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Editorial

The Editor-in-Chief's recommendation of this issue's article to readers;

The Effect of Heat Application on Fluoride Release from Antibacterial Agent Added Glass Ionomer Cement

I am pleased to inform you that I have chosen this article by Kurt et al.1 as Editor's Choice for the second issue of 2019.

Glass ionomer cements (GICs) are widely used in dental procedures and pediatric dentistry. One of the most important advantages of GIC is the property of fluoride release which leads to increase ambient pH and prevent acidity by inhibiting the carbohydrate metabolism of the surrounding bacteria, resulting in the prevention of dental caries in future.

This article shows that the effect of heat application leads an increased F− releasing pattern on fluoride release from antibacterial agent added The increased F− releasing pattern after the heating is believed to be promising for antibacterial GIC combinations.

Happy readings in the second issue of 2019!

Assoc. Prof. Burak Buldur

Co-Editor-in-Chief

REFERENCE

1. Kurt A, Tüzüner T, Altıntepe İ, Aydınoğlu S, Sökmen M. The Effect of Heat Application on Fluoride Release in Antibacterial Agent Added Glass. Cumhuriyet Dent J 2019;22:2:218-225.

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Original research

COMPLIANCE AND EFFECTIVENESS IN CERVICAL HEADGEAR

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ABSTRACT

Objectives: The aim of the present study was to evaluate the correlation between headgear wear duration and correction of skeletal and dental Class II malocclusion in preadolescent patients.

Materials and Methods: The study material consisted of pre and posttreatment lateral cephalograms, and actual headgear wear hours calculated from data recorded monthly by an electronic timer device, (Compliance Science System (CSS) and Affirm Smart Headgear Modules, Ortho Kinetics, Vista, California, USA) of 30 patients (14 female and 16 male) treated with cervical headgear for 12 months. The mean age was 10.43 ± 1.07 years. Initial and progress cephalograms were analyzed according to skeletal and dental landmarks to evaluate treatment effect of the appliance. The actual number of hours of appliance wear was calculated by data from timer modules collected every monthly visit. Statistical analysis was performed by using SPSS 24.0.

Results: While a sagittal growth was still observed in the group using the headgear for less than 12 hours, restriction of sagittal growth of maxilla was achieved in the group using the cervical headgear over 12 hours daily.

Conclusions: The cervical headgear is still used in orthodontics to restrict the forward growth of the maxilla in Class II division 1 patients with a normal or low angle profile. By means of objective data for monthly appliance usage, this study showed that in order to achieve the targeted results the cervical headgear should be used at least 12 hours daily.

Key Words: Orthodontics, extraoral traction appliances, patient compliance

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INTRODUCTION

Treatment of Class II, Division 1 malocclusion in growing patients compromises growth modification by orthopedic appliances such as cervical headgears, although treatment effect is intimately to patient's compliance and motivation.[1-3] The skeletal and dental effects of cervical headgear in growing patients depends on magnitude of force and time of daily use.[4,5]

Orthodontists currently recommend 'standard' wear times with a broad deviation in practice ranging from 12 to 20 hours daily.[6-14] However, lack of an objective measure of compliance makes it difficult to describe the dose effect relationship between headgear wear and Class II correction.[15]

In order to more accurately monitor compliance, several studies have tried to measure orthodontic patient compliance using electronic measuring devices.[6,7,16-20] The first reported use of a headgear-timing device was by Northcutt.[21] This timing headgear design was a sophisticated, miniaturized electronic clock that counted the number of hours that a headgear was worn. Mitchell[22] used the timer headgear on patients with a history of poor compliance and gained sufficient improvement in patient cooperation.

Cureton *et al.*[22] developed a timing device based on a small quartz calendar watch concealed in a headgear strap and activated by a small switch attached to a traction module. Later, Güray and Orhan[6] created their own timing headgear device. Many studies have found that these timing devices are useful in measuring patient compliance during orthodontic treatment with removable appliances.[7,18,19] Cole[19] used a commercially available timing headgear [Compliance Science System (CSS), Ortho Kinetics Corporation, Vista, California, USA] on 20 patients to encourage motivation. Doruk *et al.*[7] also used the CSS to evaluate the efficacy of timer modules on patient cooperation.

The aim of the present study is to evaluate the most favorable headgear wear duration for cervical headgear treatment of Class II, Division 1 growing patients.

MATERIALS AND METHODS

Forty eight consecutive patients presenting Class II, Division 1 malocclusion with maxillary protrusion were selected from the patients list. The parents of five patients refused to participate. Three patients aged over 12 were eliminated from the study. The mean age of forty subjects (21 female and 19 male) included in the study was 10.43 ± 1.07.

The headgear used for treatment was the Kloehn type with a long outer bow fitted to the maxillary first molars. Initial force was applied to the long outer bow parallel to the occlusal plane. The outer bow was bent upward at a 20° angle to the inner bow to tip the maxillary molar roots distally as the crown moved distally. Extraoral traction forces of 600 g per side were used, and patients were instructed to wear their headgear for 12 to 16 hours a day. Each subject received the same commercially available timing headgear (SCC); which consisted of a microprocessor-controlled timing module embedded in one of the cervical headgear traction modules. The patients used the cervical headgear for an average period of 12 months. All patients were treated by the same orthodontist.

The patients were not informed that their monthly headgear wear time was being recorded. The timer device begins a timing cycle when the module is placed under tension and stops timing when tension is released. At each monthly visit, the module was placed in an infrared reader and the data on the module was transferred to a computer using Affirm Software V 4.2 (Ortho Kinetics Corporation, Vista, California, USA). Due to limited battery life of the timer modules, a second timer module was placed for each patient after 6 months of treatment. Patients who used their headgear for less than 12 hours were assigned to Group 1 and patients who used their headgear for more than 12 hours were assigned to Group 2. Two patients were excluded from the study due to appliance breakage.

To analyze the effects of the cervical headgear therapy, lateral cephalograms were taken before (T1) and after (T2) the treatment using a cephalostat (Cranex DC2, Tuusula, Finland). Lateral cephalograms of the subjects obtained at T1 and T2 were scanned, digitized and then analyzed with the Dolphin Imaging Software 9.0 (Los Angeles,

California, USA) by the same investigator (GT). The landmarks used in our study are defined in Table 1.

Table 1. The cephalometric variables and explanations used in the study.

SNA (°)	Angle determined by points S, N, and A
SNB (°)	Angle determined by points S, N, and B
ANB (°)	Angle determined by points A, N, and B
Maxillary depth (°)	Angle formed between FH and NA planes
GoMeSN (°)	Angle formed between Go–Me and SN planes
Saddle (°)	Angle determined by points N, S, and Ar
Ar (°)	Angle determined by points S, Ar, and Go
Go (°)	Angle determined by points Ar, Go, and Me
Maxillary height (°)	Angle determined by points N, CF, and A
FMA (°)	Angle formed between FH plane and the mandibular plane
y-axis (°)	Angle formed between FH plane and S–Gn
SNOcc (°)	Angle formed between SN and occlusal planes
SN (mm)	Distance between points S and N
SAr (mm)	Distance between points S and Ar
NperA (mm)	Perpendicular distance from point A to perpendicular line to FH plane from point N
PogNB (mm)	Perpendicular distance from pogonion to the plane between points N and B
Ar–Go (mm)	Distance between points Ar and Go
N–Me (mm)	Distance between points N and Me
Ans–Me (mm)	Distance between points Ans and Me
Jarabak (ratio)	The ratio between posterior and anterior face heights (S–Go/N–Me)
AnsMe/NMe (ratio)	Ratio of lower (Ans–Me) to total (N–Me) face height
SAr/ArGo (ratio)	The ratio between posterior cranial base (S–Ar) and ramus (Ar–Go)
Go (ratio)	The ratio between the upper and lower parts of the gonial angle bisected by a line from point N
U1–SN (°)	Angle formed between the axis of the maxillary incisor to SN plane
IMPA (°)	Angle formed by the intersection of the mandibular incisor axis to the mandibular plane
U1–NA (°)	Angle formed by the intersection of the maxillary incisor axis to the plane between points N and A
L1–NB (°)	Angle formed by the intersection of the mandibular incisor axis to the plane between points N and B
Interincisal (°)	Angle formed by the intersection of the mandibular incisor axis to the maxillary incisor axis
Overjet (mm)	Horizontal distance between the tips of the maxillary and mandibular central incisors
Overbite (mm)	Vertical distance between the tips of the maxillary and mandibular central incisors
U1–NA (mm)	Perpendicular distance from the tip of the maxillary incisor to the plane between points N and A
L1–NB (mm)	Perpendicular distance from the tip of the mandibular incisor to the plane between points N and B
Nasolabial (°)	Angle determined by points columella, SN, and UL
ULE (mm)	Perpendicular distance from the upper lip point to E line
LLE (mm)	Perpendicular distance from the lower lip point to E line
SNA (°)	Angle determined by points S, N, and A
SNB (°)	Angle determined by points S, N, and B
ANB (°)	Angle determined by points A, N, and B
Maxillary depth (°)	Angle formed between FH and NA planes
GoMeSN (°)	Angle formed between Go–Me and SN planes
Saddle (°)	Angle determined by points N, S, and Ar
Ar (°)	Angle determined by points S, Ar, and Go
Go (°)	Angle determined by points Ar, Go, and Me
Maxillary height (°)	Angle determined by points N, CF, and A
FMA (°)	Angle formed between FH plane and the mandibular plane
y-axis (°)	Angle formed between FH plane and S–Gn
SNOcc (°)	Angle formed between SN and occlusal planes
SN (mm)	Distance between points S and N
SAr (mm)	Distance between points S and Ar
NperA (mm)	Perpendicular distance from point A to perpendicular line to FH plane from point N
PogNB (mm)	Perpendicular distance from pogonion to the plane between points N and B
Ar–Go (mm)	Distance between points Ar and Go
N–Me (mm)	Distance between points N and Me
Ans–Me (mm)	Distance between points Ans and Me
Jarabak (ratio)	The ratio between posterior and anterior face heights (S–Go/N–Me)
AnsMe/NMe (ratio)	Ratio of lower (Ans–Me) to total (N–Me) face height

Superimpositions of the initial and final traces were carried out in order to evaluate how much growth had taken place in the Ba-N plane, using N as the fixed point. Both initial and final point A positions were projected over the Frankfort plane as a horizontal reference. For the vertical reference plane, we projected the anterior and posterior nasal spine positions over the vertical pterygoid in both the initial and final measurements. Positive values were applied when the final point A position was in front of the initial point A position, and similarly, when the final nasal spine position was lower than the

initial one. We also took into account any rotations that might have arisen in the palatal plane. A positive rotation was defined as when the final palatal plane position had changed in a counterclockwise direction with respect to the initial position, and vice versa, a negative value was assigned to a clockwise rotation.[23]

Method Error

To estimate method error, twenty randomly selected radiographs were retraced, re-digitized, and re measured after a 1 month interval from the first measurement, by the same examiner. The method error (ME) was estimated using Dahlberg's formula[23], ME= $\sqrt{\sum d^2 / 2n}$ where d is the difference between the first and second measurements (millimeters or degrees) and n is the number of duplicated measurements.

Statistical analysis

The descriptive statistics were calculated as means and standard deviations. Means and standard deviations for all variables at T1 and T2 were calculated and intra group correlation was performed by using Wilcoxon test. The changes between pretreatment and posttreatment values (T2−T1) for both groups were calculated and compared using non-parametric Mann Whitney U Test. $p<0.05$ was considered statistically significant. Statistical analysis was performed with SPSS 24.0 (SPSS Inc, Chicago, USA).

RESULTS

The forward growth of the maxillary A-point was greatly restricted by the cervical headgear treatment, while the rest of the facial structures grew forward at a normal rate. Mean changes and standard deviations from T1 (pretreatment) to T2 (posttreatment) of angular and linear measurements for Group 1 and Group 2 are shown in Table 2 and Table 3 respectively. Correlation of changes between T1 and T2 are shown in Table 4.

Table 2. Mean values, standard deviations and comparison of T1 and T2 values for Group 1 (Wilcoxon test).

n=15	T1			T2				
	Mean		SD	Mean		SD	z	p
SNA (°)	81.36	±	±2.16	82.09	±	2.39	2.27	**0.023**
SNB (°)	75.69	±	±2.25	76.2	±	2.95	1.51	0.132
ANB (°)	5.65	±	±1.7	5.82	±	2.06	1.85	0.065
SN-Palatal Plane (°)	6.6	±	±2.56	7.38	±	3.16	2.16	**0.031**
Occ Plane - SN (°)	17.4	±	±2.64	16.2	±	2.89	2.61	**0.009**
A-Na Perp (mm)	0.45	±	±3.42	0.81	±	4	0.85	0.394
Y-Axis	60.01	±	±2.48	60.02	±	2.75	0.31	0.755
MP-SN (°)	34.65	±	±3.64	34.25	±	3.69	1.57	0.116
Saddle Angle (°)	124.12	±	±3.29	123.84	±	4.01	0.11	0.91
Articular Angle (°)	145.97	±	±5.15	146.42	±	4.06	0.17	0.865
Gonial Angle (°)	124.58	±	±5.9	123.97	±	5.07	0.79	0.433
Sum of Angle (°)	394.55	±	±3.65	394.25	±	3.69	0.97	0.33
Pog-N Perpendicular (mm)	-8.39	±	±4.06	-7.79	±	4.61	0.85	0.63
ANS-Me (perp-HP) (mm)	6.77	±	±2.83	63.36	±	3.57	1.25	0.211
Anterior Face Height (mm)	116.73	±	±3.65	119.41	±	3.97	2.9	**0.004**
ANS-Me/N-Me	57.27	±	±1.84	56.62	±	1.78	2.53	**0.011**
Posterior Cranial Base (mm)	35.58	±	±3.59	36.42	±	3.2	2.27	**0.023**
S-Go (mm)	77.07	±	±3.26	79.56	±	3.48	2.92	**0.004**
Jarabak ratio (%)	63.74	±	±2.59	64.26	±	2.93	1.85	0.065
S-Ar/Ar-Go (%)	83.76	±	±11.92	83.9	±	10.29	0.4	0.691
Gonial Ratio	71.83	±	±5.8	70.8	±	5.27	1.48	0.14
Mandibular Length (Go-Gn) (mm)	70.23	±	±3.65	71.3	±	5.25	1.53	0.125
Corpus Length (mm)	67.66	±	±3.08	69.58	±	3.14	2.84	**0.005**
U1-SN (°)	109.56	±	±4.65	110.63	±	4.56	1.59	0.112
U1-NA (°)	28.22	±	±4.83	29.17	±	5.91	1.13	0.258
U1-NA (mm)	6.16	±	±2.05	6.12	±	3.04	0.28	0.777
U1-FH (°)	118.59	±	±3.86	119.54	±	5.57	1.02	0.306
IMPA (°)	99.26	±	±4.95	98.29	±	4.47	1.65	0.1
L1-NB (°)	29.59	±	±5.22	28.61	±	4.31	1.51	0.132
L1-NB (mm)	6.55	±	1.82	6.4	±	1.75	1.08	0.28
Pog-NB (mm)	1.16	±	1.2	1.14	±	1.19	0.29	0.776
Interincisal Angle (°)	116.52	±	6.7	116.58	±	7.8	0.03	0.975
Overjet (mm)	7.66	±	2.09	7.67	±	1.68	0.71	0.48
Overbite (mm)	3.62	±	1.64	4.15	±	1.06	1.85	0.064

T1: Pretreatment, T2: Posttreatment, Statistical significance: $p<0.05$, SD: Standard Deviation, Z: Difference between pretreatment and posttreatment values.

Table 3. Mean values, standard deviations and comparison of T1 and T2 values for Group 2 (Wilcoxon test).

n=15	T1			T2				
	Mean		SD	Mean		SD	z	p
SNA (°)	82.29	±	3.68	81.78	±	2.81	0.63	0.532
SNB (°)	75.73	±	2.98	77.17	±	1.95	2.3	0.021
ANB (°)	6.5	±	2.15	4.95	±	1.95	3.41	**0.001**
SN-Palatal Plane (°)	8.85	±	2.86	8.74	±	2.96	0.31	0.755
Occ Plane - SN (°)	19.13	±	3.96	17.42	±	3.41	2.64	**0.008**
A-Na Perp (mm)	0.56	±	4.04	-0.67	±	3.9	2.33	**0.02**
Y-Axis	60.29	±	3.86	60.52	±	4.02	1.39	0.164
MP-SN (°)	34.19	±	4.6	33.25	±	4.39	1.56	0.118
Saddle Angle (°)	123.75	±	3.56	121.3	±	5.57	1.96	**0.05**
Articular Angle (°)	146.36	±	5.83	146.25	±	6.35	0.09	0.925
Gonial Angle (°)	124.09	±	5.22	123.96	±	5.64	0.23	0.82
Sum of Angle (°)	394.19	±	4.6	393.52	±	4.33	1.19	0.233
Pog-N Perpendicular (mm)	-8.99	±	7.3	-8.83	±	7.84	2.33	**0.022**
ANS-Me (perp-HP) (mm)	59.77	±	3.42	60.31	±	2.84	1.51	0.132
Anterior Face Height (mm)	114.86	±	6.82	115.57	±	4.42	1.43	0.152
ANS-Me/N-Me	55.95	±	1.22	55.59	±	1.67	0.94	0.346
Posterior Cranial Base (mm)	34.12	±	2.62	35.1	±	2.88	2.36	**0.018**
S-Go (mm)	75.61	±	4.78	77.67	±	4.41	2.61	**0.009**
Jarabak ratio (%)	64.02	±	3.22	65	±	3.38	2.16	**0.031**
S-Ar/Ar-Go (%)	80.57	±	6.54	80.56	±	6.83	0.57	0.57
Gonial Ratio	71.78	±	6.63	71.48	±	6.24	0.65	0.514
Mandibular Length (Go-Gn) (mm)	70	±	3.97	70.37	±	3.93	0.4	0.691
Corpus Length (mm)	66.85	±	2.82	67.8	±	2.96	2.02	**0.044**
U1-SN (°)	103.28	±	5.55	106.58	±	7.27	2.44	**0.015**
U1-NA (°)	20.91	±	5.88	24.79	±	7.04	2.67	**0.008**
U1-NA (mm)	3.73	±	2.47	4.95	±	2.79	2.13	**0.033**
U1-FH (°)	113.4	±	7.91	113.4	±	7.91	1.76	0.078
IMPA (°)	97.93	±	6.12	97.28	±	8.71	0.23	0.82
L1-NB (°)	27.89	±	5.39	28.36	±	6.26	0.57	0.572
L1-NB (mm)	5.76	±	2.19	5.48	±	2.5	1.38	0.166
Pog-NB (mm)	1.78	±	1,15	1.52	±	1.15	2.11	**0.035**
Interincisal Angle (°)	124.41	±	10,31	121,94	±	11.73	2.33	**0.02**
Overjet (mm)	7.77	±	2,59	5,82	±	1.82	2.03	**0.003**
Overbite (mm)	4.1	±	2,14	3,78	±	1.92	1.14	0.256

T1: Pretreatment, T2: Posttreatment, Statistical significance: $p<0.05$ SD: Standard Deviation, Z: Difference between pretreatment and posttreatment values.

