaygın rastlanılan klinik bir durumdur ve yaşla beraber görülme sıklığı da artmaktadır.[3] Multifaktöriyel etiyolojiye sahip bu lezyonlar oral hijyen alışkanlıkları, bakteriyel olmayan ajanların erozyonu kaynaklı ve servikal bölgede parafonksiyonel alışkanlıklar sonucu meydana gelen kuvvetler sonucunda meydana gelebilmektedir. Çürüksüz servikal lezyonların adeziv materyallerle restorasyonlarının sebepleri ise genellikle hassasiyet, estetik kaygı ve parsiyel bölümlü protezlere uygun yüzeyler hazırlanması amaçlı olmaktadır. Adeziv tekniklerin ve klinik etkinliklerinin değerlendirilmesinde çürüksüz servikal lezyonların restorasyonu için açılan sınıf V kaviteler önemli bir çalışma alanıdır. Bu olayın nedeni de ilgili lezyonların tedavisi için makro mekanik tutucu alanlar içermemesi ve genel olarak bu hastaların oral hijyenleri ortalamanın üzerinde olmasıdır.[4]

Son yıllarda; diş hekimliği alanındaki araştırmaların büyük bir kısmını restoratif tekniklerin ve materyallerin geliştirilmesine yönelik çalışmalar oluşturmaktır. Adeziv sistemlerdeki gelişmelerle birlikte diş dokularının daha fazla korunduğu, daha ucuz estetik teknikler giderek yaygınlaşmaktadır.[4,5] Günümüzde adeziv sistemler üzerindeki çalışmalar, geleneksel adeziv sistemlerin dezavantajlarını ortadan kaldırmaya ve hekimlere kullanım kolaylığı getiren ürünler ortaya çıkarmaya yöneliktir. Geleneksel asitle ve yıka (TE) sistemlerin başlıca dezavantajı dentinin nem miktarına olan duyarlılıklarıdır.[6,7] Dentin kollojenleri arasında olması gerekenden fazla suyun kaldığı durumlarda, rezin monomer intertubuler dentini dolduramamakta ve bağlantı ara yüzeyinde demineralize bölgeler kalmaktadır.[8,9] Bu sebeple adeziv dentin ara yüzünde interfasiyal yıkımlar oluşmakta ve bağlantı gücü oldukça zayıflamaktadır.[10,11] Asit uygulanmış dentinin aşırı kurutulması da kollojen fibrillerin rezin monomer tarafından sarılmasını engelleyip, hidrolize olarak rezinin çözünmesine ve bağlantının zayıflamasına neden olabilmektedir.[12] Ayrıca, TE sistemlerin teknik hassasiyet gerektirmesi ve işlem basamaklarının fazlalığı klinik kullanım kolaylığını zora sokmaktadır. TE sistemlerde görülen ve rezinin kollojen fibriller arasına girmesini engelleyen nem sorunu, kendinden asitli (SE) adezivler için geçerli değildir. Ancak SE adezivler de mineyi fosforik asit kadar dağlayamamaktadır ve düşük mine bağlantısı sonucunda klinik olarak sık karşılaşılan bir durum olan restorasyon kenarlarında ayrılmalar veya kopmalar meydana gelmektedir.[13] Bu sorunun çözümü amacıyla SE adeziv uygulamasından önce kavitenin mine kenarlarının selektif olarak asitlenmesi (SLE) önerilmektedir.[14] Ancak; klinik ortamda minenin asitlenmesi işlemini dentine taşırmadan yapmak mümkün olamamaktadır. Son zamanlarda klinik kulanım kolaylığı sunan tek aşamalı SE adezivlerin dezavantajlarını ortadan kaldırmaya yönelik çalışmalar sonucu "Universal" veya "Multimod" olarak isimlendirilen ürünler ortaya çıkmıştır.[15,16] Bu ürünler hem SE hem de TE olarak kullanılabildiklerinden ve kendilerine has bir yapıya sahip olduklarından dolayı ultramorfolojik ve bağlantı kuvveti çalışmalarının odağında bulunmaktadırlar. Bu sebepten piyasada yeni yerini almış olan bu tip dentin bağlayıcı ajanlar, tüm adeziv teknikleri tek bir şişede toplamış ve hekimlere klinik açıdan çok yönlü bir bağlayıcı olarak sunulmuştur. Yapılan restorasyonlar ile dişin dayanıklılığının arttırılması, servikal bölgede oluşan stresin azaltılması, hassasiyetin engellenmesi, pulpanın korunması ve estetiğin sağlanması amaçlanmaktadır.[17] Yapılan bu çalışma ile adeziv diş hekimliğinde oldukça kolaylık sağlayan farklı kullanım modları ile yeni nesil universal adezivlerin etkinliklerinin

geniş kriterlere sahip olan FDI kriterlerine göre karşılaştırılması amaçlanmaktadır.

GEREÇ VE YÖNTEM

Eskişehir Osmangazi Üniversitesi Diş Hekimliği Fakültesi Restoratif Diş Tedavisi Anabilim Dalı Kliniği'ne Mayıs 2015-Temmuz 2015 tarihleri arasında tedavi edilmiş 1448 hastadan, hasta dosyaları incelenerek, çürüksüz servikal lezyon teşhisi konulup restorasyonları aşağıdaki yöntemler kullanılarak yapılmış olan 102 hasta fakültemize tekrar çağırılmıştır. Tercih edilen bu sisteme göre; restorasyonlar tek hekim tarafından yapılmış olmalıdır. İlk olarak dişlerin polisajı yapılıp yüzeyleri temizlendikten sonra dentin aşındırılmış ve mineye bizotaj yapılmış olmalıdır. İzolasyonun sağlanması amacıyla lezyonların restorasyonundan önce retraksiyon ipi kullanılmış olmalıdır. Dişlerin restorasyonunda universal dentin bağlayıcı (3M, Deutschland GmbH, 41453 Neuss, Germany) adezivin 3 farklı kullanım modu uygulanmış olmalıdır.Bu kullanım modları hem dentin hem de minenin asitlendiği TE, sadece minenin asitlendiği SLE ve sadece adezivin uygulandığı SE modlarıdır. Üretici firmanın önerileri doğrultusunda TE modunda; mine ve dentin 15 saniye asitlenmiş, 15 sn yıkanmış, hava ile kuruttuktan sonra hem mineye hem de dentine adeziv 20 saniye boyunca ovalayarak uygulanmış olmalıdır. SLE modunda; sadece mine 15 saniye asitlenmiş, 15 sn yıkanmış, hava ile kuruttuktan sonra hem dentin hem de mineye adeziv 20 saniye boyunca ovalayarak uygulanmış olmalıdır. SE modunda; adeziv dentin ve mineye 20 saniye boyunca ovalayarak uygulanmış olmalıdır. Tüm modların hepsinde adeziv uygulandıktan sonra 10 saniye boyunca LED ışık cihazı ile polimerize edilmiş olmalıdır. Değerlendirmeye alınan hastaların her birinin ağzında kullanılan multi-mod universal adezivin her bir modu en az iki dişe uygulanmış olmalıdır. Daha sonrasında da hepsi aynı nanohibrit kompozit rezin (3M, ESPE, St. Paul, MN, USA) ile tabakalama tekniğine uygun olarak restore edilmiş ve 20 saniye boyunca kompozit materyal polimerize edilmiş olmalıdır. Sarı bantlı bitim frezleri ve cila diskleri ile su soğutması altında cila işlemi yapılarak restorasyonlar tamamlanmış olmalıdır.

Kliniğe çağırılan hastalardan Tablo 1.1.'de belirtilen kriterler açısından da değerlendirilmiş olup uygun kriterlere sahip ve çalışmaya gönüllü olarak katılabileceğini bildiren 11 kadın, 14 erkek olmak üzere toplam 25 tedavisi tamamlanmış hasta çalışmaya dahil edilerek 246 restorasyonun değerlendirilmesi FDI kriterlerine göre yapılmıştır.

Tablo 1.1 Çalışmaya Dahil Edilme Kriterleri

Kabul kriterleri	Ret kriterleri
• 18 yaşından büyük olmak • En az 6 çürüksüz servikal lezyonun restore edilmiş olması • Yaygın çürüklerin olmaması • Ağızda en az 20 diş olması	• Restorasyon bölgesinde çürük olması • Restorasyon bölgesine gelen hareketli protez varlığı • Kötü ağız hijyeni • Bruksizm veya parafonksiyon • Malokluzyon • İleri ve/veya kronik periodontitis

Gönüllü katılımcılar üzerinde bir klinik takip çalışması olarak planlanan bu çalışmaya başlamadan önce, etik kurul onayı alınmıştır (ESOGÜ Etik Kurul Karar No: 80558721/G-109). Gönüllü katılımcılara, Etik Kurulun talebine uygun olarak hazırlanan, yapılacak çalışmanın amacını, içeriğini, araştırmada kullanılacak yöntemi ve araştırıcının çalışma süresince devam edecek sorumluluğunu da belirten 'Asgari Bilgilendirilmiş Gönüllü Olur Formu' okutulmuş, imzalı onayları alınmıştır.

Çalışmaya başlamadan önce, çalışmaya katılan hastaların kimlik bilgilerinin ve restorasyonları yapılmış olan dişlerdeki lezyon boyutlarının kayıtlarının yapıldığı, restorasyonda kullanılan adezivin türü, kullanım modu ve restoratif materyalin kayıt edildiği hasta formları tekrardan gözden geçirilmiş ve kayıtlı verileri takiben gerekli diş gruplandırmaları yapılmıştır. Seçilmiş hastalar tedavilerinin bitmesini takip eden ilk ayda kliniğe restorasyonların değerlendirilmesi amacıyla çağrılmışlardır. Yapılmış restorasyonlar, FDI kriterlerine göre 1. ay, 6. ay, 12. ay ve 18. aylarda değerlendirilmiş ve hasta takip formuna işlenmiştir. Restorasyonların

değerlendirilmesi ayna ve sond yardımıyla reflektör ışığı altında yapılmıştır. Restorasyonlar, FDI kriterleri içerisindeki yüzey cilası, yüzey renklenmesi, marjinal renklenme, renk uyumu ve translusensi, estetik anatomik form, kırık ve retansiyon, marjinal adaptasyon, hastanın görüşü, post-operatif hassasiyet ve vitalite, çürük tekrarı-erozyon-abfraksiyon, diş bütünlüğü ve periodontal yanıt kriterlerinde modlar arasındaki farklılık ve her bir modun kendi içerisinde zamana bağlı değişimi açısından değerlendirilmiştir.

Değerlendirilen restorasyonlardan retansiyon kaybı olanlar yalnızca retansiyon kaybı kriterine göre değerlendirilerek 5 ile skorlanmış, diğer kriterler açısından değerlendirilmeye alınmamıştır. Değerlendirmeye alınan FDI kriterlerleri aşağıdaki tablolarda gösterilmiştir. Ayrıca tüm bu değerlendirilmelerin kayıtlarının tutulduğu 'Klinik Araştırma Takip Formu' oluşturulmuştur.

Tablo 1.2. Kullanım modları karşılaştırılan adeziv materyalin yapısı[18]

Adeziv Materyal	Üretici Firma	Sınıflama	İçerik
Single Bond Universal Adeziv	3M, Deutschland GmbH, 41453 Neuss, Germany	Etanol/Su Bazlı, Universal Adeziv Mild Ph=2,7	Mdp Fosfat Monomer Dimetakrilat Rezinler 2-Hidroksietil Metakrilat (Hema) Vitrebond™ Copolymer Doldurucu Ethanol Su Initiatörler Silan

Tablo 1.3. Adeziv Materyalin Uygulama Modları[19]

Adeziv Materyal	Mod	Uygulama
Single bond universal adeziv	TE	Mine ve dentin 15 sn asitlenir. Asit yıkanıp diş hafifçe kurutulur. 20 sn boyunca adeziv hem mine hem de dentine ovalanarak uygulanır. Hava ile inceltildikten sonra 10 sn polimerize edilir.
	SLE	Sadece mine 15 sn asitlenir. Asit yıkanıp diş hafifçe kurutulur. Adeziv hem mine hem de dentine 20 sn boyunca ovalanarak uygulanır. Hava ile inceltildikten sonra 10 sn polimerize edilir.
	SE	Adeziv hem mine hem de dentine 20 sn boyunca ovalanarak uygulanır. Hava ile inceltildikten sonra 10 sn polimerize edilir.

Tablo 1.4. Kullanılan Restoratif Materyalin Yapısı

Kompozit Materyal	Üretici Firma	Sınıflama
Filtek™ Z 550 Universal Restorative	3M ESPE, St Paul, MN, USA	Nanohibrit

Seçilmiş hastalar tedavilerinin bitmesini takip eden ilk ayda kliniğe restorasyonların değerlendirilmesi amacıyla çağrılmışlardır. Yapılmış restorasyonlar, FDI kriterlerine göre 1. ay, 6. ay, 12. ay ve 18. aylarda değerlendirilmiş ve hasta takip formuna işlenmiştir. Restorasyonların değerlendirilmesi ayna ve sond yardımıyla reflektör ışığı altında yapılmıştır. Restorasyonlar, FDI kriterleri içerisindeki yüzey cilası, yüzey renklenmesi, marjinal renklenme, renk uyumu ve translusensi, estetik anatomik form, kırık ve retansiyon, marjinal adaptasyon, hastanın görüşü, post-operatif hassasiyet ve vitalite, çürük tekrarı-erozyon-abfraksiyon, diş bütünlüğü ve periodontal yanıt kriterlerinde modlar arasındaki farklılık ve her bir modun kendi içerisinde zamana bağlı değişimi açısından değerlendirilmiştir.

Değerlendirilen restorasyonlardan retansiyon kaybı olanlar yalnızca retansiyon kaybı kriterine göre değerlendirilerek 5 ile skorlanmış, diğer kriterler açısından değerlendirilmeye alınmamıştır. Restorasyonların tüm rutin kontrollerinde restore edilen dişlerden dijital fotoğraf alınmıştır.

İstatistiksel analizler, ESOGÜ Tıp Fakültesi Bioistatistik Anabilim Dalı'nda IBM SPSS 21 paket programı ile yapılmıştır. Skor değişkenleri özet değerleri median (Q1-Q3) ile nicel değişkenlerin özet değerleri ortalama +- standart sapma ile gösterilmiştir. Nitel değişkenler frekans ve yüzde olarak tablolarda gösterilmiştir. Skor değişkenlerde normal dağılım olmadığı için tekrarlı skor değişkenleri Friedman analizi ile değerlendirilmiştir. Anlamlı fark bulunan değişkenlerde Dunn's ikili karşılaştırma testi ile hangi tekrar zamanları arasında fark bulunduğu incelenmiştir. Kategorik mod değişkeni ile skorlar arasındaki ilişki Pearson Chi-square

analizi ile değerlendirilmiştir. Analiz sonucu p<0,05 bulunan sonuçlar istatistiksel olarak anlamlı kabul edilmiştir.

BULGULAR

Yapılan çalışmaya 11 kadın 14 erkek olmak 25 adet hasta dahil edilmiştir. Çalışmaya dahil edilen 246 dişin 82'si TE, 86'sı SE ve 78 adeti de SLE moduna ait olmuştur.

Tablo 2.1 Restorasyon Sayılarının Dağılımı

	Maksilla					Mandibula					Toplam
	Anterior			Posterior		Anterior			Posterior		
Adeziv Modu	Santral	Lateral	Kanin	Premolar	Molar	Santral	Lateral	Kanin	Premolar	Molar	
TE	17	10	15	20	4	0	0	0	15	1	82
SLE	4	4	8	18	1	2	5	7	22	7	78
SE	4	5	13	19	4	1	1	9	28	2	86
	25	19	36	57	9	3	6	16	65	10	
	80			66		25			75		
	146					100					246

İlk ay ve 6. ay değerlendirmelerinde katılım %100 iken, 12 ve 18. ay değerlendirmelerinde bu oran %88 olmuştur. Restorasyonlar 1, 6, 12 ve 18 aylık süreçlerde universal bağlayıcı ajanın farklı kullanım modlarında ve zamana bağlı değişimlerde değerlendirme altına alınmıştır. Kırık ve retansiyon kriteri değerlendirmesi dışında diğer kriterlerde ilk ay 246, 6. ay 241, 12. ay 199 ve 18. ayda 188 adet diş değerlendirilmiştir. Retansiyon kaybı olan dişler sadece kırık ve retansiyon kriterinde değerlendirilip diğer kriterlerde değerlendirmeye alınmamıştır.

Tablo 2.2 Hasta ve Restorasyonların Yaş ve Cinsiyete Göre Dağılımı

Yaş	Hasta Sayısı		Restorasyon Sayısı	
	Kadın	Erkek	Kadın	Erkek
30-40	4	1	30	12
40-50	4	3	32	32
50-60	2	7	31	68
60-70	1	3	10	31
Toplam	11	14	103	143

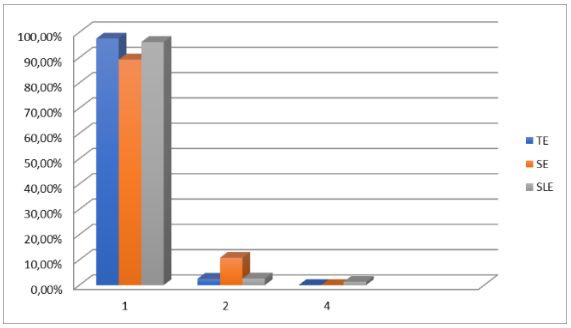
Yapılan bu çalışmada; 18 aylık değerlendirme aralığında yüzey cilası, yüzey renklenmesi, renk uyumu ve translusensi, estetik anatomik form, marjinal adaptasyon, post operatif hassasiyet ve vitalite, diş bütünlüğü, periodontal yanıt, çürük tekrarı, erozyon ve abfraksiyon kriterinde modlar arasında anlamlı bir fark bulunamamıştır (p>0,05).