Table 4. Correlation of differences between T2-T1 for Group 1 and Group 2 (Mann Whitney U test).

n=15	Group 1			Group 2				
	Mean		SD	Mean		SD	z	p
SNA (°)	0.72	±	1.17	-0.51	±	2.12	-1.89	**0.059**
SNB (°)	0.51	±	1.2	1.44	±	2.37	-1.68	0.0928
ANB (°)	0.16	±	1.77	-1.91	±	1.91	-3.92	**0.0005**
SN-Palatal Plane (°)	0.77	±	1.22	-0.11	±	2.35	-1.35	0.1773
Occ Plane - SN (°)	-1.2	±	1.36	-1.71	±	2.02	-0.68	0.4933
A-Na Perp (mm)	0.35	±	1.7	-1.23	±	2.14	-2.61	**0.009**
Y-Axis	0.007	±	2.12	0.23	±	1.41	-1.6	0.2452
MP-SN (°)	-0.4	±	1.12	-0.04	±	2.34	-0.79	0.4303
Saddle Angle (°)	-0.27	±	1.85	-2.45	±	4.95	-1.41	0.1582
Articular Angle (°)	0.45	±	2.94	-0.11	±	4.08	-0.35	0.7242
Gonial Angle (°)	-0.6	±	2.47	-0.13	±	2.23	-0.56	0.5753
Sum of Angle (°)	-0.29	±	1.2	-0.67	±	2.22	-0.52	0.604
Pog-N Perpendicular (mm)	0.6	±	3.11	0.16	±	2.04	-0.42	0.678
ANS-Me (perp-HP) (mm)	0.58	±	1.93	0.54	±	2.27	-0.31	0.756
Anterior Face Height (mm)	2.68	±	2.55	0.71	±	4.49	-1.04	0.3
ANS-Me/N-Me	-0.65	±	0.83	-0.36	±	1.59	-0.21	0.8355
Posterior Cranial Base (mm)	0.83	±	1.14	0.98	±	1.42	-0.46	0.648
S-Go (mm)	2.49	±	2.36	2.06	±	2.46	-0.39	0.693
Jarabak ratio (%)	0.52	±	1.08	0.98	±	1.66	-1.02	0.309
S-Ar/Ar-Go (%)	0.14	±	4.89	-0.007	±	4.62	-0.6	0.5475
Gonial Ratio	-1.03	±	2.29	-0.3	±	2.09	-0.52	0.604
Mandibular Length (Go-Gn) (mm)	1.06	±	2.84	0.37	±	2.92	-0.62	0.534
Corpus Length (mm)	1.92	±	2.05	0.95	±	2.81	-0.68	0.494
U1-SN (°)	1.06	±	2.44	3.3	±	4.81	-2.2	**0.0279**
U1-NA (°)	0.95	±	2.86	3.88	±	4.22	-2.59	**0.0095**
U1-NA (mm)	-0.04	±	1.44	0.86	±	1.73	-1.91	**0.05**
U1-FH (°)	0.94	±	3.71	2.08	±	4.93	-0.93	0.3503
IMPA (°)	-0.96	±	2.71	-0.65	±	6.08	-1.22	0.221
L1-NB (°)	-0.98	±	2.74	0.46	±	3.23	-1.18	0.2369
L1-NB (mm)	-0.15	±	1.13	-0.28	±	0.81	-0.15	0.884
Pog-NB (mm)	-0.02	±	0.4	-0.26	±	0.43	-1.6	0.109
Interincisal Angle (°)	-0.06	±	3.25	-2.46	±	6.15	-2.22	**0.0265**
Overjet (mm)	0.01	±	1.91	-1.95	±	2.21	-2.64	**0.008**
Overbite (mm)	0.53	±	0.98	-0.32	±	1.55	-2.01	**0.044**

T1: Pretreatment, T2: Posttreatment, Statistical significance: p<0.05, SD: Standard Deviation, Z: Difference between pretreatment and posttreatment values.

In Group 2, the SNA angle decreased an average of 0.51° (± 2.12°), whereas there was an increase in SNA angle of 1.44° (± 2.37°) in Group 1. The difference between the two groups was significant (p=0.05). SNB was not affected by CHG therapy and increased slightly during growth in both groups. The reduction of ANB was more obvious in Group 2 with a difference of 1.91° (± 1.91°) among the two groups (p<0.05).

The perpendicular distance of point A to the NA Line increased with an average of 0.35 mm (± 1.70 mm) and decreased with an average of 1.23 mm (± 2.14 mm) in Group 1 and 2 respectively. The difference between both groups was statistically significant (p<0.05).

A statistically significant difference was observed for the change of overjet and overbite (P<0.05) when two groups were compared. A decrease of 1.95 mm (± 2.21 mm) and an increase of 0.01 mm (± 1.91 mm) in the overjet was observed in Group 2 and 1 respectively. Maxillary incisors were protruded with an increase of 3.30° (± 4.8°) in the U1SN and 3.88° (± 4.22°) in the U1NA angle in Group 2.

A similar downward displacement of all skeletal variables was observed in both groups. Overbite reduction was more pronounced in Group 2 (-0.32 ± 1.55 mm) compared with Group 1 (0.53 ± 0.98 mm, p<0.05).

DISCUSSION

The majority of orthodontic patients consist of growing children with Class II malocclusion. Extraoral appliances are frequently used for orthopedic corrections of these patients. Some researchers indicated that the headgear can be considered contraindicated in the treatment of Class II malocclusions since it depends on patient compliance.[19] Compliance is more easily achieved with part-time wear, primarily while sleeping[19] Results of the present study indicate that 12 hours usage of CHG daily is sufficient to achieve

successful results in restriction of maxillary forward displacement and maxillary growth.

The results of this study demonstrated that facial profile improved by decreasing facial convexity and the angle of the mandibular plane to the Frankfort horizontal plane, and simultaneously increasing the facial axis and its angle when CHG is used more than 12 hours per day. As a result of these changes, protrusion of the chin was observed. These results indicate that in our sample the CHG produced a favorable change in the direction of facial growth from vertical to more horizontal. No significant decrease of the same planes was observed in the group in which the CHG was used less than 12 hours. There was no significant difference between the 2 groups in overall forward movement of the chin from pretreatment to posttreatment. These results are similar to the results of a previous study of compared CHG treatment effects with non-treated patients.[24]

In the present study, there was an important retrusive effect on the maxilla in Group 2. This effect is directly related to the more posterior position of point A after treatment. The forward growth of the maxillary A-point was greatly restricted by the CHG treatment, while the rest of the facial structures grew forward at a normal rate. The results obtained for sagittal changes are consistent with findings documented in the literature where changes in SNA angles ranging from –0.9° to –2.7°, changes in SNB angles ranging from 0° to +1.0°, and changes in ANB angles ranging from –0.6° to –3.3° were presented.[25-29]

Headgear wear has been recommended for 14 hours each day.[13,14] This amount of wear generally produces satisfactory tooth movement with all types of headgear.[30] According to Graber and Swain,[13] the duration of force is the critical factor for clinical success. However, clinicians are unaware of the effect of partial compliance on the rate of Class II correction.[31] According to Ramsay *et al.*[15], the lack of an objective measure of compliance makes it difficult to describe the dose-effect relationship between headgear wear and Class II correction. Hence, when headgear wear effects are evaluated, it is more important to know the frequency and duration of use than the level of force applied.[32]

Because most orthodontists report satisfaction with the tooth-movement results from their headgear patients,[14,30] it is possible that the orthodontic and orthopedic goals can be met with fewer hours of wear than usually recommended.

In a previous study the subjects were asked to wear the headgear 12 to 14 hours a day, in the evenings and at nights, and to keep a daily diary of their headgear wear.[33] Cooperation was estimated using the diary notes as well as the signs of use in the device, including the tearing of the elastic band and the neck strap.[33] These methods were found to be not reliable for estimating exact time of usage.[34]

In the present study timer device attached to the traction module of the CHG was used in order to record exact time and duration of CHG usage between every visit. The headgear traction module consists of a NiTi coil spring which applies 600 gram standard force when activated on each side. By this module design reliable data of force and force duration was achieved. By using reliable data of usage with a standard force the relationship between usage time and effectiveness of CHG could be observed.

To understand the relationship between degree of orthopedic effectiveness and usage time of removable extraoral appliances, future studies with bigger sample sizes should be planned.

CONCLUSIONS

In the limitations of the present study, it can be concluded that:

Restricting forward growth of the maxilla in growing Class II patients, by using CHG applying a standard force 600 grams on both sides, can only be achieved if the appliance is used at least 12 hours daily during the treatment period.

It is important to use a monitoring system, like a timer device placed on the headgear, to motivate and monitor patients using removable appliances in order to gain favorable results.

The timer module consists of a timer and NiTi springs which are activated when the CHG is activated and a standard force is applied during the whole treatment which can be measured in means of duration and amount in order to achieve predictable results.

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None

CONFLICTS OF INTEREST

None

Servikal Headgear Kullanımında Kooperasyon ve Etkinlik

ÖZ

Amaç: *Bu çalışmanın amacı, genç bireylerde, servikal headgear kullanım süresi ile iskeletsel ve dental Sınıf II malokluzyonun tedavi sonucu arasındaki ilişkinin değerlendirilmesidir.* ***Gereçler ve Yöntemler:*** *Çalışma materyali, servikal headgear ile tedavi olan, ortalama yaş aralığı 10,43 ± 1,07 olan 30 hastanın (14 kız ve 16 erkek) tedavi öncesi ve tedavi sonrası lateral sefalometrik radyografileri ve dijital bir modül, (Compliance Science System (CSS) and Affirm Smart Headgear Modules, Ortho Kinetics, Vista, California, USA) ile kaydedilen aylık aparey kullanım sürelerini gösteren verilerden oluşmuştur. Apareyin tedavi üzerindeki etkinliği hastaların tedavi öncesi ve sonrası lateral sefalamoterik radyografilerinin üzerinde belirlenen iskeletsel ve dental noktalar kullanılarak yapılan ölçümler ile belirlenmiştir. Aparey kullanım süreleri her ay kontrol randevularında modüllerin okutulması ile elde edilmiştir. İstatistiksel analizler SPSS 24.0 programı kullanılarak yapılmıştır.* ***Bulgular:*** *Apareyi 12 saatten fazla kullanan grupta maksillanın sagittal yön büyümesinin frenlendiği gözlenirken, apareyi 12 saatten daha az kullanan hastalarda sagittal yönde maksiller büyümenin olduğu gözlenmiştir.* ***Sonuçlar:*** *Servikal headgear, Sınıf II bölüm 1 malokluzyon tedavisinde maksiller büyümeyi frenlemek amacı ile kullanılan bir apareydir. Bu çalışmada, servikal headgear kullanımında istenilen hedefe erişilmesi için apareyin günde en az 12 saat kullanılması gerektiği objektif veriler kullanılarak ortaya konulmuştur.*

Anahtar Kelimeler: *Ortodonti, ağız dışı çekme aletleri, hasta uyumu.*

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Original research

EFFECT OF DENTIN DESENSITIZERS AND Nd:YAG LASER PRE-TREATMENT ON MICROSHEAR BOND STRENGTH OF ADHESIVE RESIN CEMENT TO DENTIN

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ABSTRACT

Objectives: The aim of this study was to evaluate how microshear bond strength of different adhesive resin cements are affected by dentin desensitizers application and preparation depth.

Materials and Methods: One hundred and forty-four maxillary incisors were randomly divided into two groups according to dentin preparation depth (0.8 and 1 mm) and each group subdivided into four dentin desensitizers, Nd:YAG (Neodymium-doped Yttrium aluminum Garnet) laser and control groups. The dentin desensitizers used were Gluma [Glutaraldehyde/ Hydroxyethyl methacrylate (HEMA)], BisBlock (Oxalate) Vivasens-Potassium Fluoride (KF) and Admira Protect (Ormocer/HEMA), respectively. Three dual cure resin based luting cement (RelyX ARC; Variolink II and Maxcem Elite) were used to create a 0.7 mm diameter and 1 mm height cylindirical shape buid-up in tygon tubes (n=10). Micro-shear bond strength (μSBS) test was performed at a crosshead of speed of 0.5 mm/min using a Universal testing device. Then tooth surface was investigated by steromicroscope and scanning electron microscopy (SEM). Data were analyzed using Kruskal-Wallis, Mann-Whitney U and Chi-Square (X^2) tests. (p = 0.05)

Results: There was no statistically difference between the groups at 0.8 mm preparation depth. At 1 mm preparation dept RelyX ARC + Gluma groups' mean bond strength value (23.96 ± 6.66 MPa) was found statistically lower according to the other groups (p<0.05). RelyX ARC + Laser groups' mean bond strength value (37.33 ± 7.39 MPa) was found statistically higher according to the other groups (p<0.05).

Conclusions: The use of desensitizing agents affected the bond strength of the resin cements to superficial dentin. Gluma desensitizer affected negatively μSBS of RelyX ARC resin cement at 1 mm depth. Application of Nd:YAG laser to superficial dentin showed positive effects to the dentin surface and bond strength. Other desensitizing agents showed no significant effects on the resin bond strength (p>0.05).

Keywords: Dentin sensitivity, dentin desensitizing agents, resin cements, shear strength

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INTRODUCTION

Dentin sensitivity is a common problem experienced during routine clinical procedures, despite improvements in dentistry. Dentin hypersensitivity (DH) is characterized by sharp and short duration pain arising from exposed dentin induced by chemical, thermal, tactile or osmotic stimuli and that can not be defined as pathology or any structural defect. Stimulus initiates pain and relieves pain when it disappears.[1,2]

It was reported that up to 74% of the general population is affected by DH.[3] DH occurs due to reasons such as the gingival recessions, bleaching, tooth cracks, poor oral hygiene, acidic beverages and foods, erosion and attrision of teeth, excessive brushing. These factors cause dentine exposure. Hovewer, it is known that various dental procedures, such as tooth preparation, cementation of restoration can cause temperature increases on the teeth surfaces.[4] and then result in postoperative sensitivity in 15% of vital teeth.[5]

Several theories about the mechanism of dentin sensitivity have been proposed. The most widely accepted theory is the Brännström's hydrodynamic theory.[1] This theory is defined as the response of nerves to the alterance in pulpal pressure with the movement of the liquid in the dentinal tubules.[2] Therefore an approach to elimination of DH, it is essential to concentrate on a treatment to close the dentinal tubules and prevent the flow of dentinal tubul fluid.

Treatment modalities are mainly used to modify the fluid flow in the dentin tubule or to modify or block the nerve response of the pulp.[6] DH relieves with occlusion of opened dentine tubules therefore mechanism of occlusive therapies depends on diminishing dentin permeability. This could be accomplished by forming a diffusion barrier with the aid of medication or bonding agent.[7] There are many agents with comprehensive classified according their mechanism of action, such as: antiinflammatory drugs (corticosteroids), protein precipitants (strontium chloride, gluteraldehyde, silver nitrate,), tubule occluding agents (calcium hydroxide, sodium fluoride, potassium nitrate), desensitizing products (oxalates, potassium ions), tubule sealants (adhesive and resins), and recently, laser treatment.[8]

The structural components of the frequently used desensitizers also state the modes of use. Oxalate desensitizers, acidic resin-free oxalate potassium solution or gel is available for use as desensitizing which applied to dentin prior to adhesive procedures have been accepted as an alternative method of treatment to prevent fluid flow between the resin dentin interface and the adhesive layer.[9,10] Glutaraldehyde reacts with plasma proteins to precipitate them and serves as a biological fixative, which inherently blocks dentinal liquid flow where hydroxyethyl methacrylate promotes interpenetration into dentin tubules.[11] Potassium nitrate or potassium chloride block nerve response causing the release of some neuropeptides. Usually involves attempts to interrupt neural activation and pain transmission both.[12] Resin based desensitizers penetrate into tubular structure and form like resin tag extensions to seal dentin surface.[13] Laser assisted treatment approaches has been presented as a preferred method for partial or total obliteration of the dentin tubules.[14] The lasers used for treating DH are mainly investigated in two groups: low-output lasers (He-Ne or GaAlAs lasers and diode) and middle-output lasers (Nd:YAG or CO_2 lasers).[15] Low output lasers exhibit anti-inflammatory and biostimulation effects on tissues. However, medium output lasers block the dentin tubules with the impact of melting and re-solidification in dentin and has rapid analgesic effects.[16]

Adhesive resin cements are currently used for the cementation of many restorations. The bond strength between resin and bond interface is a crucial factor that intercepts the microleakage and the retention of the restoration.[5] Therefore for clinical applications, the effect of dentin sensitization agents on the resistance of resin-dentin is important. Even, there are conflicting findings in the literature about their usage together.

The purpoe of this study was to evaluate the effect of using different chemical desensitizing agents and Nd:YAG laser irradiation on μSBS of three different resin cements at two preperation depth. The null-hypothesis was that preparation depth and desensitizers has no effect on bond strength.

MATERIAL AND METHODS

One hundred and forty four intact maxillary incisors extracted periodontal reasons were used in this study. After extraction, the macroscopic tissue residues on the teeth were cleaned with a periodontal instrument (Scaler H6/H7, Hu-Friedy, Chicago, USA) and thoroughly washed under stream water. The teeth were disinfected in 1% thymol solution at room temperature for one week before use.

Preparation of Dentin Surface

The structural integrity of the labial surface of the teeth and the lack of restoration were considered inclusion criteria. Teeth presenting caries, cracks and wear on the crown were excluded. Orientation grooves were made on the buccal surface of the teeth using diamond burs (Horico, Diament, FG834018, Germany) with 0.8 and 1 mm cutting-depth were used under water cooling. The grooves formed on the labial surfaces of the teeth were united with a fissure bur and a flat dentin surface was prepared. After the preparation of each five teeth, the bur was changed. The teeth were embedded into 2.5 x 2 x 1 cm sized self-cured acrylic resin (Lead Dent, Hamle Tıbbi Cih. ve Malz. İzmir, Turkey) blocks with prepared surfaces upward. Thin layer of acrylic resin and enamel remnants on the surfaces of the teeth was removed by a 180 grit silicon carbide abrasive paper under running water. In order to form standardized flat surface and smear layer 300-400 and 600 grit silicon carbide abrasive paper were used respectively.

Microshear Bond Test

The exposed dentin surfaces were checked under an steromicroscope (SMZ 800, Nikon, Tokyo, Japan) at 30 X magnification to verify the clearance of exposed dentin. All specimens were kept in distilled to obtain humid environment conditions. Flattened dentin sapmples divide into six groups according to desensitizing protocols as follows: Gluma (Heraus, Germany), BisBlock (Bisco USA), Vivasens (Ivoclar Vivadent, Liechtenstein), Admira Protect (Voco, Cuxhaven, Germany), Nd:YAG laser (Smarty - A10, Deka Laser, Italy) and control group. Following by, these samples subdivided into three dual cured resin cement groups as follows: RelyX ARC (3M ESPE, USA), Variolink II (Ivoclar Vivadent, Schaan, Liechtenstein), Maxcem Elite (Kerr, USA). Before application of desensitizers, all the surfaces etched with 37% orthophosphoric acid (Total Etch, Ivoclar Vivadent, Liechtenstein) for 15 seconds and rinsed for 20 seconds to mimic exposed sensitiv dentin. The composition and manufacturers' instructions of the desensitizers and adhesive systems are summarized in Table 1.

Table 1. Study materials, including composition and application protocol information, as described by the manufacturer.

Material Manufacturer	Composition	Application procedures
Variolink II Ivoclar Vivadent AG	Base: Bis-GMA, urethane dimethacrylate, TEGDMA, inorganic filler, ytterbium trifluoride, initiator, stabilizer Catalyst: Bis-GMA, UDMA, TEGDMA, inorganic filler, ytterbium trifluoride, benzoyl peroxide, stabilizer	Dentin: Etch with 37% orthophosphoric acid* (15 s), rinse (20 s), gently air dry (5 s), apply syntac primer (15 s), air dry, apply syntac adhesive (10 s), air dry, apply Heliobond (10 s), remove excess bonding agent and polymerize (20 s).
RelyX ARC 3M ESPE, St. Paul, MN, USA	Base paste: Bis-GMA, TEGDMA, benzoyl peroxide; catalyst paste: Bis-GMA, TEGDMA, photoinitiator system, amine, peroxide, zirconia-silica filler 67.5% by weight	Dentin: Etch with 37% orthophosphoric acid* (15 s), rinse (20 s), gently air dry (5 s), apply Single Bond (15 s), remove excess bonding agent and polymerize (20 s).
Maxcem Elite Kerr Corp.	Resin: HDDMA, GDMA, DUDMA, GPDMA Catalysts: TMBHP, CQ, stabilizer Filler: FAlSiO4 glass, SiO2, Ba-glass, YF3 (67wt.%)	Gel state can be achieved by tack-curing excess with a curing light for approximately 2-3 s, or by allowing the cement to self-cure for approximately 2-3 min after application or until the excess cement feels rubbery.
Gluma Heraeus Kulzer, Hanau, Germany	Glutaraldehyde (5%) distilled water HEMA (35%)	Apply on dried dentin and leave for 30 to 60 sec. Apply air until the fluid film has disappeared. Rinse with water.
Nd:YAG laser Smarty -A10, Deka Laser, Italy	Neodymium-doped Yttrium aluminum Garnet	The dentin surface was irradiated with a pulse 25 Hz- 40 mJ- 1 W, with a total irradiation time of 60 sec to simulate clinical manipulation
Bisblock Bisco Inc., Schaumburg, IL, USA	Oxalic acid, potassium salt and water	Etch the tooth for 15 sec, and rinse with water. Gently air dry 2-3 sec. Apply on dried dentin and leave for 30 sec. Rinse with water.
VivaSens (Ivoclar Vivadent AG, Schaan, Liechtenstein)	Varnish (ethanol, water and hydroxypropyl cellulose) containing potassium fluoride, polyethylene glycol dimethacrylate, and other methacrylates.	Gently rub liquid into tooth for at least 10s, avoiding contact with gingiva. Evenly disperse the liquid and dry by gently blowing air on the treated surfaces for 10s.
Admira Protect Voco, Cuxhaven, Germany	Monomers (bisphenol A diglycidyl ether dimethacrylate, 2-hydroxyethyl methacrylate); organic acids; and ormocer	Remove excess water with an oil-free air jet. Do not over dry dentine. Apply on all dentine surfaces for 20 s. Disperse with a faint air jet. Light-cure with a conventional polymerization device for 10 s. Apply a second layer; disperse it with a faint air jet and light-cure for 10 s. Remove the oxygen-inhibited layer with a cotton pellet.

Polyethylene tygon (TYGON Medical Tubing Formulations 54-HL, Saint Gobain Performance Plastics, Akron, OH, USA) tubes (Ø=0.7 mm, 1 mm height) were used as matrices to build up cylindirical bonded resin cement units. Prior to resin cement application two or three segments of tygon tubes were placed on treated dentin surface (Fig 1). All polymerization procedures were carried out with a halogen curing unit (Hilux 250 Benlioğlu Dental Inc, Ankara, Turkey) with a light output of 500 mW/cm^2 for 20 seconds. All the bonding procedures were conducted by the same researcher.

Figure 1. Three or two cylinders were obtained for the microshear bond strength test in each Specimen

Specimens were stored in distilled water at 37°C for 24 h. then the tubes were removed with a sharp blade then μ-SBS test were performed using a universal testing machine (LF Plus, LLOYD, Instrument, Ametek Inc, England). A thin steel wire of 0.2 mm diameter was looped and wrapped around the lower half of resin cylinder. Care was taken to ensure that the wire is adjacent to the connection interface at the same time the wire and the load center were aligned as linear as possible. The components of the wire were fixed to the crosshead and shear force was applied to each specimen at a cross-head speed of 0.5 mm/min until failure occurred and data was recorded in MPa.

After the application of desensitizers, for each desensitizer group specimens were mounted on copper mold, sputter-coated, and examined by using SEM (JEOL Ltd., Tokyo, Japan). After micro shear test, fracture patterns were evaluated and classified using SEM and stereomicroscope (SMZ 800, Nikon, Tokyo, Japan) at 30X magnification. The failure mode was classified as one of three types: Adhesive failure (Less than 25% of the bonding cement on the surface of the tooth), Cohesive failure (More than 75% of the bonding cement on the surface of the tooth), Mix failure: (Certain areas show adhesive failure).

Statistical Analysis

Mean and standard deviation were used as descriptive statistical parameters. Statistical analyses were performed using SPSS 15.0 (Statistical Package for Social Sciences, SPSS Inc., Chicago, ABD). The non-parametric Kruskall-Wallis test of one-way analysis of variance was used to compare all values of three different cements. The Kruskall-Wallis test was used to compare each group of cements with their subgroups. Mann-Whitney U test was used to compare the groups. X^2 (Chi-square) test was used to compare the distribution of failure types of the groups. Results of statistical analysis were evaluated at a $p<0.05$ significance level.

RESULTS

The mean μSBS values and standart deviations of desensitizers resin cement combination are shown in Table 2 and Table 3. The bond strength values of all three resin cements after desensitizers treatment showed statistically no difference at two preperation depth ($p>0.05$). The mean bond strength value of RelyX ARC resin cement (23.96 MPa) was lower than the other resin cement groups treated Gluma desensitizer at 1 mm preperation depth. The difference between the bond strength values of RelyX ARC, Variolink II and Maxcem resin cements was found significant in the group where Nd: YAG laser was applied as a desensitizer ($p<0.05$). The mean bond strength of RelyX ARC resin cement in the Nd:YAG laser group was 37.33 MPa and significantly different from Variolink II and Maxcem resin cements' values. The percentages of the failure modes are presented in Fig 2. The predominant failure mode of sll groups' was adhesive. However, few cohesive and mix failure were found in all three resin cements groups. In all three resin cement

groups similar failure types recorded. SEM images are presented in Fig3 and Fig4.

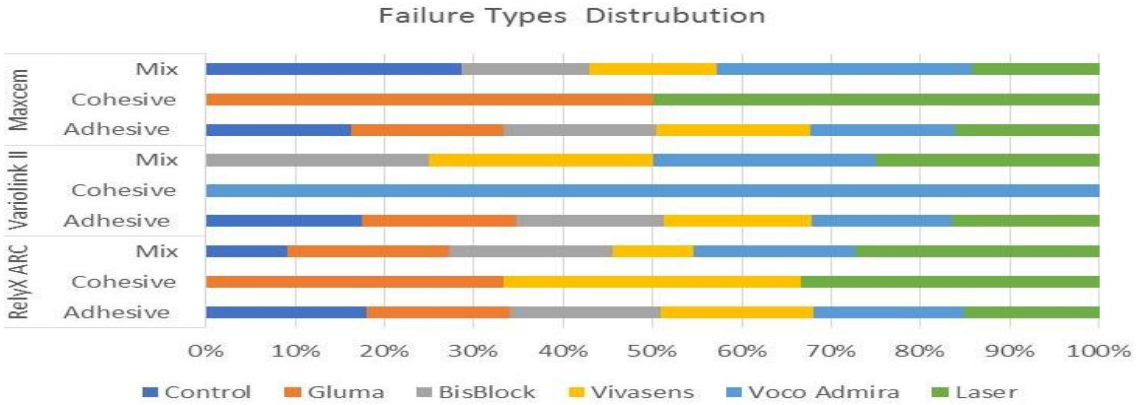

Figure 2. Graphical presentation of the incidence (%) of failure modes for each group. (n = 20).

Table 2. The mean microshear bond strength (megapascals) and standard deviation values for 0.8 mm preparation depth.

	RelyX ARC X(SD) (MPa)	Variolink II X(SD) (MPa)	Maxcem X(SD) (MPa)	KW
	0.8 mm			
Control	26.18 (6.5)[a]	26.48 (6.5)[a]	26.73 (4.8)[a]	KW=0.24 p = 0.887
Gluma	28.22 (7.2)[a]	26.04 (3.8)[a]	28.17 (6)[a]	KW=0.91 p = 0.632
Bisblock	26.74 (7.2)[a]	23.88 (4.3)[a]	25.35 (5)[a]	KW=0.87 p = 0.647
Vivasens	28.67 (6.2)[a]	24.06 (5.0)[a]	26.06(4.8)[a]	KW=2.74 p =0.254
Admira Protect	29.27 (6.1)[a]	26.76 (5.6)[a]	24.28 (4.8)[a]	KW=4.04 p = 0.192
Nd:YAG Laser	30.71 (4.2)[a]	26.40 (7.9)[a]	25.1 (5.2)[a]	KW=5.66 p = 0.059
KW	KW=4.15 p = 0.527	KW=3.03 p = 0.695	KW=3.38 p = 0.641	

*** Kruskall Wallis Test**, Means with the same superscript letters were not significantly different. SD: Standart deviation (p<0.05).

Table 3. The mean microshear bond strength (megapascals) and standard deviation values for 1 mm preparation depth.

	RelyX ARC X(SD) (MPa)	Variolink II X(SD) (MPa)	Maxcem X(SD) (MPa)	KW
	1 mm			
Control	27.98 (6.5)[A]	30.20 (6.5)[A]	25.99(6.2)[a]	KW=2.40 p = 0.300
Gluma	23.96 (6.6)[Ab]	27.53 (4.3)[Aa]	29.98 (6.1)[Aa]	KW=6.32 p = 0.042
Bisblock	28.89 (7.2)[A]	24.47 (4.1)[A]	23.00 (2.9)[A]	KW=4.90 p = 0.086
Vivasens	28.22 (4.2)[A]	28.37 (8.5)[A]	25.95 (4.8)[A]	KW=0.93 p = 0.628
Admira Protect	25.09 (5.3)[A]	25.86 (5.1)[A]	28.18 (6.3)[A]	KW=1.47 p = 0.479
Nd:YAG Laser	37.33 (7.3)[Ab]	23.75 (4.1)[Aa]	27.74 (6.5)[Aa]	KW=12.66 p = 0.002
KW	KW=16.99 p = 0.005	KW=8.12 p = 0.149	KW=5.51 p = 0.130	

*** Kruskall Wallis Test**, means with the same superscript letters were not significantly different. Lowercase letters indicate differences in rows; uppercase letters indicate differences in columns. SD: Standart deviation (p<0.05).

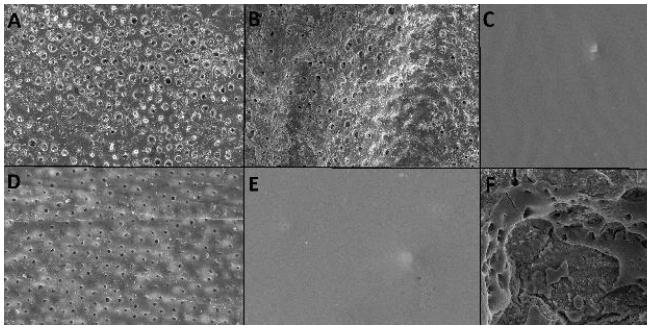

Figure 3. SEM micrograph of dentin surfaces that have been treated with desensitizers:
A; Control group X1000,
B; Gluma X1000.
C; BisBlock X1000.
D; Vivasens X1000.
E; Admira Protect X1000
F; Nd:YAG laser X5000.

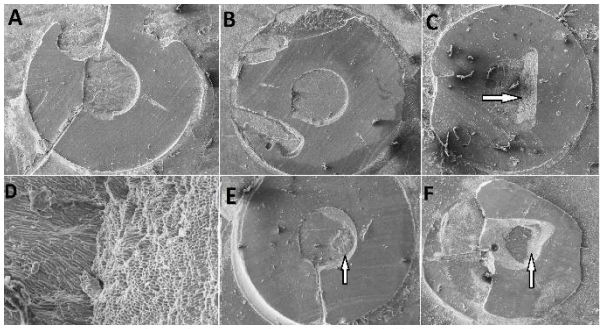

Figure 4. Scanning electron micrograph of failure surface after μSBS test:
A, B; Adhesive failure X90. Circular bonding area tracked.
C; Cohesive failure in dentin, arrow indicates fractured dentin area, X90.
D; Closer image of the cohesive area X800.
E; Mix failure, arrows indicate remnant resin cement on the dentin surface
F; Mix failure, cohesive and adhesive failure is seen together in the central part indicated by
the arrow.

SEM disclosed that all the desensitizers appreciable occluded the dentinal tubules. It was seen that the dentin tubule orifices enlarged and the smear layer was removed in the control group. Dentin surface treated with gluma 50% of tubuls presented semi-closed or closed tubular orifices. In BisBlock group, it was observed that the dentin surface was completely covered with desensitizing agent. No dentine tubules were observed on the surface. Some tubular orifices became narrow on the dentin surface treated with Vivasens however, compared to the Gluma group, it was seen that more tubules were open. Admira Protect applied to the dentin surface was covered completely, on the surface, a small number of dentin tubules were partially closed. Nd:YAG laser removed smear layer partially. Solidification and recrystallization with mineral islands and microfracture after melting in superficial dentin layer were observed. In addition to this, it was observed that the orifices of the dentin tubules were narrowed or closed as a result of the melting of the surrounding tissue and the surface had a spongy appearance.

DISCUSSION

Post-operative DH is one of the major challenge that affect the success of prosthetic treatments. Several studies have verified that effective and vigorous occlusion of dentinal tubules offers the excellent promise for instant and sustained relief of dentine hypersensitivity.[17]

The present in vitro investigation compared the effect of Nd:YAG laser and various desensitizers chemical contents with gluteraldehyde, oxalic acid, potassium florur and ormocer on μSBS of three different resin cements at two preparation depth. The result of this study indicated that application of desensitizer is effective on occlusion of tubul orifices. It was reveal that preparation depth, resin cement and some of the desensitizers were not statistically significant predictors of μSBS. On the other hand at 1 mm preperation depth for RelyX ARC resin cement, Gluma and laser groups showed statistically significant μSBS values (p<0.05). Thus the null hypothesis is partially rejected.

Several studies[4,5] on veneer preparation have indicated that much dentin is exposed during routine preparation. A standardized technique using 0.5-mm-deep grooves consequenced in dentin being exposed on 50% of the preparation area.[18] Also Christensen[19] reported that reduction of enamel for maxillary incisors may be 0.75 mm. Natress *et al.*[20] stated that most of the time the dentin was exposed in the proximal and cervical region of the tooth after the preparation without standardization and reported that the enamel thickness in majority of the teeth were less than 0.5 mm. Pahlevan *et al.*[21] reported the mean thickness of enamel at the gingival third is 410 μ on the maxillary central incisor and 367 μ on the maxillary lateral incisor.

In this study, superficial dentin was used near the enamel-dentin junction by selecting similar teeth in size. The dentine was exposed on the labial surfaces and preparations were made 0.8 and 1 mm depth to mimic the clinical conditions.

Thus, all bonding area were designed in the superficial dentin. It is stated that structural differences of each tooth affect connection resistance.[22] In our study, 2 or 3 bonded samples were attached to each tooth surface to reduce the effect of these differences.

The histological structure of the dentin tissue is highly complex and due to its different chemical content, bond strength values are affected by many factors. Moreover, each individual dentinal tubule is an inverted cone with the smallest dimensions at the dentin-enamel junction and the largest dimensions around the pulp.[23] Dentin layers could be categorized as superficial, middle and deep dentin according to preparation depth. It was reported that the bond strength decreased due to dentin tubule fluid as it approaches to the pulp.[24] Controversy to this, in the present study there was no statistically difference between preparation depth. It can be explained by lack of respectable preperation depth difference. This may be attributed to the higher water content in deep dentin as compared to superficial dentin, as a result of the larger diameters of the tubules and their greater numbers per unit area in deep dentin.[25] Finally, the similar bond strength to dentin observed in both preparation depth may be due to similar dentin surface characteristics.