Yapılan değerlendirmelerde; 6. ay sonuçlarında marjinal renklenme kriterinde modlar arasında anlamlı bir fark bulunurken (p=0,027), 12 ve 18. ay sonuçlarında marjinal renklenme kriterinde modlar arasında anlamlı bir fark bulunamamıştır (p>0,05).

Tablo 2.3 Marjinal Renklenmesi Skor Dağılımı ve Yüzdesi (6. Ay)

		Marjinal Renklenmesi 6. Ay			
		1.00	2.00	4.00	Toplam
Mod	TE	79	2	0	81
	% Mod	%97.5	%2.5	%0.0	%100.0
	SE	74	9	0	83
	% Mod	%89.2	%10.8	%0.0	%100.0
	SLE	74	2	1	77
	% Mod	%96.1	%2.6	%1.3	%100
Total		227	13	1	241
		%94.2	%5.4	%0.4	%100.0

Anlamlı fark oluşan zaman diliminde en az marjinal renklenme TE modunda olurken en fazla marjinal renklenme SE modunda olmuştur.



Şekil 2.1 Marjinal renklenme kriterinin 6. aydaki modlar arası skor dağılımı

Tablo 2.4 Ki-kare Testi (Marjinal Renklenme 6. ay)

	Değer	Df	Asemptomatik Anlamlılık (Çift Taraflı)	Monte Carlo An. (Çift Taraflı)	
				Anlamlılık	99% Alt Sınır
Ki-Kare	9,449[a]	4	,051	**,027[b]**	,023
Olabilirlik Oranı	9,153	4	,057	,038[b]	,033
Fisher'in Tam Olasılık Testi	8,132			,036[b]	,032
Doğrusal Bağlantı	,777[c]	1	,379	,432[b]	,420
Geçerli Vaka Sayısı	241				

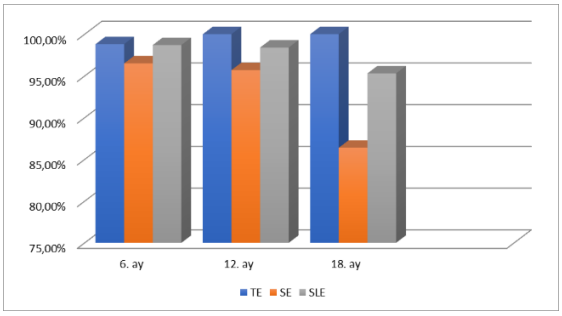
Yapılan çalışmada 6. ay kırık ve retansiyon değerlendirmelerinde modlar arasında anlamlı fark bulunmuştur (p<0,05). Fakat 12 ve 18. ay değerlendirmelerinde kırık ve retansiyon kriterinde modlar arasında anlamlı bir fark bulunamamıştır (p>0,05). Anlamlı fark oluşan zaman diliminde en çok retansiyon kaybı SE modunda olmuştur. En az retansiyon kaybı ise TE moduna ait olmuştur.

Tablo 2.5 Kırık ve Retansiyon Skor Dağılımı ve Yüzdesi (6. Ay)

		Kırık Ve Retansiyon 6. Ay			
		1.00	2.00	5.00	Toplam
Mod	TE	81	0	1	82
	% Mod	%98.8	%0.0	%1.2	%100.0
	SE	77	6	3	86
	% Mod	%89.5	%7.0	%3.5	%100.0
	SLE	76	1	1	78
	% Mod	%97.4	%1.3	%1.3	%100
Total		234	7	5	246
		%95.1	%2.8	%2.0	%100.0

Tablo 2.6 Ki-kare Testi (Kırık ve Retansiyon 6. ay)

	Değer	Df	Asemptomatik Anlamlılık (Çift Taraflı)	Monte Carlo An. (Çift Taraflı)	
				Anlamlılık	99% Alt Sınır
Ki-Kare	9,983[a]	4	,041	**,030[b]**	,025
Olabilirlik Oranı	10,910	4	,028	,054[b]	,048
Fisher'in Tam Olasılık Testi	8,407			,031[b]	,026
Doğrusal Bağlantı	,038[c]	1	,846	,896[b]	,889
Geçerli Vaka Sayısı	246				



Şekil 2.2 Aylara göre her bir modun ağızda kalma başarısı

Yapılan değerlendirmelerde 12. ve 18. ay değerlendirmelerinde hastanın görüşü kriterinde modlar arası anlamlı fark bulunmuştur ($p<0,05$). Anlamlı fark olan zaman aralıklarında en iyi görüşler TE ve SLE moduna ait olurken en kötü görüşler SE moduna ait olmuştur.

Friedman analizi ile değerlendirilen her bir modun kendi içerisindeki zamana bağlı yüzey cilası, yüzey renklenmesi, estetik anatomik form, kırık ve retansiyon, marjinal adaptasyon, hasta görüşü, post operatif hassasiyet ve vitalite, diş bütünlüğü, periodontal yanıt, çürük tekrarı, erozyon ve abfraksiyon değişimlerinde istatistiksel olarak anlamlı bir fark bulunamamıştır ($p>0,05$).

Friedman analizi ile yapılan zamana bağlı marjinal renklenme değişimi her bir mod için 6. aydan itibaren anlamlı değişiklik göstermeye başlamıştır ($p<0,05$).

Friedman analizi ile yapılan değerlendirmelerde TE modunda renk uyumu ve translusenside zamana bağlı anlamlı bir değişiklik gözlenmemiştir ($p>0,05$). SE ve SLE modunda ise anlamlı olarak 6. aydan itibaren değişim gözlemlenmeye başlamıştır ($p<0,05$).

TARTIŞMA

Bir kompozit restorasyonun klinik başarısı temel olarak mine ve dentine olan bağlanmanın etkinliği ve devamlılığına bağlıdır. Restorasyonun uzun ömürlülüğü; hasta özellikleri, preperasyon dizaynı, restorasyon materyal tipi ve adeziv sisteme bağlı olarak değişmektedir.[18] Peumans *ve ark.*[5] tarafından, adezivlerin başarısını inceleyecek klinik çalışmalarda çürüksüz servikal lezyonların tercih edilmesi gerektiği bildirilmiş ve bu durum şu gerekçelerle açıklanmıştır;

Çürüksüz servikal lezyonlarda makro-mekanik tutuculuk genel olarak sağlanamaz.

Çürüksüz servikal lezyonlarda bağlanma alanının en az %50 'sini dentin dokusu oluşturmaktadır.

Çürüksüz servikal lezyonlar hem mine hem dentin dokusunu içermektedirler.

Bu lezyonlar aynı ağızda yaygın olarak bulunabilirler.

Çoğunlukla erişimi kolay olan ön dişler de ve premolar dişlerde bulunurlar.

Çok az preparasyon gerektirirler ve restorasyonların yapımı nispeten kolaydır.

Kullanılan kompozitin özellikleri sonucu etkileyemez.

Bu sebeplerle adezyon ya da bağlanmanın başarısızlığının göstergesi olan restorasyon kaybının bu tip restorasyonlarda değerlendirilmesinin, uygulanan bağlayıcı ajanın etkinliğinin incelenmesinde en uygun parametre olacağı düşünülmüştür.[104] Klinik olarak hekim açısından ise; Sınıf V kompozit rezin restorasyonlarda ek retansiyon işlemi yapılmadan, marjinal bütünlük ile restorasyonun devamlılığının sağlanması her zaman bir zorluk oluşturmuştur. Hipermineralize tabakanın aşındırılması veya

güçlü asitler yardımıyla kaldırılması, sklerotik dentine mikromekanik bağlantıyı artırmak için kullanılabilecek stratejilerden kabul edilmiştir.[20,21] Sklerotik dentindeki zayıf difüzyon bariyerlerinde hibrit tabakası oluşturmak mümkün olabilirken, bu hibrit tabaka düzensiz olup, hatta kalın bariyerlerden yoksun olabilmektedir. Klinisyenler bu farklılıkları klinik seviyede fark edemeyebilirler. Hekim ancak yüzeye bağlayıcı ajan uygulamasından önce sklerotik dentinin yüzeyel tabakasını kaldırarak klinik olarak durumu lehine çevirebilir.[20,21] Araştırıcıların bu önerilerine rağmen sklerotik dentine bağlanmada artış gözlenmeme ihtimali de bulunmaktadır. Yine de bununla beraber bağlanmadaki başarısızlık engellerden biri kaldırılmış olur. Son zamanlarda yayımlanan birçok makalede dentine bağlanmayı arttıran alternatifler üzerinde düşünülmüş ve çoğunlukla dentin üzerinde yoğunlaşılmıştır.[22,23] Bağlanma stratejileri başlığında, mine düşünüldüğünde ise mine yüzeyine bizotaj işlemi uygulanmasının bağlantıyı arttırıcı iyi bir seçenek ortaya konulduğu çalışmalar karşımıza çıkmaktadır.[24-26] Yapılan laboratuvar çalışmalarına göre bu prosedürün; mikrosızıntı ve mine marjinlerinde kırılmayı azalttığı bildirilmektedir.[27-29] Ayrıca bizotaj işlemi daha iyi adezyon sağlamakta ve estetiği de arttırmaktadır.[30,31] Uygulanan prosedür ile mine prizmalarını asitlemeye karşı daha duyarlı hale getirmekte ve SE'lerin bağlanma performanslarını arttırmaktadır. Ancak çürüksüz servikal lezyonlarda bizotaj uygulamasının kompozit restorasyonların tutuculuk ve marjinal renklenmesi açısından etkisi açısından tartışmalı çalışmalar da mevcuttur.[31-34] Bu çalışmanın değerlendirilmesine dişlerin mine yüzeylerine bağlanmayı desteklemek amacıyla mine yüzeyine bizotaj işlemi yapılmış hastalar seçilmiştir.

Klinik takipli çalışmalarda restorasyonların nasıl yapılması gerektiği kadar, yapılan restorasyonların hangi kriterlere göre değerlendirilmesi gerektiği de önemli bir alt başlık oluşturmaktadır. Bu çalışmada restorasyonlar ağız içi bir ayna ve sond yardımıyla FDI kriterlerine göre değerlendirilmiştir. FDI kriterleri, 2007 yılında FDI World Dental Federation'ın bilimsel komitesi tarafından kriterler ve sınıflama olarak onaylanmış ve 2008 yılında klinik araştırma olarak restoratif materyal veya operatif tekniklerin değerlendirilmesinde standart kriterler olarak kabul görmüştür. Süt dişlerindeki restorasyonların değerlendirildiği bir çalışmada FDI kriterleri ile geleneksel olarak bilinen 'United States Public Health Service' (USPHS) kriterleri (RYGE kriterleri olarak bilinen); karşılaştırılmıştır ve araştırmacılar, süt dişlerinin kompozit rezin restorasyonlarının değerlendirilmesindeki belirleyici farklılıklarda FDI kriterlerinin daha hassas olduğunu görmüşlerdir.[35] Ayrıca Scotchbond Universal adezivin de 36 aylık değerlendirmeleri hem FDI hem de modifiye USPHS kriterlerine göre yapılmış ve FDI kriterlerinin küçük değişimlerin saptanmasında daha hassas olduğu gözlemlenmiştir.[19]

Klinik vakalarda kullanılan FDI kriterlerinin çeşitli sebepler nedeniyle kriter ve skorlama bakımından modifiye edilebilmesi de araştırmacıya farklı seçenekler sunabilmektedir.[35] Bu sebeple restorasyonlar açısından daha hassas değerlendirme sağlayan FDI kriterleri tercih edilmiştir.

Loguercio *ve ark.*[19] yaptığı SBU bağlayıcı ajan ile 3 sene içerisinde takip edilen 200 restorasyonun dahil edildiği klinik çalışmasında SBU bağlayıcı ajanın 3 farklı kullanım modu ve TE sistem kendi içinde hem nemli dentine hem de kuru dentine uygulama açısından marjinal renklenme, retansiyon ve kırık, marjinal adaptasyon, postoperatif hassasiyet ve çürük tekrarı bakımından hem FDI hem de USPHS kriterlerine göre karşılaştırılmıştır. Üç senelik değerlendirmeler sonucunda marjinal renklenme ve retansiyon kriterlerinde modlar arasında anlamlı fark bulunmazken, yapılan bu

çalışmada SBU bağlayıcı ajanın marjinal renklenme ve kırık ve retansiyon açısından yapılan değerlendirmelerinde 6. ay sonuçlarında modlar arası anlamlı farklılık bulunmuştur. SBU bağlayıcı ajanın marjinal renklenme açısından değerlendirmesinde kötü yönde en fazla değişim bu çalışmaya benzer şekilde SE modunda olmuştur. Bu durum marjinal renklenmelerin en fazla SE modunda gözlenmesinin nedeni olarak SE adezivlerin mineyi asitlemesinin zayıf olmasını düşündürebilir. Çünkü marjinal renklenmeler SE adeziv sistemlerde mine asitlemesinin zayıflığının bir göstergesidir.[19] Marjinal renklenme değerlendirmesi mineye hangi adeziv strateji ile bağlanılması gerektiği konusundaki yapılmış veya yapılacak çalışmalarda önemli bir parametredir. En fazla retansiyon kaybı ise SBU bağlayıcı ajanın 3 senelik değerlendirmesinde bu çalışmaya benzer şekilde SE modunda olmuştur. Her iki çalışmada da kullanılan SBU bağlayıcı ajanın SE modu tek aşamalı SE adezivler kategorisine girmektedir. Klinik kullanım açısından oldukça kolaylaştırılmış bu adezivler, 2010 yılında yayımlanmış klinik bir meta-analizin sonuçlarına göre de sınıf V lezyonlarda diğer tip dentin bağlayıcılara göre daha başarısız bulunmuşlardır.[36] Her iki çalışmada da SE modunda marjinal renklenmenin ve retansiyon kaybının fazla görülmesi kullanılan adezivlerin mineyi zayıf asitlediği ihtimalini bir kez daha düşündürmektedir.[19] Bunun sonucu olarak da zamana bağlı marjinal renklenmeler ve retansiyon kayıpları meydana gelmesi kullanılan adeziv sistemin bir sonucu olabilmektedir. Retansiyon kaybı değerlendirmelerinde; bu çalışmada SBU için en az kayıp TE modunda olurken SBU adezivin 36 aylık değerlendirilmesinde en az kayıp SLE modunda olmuştur. Bu farklılığın değerlendirme süresindeki farklılıklardan kaynaklanması düşünülebileceği gibi çalışmayı destekler nitelikte TE strateji kullanımını öneren ve smear tabakasının kaldırılmasının daha iyi olacağı yönünde çalışmalar da mevcuttur.[16,37,38] Ancak dentine bağlanmada asit kullanılmamasının daha az nano-sızıntı ve daha iyi kapanma sağlayacağını destekler çalışmalar da mevcuttur.[39] Marjinal adaptasyon, post operatif hassasiyet ve çürük tekrarı kriterlerinde ise SBU bağlayıcı ajanın değerlendirilmesinde bu çalışmayı destekler nitelikte modlar arası ve zamana bağlı anlamlı bir değişiklik söz konusu olmamıştır.[19] Post operatif hassasiyet konusunda bu çalışmaları destekler şekilde benzer sonuçlar bulunan başka çalışmalar da mevcuttur.[40,41]

Lawson *ve ark.*[41] yaptığı SU adezivin başka bir klinik çalışmasında TE, SE kullanım modları ve 2 aşamalı TE Scotchbond Multi-purpose (SMP) bağlayıcı ajan ile karşılaştırılmış ve 2 senelik klinik çalışma ile değerlendirilmiştir. Böylelikle universal bağlayıcı ajanın TE modunun 2 aşamalı TE sistemlerle karşılaştırılma imkânı bulunmuştur. İki senelik çalışmada, marjinal adaptasyon, marjinal renklenme, ikincil çürük ve post operatif hassasiyet kriterleri başlangıç, 6, 12 ve 24 aylık süreyle modifiye USPHS kriterlerine göre değerlendirilmiştir. Bu çalışmanın sonuçlarına benzer şekilde marjinal adaptasyon, sekonder çürük ve post operatif hassasiyet kriterlerinde modlar arası bir farklılık gözlenmemiştir. Marjinal renklenme değerlendirilmesinde ise SU bağlayıcı ajanın TE mod kullanımında renklenme oranı en az bulunarak yapılan çalışmadaki SBU bağlayıcı ajanın marjinal renklenme değerlendirilmesini destekler sonuçlar ortaya çıkmıştır.[131] Aynı zamanda SU adezivin TE modunun marjinal renklenmesi, 2 aşamalı TE adeziv olan SMP'den daha az bulunmuştur. Retansiyon oranlarına bakıldığında ise modlar arasında anlamlı fark bulunmazken oransal olarak SU adezivin hem SE hem de TE modu SMP'e göre daha başarılı olmuştur. Bunun sebebi olarak SU bağlayıcı ajanın geleneksel SE adezivlerdeki HEMA'dan farklı olarak daha hidrofobik HEMA içermesi ve bunun sonucunda daha hidrofobik bir materyal olması düşünülebilir. SU adezivi farklı kılan diğer bir özellik de MDP

ve polialkenoik asit kopolimeri içermesidir. Hidrofobikliği katkı sağlayan diğer madde adezivin içerisindeki MDP molekülüdür. Ayrıca MDP ve polialkenoik asit kopolimeri kalsiyuma bağlanmayı sağlayarak oluşan hibrit tabakada da yer alırlar.[42] SU bağlayıcı ajanın içerdiği 10-MDP molekülü stabil kalsiyum tuzları yaratarak mine ve dentindeki hidroksiapatit kristallerine kimyasal olarak bağlanarak bağlantıyı arttırırlar.[42,43] MDP molekülü kullanılarak piyasaya sürülen ilk adeziv Clearfil SE olmuştur ve bu adezivin 8 yıllık klinik çalışmasında başarı oranı %97 olarak bulunmuştur.[44] Bu sonuçlara göre düşünüldüğünde universal bağlayıcı ajanlar MDP molekülü içermelerinden dolayı heri bir kullanım modu için karşılığı olan strateji ile geleneksel adezivlere oranla daha başarılı olarak kabul edilebilirler.