A number of variables can compromise resin cement adhesion, such as dentin morphology, humidity, adhesive system capabilities, compatibility of adhesive system and dual-cured luting cement.[26] The use of an adequate resin cement system is particularly important for cement adhesion because it directly affects the quality of the resin-dentin interface. The recent literature precisely verified the bond strength of resin cements changes from ranges of 7 to 40 MPa.[27] The results of this study are also found to be compatible with this finding. Even μSBS values corroborate the findings of some studies.[28]

The resin cements used in the present study comprised 2 total-etch (Variolink II and RelyX ARC) and 1 self-etch (Maxcem Elite) dual-cure luting cements frequently used in prosthodontic clinical practice.[29]

Differences in bond strength between other resin cements may be due to the physical properties of cements, such as elastic modules, filler sizes, filler ratios, film thicknesses and viscosities. In terms of chemical composition Variolink II resin includes urethane dimethacrylate, maleic acid, and glutaraldehyde in the dentin primer, and the adhesives that condition the tooth surface in order to improve adhesion to dentin. By contrast, RelyX ARC relies on ethanol contained in the adhesive for conditioning, The variations of bond strengths found in this study may be attributed to the adhesive type and composition.[30] However, the mean μSBS values to dentin of all resin cements tested in this study were over 17 MPa, which is considered as the minimum value for clinically adequate bond strength to dentin.[31] The relatively high bond strengths reported in this study and previous studies may be explained by microstructural variations in tooth structure, tooth storage conditions, time, temperature, and the dimensions of the adhesive surface.[30]

Previous in vitro studies[31,32,33] have reported that the resin cement shear bond strengths to dentin ranged from 5.4 ± 2.3 MPa to 13.78 ± 8.8 MPa for Variolink II, 4.0 ± 0.8 MPa for Panavia F, and 5.42 ± 6.6 MPa for RelyX Veneer resin cements, which are in line with the values obtained in this study.

In a previous study[32] Variolink II, self adhesive Panavia F2.0, RelyX Unicem, Maxcem, iCem resin cements were used and shear bond strength to enamel and dentin evaluted. Mentioned that Variolink II groups presented highest bond strength values to dentin (39.2 ± 8.9MPa). Maxcem resin cement showed the highest bond strength (22.3 ± 3.3MPa) among self-adhesive resin cements. According to Yan *et al.*[33] RelyX ARC, Panavia-F and Variolink II resin cements showed similar μSBS and micro tensile bond strength values. These results are close to the average bond strength values of our study.

Lorenzo *et al.*[34] measured the shear bond strength of Variolink II and RelyX ARC resin cements to dentin as 22 ± 7 MPa and 22 ± 4 MPa. In these two studies, the mean bond strength

values obtained for RelyX ARC and Variolink II were similar to those obtained in our study.

Some ideal characteristics were proposed by Grossman[8], for a desensitizing agent, which would be viable for the treatment of DH currently. According to these, desensitizer would need to be easy to apply, be painless, fast acting, not be toxic for pulp, not change in the tooth structure or surface, and have a durable effect.[8]

Gluma desensitizer has been shown either to maintain or to improve bond strength to dentin.[23] In the literature, there are many studies[23,35] reporting that Gluma did not affect the resistance of resin cements statistically. Despite of several studies reporting that it decreases or increases the bond strength of resin cement.[26,36] The results of these studies are similar to our study.

In the study[36] that evaluate the effects of gluma, single-bond 2 and BisBlock desensitizers on the dentin tubules and the dentin bond strengths, it was stated that the BisBlock desensitizing agent closed the detin tubules substantially and the Gluma desensitizing agent partially closed the dentin tubules. In addition, the shear bond strength of the BisBlock dentin desensitizing agent was found to be higher than the control group (13.04 ± 2.76 MPa) and BisBlock affected positively the bond strength of resin cement. The findings obtained in this study compatible with the findings of SEM and bond strength values obtained in our study.

In the present study Gluma pretreatment decreased the μSBS of RelyX ARC resin cement. The researchers have attributed the increased bond strength values of HEMA promoted rehydration mechanism allowing time for the penetration of the primer into dentin.[37] Also application of an aqueous solution of 2-hydroxyethylmethacrylate (HEMA) and glutaraldehyde as a primer compound can promote effective dentinal bonding.[38] This result contradict to our study.

Previous studies[10,35,36] verified that potassium oxalate reacting with ionized calcium in dentin or dentin fluid composition as a result of chemical reaction that calcium oxalate crystals form. These crystals are deposite in the tubular orifices and they alter the surface texture and affect the bonding. In the previous study[39] it was reported that potassium oxalate pretreatment on etched dentin caused the crystal formation inside the dentin tubules rather than dentin surface and it is also stated that the crystal formation inside the tubules did not jeopardize the formation of typical hybrid layer.[39] Tay *et al.*[10] showed that when oxalates were used after acid-etching, micro tensile bond strength values were comparable to the non-treated dentin as well. However in the present study, BisBlock did not significantly affect the bond strength of the three resin cements.

Clinically, Admira Protect behaves as a primer that forms multiple tubular septa layers in the lumen of the dentinal tubules as a result of protein precipitation and by this way reduces dentinal fluid flow.[40] In a previous study.[41] In contrast to the findings of this study, it was observed that Admira Protect increased the bond strength of resin cements.[41]

Potassium fluoride reacts with the dentinal fluid and causes precipitation of calcium ions and proteins in the dentinal fluid that block the tubules.[42] SEM findings and mean bond strength values of this study same line with present study.[43]

Lasers are commonly used to treat DH. Treating the DH, Nd: YAG laser have been using by many researcher for treatment by obstructing or narrowing the dentinal tubules.[15] The Nd:YAG laser helps to obtain a non-porous structure by melting and resolidification the surface; also Nd:YAG laser application has an additional analgesic effect by blocking nerve conduction.[16] Also some previous studies[15,16,44] mentioned that the application of Nd: YAG laser prior to adhesive processes resulted a thinner hybrid layer and less resin tag formation. In addition to this it was observed that the bonding agent penetrated into the tubuls after application of Er: YAG laser controversy to the Nd: YAG laser group, the bonding agent was detected only on the surface so the dentin tubule orifices were closed.[45] The SEM images of this study and the dentin surface images mentioned in the literature compatible to each other. However, the bond strength values of Nd:YAG laser applied to dentin surface were found to be higher in our study compared to other groups. This difference can be explained by use of superficial dentin as bonding surface just below

the enamel layer. Consequently it is known that intertubuler dentin forms a continuous collagen-rich network that presents favorable surface condition and less affected by Nd: YAG laser application than peritubular dentin.

Further studies should be carried out to evaluate the thickness and structure of the hybrid layer in deeper dentin layers. Due to the limitations of this study, we suggest further studies with larger sample sizes and longer follow-up periods and laser applications with different device settings and varied exposure protocols.

CONCLUSIONS

Dentin desensitizers can be used to eliminate postoperative sensitivity before the cementation of the restorations. Within the limititations of this study following conclusions could be drawn.

The bonding strengths of the three resin cements used in the study were not statistically different and both preparation depths did not affect the bond strength of resin cements.

The application of Nd:YAG laser as with RelyX ARC resin cement did not affect the bond strength of resin cement at the preparation depth of 0.8 mm preparation depth However, higher bond strength values obtained at 1 mm. depth with Nd:YAG laser and RelyX ARC resin cement combination according to other resin cements and desensitizers.

Gluma desensitizer affected negatively μSBS of RelyX ARC resin cement at 1 mm depth.

The SEM images showed that BisBlock and Admira Protect desensitizing agents closed the dentin tubules more than Gluma and Vivasens. However, Nd:YAG laser removed the smear layer and melted dentin after that it caused recrystallization, which closed or contrict tubular orificies.

92% of the samples presented adhesive type failure.

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CONFLICT OF INTEREST

The authors declare that they have no competing interests.

Dentin Hassasiyet Gidericiler ve Nd:YAG Lazerin Adeziv Rezin Simanların Mikro-makaslama Bağlanma Dayanımlarına Etkisi

ÖZ

Amaç: *Bu çalışmanın amacı adeziv rezin simanların bağlanma dayanımlarının dentin hassasiyet giderici uygulamasından ve preparasyon derinliğinden nasıl etkilendiğinin değerlendirilmesidir.* ***Gereç ve Yöntemler:*** *Bu çalışmada yüz kırk dört adet çekilmiş 9insan üst keser dişleri kullanıldı. Dişlerin labial yüzlerinde rehber frezler yardımıyla 0,8 ve 1 mm derinliklerinde preparasyonlar yapıldı. İki gruba ayrılan dişler RelyX ARC, Variolink II ve Maxcem rezin siman gruplarına ayrıldı. Her rezin siman için sırasıyla Gluma (Glutaraldehyde/ Hydroxyethyl methacrylate-HEMA), Vivasens (Potassium Fluoride-KF), Admira Protect (Ormocer/HEMA), BisBlock (Oxalate) ve Nd:YAG (Neodymium-doped Yttrium aluminum Garnet) lazer hassasiyet giderici grupları oluşturuldu. Rezin simanlar 0,7 mm. çapında 1 mm. yüksekliğinde tygon tüpler içerisinde her grupta 10 adet olacak şekilde dentin yüzeylerine yapıştırıldı. Örneklerin mikro-makaslama bağlanma dayanımları üniversal test cihazında 0,5 mm çapraz baş hızında ölçüldü. Kopma yüzeyleri stereomikroskop ve SEM aracılığıyla değerlendirildi. Elde edilen veriler Kruskal Wallis (KW), Mann-Whitney U ve Ki-Kare (X^2) testi ile değerlendirildi.* ***Bulgular:*** *Grupların ortalama bağlanma dayanımı değerleri karşılaştırıldığında 0,8 mm. preparasyon derinliğinde rezin siman ve hassasiyet gidericiler uygulanmış gruplar arasında istatistiksel olarak anlamlı bir farklılık bulunmadı. 1 mm preparasyon derinliğinde ise RelyX ARC + Gluma grubundaki ortalama bağlanma dayanımı değeri (23,96 ± 6,66 Mpa) diğer gruplara göre istatistiksel olarak daha düşük bulundu ($p<0,05$).1 mm preparasyon derinliğinde RelyX ARC + Lazer grubundaki ortalama bağlanma dayanımı değeri (37,33 ± 7,39 Mpa) diğer gruplara göre istatistiksel olarak daha yüksek bulundu ($p<0,05$).* ***Sonuçlar:*** *Yüzeyel dentinde hassasiyet giderici ajanlar rezin simanların bağlanma dayanımını etkilemektedir. Gluma hassasiyet giderci 1 mm preparasyon derinliğinde bağlanma dayanımı değerlerini olumsuz etkilemiştir. Nd:YAG lazerin mine-dentin birleşimine*

yakın yüzeyel dentinde uygulanması dentin yüzeyinde ve bağlanma dayanımında olumlu sonuçlar göstermiştir. Diğer hassasiyet gidericilerin bağlanma dayanımları üzerine etkileri istatistiksel olarak anlamsız bulundu.

Anahtar kelimeler: *Dentin hassasiyeti, dentin hassasiyet giderici, rezin esaslı siman, bağlanma dayanımı.*

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Original research

ORAL HEALTH STATUS AND ASSOCIATED FACTORS IN A SUBPOPULATION OF TURKISH PATIENTS

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ABSTRACT

Objectives: Understanding the oral health behavior and knowing oral health status of a community in order to facilitate the development of satisfactory dental public health preventive program. In this context, the purpose of this study is to investigate oral health behaviour of Turkish community who live in Usak province besides and to evaluate CPITN and DMFT index scores according to age, gender and education level.

Materials and Methods: A face to face questionnaire was conducted for 2412 subjects who were divided into six age groups to understand their oral health behavior. Periodontal measurements, and dental caries were applied by three calibrated expert researchers for all teeth except the third molar.

Results: Healthy periodontal tissue only existed in 153 (10.05%) individuals of 1521 dentate participants. The mean DMFT value observed was 16.98±6.62. By aging, being male and having low education level, mean DMFT and CPITN scores showed an upward trend. 10.26% of the participants informed that they did not brush their teeth and 92.55% of them stated that they did not floss their teeth. Most of the participants (83.25%) informed that they visited a dental clinic only in emergency and pain.

Conclusions: The mean DMFT and CPITN scores increase in accordance with aging, low education and being male. Low flossing frequency, low prevalence of tooth brushing and low frequency of going to the dentist regularly were observed at the end of the study.

Keywords: Age groups, oral health, toothbrushing, dental floss, education.

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INTRODUCTION

Oral health is a critical factor in general wellness and has an extensive impact on a person's well-being and quality of life. Poor oral health can lead to difficulties in speaking, chewing and swallowing.[1] Furthermore, oral diseases can have an influence on some systemic diseases and health conditions.[2] The main basis of oral health evaluation is the examination of incidence and frequency of dental caries and periodontal status.[3]

Dental caries and periodontal diseases can affect all the population throughout the lifespan which are multifactorial diseases with many risk factors contributing to their initiation and progression.[4] Periodontal diseases and dental caries are associated with socio-demographic factors such as age, sex, education, stress, smoking and oral hygiene practices.[5]

Periodontal diseases, one of the most widespread illnesses of humanity, destroy supporting tissues around the teeth.[6] The prevalence of the periodontal disease varies in different regions of the world, and this disease affects more than 537 million people worldwide.[7] The Community Periodontal Index of Treatment Needs (CPITN) is used to record population periodontal status and treatment needs.[8] The primary clinical argument for the diagnosis of the periodontal diseases through the CPITN is probing depth which is the most rational definition for the operational features ascertained in epidemiologic periodontal studies.[9]

Dental caries is a localized destruction of dental hard tissues by acidic output from bacterial fermentation.[10] Dental caries is a process of disease that ranges from subclinical changes to damage with obvious cavitation.[11] Epidemiological studies of caries utilize the decayed, missing and filled teeth (DMFT) index as a sign of the cumulative outcome of caries on permanent teeth.[12]

Understanding of regional behavior and care conformity can lead local public health practitioners to plan and support oral health programs. Thus, this study seeks to determine the oral hygiene habits, frequency of visiting dentist and epidemiological profile of the oral health as well as to observe demographic and other indicators associated with oral disease of the general public in a Turkish city with the aim of developing satisfactory dental public health preventive programs.

MATERIALS AND METHODS

This study was carried out at the Faculty of Dentistry in Usak University. The participants were informed about the purpose of the investigation and they signed the consent form. 2412 patients who were over 18 years-old were included in the study. The research was conducted according to Helsinki Declaration and ethical permission was procured from the Local Ethical Committee of Usak University For Non-invasive Clinical Trials (Registration No: 104-06-13).

Before the clinical examination subjects filled out a questionnaire that was designed by an experienced research team. Personal data from each subject was collected through individual interviews and included demographic information, behavior and personal habits to oral health.

All study subjects were examined clinically to evaluate periodontal and dental status for all teeth except the third molar. Edentulous subjects were not included in the periodontal status analysis.

Periodontal examination was carried out according to recommendation of the World Health Organization (WHO) periodontal probe for using the CPITN.[13] The index teeth (17, 16, 11, 26, 27, 47, 46, 31, 36 and 37) were evaluated for each individual. In the presence of fewer than two functional teeth, the subjects were classified as edentulous and not included in the study. Subjects with no teeth, or teeth that could not be examined for various reasons were excluded. All teeth in the subjects were examined according to the absence of index teeth and the highest score was recorded as the sequencer score. According to which tooth showed the worst condition, each subject was given a grade and registered according to the highest recording. Each subject was entitled as either healthy (score 0), bleeding (score1), calculus detected (score 2), pockets of 4-6 mm

(score 3) and 6 mm or deeper pockets (score 4) according to the highest score at the index teeth.[17] The epidemiological profile of dental caries was evaluated according to the norm advised by the WHO using DMFT index.[14] Caries at cavitation level is a current WHO standard for detecting caries and it was used for determining the permanent tooth decay.[15]

Periodontal measurements and registrations were applied by three expert researchers. Calibration between the researchers and self-calibration of the researchers ensured for the standardization of measurements in equal clinical conditions. Intra-examiner reproducibility was evaluated on four subjects. Intraclass correlation coefficient (ICC) was 0.93 for the first researcher, 0.94 for the second researcher and 0.91 for the third researcher. The calibration of inter-examiner reproducibility was performed on ten subjects. The first and the second measurements on subjects were compared with each other to evaluate the compatibility of three researchers. The compliance level of the researchers in the first measurement was 91.8% and the compliance level in the second measurement was 92.2%.

Data analysis was performed by using the software Statistical Package version 17.0 (SPSS Inc., Chicago, IL, USA). Kolmogorov-Smirnov and Shapiro Wilks tests were used to investigate for checking the normality of data. Nonparametric Mann Whitney U and Kruskal Wallis-H Tests were used because the assumption of normality was violated. The Chi Square test was used to evaluate the relationships between the parameters. The statistical significance level for all tests was set at 0.05.

RESULTS

The distribution of individuals according to age, gender and education are shown in Table 1. A total of 2412 subjects, 816 (33.80%) male and 1596 (66.20%) female, were included in the study. The majority of the participants had the primary-school education level (50.5%). Participants were divided into six age groups and the distribution shows that the most common age group was 55-64 years (18%) followed by ≥ 74 year-old (17.70%).

Table 1. Demographic information (age, gender, education level)

		n	%
Age Groups	**18-34**	415	17.2
	35-44	422	17.5
	45-54	320	13.3
	55-64	434	18.0
	65-74	392	16.3
	≥74	429	17.7
Education	**Primary school**	1219	50.5
	High school	804	33.3
	Universty	389	16.2
Gender	**Male**	816	33.8
	Female	1596	66.2

n Number of the patients % Percentage

The incidences of CPITN scores of individuals according to age, gender and education are displayed in Table 2. Healthy periodontal tissue only existed in 153 (10.05%) individuals of 1521 dentate participants. The prevalence of periodontal disease (Codes 3+4) was 54.83%. The proportion of excluded sextants (fewer than 2 teeth) were importantly higher in subjects aged ≥ 74 years (58.74%) followed by aged 65-74 year old (58.41%).