İn vitro olarak yapılmış, universal bağlayıcı ajanların farklı asitleme modlarının bağlanma performansının değerlendirildiği bir çalışmada;[38] Futurabond Universal (FU), SU ve All-Bond Universal (ABU) bağlayıcı ajanlar SE ve TE modlarda karşılaştırılmıştır. Referans olarak da 2 adet tek aşamalı SE adeziv olan Futurabond DC (FDC) ve Futurabond M (FM) ile karşılaştırılmaları yapılmıştır. Üç universal adezivde de SE uygulama veya TE uygulama protokollerinde mikro tensile bond bağlanımı (μTBS) açısından istatistiksel bir farklılık gözlenmemiştir, ancak dentine infiltrasyon davranışlarında TE modunda dentine penetrasyon daha fazla gözlenmiştir. Asitleme uygulaması ile dentindeki smear tabakasının kaldırılarak adeziv infiltrasyonunun artması sağlanmış buna bağlı olarak daha uzun rezin tag oluşumu ve hibrit tabakası oluşumu sağlanmıştır.[45-48] Bu durum yapılan bu çalışmanın sonucunda TE modunun diğer modlara göre daha başarılı bulunmasının bir nedeni olarak açıklanabilir. İn vitro çalışmanın devamı olarak; 3 universal adezivin SE ve TE modlarının bağlanım performansının tek aşamalı SE adeziv olan FDC ve FM ile karşılaştırıldığında daha iyi olduğu gözlemlenmiştir. SBU ve ABU uygulanan gruplarda SE modunda tek aşamalı FDC ve FM'e göre daha yüksek bağlanma dayanımı gözlenmiştir. Bu sonuçlar da yine MDP molekülünün etkinliğini işaret etmiştir. SBU adeziv aynı zamanda polialkenoik asit kopolimer (Vitrebond Copolymer) de içermektedir. Hem bu molekülü hem de MDP molekülünü içeren adezivlerle, sadece MDP molekülü içeren adezivler karşılaştırılmasında ise farklı sonuçlar açığa çıkmıştır. SBU adezivin sadece MDP içeren Clearfil SE Bond ile karşılaştırıldığı bir çalışmada dentine bağlanmada SBU adeziv daha başarılı olurken; aynı adezivlerin karşılaştırıldığı bir diğer çalışmada SBU adezivin bağlanma dayanımı daha az olarak bulunmuştur. Bunun sebebi olarak da polialkenoik asit kopolimer molekülünün MDP monomeri ile hidroksiapatit kristallerindeki kalsiyuma bağlanma bölgelerinde yarış içinde olmaları düşünülmüştür.[38]

2015 yılında yayımlanan universal bağlayıcı ajanların bağlanma dayanımları meta-analizinde, TE ve SE stratejilerin mine ve dentin karşılaştırılmaları değerlendirilmiştir.[49] Mild universal adezivlerde öncelikli asit uygulaması minede bağlanma dayanımı artarken dentinin asitlenmesi durumunda bağlanmada bir artış söz konusu olmamıştır. Bu sebeple, mild self-etch adezivlerin dentine bağlanmada çeşitli asitsiz kullanımı çalışmalarda da önerilmektedir.[50-52] Karşılaştırılan universal adezivler içerisinde sadece ABU'da, TE modu hem mine hem de dentinde bağlanma dayanımını arttırmıştır. Bunun sebebi de muhtemelen ultra-mild asiditeye sahip olduğundan tam olarak asitleme ve yüzey hazırlanması işleminin yetersizliğinden kaynaklandığı düşünülmüştür (ph=3,1). Bu çalışmada retansiyon açısından yapılan değerlendirmede TE kullanım modunda SLE ve SE kullanım moduna göre bir üstünlük söz konusu olmuştur. Bu bağlamda düşünüldüğünde bu sonucun adezivin asiditesi kaynaklı olabileceği düşünülebilir. Bu

çalışmada kullanılan SBU adezivin ise asiditesi bazı çalışmalarda ultra-mild bazılarında ise mild olarak kabul edilmiştir.[19,49] SU adeziv mild adeziv kategorinde kabul edilse bile diğer mild adezivlere oranla ultra mild asiditeye yakın olduğu için asitleme konusunda yetersiz kalabileceği düşünülebilir. Sonuç olarak; öncelikli asit uygulaması tüm universal adeziv tiplerinde mineye bağlanmayı arttırırken; dentinin asitlenmesi söz konusu olduğunda kullanılan adezivin asiditesine bağlı olarak bu durum değişebilmektedir.[25,39,49,51,52]

Farklı adeziv tekniklerini karşılaştıran daha birçok laboratuvar çalışmaları mevcuttur.[53-55] Fakat ne yazık ki laboratuvar çalışmaları adeziv sistemlerin ağızdaki uzun süreli devamlılığı hakkında yeterli bilgi sağlayamamaktadır. Bu sebeple adeziv sistemlerin testi laboratuvar performanslarına göre yapılmamalı, klinik olarak performansları göz önüne alınmalıdır. Birçok bond bağlanım testi bond uygulamasının hemen ardından uygulanmakta ve sadece birkaç çalışma oral şartlardaki (çiğneme kuvvetleri, ph ve sıcaklık değişimleri) kimyasal ve fiziksel stres faktörlerini taklit etmektedir. ADA, bu sebeple bond ara yüz devamlılığı ve uzun dönemdeki oral sıvıların etkinliğinin değerlendirilebilmesi için çürüksüz servikal lezyon sınıf V klinik çalışmalarını önermektedir.[1,56]

Tüm bu sonuçlar değerlendirildiğinde universal adezivler için mineye bağlanmayı arttırma amacıyla öncelikli olarak asit uygulaması iyi bir seçenek olarak karşımıza çıkmaktadır ve SE kullanım modunda başarı oranı daha az olmaktadır. Klinik çalışmalar da göstermektedir ki SE adezivlerde minenin asitlenmesi restorasyonların bağlanımında daha sağlam marjinal bütünlük sağlamaktadır ve marjinal renkleme oranını da azaltmaktadır.[57] Dentine bağlanma strateji söz konusu olduğunda ise farklı görüşler söz konusudur. Kullanılan adezivin pH' ına bağlı olarak farklı sonuçlar açığa çıkmaktadır.[49] Bir çok çalışmada mild adezivlerin kullanımında SLE tekniği klinik olarak en iyi strateji olarak karşımıza çıkmaktadır.[19] Ancak bu durum ultra-mild adezivler için dentine hangi strateji uygulanacağı konusunda geçerli olamamaktadır.[49] Universal adezivlerin değerlendirilmesinde birçok çalışmada hiçbir kullanım modu arasında fark gözlemlenmezken oransal olarak bakıldığında SE kullanım modu en başarısız olmuştur.[19,41] Bununla beraber universal adezivlerin geleneksel tek aşamalı SE adezivlerden farklı olarak MDP molekülü içermesinin, bu adezivlerin klinik başarısının artması açısından oldukça yararlı olduğu fikri benimsenmiştir.

SONUÇLAR

1. FDI kriterlerine göre 1. aydan 18. aya kadar yapılan değerlendirmelerde yüzey cilası, yüzey renklenmesi, renk uyumu ve translusensi, estetik anatomik form, marjinal adaptasyon, hastanın görüşü, post-operatif hassasiyet, çürük tekrarı, erozyon, abrazyon, diş bütünlüğü ve periodontal yanıt kriterlerinde universal adezivin kullanım modu bakımından anlamlı bir farklılık bulunamamıştır.
2. Marjinal renklenme kriterinde 6. aylık süreçte universal bağlayıcı ajanın kullanım modları bakımından anlamlı bir farklılık bulunmuştur.
3. Zaman içerisinde meydana gelen marjinal renklenmeler en fazla SE modunda gözlemlenmiştir.
4. En az marjinal renklenme görülen kullanım modu TE olarak gözlemlenmiştir.
5. Kırık ve retansiyon kriterinde universal adezivin kullanım modu bakımından bir farklılık bulunmuştur.
6. En çok retansiyon kaybı SE kullanım modunda gözlemlenmiştir.
7. Klinik olarak ağızda devamlılığı en fazla olan kullanım modu TE olarak bulunmuştur.
8. Piyasaya sürülen bu yeni adezivler konusundaki sınırlı çalışma sayısı ve kısa süreli takipler nedeniyle multi-mod adezivlerde en iyi protokolün hangisi olduğu sorusu henüz tam anlamıyla cevaplanamamıştır. Bu sebeple bu

konu hakkında yapılmış daha çok sayıda araştırmaya gereksinim bulunmaktadır.

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Cumhuriyet Dental Journal: 2018; 21(4)
Doi: 10.7126/cumudj. 425767 *RESEARCH ARTICLES*

COMPARISON OF ANXIETY LEVELS AND PERCEPTIONS OF PATIENTS WITH INITIAL PERIODONTAL TREATMENT USING DIFFERENT ANESTHESIA AND INSTRUMENTS

Farklı Anestezi ve Enstrümanlarla Gerçekleştirilen Başlangıç Periodontal Tedavinin Hastaların Anksiyete ve Algı Düzeylerine Etkilerinin Karşılaştırılması

Aysan LEKTEMUR ALPAN

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ABSTRACT

Objectives: The aim of this study is to compare perception and anxiety levels of patients who are received different anesthesia and instruments prior to periodontal treatment.

Materials and Methods: The study performed in the Periodontology Department of Pamukkale University's Faculty of Dentistry (October 2017-February 2018) and designed as randomized controlled clinical trial. 60 periodontitis patients were divided into 6 groups: 1-Local piezo, 2-Topical piezo, 3- Piezo, 4-Local hand instrument, 5-Topical hand instrument, 6- Hand instrument. Topical groups were received xylocaine spray; local groups were received jetocaine ampoule. Patients were asked to fill dental anxiety scale (DAS) scale before the treatment and 10th day. The visual analogue scale (VAS) was filled out on the day of treatment, on the second day and on the 10th day following treatment. Clinical measurements were taken on the treatment day and on the 30th day.

Results: There was a significant decrease in clinical measurements in all groups. Local anesthesia groups revealed lower VAS pain values ($p<0.05$) compared to other groups on the day of the procedure. Topical anesthesia groups revealed lower VAS pain values as compared to the piezo and hand instrument groups, respectively ($p>0.05$). The ultrasonic groups exhibited lower DAS scores than the hand instrument groups ($p>0.05$).

Conclusion: Local anesthesia provided better patients cooperation and VAS pain scores, but did not yield good speech and chewing scores. Topical anesthesia and ultrasonic scaler usage may be more useful to patients with dental anxiety.

Key Words: anesthesia, DAS, dental anxiety, periodontitis, VAS

ÖZ

Amaç: Bu çalışmanın amacı, farklı anestezi teknikleri ve enstrümanlarla yapılan periodontal tedavi uygulanan hastaların algı ve anksiyete düzeylerini karşılaştırmaktır.

Gereç ve Yöntemler: Çalışma Pamukkale Üniversitesi Diş Hekimliği Fakültesi Periodontoloji Bölümü'nde (Ekim 2017- Şubat 2018) gerçekleştirildi ve randomize kontrollü klinik çalışma olarak tasarlanmıştır. 60 kronik periodontitis hastası 6 gruba ayrıldı: 1-Lokal piezo, 2-Topikal piezo, 3- Piezo, 4-Lokal el aleti, 5-Topikal el aleti, 6- El aleti. Topikal gruplara xylocain sprey, lokal gruplara ise jetokain ampul uygulandı. Hastalardan, tedavi öncesi ve tedavi sonrası 10. günde dental anksiyete skalasını (DAS) doldurmaları istendi. Görsel analog skala (VAS) tedavi günü, ikinci günü ve tedaviden sonraki 10. günde hastalar tarafından doldurduldu. Klinik ölçümler tedavi öncesi ve tedavi sonrası 30. günde alındı.

Bulgular: Tüm gruplarda klinik ölçümlerde anlamlı bir iyileşme gözlendi. Lokal anestezi gruplarında, işlem gününde diğer gruplara göre daha düşük VAS ağrı değerleri ($p <0,05$) ölçüldü. Topikal anestezi gruplarında ise piezo ve el aleti gruplarına göre daha düşük VAS ağrı değerleri saptandı ($p>0,05$). Ultrasonik gruplar, el aleti gruplarından daha düşük DAS skorları sergiledi ($p>0,05$).

Sonuç: Lokal anestezi daha iyi hasta kooperasyonu ve daha az VAS ağrı skorları sağladı, ancak konuşma ve çiğneme skorlarını yükseltti. Topikal anestezi ve ultrasonik scaler ile gerçekleştirilen tedavi, dental anksiyete hastaları için daha yararlı olabilir.

Anahtar Kelimeler: Anestezi, DAS, dental anksiyete, periodontitis, VAS

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INTRODUCTION

Periodontitis is a disease caused by specific microorganisms and it causes periodontal ligament and alveolar bone loss by affecting the supporting tissues of teeth.[1] It can usually be treated successfully with scaling, root planning (SRP) and periodontal surgery. Initial periodontal treatment includes subgingival and supragingival debridement and root surface planning. The SRP treatment of periodontitis involving mechanical treatment phase may be painful for the patient.[2] Curettes, which are hand instruments for performing SRP, are widely used. However, even an operator with very good hand skills is unable to navigate the difficult root anatomy to obtain a biologically efficient clean root surface[3, 4] Furthermore, working with hand instruments can be tedious, laborious and time consuming. The excessive use of hand instruments may cause unintended root surface loss and postoperative root sensitivity[5, 6] To improve the clinical and microbial results, sonic and ultrasonic scalers were developed to perform subgingival and supragingival debridement. Many studies that used these ultrasonic tools observed similar clinical outcomes to studies that used hand instruments[7, 8] Although ultrasonic scalers have many advantages, they have disadvantages as well, such as insufficient water cooling applied to pulpal and periodontal tissues[9], pathogenic bacterial aerosol[10], and disturbing the patient with tooth contact.[11]

Pain is a feeling that develops from intense or harmful stimuli. It has been difficult to define pain, as it is a complex and subjective phenomenon. The widely used definition from the International Association for the Study of Pain states, "Pain is related with real or potential tissue damage and is an unpleasant sensory and affective with regards to this damage,".[12]

Dental anxiety are the emotions which develop alongside the important physiological stimulation. It can also develop with sensory stimulation and in response to procedures, dentistry objects, or dentistry procedure resources.[13] Anxiety surrounding a dentist and his treatment is considered to be one of the most common anxieties that people experience. Various scales and questionnaires have been established to determine the pain status and dental anxiety of the patients. Two of the most common of these scales the visual analogue scale (VAS) for pain measurement and the dental anxiety scale (DAS) developed by Corah for the measurement of dental anxiety.[14] (Table 1)

Table 1: Corah's DAS scale

a.	I would look forward to it as a reasonably enjoyable experience.
b.	I wouldn't care one way or the other.
c.	I would be a little uneasy about it.
d.	I would be afraid that it would be unpleasant and painful.
e.	I would be very frightened of what the dentist would do.
2-	**When you are waiting in the dentist's office for your turn in the chair, how do you feel?**
a.	Relaxed.
b.	A little uneasy.
c.	Tense.
d.	Anxious.
e.	So anxious that I sometimes break out in a sweat or almost feel physically sick.
3-	**When you are in the dentist's chair waiting while the dentist gets the drill ready to begin working on your teeth, how do you feel?**
a.	Relaxed.
b.	A little uneasy.
c.	Tense.
d.	Anxious.
e.	So anxious that I sometimes break out in a sweat or almost feel physically sick.
4-	**Imagine you are in the dentist's chair to have your teeth cleaned. While you are waiting and the dentist or hygienist is getting out the instruments which will be used to scrape your teeth around the gums, how do you feel?**
a.	Relaxed.
b.	A little uneasy.
c.	Tense.
d.	Anxious
e.	So anxious that I sometimes break out in a sweat or almost feel physically sick.

Local anesthesia provides reversible blockage of the nerves around the tissue. Anesthesia in dentistry is performed by using different techniques such as: 1-Conduction Anesthesia, 2-Infiltration Anesthesia and 3-Topical or Surface Anesthesia.[15] Although the use of local anesthesia provides a better neural blockage, the use of topical anesthetics for the patients who are anxious to injection may be an alternative approach.

The aim of our study was to investigate the effects of initial periodontal treatment which performed with different anesthetic methods with hand instruments and ultrasonic scalers on dental anxiety and the pain, chewing, speech perceptions perception levels of chronic periodontitis patients.

MATERIAL AND METHODS

The study received the approval of the Clinical Research Ethics Committee of Pamukkale University (number 2017/14) and was designed as a randomized controlled clinical trial. The

population of our study were patients who applied for treatment in the Periodontology Department of Pamukkale University's Faculty of Dentistry between October 2017 and January 2018, and the study followed the principles of the Helsinki Declaration.

60 people, aged 26–55, came to the Pamukkale University Faculty of Dentistry Department of Periodontology with chronic periodontitis were involved in the study. The participants included chronic periodontitis patients who were healthy and at least in 4 of their teeth had a 4mm probing depth; severe periodontitis patients, pregnant women, smokers, patients who use regular analgesics and inflammatory medications, women in their menstrual cycle and those who had anesthesia allergies were not involved.

After describing the treatments that would be implemented and obtaining written consent from the patients, they were asked to answer questions on the DAS scale.[13] (Table 1) This scale involved 4 questions and 5 answers (a,b,c,d,e) that were scored 1,2,3,4 and 5, respectively, with sum of the scores achieving a total score (4 to 20 points). According to this scale, anxiety levels included mild anxiety (4 to 8), moderate anxiety (9 to 12), high anxiety (13-14), and phobia (15 to 20).[16]

The study groups were formed with complete randomization. The patients were randomly divided into 6 groups: 1–local piezo (n=10), 2–topical piezo (n=10), 3–piezo (n=10) 4–local hand instrument (n=10), 5–topical hand instrument (n=10), 6–hand instrument (n=10). (Figure 1)

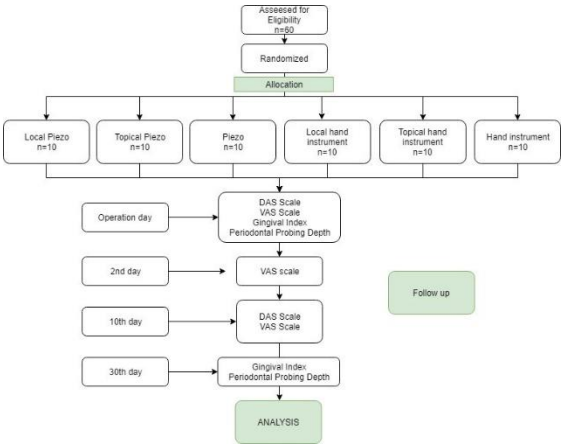

Figure 1: Study design

The patients in the piezo and hand instrument groups were not administered anesthesia, while the patients in the topical group were administered 10 mg of lidocaine spray (xylocaine pump spray, AstraZeneca, Södertalje Sweden). The local groups received an anesthetic agent containing Lidocaine HCl 20 mg / ml and Epinephrine HCl 0.0125 mg / ml (Jetocaine ampoule, Adeka, Samsun, Turkey). The periodontal pocket depth and gingival index measurements were performed.[17] Treatment of the ultrasonic groups involved a standard-unit-mounted piezoelectric scaler, and treatment in the hand instrument groups were performed with Gracey curettes and scalers for subgingival and supragingival debridement.

All patients filled out the VAS scale on the day of treatment, on the 2nd day (the day after the operation) after treatment, and the 10th day after treatment, and they were asked to fill out the DAS scale again on the 10th day. The VAS is a continuous scale comprised of a horizontal line 100 mm in length and describing pain intensity, the scale is most commonly anchored by "no pain, no trouble in chewing and speech" (score of 0) and "pain as bad as it could be" and "worst chewing and speech," (score of 100 [100-mm scale]).[18] Clinical measurements were repeated at 30th day.

Statistical Analysis

All of the data obtained from the study were evaluated by loading to SPSS data 22 (IBM Corp., NY, USA). Because parametric

hypotheses were unfulfilled in the groups, nonparametric tests were applied. In the comparison of the binary groups, the Mann Whitney U test was used, and in the comparison of the one-way variance analysis, the Kruskal Wallis test was applied. For the evaluation of the initial and subsequent measurements of the groups, The Wilcoxon test was used. To the level of significance was taken as p <0.05.

RESULTS

A total of 60 patients were enrolled in the study, with each group including 10 individuals. The ages and genders of the participants in each group were consistent.

When the initial probing depths and gingival indexes of the patients were compared with the 30th day probing depths and gingival indexes, there was a significant decrease in all groups (p<0.05), but there was no difference between the groups (p> 0.05). Different methods of initial periodontal treatment did not affect clinical outcomes during the day 30. (Table 2)

Table 2: Initial and 30th day periodontal pocket depth and gingival index measurements of the groups

	Periodontal Pocket Depth (min-max)SD		P value	Gingival Index (min-max)SD		P value
	initial	30th day		initial	30th day	
Local piezo	(4-5) 0, 51	(2-4)0,47	0.040*	(2-3)0,48	(0-1)0,48	0.005*
Topical piezo	(3-5)0,81	(2-4)0.63	0.023*	(2-3)0.51	(0-1)0.42	0.004*
Piezo	(3-6)0.84	(2-3)0.51	0.007*	(2-3)0,48	(0-2)0,69	0.006*
Local hand instrument	(3-5)0,67	(2-3)0.51	0.006*	(2-3)0.31	(0-1)0.52	0.004*
Topical hand instrument	(3-6)0,96	(2-3)0,51	0.006*	(2-3)0.42	(0-1)0.51	0.004*
Hand instrument	(3-5)0,69	(2-3)0,51	0.007*	(2-3)0.31	(0-1)0.69	0.004*

When all VAS pain values of patients were compared, initial pain levels of the groups who received local anesthesia were significantly lower than in the other groups, but in these patients the pain levels on the 2nd day increased significantly as compared to the first day levels. When we compared the initial pain levels in the topical anesthesia ultrasonic groups with the topical anesthesia hand instrument groups, we found the differences not to be statistically significant. Hand instrument groups (topical hand instrument and hand instrument) showed a significant decrease compared to the initial (p<0.05) (Figure 2).

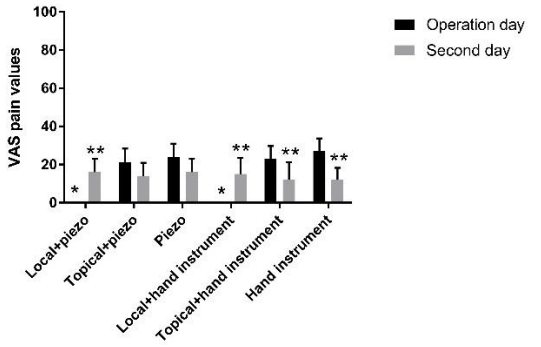

Figure 2: VAS pain values of patients. *p<0.05 local+piezo and local hand instrument groups vs other groups at operation day, **p<0.05 operation day values vs second day values.

When VAS chewing values were compared, initial chewing values in groups that were received local anesthesia were found significantly higher than the other groups (p<0.05). Although the initial chewing values in the ultrasonic groups were different from the hand instrument groups, they did not gain statistical significance (p>0.05) (Figure 3).

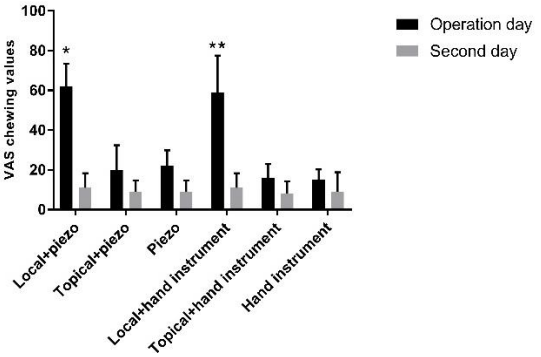

Figure 3: VAS chewing values of patients. *p<0.05, **p<0.05 local+piezo and local+hand instrument vs other groups respectively.

When VAS speech values were compared, the initial local anesthesia groups values, apart from the hand instrument group, were significantly higher than the other groups (p<0.05). On the 2nd day there were no differences between the groups (p>0.05). (Figure 4)

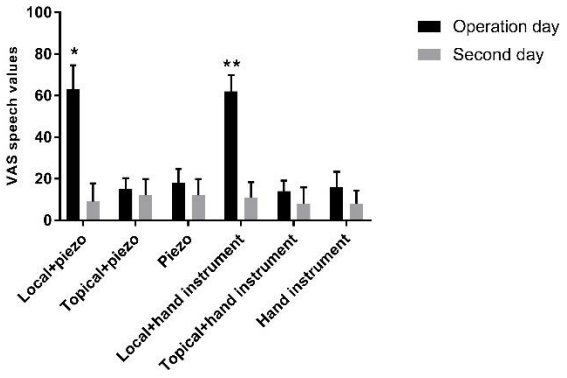

Figure 4: VAS speech values of patients. *p<0.05, **p<0.05 local+piezo and local+hand instrument vs other groups respectively.

There was no difference between the groups regarding the initial DAS scale results (p>0.05). In the 10th day measurement all groups showed a significant decrease compared to their initial values (p<0.05). (Table 3) Values in the ultrasonic groups are lower than hand instrument groups but not significant (p>0.05). Patients in this group gave lower values to question 4.

Table 3: Initial and 10th day DAS values of the groups.

Groups	Initial DAS values Mean(SD)	DAS values 10th day Mean(SD)	P value
Local piezo	14.20(1.181)	6.10(2.079)	0.005*
Topical piezo	13.30(1.947)	7.20(1.751)	0.005*
Piezo	12.70(2.869)	7.40(2.221)	0.008*
Local hand instrument	13.40(2.066)	7.80(2.098)	0.007*
Topical hand instrument	12.90(2.378)	8.60(2.716)	0.012*
Hand instrument	12.20(2.251)	8.90(1.101)	0.011*

DISCUSSION

It was planned to measure the effect of initial periodontal treatment which includes supragingival subgingival debridement and is the first step of all periodontal treatments which can also be painful and to measure the effect of this treatment that can be performed in different forms on the dental anxiety in the study. According the results, local anesthesia provides less pain also topical anesthesia. The patients who received ultrasonic scaler treatment gave less anxiety scores especially the question number 4. In our study the patients with severe periodontitis were not involved because studies have indicated that the presence of severe inflammation increases the pain which will be occur in the treatment.[19]

Pain measurement can be difficult because it involves physical and psychological elements. Communication skills, person's psychological status, social and cultural background can change the severity of the pain from person to person. There are many scales available to measure pain and discomfort feeling. The VAS scale was used to measure post-operation pain, root sensitivity, and the pain during probing.[19-21] In this study, the VAS scale which evaluates between 0-100, was used. With this scale, both pain and chewing and speaking comfort are measured. In our study, the VAS scale was applied on the day of the operation and after 2 and 10 days.[22]

Guzeldemir et al.[23] performed periodontal treatments with an ultrasonic device without using anesthesia in their study, and the average VAS scale was 19.91. In the study by Karadottir et al., the results of VAS in initial periodontal treatments, which were performed by two hygienists, varied between 15.1 and 10.8[24] And in the study by Chung et al.[2], the average scores were 22.3 and 19.5. Canakci and Canakci reported a score of 15.2.[19] In our study, we found pain values of minimum 14 to a maximum of 24 in the ultrasonic groups outside of the local anesthetic groups and a minimum of 12 and a maximum of 27 in the hand instrument groups. Local anesthesia groups stated that they did not feel any pain upon first measurement, and their values were 0. If local anesthesia had not been applied in the initial treatment of the groups, we came to the conclusion that the pain would increase, and the ultrasonic group and the hand instrument group would yield the same results. The first pain levels in ultrasonic groups were found to be higher than in the hand instrument groups. These differences may have arisen from the cooling processes while using the ultrasonic instruments and the impact of the piezo tip on cement and dentin.

In previous studies conducted, it was observed that 18% of patients had a fear of injections, and if this fear was of an average

level, it would increase to 31%.[25] In these cases, topical anesthesia was used as an alternative and was found to be more successful than the placebo.[26] In our study, topical anesthesia VAS values were lower than those of the non-anesthesia groups, but were insignificant. The VAS scale was also used to measure the chewing and speech perceptions. Even though the anesthesia groups were not able to speak or chew at first, this was due to the effects of the anesthesia. When the anesthesia wore off, there was no difference between the groups. Even though the local anesthesia groups showed less VAS values in terms of chewing and speech than the non-anesthesia groups, the differences between them and the anesthesia groups were statistically significant. This data is concordant with a recently published meta-analysis, which concluded that local anesthesia performs a decrease in the significantly deeper anesthesia and pain than in the topical anesthesia.[27] In our study, we observed that patients felt pain even in the 2nd-day measurement. The reason for this pain may have been the sensitivity that arose from open dentinal tubules, which occurred with the removal after the ultrasonic device and hand instrument. This sensitivity can also make speaking and chewing difficult.

In this study, the Corah Dental Anxiety Scale was used to measure dental anxiety levels. DAS is a reliable and valid method for adults.[14,28] In the evaluation of these scales, values between 4-6 were evaluated as low anxiety, while values of 10 and above were considered as high anxiety levels. In our study, the pre-treatment DAS values ranged from 12,20 to 14,20. These values decreased to 6.10-8.90 after treatment. The knowledge and experience which were acquired previously by the patients about this treatment may have affected pre-treatment anxiety levels. After treatment, DAS values were seen as high in hand instrument groups. These results are taken from responses to the 4th question, which reads, "Imagine you are in the dentist's chair to have your teeth cleaned. While you are waiting and the dentist or hygienist is getting out the instruments which will be used to scrape your teeth around the gums, how do you feel? Patients are afraid of the appearance of the curettage set and the instruments inside of it. In the studies, DAS scores show changes. These changes can depend on variables among people such as race, age, gender, psychological factors, and previous dental experiences.

CONCLUSION

Even though the treatment of chronic periodontitis patients occurs with anesthesia, they feel pain at a certain level when the anesthesia effect wears off. Topical anesthesia provided less benefit clinically than the local anesthesia. Dental anxiety levels have shown a decrease after treatment, but in ultrasonic groups anxiety decreased with regards to the hand instrument. More studies should be performed with more patients evaluating the levels of pain and anxiety. In addition, the patient's previous experiences should not to be ignored.

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THE PERCEPTIONS AND ATTITUDES OF DENTISTS TOWARDS CONE-BEAM COMPUTED TOMOGRAPHY REPORTS

Diş Hekimlerinin Konik Işınlı Bilgisayarlı Tomografi Raporlarına Yönelik Algı ve Tutumları

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ABSTRACT

Objectives: Radiology reports are the most important method of communication between the clinician and the radiologist. In dentomaxillofacial radiology, cone-beam computed tomography (CBCT) reporting is a new subject. The purpose of this study was to evaluate the satisfaction and expectations of dentists from CBCT reporting as well as contributing to standardization and improvement in the quality of CBCT reports.

Materials and Methods: Dentists were invited to participate in the survey by e-mail. The participants filled out a survey with their demographic data and responded to 14 questions regarding CBCT reports. The responses regarding gender, age, title, institution, and department were analysed and compared with chi-square tests.

Results: In total, 185 dentists (97 females and 88 males) participated in the study. Participants reported that the adequacy level of the reports were mostly moderate (N:87; 47%) and that the source of adequate reports was university hospitals (N:91; 49.2%). Fifty-seven percent of the surveyors (N:106) reported that they needed a consultant radiologist in clinical practice on a part time basis. There was a statistically significant difference ($p<0.05$) between participants' genders, age groups, titles, and departments regarding the source of the adequate reports.

Conclusion: The results of this study showed that most of the dentists were not satisfied about the proficiency of CBCT reports. More than half of those surveyed thought that "not reading" the radiology reports might give them a legal liability. Most dentists wanted to consult with the radiologist before and after patient examinations.

Key words: Cone-beam computed tomography, dentistry, diagnostic imaging, medical writing, radiology, survey

ÖZ

Amaç: Radyoloji raporları klinisyen ve radyolog arasındaki en önemli iletişim yöntemidir. Diş hekimliği radyolojisinde, konik-ışınlı bilgisayarlı tomografi (KIBT) raporlaması yeni bir konudur. Bu çalışmanın amacı, KIBT raporlarından diş hekimlerinin memnuniyet ve beklentilerini değerlendirmek, aynı zamanda KIBT raporlarının kalitesinde iyileştirmeye ve raporların standardizasyonuna katkıda bulunmaktır.

Gereç ve Yöntemler: Diş hekimleri hazırlanan ankete e-posta yoluyla davet edildi. Katılımcılar, demografik bilgilerini ve KIBT raporlarıyla ilgili 14 sorudan oluşan bir anketi doldurdu. Cinsiyet, yaş, unvan, çalıştığı kurum ve branşlara göre verilen cevaplar analiz edilerek ki-kare testiyle karşılaştırıldı.

Bulgular: Çalışmaya toplam 185 diş hekimi (97 kadın ve 88 erkek) katıldı. Katılımcılar, raporların yeterlilik düzeyinin çoğunlukla orta düzeyde (N: 87; %47) olduğunu ve yeterli raporların kaynağının üniversite hastaneleri olduğunu belirtmiştir (N: 91; %49,2). Çoğu diş hekimi (N: 106; %57) klinik uygulamalarda yarı zamanlı olarak bir radyoloji uzmanına ihtiyaç duyduklarını bildirmiştir. Yeterli olarak görülen raporların kaynağı ile katılımcıların cinsiyetleri, yaş grupları, unvanları ve branşları arasında ilgili istatistiksel olarak anlamlı bir fark vardı ($p <0,05$).

Sonuç: Bu çalışmanın sonuçları, diş hekimlerinin çoğunun KIBT raporlarının yeterliliğinden memnun olmadıklarını göstermiştir. Ankete katılanların yarısından fazlası, radyoloji raporlarının "okunmamasının" kendilerine yasal sorumluluk doğurabileceğini düşünmüştür. Çoğu diş hekimi, hastaları incelemelerinden önce ve sonra radyoloji uzmanına danışmak istemiştir.