Table 2. CPITN scores of individuals according to age, gender and education (n/%)

		n	0	1	2	3	4	c	p value
Age Groups	**18-34**	360	41/11.4	57/15.83	76/21.11	87/24.16	99/27.5	31.21	0.001*
	35-44	305	33/10.81	49/16.06	59/19.34	81/26.55	83/27.21		
	45-54	251	31/12.35	43/17.13	49/19.52	57/22.72	71/28.28		
	55-64	265	28/10.59	47/17.73	57/21.50	64/24.15	69/26.03		
	65-74	163	11/6.76	19/11.65	23/14.11	41/25.15	69/42.33		
	≥74	177	9/5.11	21/11.86	34/19.20	51/28.81	62/35.02		
	Total	1521	153/10.05	236/15.51	298/19.59	381/25.04	453/29.81	1521	
Education	**Primary school**	617	17/2.75	97/15.72	132/21.39	165/26.74	206/33.4	141.75	0.001*
	High school	558	46/8.24	87/15.59	107/19.17	139/24.91	179/32.09		
	Universty	346	90/26.01	52/15.02	59/17.05	77/22.25	68/19.67		
	Total	1521	153/10.05	236/15.51	298/19.59	381/25.04	453/29.81	1521	
Gender	**Male**	380	31/8.15	33/8.68	82/21.57	105/27.63	129/33.97	22.38	0.001*
	Female	1141	122/10.69	203/17.79	216/18.93	276/24.18	324/28.41		
	Total	1521	153/10.05	236/15.51	298/19.59	381/25.04	453/29.81	1521	

n Number of the patients 0 Healty 1 Bleeding 2 Calculus 3 Pocket depth 4-6 mm 4 Pocket depth >6 mm c chi-square test
* p=0.001

In the 18-34 year-aged group, 41(11.4%) individuals had no periodontal disease. However, in the subjects aged ≥ 74 year old, only 9 (5.11%) individuals were healthy. The proportion of shallow pockets (pockets depth 4-6mm) and deep pockets (pockets depth>6mm) in the subjects aged ≥ 74 year old was 63.83%. There was a statistically significant relationship between age groups and CPITN (Chi-square test, p<0.05). CPITN index increased as the ages of the participants increased.

There was a prominent association between CPITN and schooling (Chi-square test, p<0.005). The outcome indicated that individuals with university education had less bleeding (Code 1), less calculus (Code 2), less shallow and deeper pockets (Codes 3+4) than individuals with primary and high education level.

There was a significant difference between CPITN and gender. More females (10.69%) than males (8.15%) were periodontally healthy (Code 0), and the prevalence of periodontal disease (Codes 3+4) was significantly higher in males (61.6%) than in females (52.59%), and these differences were significant (Chi-square test, p<0.05).

DMFT score according to age, gender and education is shown in Table 3 and 4. The mean DMFT value observed was 16.98±6.62. With aging, the mean DMFT showed an upward trend and increased from 11.97 in 18-34 year-olds to 23.60 in ≥74 year-olds. The differences in mean DMFT between the age categories were statistically significant (Kruskal-Wallis test, p<0.05). The mean DMFT value was importantly higher in males (19.16) than in females (15.86) and these differences were significant (Mann-Whitney test, p<0.05). The mean DMFT value was 10.69 in subjects with university education level, was 14.83% in subjects with high school education level and 20.40 in subjects with primary school education level. All these differences were statistically significant (Kruskal-Wallis test, p<0.05).

Table 3. DMFT score according to age, gender and education

		n	Mean±sd	C	p value
Age groups	**18-34**	415	11.97±4.84	1038.967	0.001*
	35-44	422	13.30±4.75		
	45-54	320	13.99±4.62		
	55-64	434	16.59±5.39		
	65-74	392	21.85±5.17		
	≥74	429	23.60±4.72		
	Total	2412	16.98±6.62		
Education	**Primary school**	1219	20.40±5.95	786.312	0.001*
	High school	804	14.83±5.38		
	Universty	389	10.69±3.97		
	Total	2412	16.98±6.62		
				Z	
Gender	**Male**	816	19.16±6.41	-11.967	0.001*
	Female	1596	15.86±6.45		
	Total	2412	16.98±6.62		

n Number of the patients sd Standard deviation c Chi-square test * p=0.001 z Mann-Whitney test

Table 4. Proportion and number of decay, missing, filling teeth according to age, gender and education

		D	M	F	Total	DMFT index
Age Groups	**18-34**	.521(30.61%)	1776(35.74%)	1671(33.65%)	4968	11.97
	35-44	1463(26.06%)	2563(45.66%)	1587(28.28%)	5613	13.30
	45-54	1204(26.88%)	2141(47.81%)	1133(25.31%)	4478	13.99
	55-64	1463(20.31%)	4319(59.97%)	1419(19.72%)	7201	16.59
	65-74	1603(18.70%)	5587(65.20%)	1378(16.1%)	8568	21.85
	≥74	2566(25.32%)	6474(63.89%)	1092(10.79%)	10132	23.61
	Total	**9820(23.97%)**	**22860(55.8%)**	**8280(20.22%)**	**40960**	**16.98**
Education	**Primary school**	4783(19.22%)	15872(63.8%)	4219(16.98%)	24874	20.40
	High school	3318(27.81%)	5769(48.36%)	2840(23.83%)	11927	14.83
	Universty	1719(41.33%)	1219(29.30%)	1221(29.37%)	4159	10.69
	Total	**9820**	**22860**	**8280**	**40960**	
Gender	**Male**	4057(25.94%)	7863(50.27%)	3719(23.79%)	15639	19.16
	Female	5763(22.75%)	14997(59.22%)	4561(18.03%)	25321	15.86
	Total	**9820**	**22860**	**8280**	**40960**	

D Decay M Missing F Filling

Oral health attitudes are shown in Table 5. 10.26% of the participants informed that they did not brush their teeth. However, 24.25% of them indicated that they brushed their teeth twice a day or more. Of all the participants, 92.55 % stated that they did not floss their teeth. Most of the participants (83.25%) informed that they visited a dental clinic only in emergency and pain. Almost half of the participants (46.64 %) indicated that they were changing their tooth brushes at every 3 months. Among individuals 53.78% of them stated that they had no periodontal treatment before. The prevalence of self reported halitosis was 58.74%. 56.26% of all participants reported themselves as being non-smokers or occasional smokers.

Table 5. Oral health behavior of participants

		n	%
Tooth brushing	**Twice or more daily**	585	24.25
	Once Daily	990	41.04
	Once every three or four days	385	15.96
	Once a week	205	8.49
	No Brushing	247	10.26
Flossing	**Twice or more daily**	15	0.62
	Once Daily	22	0.91
	Once every three or four days	51	2.11
	Once a week	92	3.81
	No Flossing	2232	92.55
Dental visit frequency	**Every 6 months**	123	5.09
	Every year	93	3.85
	Emergency	2088	83.25
	Never visit before	108	7.81
Tooth brush changing frequency	**Every 3 months**	1125	46.64
	Every 6 months	510	21.14
	Every year	525	21.76
	Using the same brush for years	252	10.46
Periodontal therapy	**At least one periodontal treatment before**	1115	46.22
	No periodontal treatment before	1297	53.78
Self reported halitosis	**Patients reported halitosis**	1417	58.74
	Patients reported no halitosis	995	41.26
Smoking	**Non-smoking or occasional smoking**	1357	56.26
	< 1 cigarette/day	113	4.68
	1-15 cigarettes/day	243	10.74
	16-24 cigarettes/day	301	12.47
	≥ 25 cigarettes/day	398	15.85

n Number of the patients % percentage

DISCUSSION

In the current study, the proportion of individuals with periodontal pocket with probing depth of 4-6 mm was 26.55% for the age cohort 35-44 and 25.15% in 65-74 year-old. Probing depth >6 was 27.21% in 35-44 year-old and 42.33% in 65-74

year-old, which is higher than what was reported from other developing countries and the majority of European countries.[16] In a study, the lowest probing depth of ≥4 mm for the 35-44 age group is found in Sweden and Spain (26%) while the highest probing depth is detected in Lithuania and Germany (62.9%). This rate rises to 42.7% individuals with 65-74 age group in Sweden and Spain while it rises to 68% in Germany and Lithuania with the same age group.[17] In this study, the lowest probing depth of ≥4 mm for the 35-44 age group was 53.76% and 67.48% for 65-74 age group. These results are the same as Lithuania and Germany but worse than Sweden and Spain. It was revealed that the lowest score of periodontal health (score 4) was limited to between 10% and 15% of the adult population worldwide[18], whereas in Turkey, as many as 29.81% of the adult population had score 4. The result of the current study unearthed that periodontal status in the Turkish population is worse than other developing countries.

The average DMFT was found to be 13.30 for 35-44 age group in this survey and the factor that increases the value of DMFT was the missing (M) component. In 55-64 age group, the mean DMFT was 21.85 and the factor that increases the value of DMFT was the M component again. The prevalence of DMFT score in this present national study was 16.98. The DMFT values in European countries ranged between 14 and 20 in adults and 22 to 27 in the 65-74 age group.[19] The average DMFT value in China at the age group 35-44 was 2.1 while at the age group 65-74, this rate raises to 13.4.[20] The results of this study are in line with the results of other studies done in European countries but higher than reported in China.

In this research, the widespread presence and severity of periodontal disease increased with age as reported before.[21] With aging, the prevelance of periodontitis increased from 51.66% in the 18-34 year-olds to 63.88% in the ≥74 year-olds. The present study showed a positive correlation of the DMFT score with the age of the participants. The most prominent component of DMFT was the missing teeth (35.74%) in the 18-34 age group and this ratio dramatically increased to 63.89% in the ≥74 year-olds. This study has shown that people living in Turkey are at a greater risk of having few remaining teeth. In our opinion, the main reason for high DMFT and CPITN scores are associated with a lack of awareness about oral health which includes smoking, poor oral hygiene, infrequent dental visits, absence of dental treatment, etc. In addition, cumulative tissue destruction and age-related intrinsic abnormality are also reasons for missing teeth.

In this study, the prevalence of periodontal disease and sextants with pockets>6mm was significantly lower in highly educated people than less educated as it has been found.[22-24] There was also a significant relationship between the individual's education level and mean DMFT. The average DMFT was 20.40 in the primary school group, whereas it was 10.69 in the university group. The proportion of missing teeth was higher in low educated group, while the proportion of filling teeth was greater in the higher educated group. This study unearthed that there was a positive association between education and oral health status**.** Awareness about the prominence of oral health, socio-economic status, monthly income, insurance coverage and leading healthy lifestyle seem to be correlated with better health status in high education group.

In this epidemiological study, it was found that males had worse oral health than females according to CPITN and DMFT indexes. Periodontally healthy subjects were more frequently observed in females, while males were associated with CPITN scores 3 and 4. DMFT score was 15.86 among female individuals, while it was 19.16 in male individuals. It was concluded that men were at a bigger risk for periodontal disease and tooth loss when compared with women.[25] This might be explained by the fact that males have worse oral hygiene practices, higher smoking rate and less-frequent usage of oral health services.[26]

In this study, the prevalence of tooth brushing twice or more was 24.25% and daily once was 41.04%. 10.26% of the participants reported that they had no tooth brushing behaviour. The prevalence of tooth brushing was reported to be 44.4% in China[27] and 31% in Jordan[28]. This proportion varies between 80% and

89% in European countries, USA and Canada.[29] The prevalence of tooth brushing in this present study was lower than what was reported in the developed countries.

92.55% of the participants reported that they did not use dental floss in this survey. It was reported that 41% of Americans flossed their teeth at least once daily and 20% never flossed their teeth.[30] Higher flossing frequencies than our findings were reported in Denmark[31], Canada[32] and similar inter-dental cleaning samples were reported from China[33] and Saudi Arabia.[34]

In this study, it was revealed that 83.25% of the participants go to the dentist in case of pain and emergency and that 7.81% of them never visited a dentist before. The percentage of who go to the dentist regularly was %8.94. In Canada[32], 69% of the individuals visit the dentist regularly every year and 69.9% of the individuals visit the dentist regularly in the United States.[35] Only 26.4% of the participants visit the dentist regularly in Nigeria[36] and the frequency of dental visits in China[33] is reported as 28%. The frequency of going to the dentist in Turkey is lower than those of developed and developing countries. The reason for this has not been known but it can be speculated that dental fear, limited access to oral health services and lack of oral health knowledge might be the contributing factors.

In our study sample, the frequency of changing tooth brush within 3 months was 46.64% and 10.46% of the participants indicated that they used the same brush for years. The average usage of brushes per capita and year in Turkey is 0.3, while the average usage of brushes per capita and year in the UK is 2.4 and is 2.5 in Sweden.[37] Tooth brush changing frequency in Turkey is lower than developed countries. Lower socioeconomic status, lack of tooth brushing habits and unconsciousness about oral health could be some reasons for this.

In this study, the evaluation of malodour is based on the subject's own perception as reported before.[38] In the present study, the prevalence of self reported halitosis was 58.74% and it was higher than the findings reported in Brazil [39], the USA[38] and France.[40] Halitosis is a problem which is perceived in different regions of the world but the prevalence of it in Turkey is higher than developed countries. The lower frequency of tooth brushing, visiting a dentist only in case of pain and using a tooth brush more than three months can be related to the higher occurrence of halitosis.

The proportion of smoking in this study was 43.74%. This rate is identified as 19% in older individuals in the United States.[41] The rate of smoking between the ages of 30-39 is detected as 39%, between the ages of 50-59 and it is 45% in Thailand.[42] Although the awareness of the adverse effects of smoking on health has increased in developed countries, smoking prevelance is high and it continues to increase in Turkey.

Also, it was found in the present study that 53.78% of the participants have never had any periodontal treatment before. Bad oral self-care, irregular dentist visits, low level of education and income might be connected with this result.

One of the limitations of the current study is the information obtained according to the personal evaluations of the individuals and the small number of the subjects included in the population. Besides, self-reported information is the most commonly used method of collecting answers and positive correlations were identified even if the examined community was relatively small. A future targeted screening of periodontal disease which may be considered as a public health problem and associated risk indicators would clarify the implementation of preventive programs. Community-based prevention-oriented projects should be implemented by national health authorities to improve the oral health of people from all ages.

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CONFLICT OF INTEREST

The authors report no conflicts of interest related to this study.

Türk Populasyonunun Bir Alt Grubunda Ağız Sağlığı ve İlişkili Faktörlerin Belirlenmesi

ÖZ

Amaç: *Tatmin edici bir koruyucu ağız sağlığı programının geliştirilmesi için, toplumun ağız sağlığı ile ilgili alışkanlıklarının ve ağız sağlığı durumunun*

bilinmesi gereklidir. Bu bağlamda bu çalışmanın amacı; Uşak ilinde yaşayan Türk toplumunda ağız sağlığı tutum ve davranışlarının yanında CPITN ve DMFT indeks değerlerini yaş, cinsiyet ve eğitim durumuna göre değerlendirmektir. ***Gereç ve Yöntemler:*** *Ağız sağlığı davranışlarını anlamak için altı yaş grubuna ayrılan 2412 bireye yüz yüze sorular yöneltildi. Periodontal klinik ölçümler ve diş çürüğü varlığının tespiti kalibre üç periodontolog tarafından yapıldı.* ***Bulgular:*** *Periodontal olarak sağlıklı birey sayısı sadece 153 kişi (%10,05) idi. Bireylerin ortalama DMFT değeri 16,98±6,62 idi. Yaşlılık, cinsiyetin erkek olması ve düşük eğitim seviyesine sahip olma gibi faktörler ortalama DMFT ve CPITN değerlerinde artışa neden olduğu gösterildi. Katılımcıların %10,26'sı dişlerini fırçalamadıklarını bildirdi ve %92,55'i diş ipi kullanmadıklarını belirtti. Katılımcıların çoğu (%83,25) yalnızca acil durumlarda ve ağrı varlığında diş hekimine gittiğini belirtti.* ***Sonuçlar:*** *Ortalama DMFT ve CPITN skorları yaşlanma, düşük eğitim düzeyi ve cinsiyetin erkek olması durumlarında arttığı saptandı. Düşük diş ipi kullanma sıklığı, diş fırçalama prevalansının düşük olması ve diş hekimine düzenli gidilme sıklığının yetersiz olduğu belirlendi.*

Anahtar Kelimeler: *Yaş grupları, ağız sağlığı, diş fırçalama, diş ipi, eğitim.*

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Original research

OPTICAL PROPERTIES OF NOVEL RESIN MATRIX CERAMIC SYSTEMS AT DIFFERENT THICKNESSES

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ABSTRACT

Objectives: The purpose of this study was to investigate the effect of material and thickness on the translucency parameters (TP) and opalescence parameters (OP) for resin matrix ceramic blocks.

Materials and Methods: 90 disc-shaped specimens (8 mm diameter and A2 shade, High Translucency) were fabricated from Vita Enamic, Lava Ultimate and GC Cerasmart resin-matrix ceramic blocks and prepared to thicknesses of 0.5 mm, 1 mm and 1.5 mm (n=10). A dental spectrophotometer (VITA Easyshade Advance) was used to calculate the TP and OP. All specimens were placed on white and black backgrounds. The color measurements were repeated three times for each of the specimens and the mean values of L, a and b were calculated. Data were analyzed by a two-way analysis of variance (ANOVA) and Tukey's test.

Results: For the 0.5 mm thickness groups, GC Cerasmart had the highest and Vita Enamic had the lowest TP values. For the 1 mm thickness groups, GC Cerasmart had the highest TP, whereas Vita Enamic had the lowest TP. For the 1.5 mm thickness groups, Lava Ultimate had the highest TP, whereas Vita Enamic had the lowest TP. For the 0.5 mm thickness groups, Vita Enamic, and GC Cerasmart had the highest and lowest OP, respectively. The OP values in the 1 mm thickness group of Vita Enamic groups were higher than the GC Cerasmart and Lava Ultimate groups. The OP values in the 1.5 mm thickness group Lava Ultimate group were higher than the GC Cerasmart and Vita Enamic groups. In all groups, the OP values showed an increase in parallel with the increase in thicknesses, in contrast, the TP values showed a decrease.

Conclusions: Type and thickness of the resin matrix ceramics affect the optical properties of the materials.

Keywords: Ceramics, color, spectrophotometry.

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INTRODUCTION

The goal of restorative and prosthetic dentistry is to restore the lost tooth structure using aesthetic materials that mimic the physical and structural properties of natural teeth.[1] While ceramic and composite materials have been used in restorations for many years, both materials have several disadvantages. In order to eliminate these disadvantages, more studies have investigated the production of materials with improved properties.[2–4]

While ceramics have advantages, such as high bending strength, biocompatibility, and color stability, they also have disadvantages, such as abrasion of the antagonist teeth and the consequent loss of tooth structure. These negative properties of ceramics are better for resins, but the material wear is higher.[5] Nowadays, new materials known as resin matrix ceramics (RMC) have been developed that combine the positive properties of ceramics and composites.[4]

Novel ceramic reinforced polymers, a combination of the ceramic and polymer phases, have been developed with innovative processes.[6] For this purpose, a new polymer infiltrated ceramic network (PICN) material has been developed that mimics the structure of natural teeth and improves their physical properties.[1] This material (Vita Enamic, Vita Zahnfabrik, Bad Sackingen, Germany) consists of a double network system comprised of a feldspathic ceramic network (86% by weight/75% by volume) and a polymer network (14% by volume/25% by weight).[7] Another resin matrix ceramic, Lava Ultimate, which is a resin nanoceramic, consists of nano-ceramic particles in the resin matrix of 80% by weight. High nanoceramics consist of a combination of discrete silica nanoparticles (20 nm in diameter), zirconia nanoparticles (4 nm to 11 nm in diameter), and zirconia-silica nanoclusters.[4] GC Cerasmart, one type of nanoceramic RCM, is a high-intensity material containing 71% filler particles by weight.[8] Lava Ultimate, Vita Enamic, and GC Cerasmart materials have indications for use in inlay, onlay, and veneer restorations.[9]

The appearance of materials is evaluated by the amount of light that they transmit or reflect. The translucency of the material is one of the most important factors in providing aesthetics, and it is an important factor in the choice of the material used in the restoration.[10] Translucency is the state between transparency and opacity that allows for the transition of light through the material.[11] Increased light transmission through the material demonstrates that the material is more translucent.[12] In dentistry, the translucency of the materials is usually determined by the translucency parameter (TP), which is the measurement of color differences on the black and white background of the sample. A high TP value indicates that the materials have high translucency.[13]

Another important optical characteristic of ceramic materials is opalescence, which refers to the scattering of shorter wavelengths of visible light. This feature provides a bluish appearance when the color is reflected, and an orange/brown appearance when the color is transmitted.[14]

RMC blocks are novel materials; thus, very few previous studies have investigated their translucency. This study aimed is to examine the translucency and opalescence values of different RMC materials at different thicknesses. The first null hypothesis of this study is that there is no difference between the translucencies of different RMC materials at different thicknesses. The second null hypothesis is that there is no difference between the opalescence properties of different RMC materials at different thicknesses.

MATERIALS AND METHODS

Preparation of the specimens

The three different RCM blocks (12×14×18 mm), Vita Enamic (Vita Zahnfabrik, Bad Säckingen, Germany), Lava Ultimate (3M ESPE, St. Paul, MN, USA), and GC Cerasmart (GC Dental Products Corp., Aichi, Japan), used in the present study are shown in Table 1. The A2 color and high translucency (HT) of these blocks were investigated.

Table 1. Material, material type, composition, manufacturer and shade of all tested materials in the study

Material	Material type	Composition	Manufacturer	Shade
Vita Enamic	Polimer infiltrated resin ceramic	Polymer-infiltrated-feldspathic-ceramic-network material (UDMA, TEGDMA) with 86 wt% ceramic (SiO_2, Al_2O_3, Na_2O, K_2O, and other oxides)	Vita Zahnfabrik, Bad Säckingen, Germany	HT 2M2
GC Cerasmart	Nanoceramic	Composite resin material (Bis-MEPP, UDMA, DMA) with 71 wt% silica and barium glass nanoparticles	GC Dental Products Corp., Aichi, Japan	HT 2M2
Lava Ultimate	Resin nanoceramic	Composite resin material (Bis-GMA, UDMA, Bis-EMA, TEGDMA) with 80 wt% silica and barium glass nanoparticles and zirconia/silica nanoclusters	3M ESPE, St.Paul, MN, USA	HT 2M2

First, the RMC blocks were milled in the computer-aided manufacturing (CAM) unit (Yenamak D50, Yenadent Ltd, Istanbul, Turkey) and 8 mm diameter cylinder blocks were obtained. The RMC blocks were cut into circular slices of 0.5 mm, 1 mm, and 1.5 mm thickness using a diamond saw (Diamond cut-off wheels type LM+ Ø 100 mm, Presi SA, Angonnes, France) and a precision cutting machine (Mecatom T180; Presi SA, Angonnes, France) at a speed of 290 rpm under constant water cooling. All the specimens were polished using 600, 800, and 1200 grit silicon carbide paper (Atlas Zımpara, İstanbul, Turkey). Then, the prepared specimens were ultrasonically cleaned for 10 minutes in the ultrasonic cleaner (Skymen Heatable Ultrasonic Cleaner JP-4820, Shenzhen, China). In all, 90 circular samples (8 mm diameter) with three different thicknesses (0.5 mm, 1.0 mm, and 1.5 mm) were prepared for each of the RMC blocks (n=10). All the specimens were carefully evaluated using a digital micrometer (Mitutoyo Corporation, Kanagawa, Japan) to ensure that the 0.5 mm, 1 mm, and 1.5 mm thicknesses of each sample were even.

Evaluation of the translucency and opalescence parameters

The color values of all the samples were registered based on the Commission Internationale de l'Elcairage (CIE) L* a* b* system. In this system, the L value is the lightness-darkness axis, the a value is the red-green axis, and the b value is the yellow-blue axis[15]. In present study, the translucency and opalescence values on a black background (L= 1.06, a= -1.3, b= 0.8) and a white background (L=96.2, a= -0.7, b= 1.8) were measured relative to the D65 standard illuminant using a digital spectrophotometer (VITA Easyshade Advance, Bad Sackingen, Germany).

Before each measurement, the digital spectrophotometer was calibrated based on the manufacturer's instructions. To ensure standardization, all measurements were made from the center of the samples. Each sample was measured three times, and the mean value was recorded.

In the present study, TP was determined using the following formula[16]:

$$TP = \sqrt{(L_B - L_W)^2 + (a_B - a_W)^2 + (b_B - b_W)^2}$$

To calculate the opalescence parameter (OP), the a and b parameter values on the black background and white background were used, as shown in the following formula[16]:

$$OP = \sqrt{(a_B - a_W)^2 + (b_B - b_W)^2}$$

Materials with a high OP have a higher opalescence.[17]

The color parameters in the black background were indicated with a subscript B, and the subscript W was used for the color parameters in the white background.[13]

Statistical analysis

All of the statistical analyses were conducting using SPSS software (SPSS Inc., Chicago, IL USA). Levene's test was used to evaluate the homogeneity of the variances. Data from the optical properties were statistically compared using two-way analysis of variance (ANOVA) and the Tukey's Honest Significant Difference (HSD) post-hoc test. The analysis was performed with a confidence level of 0.05.

RESULTS

TP values varied from 28.93 to 32.67 in the 0.5 mm thickness group. GC Cerasmart specimens showed higher TP values than Lava Ultimate specimens, while Lava Ultimate specimens showed higher TP

values than Vita Enamic specimens (Table 2). Significant differences were observed between all groups in 0.5 mm thickness ($p<0.05$).

In the 1.0 mm thickness group, TP values varied between 20.14 to 24.40. GC Cerasmart had the highest TP, whereas Vita Enamic had the lowest TP. Although there was no significant difference between Lava Ultimate and GC Cerasmart ($p>0.05$); Lava Ultimate and GC Cerasmart indicated significantly higher TP values than Vita Enamic ($p<0.05$).

For the 1.5 mm thickness groups, Lava Ultimate had the highest TP, whereas Vita Enamic had the lowest TP. Although a significant difference wasn't observed between Lava Ultimate and GC Cerasmart ($p>0.05$); Lava Ultimate and GC Cerasmart indicated significantly higher translucency values than Vita Enamic ($p<0.05$).

When different thicknesses of the same material group were compared, a statistically significant difference was observed between 0.5 mm, 1 mm, 1.5 mm groups of all material groups ($p<0.05$).

The results of the mean translucency values of the different RMC blocks in different thickness are shown in Table 2 and Figure 1.

For the 0.5 mm thickness groups, Vita Enamic, and GC Cerasmart had the highest and lowest OP, respectively. Vita Enamic specimens showed higher OP values than Lava Ultimate specimens, while Lava Ultimate specimens showed higher OP values than GC Cerasmart specimens (Table 2). Between the all groups had significantly different values ($p<0.05$).

The OP values in the 1 mm thickness group of Vita Enamic groups were higher than the GC Cerasmart and Lava Ultimate groups. Although there was no significant difference between Lava Ultimate and Vita Enamic ($p>0.05$); Lava Ultimate and Vita Enamic showed significantly higher opalescence values than GC Cerasmart ($p<0.05$).

The OP values in the 1.5 mm thickness group Lava Ultimate groups were higher than the GC Cerasmart and Vita Enamic groups. Although there was no significant difference between Vita Enamic and GC Cerasmart($p>0.05$); Lava Ultimate showed significantly higher opalescence values than GC Cerasmart and Vita Enamic ($p <0.05$).

The results of the mean opalescence values of the different RMC blocks in different thickness are shown in Table 2 and Fig. 2.

In all groups, the OP values showed an increase in parallel with the increase in thicknesses, in contrast, the TP values showed a decrease.

Table 2. The mean translucency and opalescence values of the groups and their comparisons

	TP			OP		
Material	**0.5 mm**	**1 mm**	**1.5 mm**	**0.5 mm**	**1 mm**	**1.5 mm**
Lava Ultimate	31.27(±1.04)^{Aa}	23.73 (±0.73)^{Ab}	18.03 (±0.77)^{Ac}	4.93 (±0.25)^{Aa}	6.85 (±0.31)^{Ab}	8.35 (±0.27)^{Ac}
VitaEnamic	28.93 (±1.31)^{Ba}	20.14 (±0.48)^{Bb}	14.82 (±0.52)^{Bc}	5.59 (±0.31)^{Ba}	7.03 (±0.17)^{Ab}	6.78 (±0.18)^{Bb}
GC Cerasmart	32.67 (±0.90)^{Ca}	24.40 (±0.96)^{Ab}	17.87 (±0.98)^{Ac}	3 (±0.41)^{Ca}	5.46 (±0.23)^{Bb}	6.54 (±0.15)^{Bc}

Superscripts with capital letters show the differences between material types and lower case letters show differences between thicknesses.

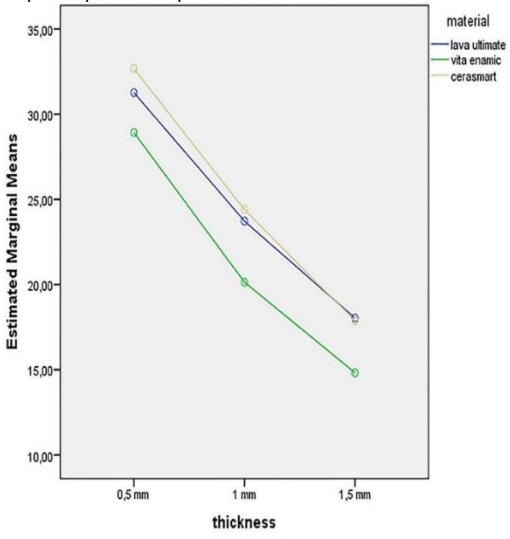

Figure 1. Translucency values of the groups

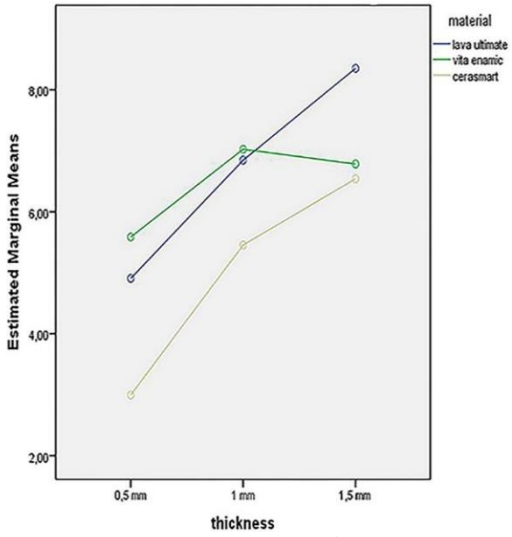

Figure 1. Translucency values of the groups

DISCUSSION

Two null hypotheses were rejected because there were significant differences between the TP and OP values of the various thicknesses of the tested RMC blocks.

Novel hybrid dental materials, called RMC, combine the clinically useful properties of ceramics and composites.[18] In the present study, the optical properties of Vita Enamic, GC Cerasmart, and Lava Ultimate RMC materials, which are indicated for laminate veneer restorations, were evaluated.

Vita Enamic, a polymer-infiltrated resin ceramic, contains an 86% ceramic matrix and a 14% polymer network.[19] The flexural strength of Vita Enamic is 150–160 MPa, and the elastic modulus and stiffness (hardness) of this material are 30 GPa and 2.5 GPa, respectively.[20] The nano-ceramic particles in the resin matrix constitute 80% of the weight of the Lava Ultimate material, a resin nano-ceramic.[7] The flexural strength of Lava Ultimate is 200 MPa, and the elastic modulus has been reported as 29.8 GPa.[21] For GC Cerasmart, a nano-ceramic, 71% of its weight is filler particles (silica and barium), and the resin matrix consists of BisMEPP, UDMA, and DMA.[22] The flexural strength of GC Cerasmart is 238 MPa,[23] and the elastic modulus is 12.1 GPa.[24]

Previous studies[25–27] have evaluated the effect of thickness on the translucency of materials. Wang *et al*.[25] researched the TP values of 2 mm-thick specimens of glass ceramics and 1 mm-thick specimens of zirconia ceramics, and they stated that the translucency of all materials increased as the thickness decreased. Barizon *et al.*[26] examined the effect of thickness on the translucency of restorative materials and concluded that TP increased as thickness decreased. Vichi *et al*.[27] investigated the translucency properties of Cerec CAD-CAM materials with thicknesses of 0.5 and 1.0 mm and found that there were decreases in translucency due to increases in thickness.

The total refractive index and thickness of a material are directly related to each other[16]. Since light transmission decreases due to increases in thickness, the TP value of a material decreases. In our study, as the thickness of the materials increased, the TP values decreased, and the OP values increased.

In the present study, the mean TP values in the 0.5 mm thickness group were evaluated as 28.93 for Vita Enamic, 31.27 for Lava Ultimate, and 32.67 for GC Cerasmart. The GC Cerasmart specimens showed higher TP values than the Lava Ultimate specimens while the Lava Ultimate specimens had higher TP values than the Vita Enamic specimens. There were significantly different values among all groups ($p<0.05$). The TP values in the 1 mm thickness group of Vita Enamic (20.14) were lower than the GC Cerasmart (24.40) and Lava Ultimate (23.73) groups. The TP values in the 1.5 mm thickness groups both of GC Cerasmart (17.87) and Lava Ultimate (18.03) were higher than in the Vita Enamic (14.82) group. Lava Ultimate and GC Cerasmart showed significantly higher translucency values than Vita Enamic ($p<0.05$) in the 1 mm and 1.5 mm thickness groups.

In the present study, for the 0.5 mm thickness groups, Vita Enamic (5.59) and GC Cerasmart (3) had the highest and lowest OP values, respectively, and there were significantly different values among all the groups ($p<0.05$). The OP values in the 1 mm thickness group of Vita Enamic (7.03) were higher than in the GC Cerasmart (5.46) and Lava Ultimate (6.85) groups. Although no significant difference was observed between Lava Ultimate and Vita Enamic ($p>0.05$), Lava Ultimate and Vita Enamic showed significantly higher opalescence values than GC Cerasmart ($p<0.05$). The OP values in the 1.5 mm thickness group of Lava Ultimate (8.35) were higher than in the GC Cerasmart (6.54) and Vita Enamic (6.78) groups. Although no significant difference was observed between Vita Enamic and GC Cerasmart ($p>0.05$), Lava Ultimate showed significantly higher opalescence values than GC Cerasmart and Vita Enamic ($p <0.05$).

Awad *et al.*[11] examined the translucency values of the 1 mm and 2 mm thick Vita Enamic and Lava Ultimate materials and reported that Lava Ultimate showed higher translucency values than Vita Enamic. In this study, Lava Ultimate showed values of 42.10 and 24.96 in the 1 mm and 2 mm thickness groups (respectively) whereas

Vita Enamic showed 23.92 and 11.28 values in the 1 mm and 2 mm thickness groups, respectively. In the study, it was reported that Vita Enamic showed a lower TP value due to the high content of Al_2O_3; additionally, the nano-filler particles in this material are smaller than the wavelength of visible light, which results in less light scatter and higher translucency. This also explains the high TP value of the Lava Ultimate material containing nano-filler particles.

In a similar study using 0.5 mm-thick samples, lower translucency values were obtained for Vita Enamic (24.95), GC Cerasmart (31.16), and Lava Ultimate (29.84).[16] There were significantly different values among all the groups at 0.5 mm thickness ($p<0.05$). In the same study, lower translucency values were obtained compared to our study in the 1 mm samples of Vita Enamic (14.15), GC Cerasmart (18.64), and Lava Ultimate (17.93). Although no significant difference was observed between Lava Ultimate and GC Cerasmart ($p>0.05$), Vita Enamic showed significantly lower translucency values than GC Cerasmart and Lava Ultimate in the 1 mm thickness group ($p <0.05$).

Sarıkaya *et al*.[28] examined the TP values of 1 mm-thick Vita Enamic and Lava Ultimate samples. As a result of this research, the Vita Enamic group's TP value was 19.1 and the TP of the Lava Ultimate group was 19.2; no significant difference was observed between the Lava Ultimate and Vita Enamic groups. The reason for the differences in the statistical significance between these other studies and the current study may be related to the L*a*b* values of the background used in the translucency measurements.