Anahtar Kelimeler: Konik-ışınlı bilgisayarlı tomografi, diş hekimliği, tanısal görüntüleme, raporlama, radyoloji, anket

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INTRODUCTION

Radiology reports are the most important method of communication between the clinicians and the radiologists.[1] They include findings, pre-diagnosis, conclusive diagnosis, definitive diagnosis, conclusions, and suggestions for further investigation. The reports reflect the knowledge, talent, and training level of the radiologists.[2-4] Furthermore, they are a critical legally-binding document.[5]

The remarks of the radiologist are shared with the clinician through the reports.[6] Effective communication allows the consultant to play the role of the radiologist and thus increase his or her value.[7] Radiology reports also contribute to the quality of patient treatment. Thus, the purposes of the reporting must be correctly defined and standardized.[8] The medical radiologists use two reporting formats, traditional free-text and structured reports.[9] Structured reports have become widely used in comparison to free-text.[5] These types of reports have templates or checklists.[6] Structured reports were found more effective than unstructured reports.[10] In recent years, alternative reporting types were suggested like contextual reporting which was specifically related with the disease or indication.[11] However, there has been no consensus with either clinicians or radiologists about radiology reporting.[1]

In dentomaxillofacial radiology, cone-beam computed tomography (CBCT) reporting is a relatively new area. Recently, the method has come to be commonly used in dental practice and reporting requirements have become necessary.[12] To the best of our best knowledge, there is little to no data of published research about the assessment of dentists' comments/expectations from CBCT reporting by dentomaxillofacial radiologists. Selim *et al*.[13] published a study about the satisfaction of dentists with dental radiology reports, not involve only CBCT. The other study about CBCT reporting was Peker *et al*'s study, which was conducted about the approaches of dentomaxillofacial and medical radiologist about reporting.[14]

The primary purpose of this study was to evaluate the expectations of dentists of CBCT reports, and secondary purpose of this study was to raise awareness of the standardization and the quality of CBCT reports in dentistry. The null hypothesis in this study; dentists are not satisfied with CBCT reports.

MATERIALS AND METHODS

Before starting the study, Ethical Approval was received from the Gazi University Ethics Board of the Institutional Ethics Committee (decision number, 77082166/604, 01/02; September 10, 2015). The validated questionnaires for the study were prepared by three dentomaxillofacial radiologists with least five years of experience. Some questions used in previous studies were modified, and new questions were added with the consensus of the dentomaxillofacial radiologists.[1] Then, the prepared questionnaires consisting of 15 questions were checked by an expert in linguistics, and minor changes were made. After that, the questionnaires were reviewed by five blinded dentomaxillofacial radiologists and, upon their suggestion, one question was removed. Finally, the questionnaires comprised of 14 questions was ratified. In the invitation letter and on the entrance page of the survey, it was stated that the survey covered only dentists who used CBCT. Dentists who use CBCT scans were invited to the survey via www.surveey.com, a web-based survey tool. The participation was voluntary, and all respondents were clearly advised that participation was anonymous and that the confidentiality of the responses were guaranteed. The responders entered their demographic data and answered 14 questions (Table 1) about CBCT reports.[1] Demographic variables included gender, age, title, institution, department, and frequency of CBCT request.

Table 1: Demographic variables, survey questions and distribution of views on CBCT reports (N=185)

Variable		N	%
Demographics			
Gender	Female	97	52.4
	Male	88	47.6
Age group	22-30	86	46.5
	30-50	76	41.1
	50-75	23	12.4
Title	Research assistant	62	33.5
	General dentist	53	28.6
	Specialist dentist	39	21.1
	Lecturer	31	16.8
Institution	Non-university	87	47.0
	University	98	53.0
Department	Surgical (specialist) dentist*	50	27.0
	Orthodontist	41	22.2
	Non-surgical (specialist) dentist**	41	22.2
	General dentist	53	28.6
The questions related with CBCT reports			
Frequency of request	A few times in week	46	24.9
	A few times in month	63	34.1
	A few times in year	76	41.1
Adequacy level	Very good	18	9.7
	Moderate	87	47.0
	Inadequate	80	43.3
Source of the adequate reports	Private imaging centre	47	25.4
	University hospital	91	49.2
	Equal rate from all institutes	47	25.4
Does "not reading" the reports give you a legal liability?	Yes	108	58.4
	No	18	9.7
	No idea	59	31.9
Do you write a clinical information/history on the request paper?	Yes	82	44.3
	Partially	62	33.5
	No	41	22.2
Reaction against long report	I read only the conclusions section	72	38.9
	I read all the contents	78	42.2
	I read only findings and the conclusions section	35	19.2
Report sequence	It should be written starting with the most important lesion	112	60.5
	Pathological lesions should be written in standard format (on the anatomical localization line)	73	39.5
Should each lesion be described in detail? (e.g. in the case of many similar lesions such as numerous periapical lesions)	Yes	105	56.8
	No, after describing the biggest/the most important one, it is enough to point out that there are similar lesions	80	43.2
Is it necessary to include the "recommendations" section in the report?	Yes, it helps the clinician	50	27.0
	No, the clinician can decide which examination needs	71	38.4
	Not sure	64	34.6
Is it necessary to use radiological terms in the report? (e.g. irregular remodelling or subchondral sclerosis of temporomandibular joint)	Exactly, it's necessary	120	64.9
	It is adequate for the lesion to be expressed clearly by the clinician (e.g. lesion, calcification…)	65	35.1
Should the location of lesion be marked on the radiograph?	No, anatomical location of the lesion should be indicated only in the report	51	27.6
	The lesion should be marked on the radiograph.(e.g. with arrow)	26	14.1
	It is enough to write the section numbers of lesion in the report	52	28.1
	Both pointing out the cross-section number and signing the lesion should be better	56	30.3
Obtaining the report	The report should be given to the patient or patient's relatives	39	21.1
	The report should be given to patient, at the same time it should be sent to clinician by e-mail	123	66.5
	The report should be given to patient, at the same time it should be sent to clinician by e-mail, mail, courier or hospital information system	23	12.4
How should images be presented with the report?	CD/DVD	128	69.2
	Both CD/DVD and negative film	57	30.8
Do you want to consult with the radiologist before and after patient examinations?	Yes	106	57.3
	No	79	42.7

*Oral & maxillofacial surgeon and periodontist **Endodontist, prosthodontist and paediatric dentist

The responses regarding gender, age, title, institution, and department were analysed and compared with chi-square tests. During interpretation, α=0.01 and α=00:05 levels were been considered. Analyses were performed using IBM SPSS 22.0 (SPSS, Inc., Chicago, IL, USA).

RESULTS

In total, 185 dentists participated in the survey. The female-male ratio (52.4%-47.6%) was close. The majority of the responders were in the 22-30 age group (N:88; 46.5%), and most of the dentists were research assistants (N:62; 33.5%). The distribution of responses of the participants to the questions regarding CBCT reports are shown in Table 1.

Most of the responders (N:108; 58.4%) thought that "not reading" the radiology reports may give them legal liability. The source of adequate reports was university hospitals (N:91; 49.2%). Forty-four percent of the surveyors (N:82) said that they wrote clinical information in the report requests. A majority of the dentists (N:112; 60.5%) thought that the most important lesion should be written at the beginning of the conclusion section of the reports, not on the anatomical localization line. Fifty-seven percent of the participants (N:105) stated "yes" to the question of whether each lesion should be written in details. Only 27% (N:50) of the participants thought that there should be a recommendations section in the reports.

Most of the dentists (N:120; 64.9%) remarked that it is necessary to use radiological terms in the reports. Two-thirds of the participants (N:123; 66.5%) wanted the reports to be available to patients at the same time by e-mail. Most of the participants (N:128; 69.2%) said that the images should only be presented by CD/DVD. A little more than half (N:106; 57.3%) wanted the radiologist to be a consultant before and after the radiological examination. Details are shown in Table 1.

There was a statistically significant difference ($p<0.05$) between males and females in the questions about the source of the adequate reports, opinions about the manner in which the most important lesions were indicated, and the request that radiologists be consultants (Table 2).

Table 2: Comparison of views on radiology reports by gender and age groups.

		Gender						Age groups							
		Female		Male				22-30		30-50		50-75+			
		N	%	N	%	χ^2	P	N	%	N	%	N	%	χ^2	P
Adequacy level	Very good	8	8.2	10	11.4	.52	.772	9	10.5	6	7.9	3	13.0	1.45	.835
	Moderate	46	47.4	41	46.6			43	50.0	34	44.7	10	43.5		
	Inadequate	43	44.3	37	42.0			34	39.5	36	47.4	10	43.5		
Source of the adequate reports	Private imaging centre	17	17.5	30	34.1	7.33	.026*	16	18.6	20	26.3	11	47.8	23.53	.000**
	Equal rate from all institutes	25	25.8	22	25.0			13	15.1	27	35.5	7	30.4		
	University hospital	55	56.7	36	40.9			57	66.3	29	38.2	5	21.7		
Does "not reading" the reports give you a legal liability?	Yes	53	54.6	55	62.5	2.69	.260	52	60.5	38	50.0	18	78.3	6.11	.191
	No	8	8.2	10	11.4			8	9.3	9	11.8	1	4.3		
	No idea	36	37.1	23	26.1			26	30.2	29	38.2	4	17.4		
Do you write a clinical information on the request paper?	Yes	45	46.4	37	42.0	.37	.832	41	47.7	34	44.7	7	30.4	4.04	.401
	Partially	31	32.0	31	35.2			30	34.9	22	28.9	10	43.5		
	No	21	21.6	20	22.7			15	17.4	20	26.3	6	26.1		
Reaction against long report	I read only the conclusions section	39	40.2	33	37.5	.83	.660	33	38.4	35	46.1	4	17.4	6.86	.144
	I read all the contents	38	39.2	40	45.5			36	41.9	30	39.5	12	52.2		
	I read only findings and the conclusions section	20	20.6	15	17.0			17	19.8	11	14.5	7	30.4		
Report sequence	It should be written starting with the most important lesion	59	60.8	53	60.2	.01	.934	51	59.3	53	69.7	8	34.8	9.13	.010*
	Pathological lesions should be written in standard format	38	39.2	35	39.8			35	40.7	23	30.3	15	65.2		
Should each lesion be described in detail?	Yes	50	51.5	55	62.5	2.26	.133	40	46.5	48	63.2	17	73.9	7.71	.021
	No	47	48.5	33	37.5			46	53.5	28	36.8	6	26.1		
Necessity of "recommendations" section	Yes	30	30.9	20	22.7	1.64	.440	25	29.1	20	26.3	5	21.7	2.62	.623
	No	36	37.1	35	39.8			28	32.6	32	42.1	11	47.8		
	Not sure	31	32.0	33	37.5			33	38.4	24	31.6	7	30.4		
Necessity of radiological terms	Exactly, it's necessary	64	66.0	56	63.6	.11	.739	58	67.4	51	67.1	11	47.8	3.35	.188
	It is adequate for the lesion to be expressed clearly by the clinician	33	34.0	32	36.4			28	32.6	25	32.9	12	52.2		
Marking lesion on the radiograph	Anatomical location of the lesion should be indicated only in the report	20	20.6	31	35.2	9.33	.025*	20	23.3	24	31.6	7	30.4	5.53	.478
	The lesion should be marked on the radiograph	38	39.2	18	20.5			32	37.2	20	26.3	4	17.4		
	It is enough to write the section numbers of lesion in the report	12	12.4	14	15.9			11	12.8	12	15.8	3	13.0		
	Both pointing out the cross-section number and signing the lesion should be better	27	27.8	25	28.4			23	26.7	20	26.3	9	39.1		
Obtaining the report	The report should be given to the patient or patient's relatives	17	17.5	22	25.0	4.23	.120	12	14.0	20	26.3	7	30.4	a	
	The report should be given to patient, at the same time it should be sent to clinician by e-mail	71	73.2	52	59.1			63	73.3	46	60.5	14	60.9		
	The report should be given to patient, at the same time it should be sent to clinician by e-mail, mail, courier or hospital information system	9	9.3	14	15.9			11	12.8	10	13.2	2	8.7		
Presentation of the images	CD/DVD	65	67.0	63	71.6	.45	.500	57	66.3	58	76.3	13	56.5	3.88	.143
	Both CD/DVD and negative film	32	33.0	25	28.4			29	33.7	18	23.7	10	43.5		
Do you want to consult with the radiologist?	Yes	63	64.9	43	48.9	4.88	.027*	55	64.0	41	53.9	10	43.5	3.70	.157
	No	34	35.1	45	51.1			31	36.0	35	46.1	13	56.5		

** P<.05; ** P<.01; a: Chi-square test not performed*

There was a statistically significant difference ($p<0.05$) between the age groups regarding the source of the adequate reports, whether the description of the lesions should be in the conclusions sections, and whether all lesions should be described in detail (Table 2).

Statistically significant differences ($p<0.05$) were found between titles of the participants regarding the source of the adequate reports, whether the description of all lesions should be in detail, the terminology used in the report, and the request for consultant radiologist before and after the examination (Table 3). Statistically significant differences ($p<0.05$) were found between titles and institutions of the participants regarding the source of the adequate reports, description of all lesions in detail, the terminology used in the report, and the request of consultant radiologist before and after the examination (Table 3).

Table 3: Comparison of views on radiology reports by titles and institutions

		Title										Institution					
		Research assistant		General dentist		Specialist dentist		Lecturer				Non-university		University			
		N	%	N	%	N	%	N	%	χ^2	p	N	%	N	%	χ^2	p
Adequacy level	Very good	6	9.7	3	5.7	3	7.7	6	19.4	8.80	.185	6	6.9	12	12.2	4.10	.129
	Moderate	32	51.6	20	37.7	21	53.8	14	45.2			37	42.5	50	51.0		
	Inadequate	24	38.7	30	56.6	15	38.5	11	35.5			44	50.6	36	36.7		
Source of the adequate reports	Private imaging centre	11	17.7	23	43.4	9	23.1	4	12.9	16.57	.011*	33	37.9	14	14.3	14.48	.001**
	Equal rate from all institutes	13	21.0	13	24.5	11	28.2	10	32.3			21	24.1	26	26.5		
	University hospital	38	61.3	17	32.1	19	48.7	17	54.8			33	37.9	58	59.2		
Does "not reading" the reports give you a legal liability?	Yes	39	62.9	32	60.4	23	59.0	14	45.2	4.09	.664	54	62.1	54	55.1	.94	.624
	No	6	9.7	4	7.5	5	12.8	3	9.7			8	9.2	10	10.2		
	No idea	17	27.4	17	32.1	11	28.2	14	45.2			25	28.7	34	34.7		
Do you write a clinical information on the request paper?	Yes	31	50.0	16	30.2	20	51.3	15	48.4	8.23	.221	34	39.1	48	49.0	1.83	.400
	Partially	17	27.4	23	43.4	10	25.6	12	38.7			32	36.8	30	30.6		
	No	14	22.6	14	26.4	9	23.1	4	12.9			21	24.1	20	20.4		
Reaction against long report	I read only the conclusions section	20	32.3	21	39.6	16	41.0	15	48.4	4.18	.652	34	39.1	38	38.8	.97	.615
	I read all the contents	27	43.5	21	39.6	18	46.2	12	38.7			39	44.8	39	39.8		
	I read only findings and the conclusions section	15	24.2	11	20.8	5	12.8	4	12.9			14	16.1	21	21.4		
Report sequence	It should be written starting with the most important lesion	35	56.5	35	66.0	22	56.4	20	64.5	1.59	.662	52	59.8	60	61.2	.04	.840
	Pathological lesions should be written in standard format	27	43.5	18	34.0	17	43.6	11	35.5			35	40.2	38	38.8		
Should each lesion be described in detail?	Yes	28	45.2	30	56.6	29	74.4	18	58.1	8.34	.039*	57	65.5	48	49.0	5.14	.023*
	No	34	54.8	23	43.4	10	25.6	13	41.9			30	34.5	50	51.0		
Necessity of "recommendations" section	Yes	19	30.6	11	20.8	12	30.8	8	25.8	4.37	.627	21	24.1	29	29.6	1.32	.517
	No	21	33.9	21	39.6	18	46.2	11	35.5			37	42.5	34	34.7		
	Not sure	22	35.5	21	39.6	9	23.1	12	38.7			29	33.3	35	35.7		
Necessity of radiological terms	Exactly, it's necessary	42	67.7	30	56.6	25	64.1	23	74.2	3.01	.391	53	60.9	67	68.4	1.12	.290
	It is adequate for the lesion to be expressed clearly by the clinician	20	32.3	23	43.4	14	35.9	8	25.8			34	39.1	31	31.6		
Marking lesion on the radiograph	Anatomical location of the lesion should be indicated only in the report	15	24.2	12	22.6	13	33.3	11	35.5	16.61	.055	23	26.4	28	28.6	5.43	.143
	The lesion should be marked on the radiograph	27	43.5	10	18.9	10	25.6	9	29.0			21	24.1	35	35.7		
	It is enough to write the section numbers of lesion in the report	9	14.5	9	17.0	3	7.7	5	16.1			12	13.8	14	14.3		
	Both pointing out the cross-section number and signing the lesion should be better	11	17.7	22	41.5	13	33.3	6	19.4			31	35.6	21	21.4		
Obtaining the report	The report should be given to the patient or patient's relatives	11	17.7	14	26.4	8	20.5	6	19.4	9.26	.160	22	25.3	17	17.3	2.06	.356
	The report should be given to patient, at the same time it should be sent to clinician by e-mail	42	67.7	36	67.9	28	71.8	17	54.8			56	64.4	67	68.4		
	The report should be given to patient, at the same time it should be sent to clinician by e-mail, mail, courier or hospital information system	9	14.5	3	5.7	3	7.7	8	25.8			9	10.3	14	14.3		
Presentation of the images	CD/DVD	43	69.4	31	58.5	32	82.1	22	71.0	5.92	.116	58	66.7	70	71.4	.49	.484
	Both CD/DVD and negative film	19	30.6	22	41.5	7	17.9	9	29.0			29	33.3	28	28.6		
Do you want to consult with the radiologist?	Yes	44	71.0	26	49.1	15	38.5	21	67.7	13.24	.004**	39	44.8	67	68.4	10.44	.001**
	No	18	29.0	27	50.9	24	61.5	10	32.3			48	55.2	31	31.6		

** P<.05; ** P<.01; a: Chi-square test not performed*

Statistically significant differences ($p<0.05$) were found between the participants' departments regarding the source of the adequate reports, whether a clinical information/history of the patient should be sent to the radiologist before the radiological examination, the terminology used in the report, and the presence of the images at the report (Table 4).

Table 4: Comparison of views on radiology reports by departments.

		Departments									
		Surgical (specialist) dentist***		Orthodontist		Non-surgical (specialist) dentist****		General dentist			
		N	%	N	%	N	%	N	%	χ^2	P
Adequacy level	Very good	5	10.0	3	7.3	8	19.5	2	3.8	a	
	Moderate	25	50.0	17	41.5	25	61.0	20	37.7		
	Inadequate	20	40.0	21	51.2	8	19.5	31	58.5		
Source of the adequate reports	Private imaging centre	14	28.0	3	7.3	8	19.5	22	41.5	22.88	.001**
	Equal rate from all institutes	9	18.0	17	41.5	7	17.1	14	26.4		
	University hospital	27	54.0	21	51.2	26	63.4	17	32.1		
Does "not reading" the reports give you a legal liability?	Yes	30	60.0	22	53.7	23	56.1	33	62.3	a	
	No	8	16.0	2	4.9	4	9.8	4	7.5		
	No idea	12	24.0	17	41.5	14	34.1	16	30.2		
Do you write a clinical information on the request paper?	Yes	33	66.0	16	39.0	18	43.9	15	28.3	15.89	.014*
	Partially	10	20.0	14	34.1	14	34.1	24	45.3		
	No	7	14.0	11	26.8	9	22.0	14	26.4		
Reaction against long report	I read only the conclusions section	17	34.0	13	31.7	21	51.2	21	39.6	4.21	.648
	I read all the contents	22	44.0	20	48.8	14	34.1	22	41.5		
	I read only findings and the conclusions section	11	22.0	8	19.5	6	14.6	10	18.9		
Report sequence	It should be written starting with the most important lesion	27	54.0	29	70.7	21	51.2	35	66.0	4.84	.184
	Pathological lesions should be written in standard format	23	46.0	12	29.3	20	48.8	18	34.0		
Should each lesion be described in detail?	Yes	34	68.0	19	46.3	21	51.2	31	58.5	4.96	.174
	No	16	32.0	22	53.7	20	48.8	22	41.5		
Necessity of "recommendations" section	Yes	12	24.0	13	31.7	14	34.1	11	20.8	3.91	.690
	No	22	44.0	15	36.6	12	29.3	22	41.5		
	Not sure	16	32.0	13	31.7	15	36.6	20	37.7		
Necessity of radiological terms	Exactly, it's necessary	39	78.0	27	65.9	24	58.5	30	56.6	6.11	.106
	It is adequate for the lesion to be expressed clearly by the clinician	11	22.0	14	34.1	17	41.5	23	43.4		
Marking lesion on the radiograph	Anatomical location of the lesion should be indicated only in the report	12	24.0	14	34.1	13	31.7	12	22.6	9.09	.429
	The lesion should be marked on the radiograph	17	34.0	14	34.1	13	31.7	12	22.6		
	It is enough to write the section numbers of lesion in the report	7	14.0	7	17.1	4	9.8	8	15.1		
	Both pointing out the cross-section number and signing the lesion should be better	14	28.0	6	14.6	11	26.8	21	39.6		
Obtaining the report	The report should be given to the patient or patient's relatives	9	18.0	9	22.0	7	17.1	14	26.4	10.89	.092
	The report should be given to patient, at the same time it should be sent to clinician by e-mail	32	64.0	23	56.1	32	78.0	36	67.9		
	The report should be given to patient, at the same time it should be sent to clinician by e-mail, mail, courier or hospital information system	9	18.0	9	22.0	2	4.9	3	5.7		
Presentation of the images	CD/DVD	34	68.0	36	87.8	28	68.3	30	56.6	10.65	.014*
	Both CD/DVD and negative film	16	32.0	5	12.2	13	31.7	23	43.4		
Do you want to consult with the radiologist?	Yes	28	56.0	24	58.5	27	65.9	27	50.9	2.16	.540
	No	22	44.0	17	41.5	14	34.1	26	49.1		

** P<.05; ** P<.01; **** Oral & maxillofacial surgeon and periodontist; ****** Endodontist, prosthodontist and paediatric dentist *a: Chi-square test not performed*

DISCUSSION

Dentomaxillofacial radiology is one of eight dental specialities in our country. There are about 300 members in the national dentomaxillofacial radiology association. Only dentomaxillofacial radiologist and medical radiologists are authorized for CBCT reporting. Recently, due to revisions in legal regulations for the medical sciences, some new medico-legal issues have occurred, and available requirements have become more important.[15] The radiology reports are the first reference documents used in forensic cases to determine whether the standard of attention was met.[16] The clinicians' opinions about reporting have been investigated in several studies, and all the studies were related to medical radiologists.[1,17,18] To the best of our

knowledge, this is the first study of the approaches and opinions of dentists regarding the reporting of CBCT, specially. In this study, the questionnaires were prepared, some questions were modified from previous studies, and some new questions confirmed by blinded dentomaxillofacial radiologists were added.[1]

Age, gender, occupation, tooth brushing habits, etc. are questions with certainty and do not require a scale because these kinds of questions are tangible, and their answers are very accurately known to people with. Intangible structures that cannot be determined by a single question require a measuring instrument which is usually behavioural and intellectual.[19] For this reason, validity and reliability studies were not performed, and there was no need for them. Also, the aim of this study was not to create a scale. We aimed to evaluate the expectations of dentists of CBCT reports and to attract attention to standardization and to the quality of the reports in dentistry.

Sistrom *et al*.[20] declared that medical radiology residents receive verbal instruction only one hour per year, approximately. It has been reported that 98% of medical radiology residents did not have any education in report writing, and 78% of them wrote reports with the guidance of a senior resident.[21] McLoughlin *et al*.[22] reported that radiologists do not pay much attention to clinicians' requests regarding reporting.

In a recent study from Australia, Selim *et al*.[13] evaluated the satisfaction level of dentists from dental radiology reports, not only CBCT reports. In that country, there are limited numbers of dentomaxillofacial radiologists in that country, dental radiology reports were prepared by medical radiologists more than dentomaxillofacial radiologists. Dentomaxillofacial radiologists' reporting satisfaction level was higher than medical radiologists'. Most general dentists (93.1%) and specialist dentists (85.9%) preferred the reports to be written by dentomaxillofacial radiologist, beside medical radiologists.[13] It was also stated that most dentists complained about the deficiencies of details and dental view in medical radiology reports.[13]

The results of our study showed that very few dentists thought the radiology reports were very good. In the study of Selim *et al*.[13] from Australia, the researchers found that majority (80.2%) of general dentists and most (58.6%) of specialist dentists were not satisfied about dental radiology reports (Selim). In a study from Turkey, Dogan *et al*.[1] evaluated medical doctors' expectations of radiology reports and demonstrated that the reports were found to be adequate by most (60%) of the doctors. The results of our study (9.7% satisfaction rate) were compatible with Selim *et al*.'s dentists-oriented survey, whereas opposite to the study of Dogan *et al*.'s medical doctors-oriented survey.

The most important request of that clinicians make of radiologists is to provide clinical information, but it is often inadequate or unreadable.[1] Dogan *et al*.[1] reported that 53.5% of the clinicians provided adequate clinical information while 41.5% only wrote a short note, and 5% did not write any clinical information because of their extremely busy schedule. In this study, the results were closer to each other, but the percentage of dentists who did not write clinical information was higher (22.2%) than in the previous report.[1] This condition may possibly be because dentists do not care as much about writing clinical information as do medical doctors.

Dogan *et al*.[1] reported that 46% of the doctors just read the conclusions section, and, with long reports, only 39% read the entire report. They also reported that most of the participants (72%) preferred a detailed report.[1] Likewise, Naik *et al*.'s[23] study found that most of the participants preferred standardized detailed reports. In the present study, the rate of dentists who just read the conclusion section

(38.9%) and the rate of those who read the entire report (42.2%) were found to be close to each other for long reports.

It was determined that most clinicians (70.5%) wanted a recommendations section in the reports.[1] Yesildere *et al*.[17] emphasized that the doctors wanted the medical radiologist to write recommendations at the end of the report, but not to verbally inform the patients about the treatment options or the next step. Plumb *et al*.[24] reported that clinicians have adopted additional imaging recommendations from radiologists at very high rates but have indicated that additional imaging decisions should be made by themselves. The stated reason that doctors believed this that radiology specialists did not have enough clinical knowledge about patients.[17,24] In this study, only 27% of the dentists wanted recommendations in the reports.

In the previous study, most clinicians (56%) want to include expressions that they use among themselves such as calcification, necrosis, and haemorrhage rather than radiological terms like Wesmark sign, hypointense, etc.[1] The present study yielded a different result; most of the participants (64.9%) wanted to see radiological terms in the reports. According to the study by Dogan *et al*.[1], most clinicians do not want patients to read reports, and international medical terms provide better communication between doctors.

Regarding the question of marking the location of the lesions, the results of the previous study demonstrated that 73% of doctors preferred the lesion location to be marked; a similar rate of our dentists had the same opinion (72.4%).[1] The proportion of those who preferred to write the cross-sectional number of the lesions was 14% in doctors and 28.1% in dentists.[1] In the study by Dogan *et al*.[1], the doctors in universities preferred the images as CD/DVD while 37% of the doctors in public hospitals wanted negative films. In our study, most of the general dentists preferred the choice of CD/DVD. Likewise, orthodontists preferred report presentation in the CD/DVD format at a statistically higher rate than other dentists. It was determined that most clinicians exchange ideas with the radiologists before and after imaging. In Dogan *et al*.'s[1] study, only 16.5% of the medical doctors thought that they did not need the help of the radiologists. In our study, 42.7% of the dentists did not want the radiologist to be a consultant before and after the radiological examination.

This study differs from previous studies in the literature regarding radiological reporting. Related studies focused on the opinions of medical doctors, but there was no data about dentists. However, there were some limitations in the present study. This study is a subpopulation survey and the views expressed in the study may differ from general dentists' views. The survey was performed in only one country, so the opinions of the dentists and their way of reporting may be different in other countries. It is recommended that further studies be undertaken in different countries and with larger survey groups.

CONCLUSIONS

The results of this study showed that most of the dentists were not satisfied with the adequacy of CBCT reports and the source of adequate reports was university hospitals. Most dentists thought that "not reading" the radiology reports may give them legal liability and wanted the radiologist to consult before and after the examination. The results of this study may help dentomaxillofacial radiologists to improve their reports.

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Doi: 10.7126/cumudj. 475498 *RESEARCH ARTICLES*

HISTOMORPHOMETRIC ASSESSMENT OF THE IMPACT OF BOVINE DEMINERALIZED BONE GRAFT ON BONE HEALING VERSUS AUTOGENOUS, ALLOGENEIC AND SYNTHETIC GRAFTS IN EXPERIMENTALLY- INDUCED CRITICAL SIZE BONE DEFECTS IN RATS

Ratlarda Deneysel Olarak Oluşturulan Kritik Boyutlu Kemik Defektlerine Uygulanan Sığır Kaynaklı Deminarelize Kemik Greftininin Kemik Iyiyleşmesine Olan Etkisinin Otojen, Allojenik ve Sentetik Greftlerle Karşılaştırılmasının Histomorfometrik Olarak İncelenmesi

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ABSTRACT

Objectives: Bone tissue has the ability to heal itself (regeneration) and may restore its morphology and function when injured. However, healing may be limited in the case of large wounds. A "critical-size defect" is an intraosseous wound in a particular bone and species of animal that will not heal spontaneously morphologically and functionally during the lifetime of the animal. Autogenous bone grafts have been regarded as "gold standard" for treatment of critical-size bone defects. Known drawbacks of autogenous bone graft have led to research efforts focusing on different graft materials and resulted in several alternative substitutes including xenografts, allografts and synthetic graft materials.

The aim of the present study was to perform a histomorphometric study to investigate the effect of bovine demineralized bone graft on bone healing in comparison to autogenous, allogeneic and synthetic graft materials when applied into critical size bone defects with a diameter of 5 mm.

Materials and Methods: Experimental animals were divided into 4 groups, each having 8 rats. In the control group, a mandibular defect was created and then filled with a bovine graft (Integros Bone Plus XS Adana/Turkey). In the experimental groups, autogenous bone was reinserted into the critical-size defect which was created using a trephine bur in Group I (autogenous group) and Group II received a human graft (Korea Bone Bank (KBB) Gasandong Keumcheongu Seoul/South Korea) to fill the critical-size defect. For Group III, a synthetic bone graft β-tricalcium phosphate (Cerasorb North Carolina/USA) was applied on the critical-size bone defect. Specimens were obtained for histomorphometric examination and rats were sacrificed on day 28.

Results: Histomorphometric examination performed on day 28 to evaluate the relative effects of different graft materials on new bone formation showed no significant difference in the volume of newly formed bone between groups receiving autogenous bone graft, allograft and bovine xenograft but a significant difference was observed versus synthetic bone graft group.

Conclusion: While autogenous bone graft is currently regarded as the gold standard for bone regeneration, the difficulties in harvesting and application of autografts limit their use. Our results demonstrate that bovine bone graft may be used as a safe and effective alternative to autogenous bone graft.

Keywords: dental graft, autogenous graft, allogeneic graft, xenograft, bone regeneration

ÖZ

Amaç: Kemik dokusu iyileşme özelliğine (rejenerasyon) sahiptir ve yaralanan kemik dokusu şekil ve fonksiyonunu yeniden kazanabilmektedir. Fakat yaralanmanın boyutu büyük olduğu zaman iyileşme sınırlı kalabilmektedir. Kritik boyutlu kemik defekti; kemik dokusunda, canlının yaşamı boyunca, şekil ve fonksiyon olarak, kendiliğinden tamamen iyileşmesinin mümkün olmayacağı boyuttaki defekt anlamına gelir. Kritik kemik defektlerinde tedavi için otojen greft uygulaması altın standart olarak kabul edilir. Otojen kemik greftinin bazı dezavantajları nedeniyle araştırmacılar çalışmalarını farklı greft materyalleri üzerinde yoğunlaştırmışlardır. Bu çalışmalar neticesinde Ksenogreft, Allogreft ve sentetik greft materyalleri gibi seçenekler ortaya çıkmıştır.

Çalışmamızın amacı 5mm çapında kritik boyutlu kemik defektlerinde sığır kaynaklı demineralize kemik grefti uygulamasının kemik iyileşmesine etkisi ile aynı çaptaki defektlere otojenik, allojenik ve sentetik greft materyali uygulandığı zaman elde edilen iyileşmelerin histomorfometrik olarak incelenmesidir.

Gereç ve Yöntemler: Deney hayvanları her grup 8 deney hayvanından oluşan 4 gruba ayrıldı. Kontrol grubunda mandibulada defekt oluşturulduktan sonra defekt sığır kaynaklı kemik grefti (Integros Bone Plus XS Adana/Türkiye) ile dolduruldu. Daha sonraki deney gruplarında; I. grupta oluşturulan kritik boyutlu defekte trefin frezle çıkartılan otojen kemik tekrar konuldu. II. grupta oluşturulan kritik boyutlu defekte insan kaynaklı kemik grefti (Korea Bone Bank (KBB) Gasandong Keumcheongu Seoul/Korea) uygulandı. III. grupta oluşturulan kritik boyutlu kemik defektine ise sentetik kemik grefti grubunda yer alan β-trikalsiyum fosfat (Cerasorb North Caroline/USA) uygulandı. 28 gün sonra ratlar öldürüldü.Her grup sakrifiye edilerek histomorfometrik incelemeye alındı.

Bulgular: Farklı greft materyallerinin 28. günde yeni kemik oluşumuna olan etkisinin histomorfometrik olarak incelendiğinde otojen kemik grefti, allogreft ve sığır kaynaklı kemik grefti uygulanan gruplar arasında yeni oluşan kemik hacmi bakımından anlamlı bir fark bulunmazken, sentetik kemik grefti uygulanan grupla aralarındaki fark anlamlı bulunmuştur.

Sonuç: Otojen kemik grefti günümüzde hala altın standart olarak kabul edilmesine rağmen, elde edilmesi ve uygulanmasındaki zorluklar nedeniyle çalışmamızda kullandığımız sığır kaynaklı kemik greftinin otojen kemik greftine alternatif olarak güvenilir ve etkili biçimde kullanılabileceği belirlenmiştir.

Anahtar kelimeler: dental greft,otojen greft,allojenik greft,ksenogreft,kemik rejenerasyonu,

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INTRODUCTION

Bone tissue has the ability to regenerate and may restore its morphology and function when injured.[1] However, healing may be limited in the case of large wounds. Bone healing after a bone defect varies in relation to the size of the defect and the animal species.

A "critical-size defect" is an intraosseous wound in a particular bone and species of animal that will not heal spontaneously morphologically and functionally during the lifetime of the animal.[2,3] During healing, critical-size bone defects are filled with fibrous connective tissue rather than bone tissue.[4-6] While oral and maxillofacial surgeries depend primarily on bone regeneration for healing, critical-size bone defects do not heal spontaneously and several alternative materials are used to trigger healing process. Ideally, the best method would be filling of the defect with another bone tissue having similar size, shape and antigenic properties with the original bone.[7,8]

Repair and restoration of bone defects date far back in history. In the 30th century B.C., surgeons have used gold or silver plates as graft material for reconstruction purposes. Later on, especially in the 20th century, studies have extensively focused on graft materials and allografts, xenografts and alloplastic materials have been largely used as an alternative to autogenous grafts.[9]

Autogenous bone grafts derive from the individuals themselves and in terms of osteogenesis, autogenous bone grafts are the only most effective graft material among all bone grafts. Autogenous bone graft combines osteoconductive, osteoinductive, and osteogenic characteristics. Autogenous bone grafts have been regarded as "gold standard" for repairing bone defects.[10-14] The advantages conferred by autogenous bone grafts include direct osteogenesis via living osteoblasts and osteoprogenitor cells in the bone marrow, osteoconduction through collagen matrix and osteoinduction by BMPs (bone morphogenetic proteins).[15] On the other hand, autogenous graft use has certain important limitations including requirement for a repeat surgical procedure for bone harvesting which adds to discomfort of the patient in the postoperative period and creation of a new defect in the donor site poses risk of infection or morbidity.