Pecho *et al.*[29] compared the TP values of 0.5 mm-thick human and bovine dentin and zirconia systems, and they reported that no statistically significant difference was observed between the dentin and zirconia groups. In a study by Yu *et al.*,[30] human dentin indicated lower TP values and higher CIE L*a*b* values than human enamel of the same thickness, and the mean TP values of 1 mm-thick human enamel and human dentin were 18.7 and 16.4, respectively.

Gunal *et al.*[16] examined the TP and OP values of Vita Suprinity and other novel CAD / CAM materials. As a result of research, the TP values of Vita Suprinity with thicknesses of 0.5 mm and 1 mm were reported as 23.30 and 14.26 and OP values as 10.07 and 10.56, respectively. Vita Suprinity showed significantly lower TP values in the 0.5 mm thickness group compared to Lava Ultimate, Vita Enamic, and GC Cerasmart. While no significant difference was observed between Vita Suprinity and Vita Enamic in 1 mm thickness group; Vita Suprinity showed significantly lower TP values compared to GC Cerasmart and Lava Ultimate. Suprinity (VITA Zahnfabrik, Bad Sackingen, Germany), another block of the novel CAD / CAM blocks, is a zirconia-reinforced lithium silicate ceramic.[31]

Many factors such as the resin matrix and filler composition and this composition content, pigment, and other additives affect the optical properties of the resin materials.[32] The filler content, shape and size of Vita Enamic, Lava Ultimate and GC Cerasmart materials used in the present study were different.

In most of the studies evaluating the optical properties of materials, researchers were preferred the use of materials of A2 color.[16,22] In order to compare the optical properties of restorative materials with other studies and to obtain standardization, was preferred to use of A2 color HT blocks for all groups in the present study.

The color of residual tooth structure or the substructure material ought to be take consider while deciding the correct prosthetic material. In this study, the material type and thickness significantly affected the optical properties of RMCs. Therefore, to obtain natural looking restorations and provide correct shade matching with neighboring dentition especially for anterior teeth, RMCs should be carefully chosen due to their different optical properties.

Three methods are used to evaluate the translucency of materials used in dentistry, and these methods can be classified as direct transmission, total transmission, and spectral reflection.[33] TP is described as the difference between the reflected colors of a material of equal thickness on the background in two different

colors, black and white, and this study the TP value was evaluated by determining the spectral reflections.[13] Generally, spectrophotometers have been preferred for instrumental translucency determination.[34-37] The spectroradiometer (SR) was introduced as an alternative color measuring device to the spectrophotometer in dentistry.[38] With the use of a spectroradiometer (SR), the effect of edge-loss can be avoided since there is no aperture between the spectroradiometer, the light source, and the material.[39] Lim *et al.*[33] reported that the TP values obtained with spectrophotometer and spectroradiometer showed a high correlation.

In this study, the spectrophotometer was used for the measurement of TP values since it is simpler to use and is preferred in previous studies. There may be differences between the spectroradiometer and spectrophotometer measurements. The limitation of this study is that measurements are done with spectrophotometer only.

The color of the teeth to be restored is important in determining the color and translucency of the restorative materials. While teeth without discoloration can be restored with more translucent materials, more opaque materials are preferred for teeth with discoloration. In this study, the TP and OP values of resin matrix ceramic materials were determined and it was investigated which materials could be more advantageous in clinical use.

CONCLUSIONS

Choosing the right restorative material in the anterior region is a critical issue for achieving natural looking aesthetic restorations. According to the findings of this study GC Cerasmart has the highest TP value in 0.5 mm and 1 mm thickness groups. For the 1.5 mm thickness groups, Lava Ultimate and GC Cerasmart indicated significantly higher translucency values than Vita Enamic. GC Cerasmart has the lowest OP value for all thickness groups. As the thickness of materials increased, TP values decreased and OP values increased. The use of GC Cerasmart and Lava Ultimate materials may be appropriate in anterior aesthetic restorations, as the use of materials with a high TP value is advantageous.

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None

CONFLICT OF INTEREST

None

Güncel Rezin Matriks Seramiklerin Farklı Kalınlıklardaki Optik Özellikleri

ÖZ

Amaç: *Bu çalışmanın amacı, rezin matriks seramik blokların materyal çeşitlerinin ve kalınlıklarının translusensi parametrelerine (TP) ve opalesans parametrelerine (OP) etkilerini araştırmaktır.* ***Gereç ve Yöntemler:*** *Vita Enamic, Lava Ultimate ve GC Cerasmart rezin matriks seramik bloklarından oluşan 90 adet disk şeklindeki örnek (8 mm çap ve A2 renk, yüksek translusensi) 0,5 mm, 1 mm and 1,5 mm kalınlıklarında hazırlandı. TP ve OP değerlerini ölçmek için dental spektrofotometre (VITA Easyshade Advance) kullanıldı. Tüm örnekler beyaz ve siyah zemin üzerine yerleştirilip renk ölçümleri her örnek için 3 defa tekrarlandı ve L, a ve b değerleri hesaplandı. İstatistiksel analizler, çift yönlü varyans analizi (ANOVA) ve Tukey testleri ile yapıldı.* ***Bulgular:*** *0,5 mm kalınlığındaki gruplarda, GC Cerasmart en yüksek, Vita Enamic ise en düşük TP değerleri göstermiştir.1 ve 1,5 mm kalınlığındaki gruplarda, GC Cerasmart ve Lava Ultimate yüksek TP değerleri gösterirken, Vita Enamic düşük TP değeri göstermiştir. OP değerleri ise 0,5 mm kalınlığındaki gruplarda, Vita Enamic'te en yüksekken GC Cerasmart'ta en düşük bulunmuştur. 1 mm kalınlığındaki gruplarda Lava Ultimate ve Vita Enamic, GC Cerasmart'a göre daha yüksek OP değerleri göstermiştir. 1,5 mm kalınlığındaki gruplarda, Lava Ultimate, GC Cerasmart ve Vita Enamic gruplarına göre daha yüksek OP değerleri göstermiştir. Tüm gruplarda, OP değerleri kalınlığın artmasıyla paralel bir artma gösterirken, tam tersine TP değerleri azalma göstermiştir.* ***Sonuç:*** *Rezin matriks seramiklerin çeşitleri ve kalınlıkları, materyallerin optik özelliklerini etkilemektedir.*

Anahtar Kelimeler: *Seramikler, renk, spektrofotometri.*

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Original research

EFFECTS OF Er,Cr:YSGG LASER ON MICROLEAKAGE OF A SELF-ETCH ADHESIVE SYSTEM

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ABSTRACT

Objectives: The purpose of this in-vitro study was to evaluate the microleakage of a self-etch dentin adhesive system in cavities prepared by a conventional dental bur and an Er,Cr:YSGG laser.

Materials and Methods: Forty extracted premolar teeth were selected randomly. Standardized Class V cavity preparations were placed in the buccal and lingual surfaces using a bur and an Er,Cr:YSGG laser. Eighty preparations were randomly assigned to 4 groups of 20 samples each and restored as follows: (G1, Control group) Bur; (G2) Bur + Laser etch; (G3) Er,Cr:YSGG laser; (G4) Er,Cr:YSGG laser + Laser etch. The cavities were restored with a self-etch adhesive system (GC, Unifil Bond) and composite resin (GC, Gradia). The preparations were sectioned buccolingually into three parts and scored for microleakage using a light stereoscope. The data were analyzed with Mann-Whitney U test, and Chi-squared test was used for comparisons across groups.

Results: In all groups, there was higher microleakage in the gingival margin than in the occlusal margin. In the control group (G1), the lowest microleakage values were obtained in all the cavities. In comparison among the groups, statistically significant microleakage values were obtained in the occlusal margins. Significantly high microleakage was observed in G4 in comparison to G1 and G3 ($p = 0.001$, $p = 0.003$).

Conclusions: Preparation and etching by using an Er,Cr:YSGG laser does not decrease microleakage, but this may also be due to the properties of the self-etch adhesive. Further clinical research and long-term follow-ups are needed to analyze the findings in more detail.

Key Words: Dental adhesives, dental leakage, ysgg laser.

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INTRODUCTION

Microleakage that might occur in the bonding of the tooth-restoration interface is an important factor that affects the lifespan of the restoration. Bonding of the restoration material to the dentine and the enamel has always been an area of interest in dentistry.[1] In adhesive systems, various classifications were made according to chronological developments or changes in their contents. Van Meerbeek *et al*.[2] made a simple classification as total-etch adhesives/self-etch adhesives / glass ionomer adhesives based on the interaction between the adhesive system and the tooth and the number of the steps of application.

For good restoration-tooth bonding, a well-prepared enamel surface morphology is needed. It is known that the efficiency of bonding systems depends on the morphological characteristics and changes on the surface of the teeth.[3] For this reason, etching with acid and bonding systems has faced several changes in parallel to dentistry material technology which has advanced in time. The steps of etching with acid and rinsing are not applied in self-etch adhesive systems. However, although these systems shorten application time, they still bear several questions about bonding to the dentine and the enamel.

As a result of the developments in laser technology, laser-based practices have become widespread in many areas of dentistry such as diagnosis, preventive dentistry, restorative treatments and endodontic treatments.[4] As an alternative to conventional treatment methods, which were applied with high-speed and low-speed revolving tools, laser technology has provided an up-to-date approach to removal of caries and preparation of cavities. The use of laser technology is another promising alternative to etching with acid.[5]

Erbium, Chromium: Yttrium, Scandium, Gallium, Garnet (Er,Cr:YSGG), Erbium: Yttrium-Aluminum-Garnet (Er:YAG), Nd:YAG, Diode lasers, Argon lasers and CO_2 lasers are the types of laser that are used in dentistry. Er,Cr:YSGG and Er:YAG lasers are preferred in dentistry especially in hard tissues because they provide high absorption with water and hydroxyapatite. They also provide ablation on the enamel and the dentine in an efficient way. It has been demonstrated in previous studies that these surfaces that are exposed to lasers show a characteristically rough surface, are clean and smear-free, have open dentin tubules and enable the dentist to preferably remove the intertubular dentin, which means they have micro irregularities.[6,7]

The purpose of this *in-vitro* study is to evaluate the efficiency of a self-etch dentin adhesive system in cavity preparation with a conventional dental bur and an Er,Cr:YSGG laser in terms of microleakage.

MATERIALS AND METHODS

This study forty recently extracted human premolar teeth that were intact and free from caries, restoration, cracks and defects. After extraction, the tissues on the roots were removed with hand-scaling instruments, and the teeth were cleaned with pumice and stored in a 0.1% thymol solution for 24 hours.

Cavity Preparation

Standard Class V cavities with occlusal margin ending at the enamel and gingival margin ending at the cement were prepared using a template on the buccal and lingual surfaces of each tooth. Cavities had a 3 mm occlusogingival height, 4 mm mesiodistal length and 2.5 mm depth at the dentin tissue. The occlusal wall on the enamel was beveled with a 0.5 mm 45° angle. The cement was revealed by removing the whole enamel in the gingival edge of the cavity.

After cavity preparation, the teeth were randomly divided into 4 groups, and each group contained 10 teeth. A total of 80 preparations consisting of 20 samples were randomly assigned to 4 groups and were prepared respectively as follows: Group 1, Control Group (G1) bur, Group 2 (G2) bur+laser etching, Group 3 (G3) Er,Cr: YSGG laser and Group 4 (G4) Er,Cr:YSGG laser +laser etching.

For standardization of the cavities, ready-made metal templates were used. In the cavities which were prepared by burs, a diamond bur (ISO 001/018 BR-31 Dia-Scholarship, MANI Inc., Tochigi, Japan) was used for enamel, and carbide bur was used for dentin under water-cooling with a high-speed hand piece. A new bur was used after preparing every 10 cavities.

For cavity preparation/etching with laser, this study used an Er,Cr:YSGG (MillenniumTM, Biolase

Technology, San Clemente, CA, USA) hydrokinetic laser system with a 2780 nm wavelength and a 20 mHz frequency. The laser was applied under the following conditions according to the manufacturer's recommendations: 5.5 W (85% water and 85% air) was used at the enamel and 3 W (55% water and 65% air) was used at the dentin for cavity preparation, and for surface etching, 1.5 W (75% water and 85% air) was used. In transmission of energy to the surface by a fiberoptic system, a sapphire tip with a 6 mm length and a 600 μm diameter (Biolase-Waterlase) was used. The dimensions of the prepared cavities were approximately the same as the bur-prepared specimens.

After preparation, all cavities were restored with a self-etch bonding agent (Unifil Bond, GC Europe), and a composite resin material (Gradia Direct, GC Europe) according to the manufacturer's instructions (Table 1).

Table 1. Groups

Groups	Cavity preparation technique	Surface preparation/Etching	Bonding step	Restoration material
Group 1 (G1)	Bur	None	GC Unifill Bond	GC GRADIA
Group 2 (G2)	Er,Cr:YSGG laser	None	GC Unifill Bond	GC GRADIA
Group 3 (G3)	Bur	Er,Cr:YSGG Laser	GC Unifill Bond	GC GRADIA
Group 4 (G4)	Er,Cr:YSGG laser	Er,Cr:YSGG Laser	GC Unifill Bond	GC GRADIA

Dye penetration and microleakage measurement

After the polishing process, the restored teeth were stored in deionized water at 37 °C for 24 h. The teeth were then subjected to 1000 thermal cycles in water baths at 5–55 ± 2 °C with a dwelling time of 30 s and a transfer time of 3 s. After the thermocycling process, the teeth were stored in distilled water at 37 °C for 24 h to prevent dehydration. The apices of the teeth were covered with glass ionomer cement (VOCO- Ionofil Molar AC, Germany). Microleakage was evaluated using a conventional dye penetration method. Each specimen was sealed with two coats of nail varnish leaving a 1-mm window around the cavity margins. The specimens were immersed in 0.5% of basic fuchsine for 24 h for dye penetration. The samples were divided into three sections in the buccolingual direction using a slow-speed diamond saw (Isomed 1000 Precision saw, Buehler Ltd, Lake Bluff, IL) mounted in a diamond wafering blade (6″ Dia. × 0.20″ Buehler Ltd) under running water. The digital images were examined by using a stereomicroscope (M80, Leica Microsystems GmbH, Germany) under 10X magnification, and the worst scores for both the occlusal and gingival margins were used for data analyses. The depth of the cavity walls and the length of the microleakage zone (μm) along the occlusal and cervical margins were recorded at an accuracy of 0.1 mm by using a calibrated ocular scale, and the percentage of dye penetration was calculated. The statistical analyses were carried out using the NCSS 2007 and PASS 2008 Statistics Software (Utah, the USA). Mann-Whitney U test and the Chi-squared tests were applied for comparing the findings among the groups.

RESULTS

The microleakage scores (percentages, %) for all four groups at the occlusal and gingival margins are shown in Table 2. Examples of images for the groups are seen in Figures 1-4. The lowest microleakage values were obtained in the Control Group (G1) in the gingival and occlusal margins (Figure 1). In the comparison among the groups, statistically significant differences were found between G1 and G4 (p=0.001) and between G3 and G4 (p=0.003) in terms of their microleakage values in the occlusal margins. No statistically significant differences were found between the microleakage values among the groups in the gingival margins (Table 3).

Table 2. Occlusal and gingival microleakage values in the Groups

Groups		N	Minimum	Maximum	Mean ± Std. Deviation
G1 (Control group)	Occlusal	10	0	24	7.80 ± 7.510
	Gingival	10	0	50	19.80 ± 17.165
G2	Occlusal	10	0	38	14.00 ± 12.875
	Gingival	10	0	47	20.00 ± 13.491
G3	Occlusal	10	0	23	9.40 ± 7.633
	Gingival	10	4	50	19.40 ± 15.939
G4	Occlusal	10	10	100	41.40 ± 33.417
	Gingival	10	10	100	48.90 ± 33.241

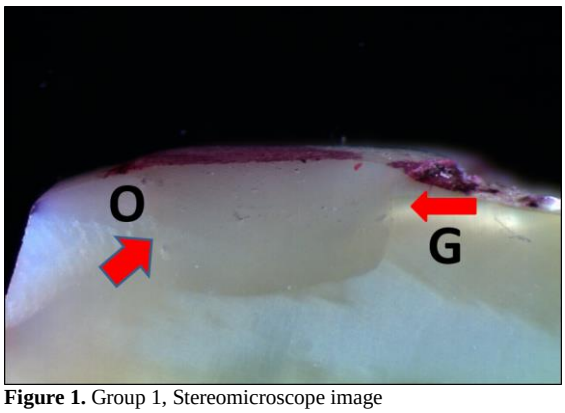

Figure 1. Group 1, Stereomicroscope image

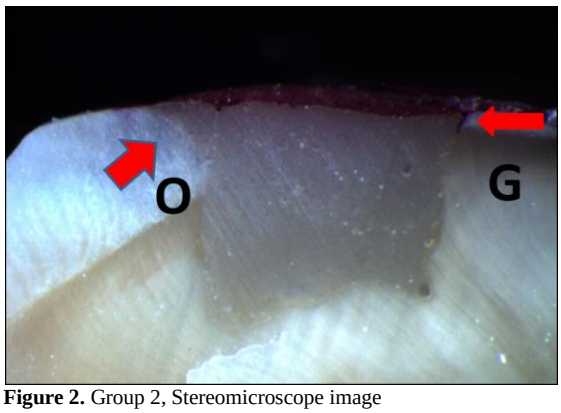

Figure 2. Group 2, Stereomicroscope image

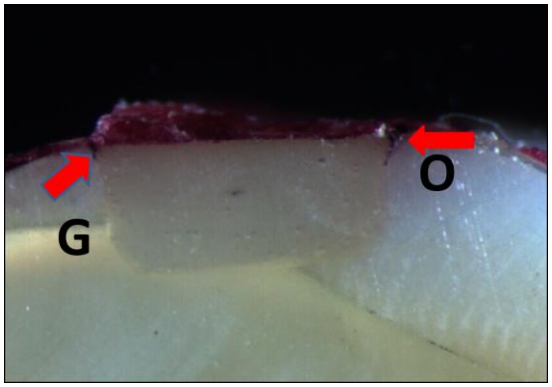

Figure 3. Group 3, Stereomicroscope image

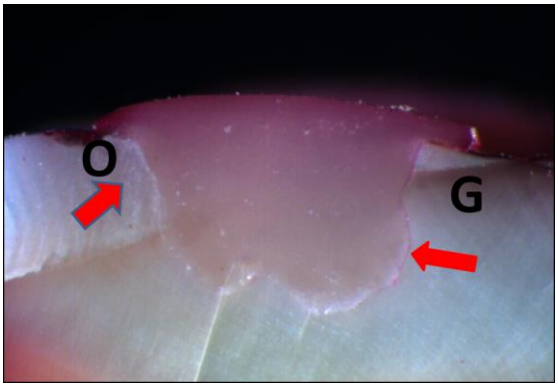

Figure 4. Group 4, Stereomicroscope image

Table 3. Comparison of the Occlusal and Gingival Microleakage Values of the Groups