Allografts are bone grafts that are harvested from another individual of the same species with a different genotype and most commonly used as an alternative to autogenous grafts. Allografts do not have the disadvantages of the autogenous grafts such as donor site injury and limited quantity of bone available for harvesting. Allografts are obtained from living humans or cadavers and stored in bone banks. Allograft use has been long reported in the literature for defects involving long bones and posttraumatic bone defects.[16-18] Allografts are available in different shapes.[19-22]

Donor and recipient species are different in heterogeneous bone grafts. Bovine, porcine, coral and equine bones are mostly used as a source of graft. Natural hydroxyapatite is synthesized from the calcium carbonate skeleton of the coral and the resulting material is highly biocompatible. In recent years, bovine xenografts have been the major focus of studies.[23] Bovine bone graft is a biocompatible and osteoconductive material.[24,25] Concerns have been raised recently over the risk of prion infection through bovine graft materials causing Bovine spongiform encephalopathy (BSE) in the cattle and Creutzfeldt-Jacob disease in humans. Heterogeneous bone grafts are associated with these risks.

Recently, biocompatible synthetic materials have been manufactured to overcome the limitations of allografts and xenografts.[26] Synthetic materials are commercially available with a wide range of products.

Combinations of different grafts have been used in research studies for treatment of defects that maxillofacial surgeons deal with. Thus, synthetic materials can be used in combination

with autogenous and/or allogeneic bone grafts with osteoinductive properties.[27-29]

The advantages of alloplastic materials include no risk of cross-infection, ease of access, sterilizability, biocompatibility and easy storage. However, they do not have osteogenic and osteoinductive features, which constitute a major disadvantage.[30]

The aim of the present study was to examine the potential of aforementioned diffirent graft materials in inducing bone formation in critical-size bone defects by histomorphometric means.

MATERIALS AND METHODS

Approval for the conduct of the study was obtained from Cumhuriyet University Ethics Committee for Animal Experimentation before initiation of the study (Approval No. 170, 04/06/2009). Throughout the study, the 13th item of Adherence to Ethical Principles of Cumhuriyet University Ethics Committee Directive was followed.

The study was conducted on 32 adult Wistar albino rats with a mean age of 12 weeks and approximate weight of 250-300 grams. All rats were examined and confirmed to be in good health by a veterinarian. Study rats were supplied by Cumhuriyet University Experimental Animals Laboratory.

Stratification of Experimental Animals

Experimental animals were divided into 4 groups, each having 8 rats. In the control group, a mandibular defect was created and then filled with a bovine graft (Integros Bone Plus XS Adana/Turkey). In the experimental groups, a critical-size defect was created using a trephine bur and autogenous bone was reinserted in the area in Group I (autogenous group) and Group II received a human graft (Korea Bone Bank (KBB) Gasandong Keumcheongu Seoul/South Korea) to fill the critical-size defect. KBB was chosen as the supplier of the human graft because it has been certified by both KFDA (Korean Food and Drug Administration) and FDA (US Food and Drug Administration) and their grafts were used in many studies in Korea and globally due to its established safety and effectiveness. For Group III, a synthetic bone graft β-tricalcium phosphate (Cerasorb North Carolina/USA) was used to fill the critical-size bone defect. We used Cerasorb because of its proven safety and efficacy demonstrated through several scientific studies.[31]

Surgical Technique

Anesthesia of the experimental animals was induced by intramuscular injections of 3 mg/kg xylazine (Rompun 2%, Bayer, İstanbul, Turkey) and 90 mg/kg Ketamine HCl (Ketalar, Eczacıbaşı-Warner Lambert, Istanbul, Turkey). Rats were sacrificed on day 28. Adequate depth of anesthesia was confirmed by observation of the loss of pupillary reflex and the skin overlying the angulus mandibularis area was shaved bilaterally (Figure1).

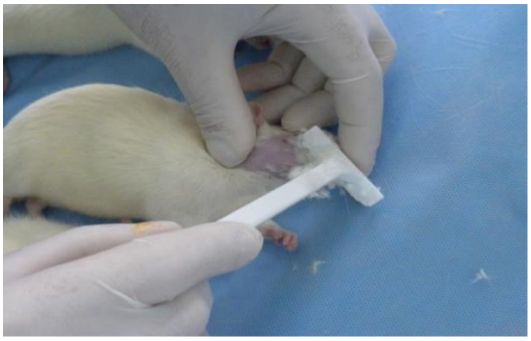

Figure 1. Angulus mandibularis area was shaved bilaterally)

Betadine® was used to stain and disinfect the perimandibular area (Figure 2).

Figure 2. Disinfect the perimandibular area

An incision of 1 cm was made at the angulus mandibularis area 1 cm below the mandibular basis to remove skin, subcutaneous tissue and periosteum. Skin flap was raised to expose the bone surface (Figure3).

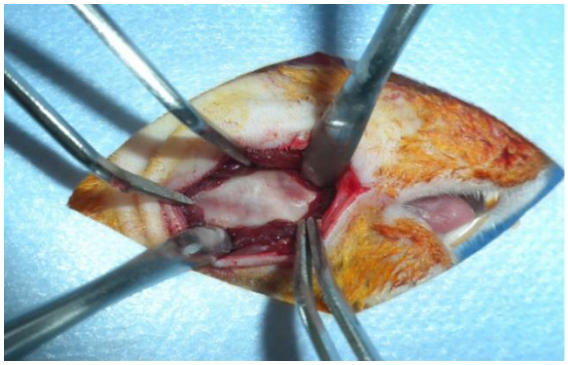

Figure 3. Skin flap was raised to expose the bone surface

A standard critical-size bicortical bone fragment with a diameter of 5 mm was removed with trephine bur under irrigation (Figure 4).

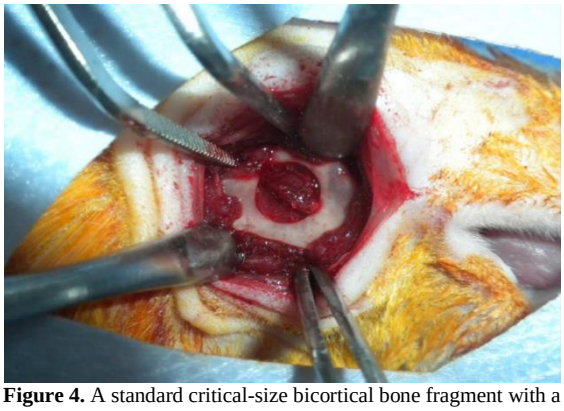

Figure 4. A standard critical-size bicortical bone fragment with a diameter of 5 mm was removed with trephine bur

Subsequently, critical-size bone defects were filled with human bone graft (Figure 5), bovine bone graft and synthetic biomaterial.

Figure 5. Critical-size bone defects were filled with human bone graft

Postoperative care of study rats and termination of experiment

All rats were given Carprofen 4mg/kg (Rimadyl, Pfizer) as analgesic and Ceftriaxone 25 mg/kg (Rocephin, Roche) as antibacterial agent postoperatively by intramuscular route for 5 days. Rats were sacrificed on the last study day (day 28) using 200 mg/kg sodium pentobarbital (Pentothal, Abbott, USA). Rat mandibles with the defect area and surrounding soft tissue were removed by dissection and placed in a 10% formalin solution.

Histomorphometric Method

Undecalcified sections containing grafts and surrounding bone tissue were prepared by the method described by Donath and Breuner (1982).

All sections were used for histomorphometric examination. Digital images of the sections were obtained under 4 x magnification using a digital camera (Olympus® DP 70, Tokyo, Japan) mounted on the light microscope (Olympus® BX50, Tokyo, Japan). Then, images were transferred to a personal computer. Histomorphometric analyses were performed using WinTas image analysis software (WinTAS Trabecular Analyze System, version 1.2.9).

Statistical analyses

Study data were uploaded on SPSS (Version 14.0 for Windows) software. Kolmogorov-Smirnov tests,analysis of variance (ANOVA) and Tukey's test were used for data analyses. Data expressed as arithmetic mean ± standard deviation were presented in tabulated form. Type I error level was set at 0.05.

RESULTS

In each section, newly formed bone volume and unossified graft content were examined for each group histologically. Significant differences were observed when newly formed bone volumes were compared between groups ($p<0.05$). Pair-wise comparison of values

between groups revealed a significant difference between the autogenous group and Cerasorb group ($p<0.05$) but other groups showed non-significant differences ($p>0.05$) (Figure 6)

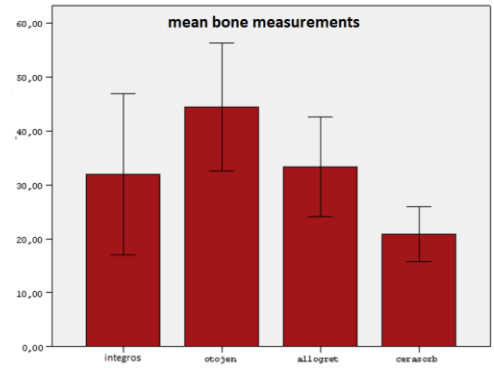

Figure 6. Results for mean bone measurements

Comparison of unossified graft content showed significant differences between groups ($p<0.05$). Pair-wise comparison of values between groups demonstrated a significant difference between Integros group and the autogenous group, between Integros group and the allograft group and between the autogenous group and Cerasorb group ($p<0.05$); there were no significant differences between other groups ($p>0.05$). (Figure 7)

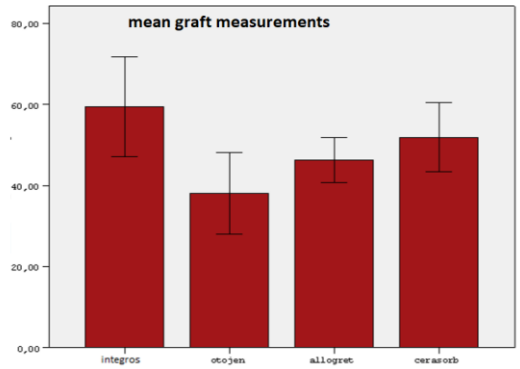

Figure 7. Results for mean graft measurements

Y axis=Mean graft volumes

X axis= Integros, Autogenous, Allograft, Cerasorb

Table 1.
Comparison of measurements for all groups

Groups	New Bone Volume $\bar{X}$±Ss	Graft Volume $\bar{X}$±Ss
İntegros	31,94 ± 14,94	59,45 ± 12,35
Otojen	44,38 ± 11,87	38,09 ± 10,12
Allogreft	33,28 ± 9,26	46,30 ± 5,51
Cerasorb	20,82 ± 5,12	51,87 ± 8,50
Results	F = 6,23 p = 0,002	F = 7,29 p = 0,001

$\bar{X}$: mean volue , Ss:Standart deviation Variance analysis : Tukeys test $p<0,05$

DISCUSSION

As with other musculoskeletal areas, bone defects in the maxillofacial area may result from infectious, degenerative, cystic, post-traumatic or neoplastic lesions and the field of maxillofacial surgery is primarily engaged in the repair of such defects. As such, investigators have put so much effort in exploring ways to contribute to the repair of these defects. Use of bone grafts has been the major focus of these studies.[32]

Materials used in bone grafting are classified according to their effect on bone healing. Osteogenesis is the process of new bone formation by cells that have the ability to produce new bone tissue. Autogenous bone is the only graft material with osteogenic properties.[33] Osteoinduction is a mechanism of bone formation whereby undifferentiated mesenchymal cells within the tissue are stimulated to develop into a bone-forming cell lineage called osteoblasts. Osteoconduction occurs when the bone graft material serves as a scaffold for new bone growth that is perpetuated by the native bone-forming cells.[34] An ideal bone graft material should have both osteoinductive and osteoconductive features.[35,36]

Autogenous bone grafts are considered as the gold standard and widely used in maxillofacial surgery for bone regeneration.[37-40] However, autogenous grafts have several drawbacks including the need for repeat surgery for a separate incision, its traumatic nature, and the risks involved such as high postoperative

morbidity, risk of infection and postoperative resorption.[41-45]

In a 2008 study, Mokbel *et al.* evaluated the healing patterns of critical-size bone defects in 6 groups of rats treated with deproteinized bovine xenograft, bovine xenograft covered with a resorbable membrane, decalcified freeze-dried bone allograft, composite bone substitute made of bovine xenograft and collagen, autogenous bone graft and no grafting (control group) respectively. Histomorphometric examination at 2 months showed the superiority of autogenous bone graft to other substitutes, achieving the highest mean bone formation of 2.97 mm^2.[46]

Pripatnanont *et al.* (2009) assessed new bone formation in bicortical skull defects in rabbits following application of autogenous bone, deproteinized bovine bone and different proportions of both. Histomorphometric examination at 2 months showed the greatest bone formation in the group receiving autogenous bone graft with a 30.223% of new bone. [47]

Shand *et al.* (2002) induced critical-size calvarial defects in rabbits and investigated the incorporation of allogeneic and autogenous bone grafts into these defects. Rabbits were sacrificed at 9 and 12 months postoperatively and the specimens were examined histomorphometrically. They reported that complete healing was achieved in the bone defects undergoing allograft, with no significant difference in comparison to the bone defects filled with autogenous bone.[48] Athanasiou *et al.* (2010) evaluated the differential histological properties of various bone graft substitutes when applied to critical-size bone defects and their effects on bone healing. They used 90 New Zealand rabbits which were divided into 6 groups. Critical-size (4.5 mm) bone defects were created in each group of rabbits and filled with various grafts including autogenous bone graft, human bone graft, bovine cancellous bone xenograft, calcium phosphate hydroxyapatite substitute and calcium sulfate substitute. The control group (group 6) underwent no filling. Rabbits were sacrificed at 1, 3 and 6 months after implantation and tissue samples from the grafted areas were examined histologically. The highest histological grades were obtained with the use of autogenous bone graft, the second best being bovine xenograft. Other bone graft materials achieved nearly identical healing. They concluded that apart from the autogenous bone graft, bovine xenograft was also associated with better biological response than other bone graft materials.[49]

Similarly, in the present study, the samples were examined histomorphometrically with the aim to investigate changes at the cellular level. Our histomorphometric findings showed no significant difference in newly formed bone volume between control group, autogenous bone graft and allogeneic bone graft groups but a significant difference was observed between groups undergoing autogenous bone graft and synthetic bone graft. Consistent with the previously published studies, our results suggest that bovine xenograft is a safe and effective grafting material for critical size bone defects as shown in the control group receiving bovine bone graft in this study. Absence of significant differences between control group and autogenous and allogeneic bone graft groups as observed in the current study suggests that this graft material which is manufactured in Turkey may be used as a good alternative to other graft substitutes in maxillofacial surgery.

CONCLUSION

While autogenous bone graft is currently regarded as the gold standard for bone regeneration, the difficulties in harvesting and application of autografts limit their use. Our results demonstrate that bovine bone graft may be used as a safe and effective alternative to autogenous bone graft. The only recognized disadvantage of the bovine bone graft is their long resorption time. However, they can be

safely used over a long period of time for critical-size bone defects.

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ELONGATION OR ANGULATION OF STYLOID PROCESS: DISCUSSION WITH A CASE REPORT AND REVIEW OF THE LITERATURE

Styloid Çıkıntının Angulasyonu veya Uzaması: Vaka Sunumu eşliğinde Literatür Tartışması

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ABSTRACT

Styloid process of temporal bone is a pointed projection from the petrous part of temporal bone which ranges with an average of 25 mm in length, and any process longer than 30 mm is defined as the "Elongated Styloid Process". In asymptomatic cases, diagnosis is usually made with routine radiological examination, but morphological aspects of styloid process can be evaluated with different imaging modalities. Although digital panoramic radiographs are sufficiently accurate for the diagnosis of elongated styloid process, multislice computed tomography scan with 3D reconstruction can further assist in determining the actual length and correct relationship with the surrounding adjacent anatomical structures.

The aim of this case report is to investigate the morphological characteristics of an unilateral elongated styloid process using both conventional and multidetector computed tomography (MDCT) on a 55 year old asymptomatic male patient and to review the literature.

Keywords: elongated styloid process, multidetector computed tomography, structural deviation

ÖZ

Temporal kemiğin styloid çıkıntısı, temporal kemiğin petroz kısmından başlayan, ortalama 25 mm uzunluğunda olan sivri bir çıkıntıdır ve 30 mm' den uzun olan styloid çıkıntılar "Uzamış Styloid Çıkıntı" olarak tanımlanır. Asemptomatik olgularda genellikle rutin radyolojik inceleme ile tanı konmaktadır, ancak styloid çıkıntının morfolojik özelliklerinin değerlendirilmesi farklı görüntüleme yöntemleri aracılığıyla yapılabilmektedir. Dijital panoramik radyografiler styloid çıkıntının doğru olarak tanılanması için yeterli olmasına rağmen, multidetektör bilgisayarlı tomografi (MDCT) taraması ile 3D rekonstrüksiyon yapılarak styloid çıkıntının gerçek uzunluğu ve komşu anatomik yapılarla ilişkisi daha doğru değerlendirebilir.

Bu olgu sunumunun amacı, 55 yaşında asemptomatik erkek hastada tek taraflı uzamış styloid çıkıntının morfolojik özelliklerini hem konvansiyonel hem de multidetektör bilgisayarlı tomografi (MDCT) kullanılarak araştırmak ve literatürü gözden geçirmektir.

Anahtar kelimeler: Uzamış styloid çıkıntı, multidetektör bilgisayarlı tomografi, yapısal anomali

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INTRODUCTION

The styloid process (SP) of temporal bone is a thin, cylindrical, sharp osseous projection which is located on the inferior aspect of temporal bone, posterior to the mastoid apex, anteriomedial to the stylomastoid foramen and lateral to the foramen jugulare and canalis caroticus. It is a component of human stylohyoid chain, which also includes the stylohyoid ligament and the cornu minus of the hyoid bone.[1,2] SP provides attachment to M. stylopharyngeus, M. stylohyoideus, M. styloglossus, stylohyoid and stylomandibular ligaments which have critical roles in mastication and swallowing.[3] Also, its tip lies in close proximity to important neurovascular structures, including hypoglossal nerve, external-internal carotid artery, and internal juguler vein.[4] Thus, any abnormalities of SP can have clinicopathological outcomes, such as severe pain in head and neck region especially observed as ear and throatache, dysphagia, sense of a foreign body in throat and limitation in mouth opening.[5,6,7]

Even though the exact etiology of SP elongation is still obscure, trauma, surgery, endocrine disorders, embriological mesenchymal remnants, intraligamentary metaplasia, osseous tissue growth and mechanical stress have been suggested among the factors in calcified hyperplasia of the SP.[1,7] Because of cartilaginous content of the ligament itself, the stylohyoid chain may present various degrees of ossification[8], and this calcium deposition on the tip of the process results with the elongation of the SP.[1] After entire ossification of the stylohyoid ligament, a solid stylohyoid chain results with many variations including incomplete ossification, segmentation, and diversities in thickness and/or angle. In some cases, the stylohyoid ligament can be divided into two or more supernumerary bones articulated through fibrous or cartilaginous joints, with more or less articulated osseous chains.[9] According to the type of elongation, Langlais[10] has classified elongated SP as Type I, elongated; Type II, pseudoarticulated; and Type III, segmented. However, other classification methods which evaluate the pattern, length and the angle of the stylohyoid chain complex have been used in literature.[1,7,10-14]

The length of SP can vary depending on individual factors of different populations; but in the literature, the normal length of this anatomical structure has been reported between 20-30 mm and any process longer than 30 mm is defined as the "Elongated Styloid Process (ESP). Although subsequent studies have observed lengths between 15.2 and 50 mm, most authors agree that SPs greater than 30 mm in length should be considered abnormal.[15-17] This abnormality is observed in 4% of the general population and only 4-10% of this group is symptomatic. Rarely, ESP is associated with clinical symptoms of neck and orofacial pain due to compression of surrounding anatomical structures, and the pain is usually referred to the ear, especially during swallowing. Also, vertigo attacks during sudden contralateral head movements, occasional tinnitus, hypersalivation and episodic pain with muscular spasm may be observed[1], and in such cases, the pathology is characterized as “Eagle’s syndrome”. Observation is the treatment of choice for asymptomatic cases, but for symptomatic patients, the treatment plan includes both medical and surgical options.[18] In addition to Eagle’s syndrome, the calcified stylohyoid ligament and the ESP can be associated with other pathologies such as the carotid artery syndrome, stylohyoid syndrome, and pseudostylohyoid syndrome.[19-21]

In asymptomatic cases, ESP is usually detected during routine dental radiographic examination using panoramic radiographs. However, superimposition of the mandibular bone and teeth on SP reduces the quality of the image on conventional radiographs. At this point, multidetector computed tomography

(MDCT) and 3D reconstruction are considered as the best imaging modality in order to accurately assess the location and morphological features of this pathology, especially before any surgical planning or intervention.[22,23] This paper reports an asymptomatic male patient with unilateral ESP and presents the morphological details of the pathology using MDCT.

CASE REPORT

A 56-year-old male patient was referred to the outpatient clinic of Ege University, School of Dentistry, Department of Oral and Maxillofacial Radiology for prosthetic rehabilitation. The patient's medical history was noncontributory. After receiving informed consent; extraoral examination revealed no abnormalities; besides the patient had no complaints on his neck region, such as pain, foreign body sensation, dysphagia or visual impairment. Intraoral examination disclosed missing teeth #14, 15, 17, 22-25, 36, 37, 46, 47, distoproximal caries in #44, and generalized periodontitis. Conventional panoramic radiographic examination revealed a right styloid process with two articulated supernumerary bones protruding to the basal region of mandible, while left styloid process was observed as normal (Figure 1).

Fig. 1: Panoramic view of the patient

In order to accurately assess the location and morphological features of the pathology, further detailed radiographic analysis with MDCT was required. Computerized tomography (CT) scans were obtained with a 64-MSCT scanner (Discovery HD 750 dual energy CT, GE, Milwakee, USA) using 0,625 mm slice thickness, 180 cm FOV, 110 kV, 220 mA scanning parameters. Besides, 3D reformatting of images was also prepared using axial dicom images on recontruction software integrated into the PACS Workstation (syngo, Siemens).

In 3D-CT examination, the length of SP were measured by rotating the image until the long axis of the SP was parallel to the viewing to provide an unobstructed view. According to this technique, the length of the right styloid process from the attachment point of the SP to the temporal bone to the tip of the SP was measured as 80.6 mm while left SP was measured as 27.0 mm in length. Langlais classification concluded that the right styloid process was a Type 3 ESP, while it was normal for the left side (Figure 2).

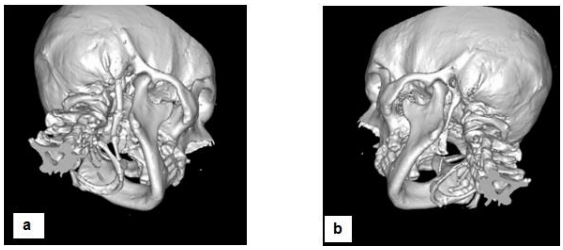

Fig. 2: Multidedector computed tomography images; **a, b.** Three-dimensional (3D) of computed tomography (CT) scan shows length measurement and Type 3 ESP according to Langlais classification.

The medial-lateral angle (MLA) was defined as the angle between the line connecting the base of the SPs and long axis of the SP on the anteroposterior view of 3D-CT images and MLA of elongated SP was measured as *65.95°* (Figure 3a) while it was *59.31°* for the normal SP (Figure 3b).

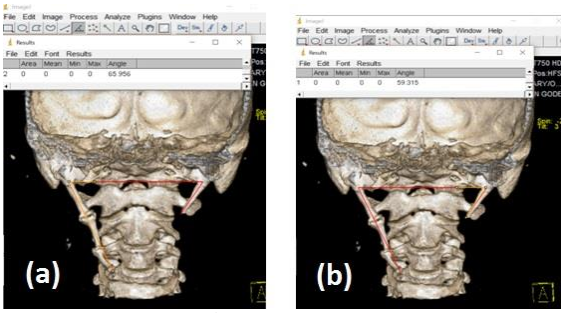

Fig. 3: Coronol view of three dimensions (3D) reconstructions showing MLA of elongated and normal styloid process (a) Medial angulation of the elonge SP (b) Medial angulation of the normal SP

The anterior-posterior angle (APA) was determined as the angle of intersection between a line tangential to the tip of the mastoid process and the axis of the SP on the lateral view of 3D-CT images and was measured as *69.06°* (Figure 4a). APA of normal SP was measured as 80.46 mm (Figure 4b).

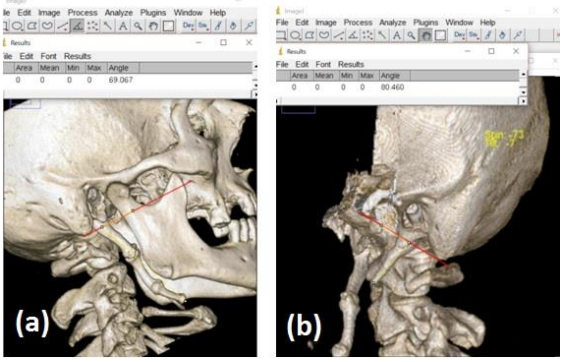

Fig. 4: Sagitall view of three dimensions (3D) reconstructions showing APA of elongated and normal styloid process (a) Anterior angulation of the elongated SP (b) Anterior angulation of the normal SP

All measurements related APA and MLA on right (elongated type) and left side (normal type) were summarized in Table 1. During the evaluation process, the mastoid tip was chosen as a reference landmark because it was reliably visualized in all lateral views.

Table 1: Angle and length measurements of normal and elongated styloid process made on computed tomography

	Right	Left
Length (mm)	80.6 mm	27.0 mm
Anteroposterior angle	69.06°	80.46°
Mediolateral angle	65.95°	59.31°

DISCUSSION

In this report, we describe an unusual case of an unilateral ESP with a length of 80.6 mm. The normal length of the SP ranges from 25 mm to 30 mm.[24] Although most authors agree that SPs greater than 30 cm in length should be considered abnormal[25], other studies claim that a length between 15.2 mm and 47.7 mm could be considered as normal.[26] The variations between the measurements of SPs in abovementioned studies may originate from utilization of various imaging modalities, which fall short to demonstrate the morphological features of SP accurately.

In order to provide an accurate and adequate measurement, the full length of SP must be visualized.[1,27] For this purpose, several imaging modalities including conventional lateral and anteroposterior (AP) views of head and neck radiograph, orthopantomography, CT and more recently, cone beam computerized tomography (CBCT) can be used. Panoramic radiography is frequently selected because it is a regular radiographic examination method requested by dental practitioners to inspect the structures of the maxillofacial complex, including the full length of SP. However, the visualization is not easy on panoramic radiographs due to superimposed neighbouring anatomical structures.[1,8,24] Recent studies showed that Multislice CT scans with 3D reconstruction can overcome the limitation of 2D imaging modalities and provide the most accurate information about the course, morphometric properties (length, angle, etc) of SPs and their relationship with adjacent anatomical structures.[5,28] Furthermore, 3D-CT reconstruction has been advocated as the gold standard for examination of the SP.[29]

In previous studies using CT scans, the length of the SP in millimeters was measured in standard coronal planes of CT.[5,6] However, CBCT images which were rotated sagitally have been utilized in order to investigate the whole structure of SP on a single image.[7] Similarly, in the present study, the image plane was rotated until an angle demonstrating the entire long axis of the SP was obtained to provide an unobstructed view of the anatomically complex SP, and afterwards, the length of the SP in millimeters was measured on 3D-CT images. On the other hand, this methodology may present a limitation: as Kent *et al*.[28], have suggested rotating the image until the long axis of the SP was parallel to the viewing may account for longer SP values than the others reported in the literature.

When ESP is associated with clinical symptoms of neck and orofacial pain, it is referred as "Eagle's syndrome". Although this syndrome is thought to be caused by ESP, the presence of ESP is not a pathognomonic finding, because many patients with incidental findings of ESP are asymptomatic[1], as observed in our case. At this point, another morphometric parameter that requires further evaluation is the angle of the SP.[7,16,30] This concern has been already declared in the literature, and the potential association between the angulation of the SP and clinical symptoms has been emphasized, as presented in Table 2.

Table 2: A summary of studies investigating the angulation and length of the styloid process of the patients with/without symptoms using different imaging modalities.

					Angle (APA)		Angle (MLA)	
Author/year	**Complaints**	**Patient**	**Average of Length (sympt / asympt)**	**Technique**	**Mean value (sympt / asympt)**	**Reference line**	**Mean value (sympt / asympt)**	**Reference line**
Onbaş 2005	asymptomatic	283	26.8 mm	MDCT	93.5°	the skull base line connecting the nasion and the opisthion - axis of the SP	72.7°	the line connecting the base of the SPs-the axis of the SP
Başekim 2005	asymptomatic	138	28.3 mm	3D-CT	-	-	69.4°	the line connecting the base of the SPs-the axis of the SP
Ramadan 2007	asymptomatic	100	27 mm	3D-CT	63.7°	Mc Rae's line-axis of the SP	72.7°	the line connecting the base of the SPs-the axis of the SP
Yavuz 2008	symptomatic+ asymptomatic	30+31	50 mm /27 mm	lateral skull+ Towne's rad.	33.6-36.7 /21.4-18.5	vertical line*-axis of the SP	14-18.1/15-16.3	vertical line-axis of the SP
Okur 2014	symptomatic+ asymptomatic	100+100	40.5 /39 mm	3D-CT	16.5/15	the line passing from cranial base of the SP and axis of the SP	22.60/20	vertikal line-axis of the SP
Kent 2014	symptomatic+ asymptomatic	37+30	48/40 mm	3D-CT	66/66	the line tangential to the mastoid proc.-axis of the SP	62/70	the line connecting the base of the SPs-the axis of the SP
Burulday 2017	symptomatic+ asymptomatic	25+25	40.3/16.8 mm	3D-CT	73.2/74	the line tangential to the mastoid proc.-axis of the SP	69.2/66.5	the line connecting the base of the SPs-the axis of the SP
Kumar 2017	normal+ elongated type	96 skulls	36/14 mm	goniometer	57.7/66.3	frankfurt line-axis of the SP	73.3/74.3	the line connecting the base of the SPs-the axis of the SP
Eraslan 2017	asymptomatic	125	31.3 mm	3D-CTA	57.3	angle of the calcification of the SHC with the sagittal axis of the 3D-CTA image	72.7	the line connecting the base of the SPs-the axis of the SP
Buyuk 2018	asymptomatic	1000	34.5 mm	3D-CBCT	72.2	Skull base- axis of the SP	71.2	the line connecting the base of the SPs-the axis of the SP

Although the normal length and angles of the SP varies considerably according to the different measurement techniques and reference points, most of the studies showed that abnormal angulations of SP rather than elongation are responsible for clinical symptoms. However, previous studies have not reached a consensus on which angulation is the most important.[16,21] Yavuz *et al.*[21] investigated the effect of the angulation of SP on Eagle syndrome (ES) using 2D radiographic techniques and found a significant difference between symptomatic patient and control group in anterior-posterior SP angulation (APA), but there were no significant differences between 2 groups with respect to medial-lateral SP angulation (MLA). However, recent studies using 3D-CT reconstructions of the SP showed that rather than the anterior angulation or the length of SP, the decreased medial angulations of SP might more strongly influence the presence and severity of clinical symptoms.[4,16,29,30] A recent morphological study of SP on human skulls also revealed that the angulations were decreased in ESP as compared with normal type of SP.[4] According to that study, the mean anterior angle of the ESP was 57°, while for the normal type, it was 66°. Burulday *et al.*[30] used 3D CT images to evaluate the importance of MLA in symptomatic eagle syndrome and found that the symptoms are more intense when the angle is smaller. In such cases, the tip of the SP approaches medially in the coronal plane and causes more intense clinical complaints by compressing the surrounding tissues.[7,28,29,31] Kent *et al.*[28] evaluated the SP anatomy in ES and asymptomatic control populations using 3D CT reconstructions. They revealed that the length or angulation of the SP in ES may be

less important than its approximation to the adjacent soft tissue structures, such as the superior constrictor muscle and glossopharyngeal nerve. Rather, the minimum distance from SP tip to the tonsillar fossa was found to have a much greater effect size than any other measured variable.[28] Additionally, a long stylohyoid complex with a narrow anterior sagittal angle and/or a narrow transverse angle may irritate the adjacent anatomical structures and result with clinical complaints due to the compression of the adjacent structures.[7]

Several classification has been reported previously according to the morphology, length and angle of the styloid apparatus.[1,7,10-14] Viela suggested a classification based on the morphogenesis of the skull, while Langlais *et al.* proposed a radiological classification in three types.[10,11] The broadest classification cited in the literature was defined by MacDonald-Jankowski *et al.*[12] who used embryological considerations to describe 12 subtypes according to the ossified segment part of the ligament. Regarding angulation of SP, Buyuk *et al.*[7] classified the transverse angles into three groups; <65° were determined as narrow, 65°-75° as normal, and >75° as wide angles. Similarly, sagittal angles were divided into three groups; <60° were defined as narrow, 60°-70° as normal, and >75° as wide anglesi.[7] However, there is only one study in the literature including both length, angulation and morphological findings of the SP to the classification, and this classification was termed as "LAM "(length, angulation and morphology).[1] According to LAM classification; assessment ranges related length, angulation and morphology are yielded in the below.[1]

L: Length of the SP

1. Short (<2.00 cm)
2. Long (2.00–4.00 cm)
3. Elongated (>4.00 cm)

A: Angulation of the SP

1. Narrow (<65.0°)
2. Normal (65.0–75.0°)
3. Wide (>75.0°)

M: Morphology of the SP

0. Absence of SP
1. Normal appearance of SP
2. Other morphological findings (absence of the proximal part of the SP, duplication of the proximal part of the SP, bent SP, segmented SP, pseudoarticulated SP, etc.)

We think that this classification seems clinically handier and more pertinent to make a comprehensive evaluation, and according to this classification, right SP of our case was L3, A12, M2; while it was L2, A1, M1 for the left side.

In our case, an asymptomatic unilateral ESP was reported. The length of the right SP was measured as 80.6 mm, while left SP was measured as 27.0 cm in length. Besides, the angulations of anterior-posterior and medial-lateral ESP were 69.06° and 65.95° respectively and were within the normal range reported in the literature. Although the length of the SP was extremely longer than the mean levels, our patient presented no clinical symptoms. On the other hand, the angulations of the processes were narrower in our case as compared with the symptomatic ones reported in the literature, and this may be considered as the reason of the absence of clinical complaints.

CONCLUSION

Up to date, severe clinical consequences have been associated with ESP. However, our case approved the results of previous reports and suggested that the angulations rather than the length of ESP may be responsible for patients' clinical complaints. In order to appropriately evaluate the length, angulations and other morphological characteristics of SP, MDCT may be offered as an effective radio diagnostic method.

Compliance with ethical standards

Conflict of Interest: The authors declare that they have no conflict of interest.

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All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and later versions. Informed consent was obtained from all patients for being included in the study. Informed consent was obtained from the patient for being included in the study.

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