	Groups		Difference between means (I – II)	p
Occlusal	Bur (Control group)	Laser	-6.2	0.322
		Bur + Laser Etching	-1.6	0.704
		Laser + Laser Etching	-33.6	**0.001***
	Laser	Bur + Laser Etching	4.6	0.469
		Laser + Laser Etching	-27.4	0.037
	Bur + Laser Etching	Laser + Laser Etching	-32.0	**0.003***
Gingival	Bur (Control group)	Laser	-0.20	0.733
		Bur + Laser Etching	0.40	0.909
		Laser + Laser Etching	-29.10	0.028
	Laser	Bur + Laser Etching	0.60	0.570
		Laser + Laser Etching	-28.90	0.028
	Bur + Laser Etching	**Laser + Laser Etching**	**-29.50**	**0.023**

DISCUSSION

It is already known that such leakage occurs especially in Class II and Class V restorations under the enamel-cement junction through the gingival margin. Microleakage that occurs in the cervical areas causes high secondary caries rates, post-operative sensitivity and deterioration of marginal integrity. Consequently, restorations fail under clinical conditions.[8] It has been aimed to develop cavity preparation and adhesive methods to solve these problems. When they are used with appropriate parameters, dental lasers may be suitable for several functions such as cavity preparation and etching of the enamel and the dentin. The etching stage may support the bonding of restorative material to the surface of the tooth. Previous studies supported the finding that using lasers is more beneficial in comparison to other methods. Additionally, a roughening process with lasers does not have the risks of possible chemical contamination or tissue damage, which are possible in roughening processes that are carried out by using hydrofluoric acid. Considering the advantages of Erbium lasers and self-etch adhesive systems, this study was undertaken to determine whether or not the use of an Er,Cr:YSGG laser would be an alternative to conventional diamond burs in decreasing microleakage for self-etch

adhesives in Class V cavities. There are some studies which showed that laser etching has higher binding characteristics.[9,10] Hossain *et al.*[11] reported that enamel and dentin surfaces treated with Er:YAG laser irradiation might reduce the microleakage of restorations that use a composite resin. Kalyoncu *et al.*[12] used an Er:YAG laser for cavity preparation and surface alteration in primary molar teeth. They concluded that self-etch bonding systems and cavity preparation with an Er:YAG laser might be used as an alternative to conventional methods.

Microleakage tests are one of the techniques that are commonly used for evaluating the sealing performance of restorative materials and bonding systems.[13] In recent years, researchers have examined microleakage values following laser applications and compared them to conventional methods.[14-16] Yamada *et al.*[17] conducted a study and evaluated cavities prepared with an Er:YAG laser and those prepared with conventional methods in terms of microleakage, and they reported that there were no statistically significant differences between these methods. In an *in vitro* study that was conducted by Yazıcı *et al.*[18], cavity preparations were carried out with diamond and carbide burs, an Er,Cr:YSGG laser system and chemical vapor deposition. When the enamel and dentin microleakage scores were compared among the groups, no statistically significant differences were observed ($p>0.05$).

In this *in vitro* study, cavity preparations were carried out on permanent teeth with an Er,Cr:YSGG laser, which is becoming common in pediatric dentistry, and with burs. After cavity preparation, the same laser was employed for etching the cavities with the appropriate parameters. The same restorations were applied to the cavities prepared with different methods, and the microleakage values were compared. For Class V cavities, with the adhesive materials that are employed, lower microleakage values occur with bur-cut surfaces than with surfaces created by use of a laser with additional laser conditioning. The results of our study showed that using Er,Cr:YSGG laser and self-etch adhesive bonding systems together was not successful in comparison to conventional methods.

When caries-affected tissues are removed with a laser, the changes that occur on the surface of the enamel and the dentin might cause differences in the dentin-adhesive bonding process. The changes that occur on the enamel and dentin surfaces are different in comparison to those traditional methods, and these changes may be turned into an advantage in terms of adhesive properties. Shahabi *et al.*[19] reported that, after Class V cavity preparation by using an Er,Cr: YSGG laser, higher microleakage occurred with phosphoric acid etching of bur- or laser-prepared surfaces than those that occurred with the surfaces created by the use of the laser alone without additional conditioning. The surface energy of the lased surface and the presence of moisture may contribute to optimal wetting induced by using hydrophilic bonding agents. Kohara *et al.*[20] reported that there were less marginal microleakages with an Er:YAG laser in comparison to cavities that were prepared with traditional methods. Likewise, Moldes *et al.*[21] observed significantly lower microleakage in their Er:YAG and Er,Cr:YSGG lasers and self-etch adhesives groups in comparison to etch and rinse systems.

Aranha *et al.*[22] prepared Class V cavities by using laser-based and traditional methods and evaluated microleakage by applying different adhesive systems. Although there were no statistically significant differences between the different preparation techniques that were employed by the authors, there was a significant difference in the microleakage values between the adhesive systems that were used.[23] Another factor, which might affect the adhesion of the material based on the adhesive method used on the enamel, is the laser parameters that are used. Ergucu *et al.*[24] examined the microleakage values by using single-step self-etch and total-etch adhesives with burs and different Er:YAG laser parameters in class V cavities. They reported that the laser parameters were effective on microleakage, and higher microleakage was observed in the samples to which the self-etch adhesive was applied in comparison to the total-etch adhesive. They also reported that the best results were obtained with the combination of acid and laser.

Although our findings were consistent with those obtained by previous *in vitro* studies, higher

microleakage values were measured in the groups to which the self-etch adhesive was applied following etching with laser in the gingival margins. Different Er,Cr:YSGG laser parameters were not applied the during cavity preparation, and this may be considered as a limitation of our study. Further *in vitro* and *in vivo* studies are needed to fully elucidate the effects of laser-based dental studies.

CONCLUSIONS

Consequently, it was determined that conventional methods yielded more successful outcomes in terms of microleakage. It is considered that, when it is applied alongside self-etch adhesive, etching with a laser technique yields higher microleakage values in the interface between the tooth and the restoration depending on tooth surface characteristics. More clinical studies with longer durations are needed in this respect.

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None

CONFLICTS OF INTEREST

All of the authors declare that they have no conflict of interest.

Er,Cr:YSGG Lazerin Self Etch Adeziv Sistemde Mikrosızıntıya Etkisi

ÖZ

Amaç: *Bu in-vitro çalışmanın amacı, geleneksel yöntem ve Er,Cr:YSGG lazer ile hazırlanan kavite preparasyonlarında; self etch dentin adeziv sisteminin mikrosızıntısı açısından değerlendirilmesidir.* ***Gereç ve Yöntemler:*** *Kırk adet yeni çekilmiş premolar diş rasgele seçildi. Standardize edilmiş Sınıf V kavite preparasyonları frez ve Er,Cr:YSGG lazer kullanılarak bukkal ve lingual yüzeylere hazırlandı. Her biri 20 örnekten oluşan 80 örnek kavite yüzeyi hazırlama yöntemine göre 4 deney grubuna rastgele ayrıldı: (G1, Kontrol grubu) Frez; (G2) Frez + Lazer Pürüzlendirme; (G3) Er,Cr:YSGG lazer; (G4) Er,Cr:YSGG lazer + Lazer Pürüzlendirme. Ardından tüm kavitelere self etch adeziv bonding ajanı (GC, Unifil Bond) uygulanarak kompozit rezin (GC, Gradia) ile restore edildi. Örnekler bukko-lingual yönde üçe bölündü ve ışık mikroskobu altında incelenerek, mikro-sızıntı açısından skorlandı. Elde edilen veriler NCSS 2007 ve PASS 2008 İstatistik Yazılımı (Utah, ABD) ile analiz edildi. Gruplar arasında bulguları karşılaştırırken Mann Whitney U testi, ki-kare testi uygulandı.* ***Bulgular:*** *Tüm gruplarda gingival marjinde, okluzal marjine göre daha yüksek mikrosızıntı bulundu. Kontrol grubunda (G1) tüm kavitelerde en düşük mikrosızıntı değerleri elde edildi. Gruplar arasındaki karşılaştırmalarda; okluzal marjinlerde mikrosızıntı açısından istatistiksel olarak anlamlı değerler elde edildi. G4'de, G'e ve G3'e göre istatistiksel olarak anlamlı düzeyde daha yüksek mikrosızıntı değerleri gözlendi (p=0,001, p=0,003).* ***Sonuçlar:*** *Bulgulara göre; Er,Cr:YSGG lazerle preparasyon ve pürüzlendirme işleminin mikrosızıntıyı azaltmadığı ancak bunun self etch adeziv sistemlerin özelliklerinden de kaynaklanabileceği belirlenmiştir. Bulguları analiz etmek için daha ileri klinik araştırmalar ve uzun vadeli takip gereklidir.*

Anahtar Kelimeler*: Dental adezivler, dental sızıntı, ysgg lazer.*

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Original research

COMPARISON OF APICALLY EXTRUDED DEBRIS ASSOCIATED WITH DIFFERENT NICKEL–TITANIUM SYSTEMS

ABSTRACT

Objectives: The aim of this study is to evaluate the influence of different instrument systems on the amount of extruded debris.

Materials and Methods: A total of 30 extracted mandibular molars with two separate canals and apical foramina in the mesial roots were selected. The root canals (n=10) were randomly assigned to the six groups of file systems as follows: ProTaper Next (PTN), WaveOne (WO), WaveOne Gold (WOG), One Shape (OS), Reciproc (R) and Reciproc Blue (RB). The extruded debris during the instrumentation was collected into Eppendorf tubes, which were weighed and then stored in an incubator at 70°C over a period of five days to evaporate the irrigant. After the incubation process, the Eppendorf tubes were weighed again. The difference between these two measurements, the first one before and the second one after the incubation process, was calculated. Data were statistically analyzed, and the significance level was set at $p<0.05$.

Results: R produced less debris compared to WO. R and PTN files produced significantly less debris compared to the OS files ($p<0.05$). Extruded debris in RB and WO groups were not significantly different, while RB produced less debris than WOG and OS ($p<0.05$).

Conclusions: All instrumentation systems allowed for the apical extrusion of the debris.

Keywords: Endodontics, root canal preparation, root canal therapy.

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INTRODUCTION

Nickel-titanium (NiTi) rotary files have become increasingly popular among clinicians for reducing the time required to complete the instrumentation and also for minimizing the procedural errors.[1] As manual files, all types of rotary or reciprocating files result in different amounts of extruded debris, which may vary according to the instrumentation technique and the design of the file systems.[2-4] This may cause delayed apical healing, flare-ups, and postoperative pain.[5]

New types of reciprocating NiTi systems are continuously being developed, such as Waveone Gold (WOG) (Dentsply Maillefer, Ballaigues, Switzerland), and Reciproc Blue (RB) (VDW Dental, Munich, Germany), the successors of WaveOne (WO) (Dentsply Maillefer, Ballaigues, Switzerland) and Reciproc (R) (VDW Dental, Munich, Germany) systems.[6,7] RB undergoes an innovative heating–cooling treatment and with this unique thermal treatment, the blue titanium oxide layer appears on the surface of the instrument.[6] The WOG system is the improved version of the WO system. The cross-section of the file has been altered.[7] Furthermore, the alloy is altered from M-Wire to gold. Gold wire technology is based on heating the file and then slowly cooling it, whereas M-Wire technology involves heat treatment before production.[7,8] This thermal treatment modifies the transition temperatures, which result in superior mechanical properties and better performance of the instrument.[6-8]

There are limited studies evaluating the extrusion potentials of these two file systems'.[9-12] Therefore, this study was conducted to compare the amounts of apical extruded debris with either of these two novel single-file reciprocating systems, namely WOG and RB, with those of two other most commonly used single-file reciprocating systems, WO and R. A multifile system, ProtaperNext (PTN) (Dentsply Maillefer, Ballaigues, Switzerland), and a single-file system, OneShape (OS) (Micro Mega, Besançon, France), which using with continuous rotation, were used as references for comparison. The null hypothesis was that there would be no difference among these file systems in terms of the amount of the apically extruded debris.

MATERIALS AND METHODS

Thirty freshly extracted mandibular human molars with two separate canals and apical foramina in the mesial root were selected for this study after Hacettepe University non-invasive Ethics Committee approval was granted (No:GO 17/461 - 50) on May 2017. The molars with completely formed, straight roots (having a curvature of less than 10°) according to the Schneider method[13], having no visible caries, fractures, calcifications, cracks or resorptions were included. Following the removal of the distal roots, the presence of the separate canals was confirmed by radiographic means obtaining the buccolingual and mesiodistal views. The tissue remnants and calculus on the root surfaces were removed. The remaining parts of the distal roots were sealed with sticky waxes in orthograde and retrograde ways. A conventional straight-line access preparation was performed. The ♯10 K-file was inserted into the canal until its tip was visible at the apical foramen, confirming the apical patency. The working length (WL) was set by subtracting 1 mm from the initial length for each canal.

Debris Collection

The process of debris collection was evaluated by a technique previously described by Myers and Montgomery.[14] Stoppers were separated from Eppendorf tubes. An analytical balance (Radwag, Radom, Poland) with an accuracy of 10^{-5} was used to measure the pre-experimental weights of the tubes. After each tube was weighed without stoppers three times, the mean values of these measurements were calculated and noted as initial weights. A hole was made on the stoppers of each of the tubes. The teeth were inserted into the cementoenamel junction by using a 27-gauge needle (Genject, Ankara, Turkey) to balance the air pressure inside and outside the tubes. The teeth were fixed to the stoppers with cyanoacrylate. The stoppers were then attached to their Eppendorf tubes and this set-up was placed into the vials. The 30 molar teeth were randomly assigned to 6 groups of 5 specimens (n=10 canals/per group) in each.

Group WOG: WaveOne GOLD (Dentsply Maillefer, Ballaigues, Switzerland) Primary (25/.07) instruments were used with "WaveOne" mode of an endodontic motor (X-Smart Plus, Dentsply Maillefer, Ballaigues, Switzerland).

Group WO: WaveOne (Dentsply Maillefer, Ballaigues, Switzerland) Primary (25/.08) instruments were used with "WaveOne" mode of the endodontic motor (X-Smart Plus).

Group R: Reciproc (VDW Dental, Munich, Germany) R25 (25/.08) instruments were used with "Reciproc" mode of the endodontic motor (X-Smart Plus).

Group RB: Reciproc Blue (VDW Dental, Munich, Germany) R25 (25/.08) instruments were used with "Reciproc" mode of the endodontic motor (X-Smart Plus).

Group OS: One Shape (Micro Mega, Besançon, France) 25.06 instruments were used with the endodontic motor (X-Smart Plus) at 350 rpm and 2.5 N/cm.

Group PTN: ProTaper Next (Dentsply Maillefer, Ballaigues, Switzerland) instruments were used with the endodontic motor at 300 rpm and 2N/cm. The instrumentation sequence consisted of X1 (17.04) and X2 (25.06) files.

In all experimental groups, once the instrument reached to the WL and started rotating freely, it was removed. The fractured files during the process were noted. A total of 10 mL of distilled water was used in each canal during the preparation process to avoid any potential crystallization of sodium hypochlorite.[15] After completing preparations, a final irrigation was performed with 2 mL distilled water. The apical parts of the teeth were washed with 1 mL distilled water to collect the adhered debris at the root surface**.** Each of the mesiobuccal (MB) and mesiolingual (ML) canals was prepared separately and the debris extruded from MB and ML roots were collected in different tubes (a total of 10 tubes per group; n=10 per group). The MB canal orifices were sealed with a composite material (Dentonics, Monroe, NC, USA) while instrumenting the ML canal or vice versa. Then all tubes were stored in an incubator at 70°C over a period of 5 days to evaporate the distilled water before weighing the extruded debris. The tubes were weighed using the same analytical balance (Radwag) to obtain the final weight of the tubes containing the extruded debris. Each tube was weighed 3 times and the mean value was calculated for each. The amount of apically extruded debris was calculated by subtracting the initial weight of tube from the final weight.

Statistical Analysis

The distribution of the data was analyzed using the Kolmogorov-Smirnov normality test. The comparisons of the amounts of extruded debris were analyzed using the one-way ANOVA and Bonferroni post-hoc tests using the SPSS 22.0 software (IBM SPSS, Chicago, IL, USA). The significance level was set at $p<0.05$.

RESULTS

The mean values and standard deviations for all groups are listed in Table 1.

Table 1. Amount of extruded debris of experimental groups as mean± standard deviations (SD).

File Systems*	N	Mean ± SD (gram)
Reciproc[a]	10	0.005±0.003
Reciproc Blue[ab]	10	0.007±0.001
WO[bc]	10	0.009±0.003
WOG[c]	10	0.011±0.003
PTN[a]	10	0.005±0.002
OS[c]	10	0.013±0.004

*Different superscripts mean statistically significant difference. Significant at $p<0.05$.

All instrumentation systems yielded apical extrusion materials. The lowest amount of debris was obtained in the R, RB, and PTN groups and there were no significant differences among them ($p>0.05$). On the other hand, WO, WOG, and OS groups extruded significantly more debris compared to the R and PTN Groups ($p<0.05$). Extruded debris in RB and WO groups were not significantly different, while RB produced less debris than WOG and OS ($p<0.05$).

DISCUSSION

In this present study, different single-file reciprocating instruments were compared in terms of their apical extrusion potentials. A rotating single-file system, One Shape, and a multi-file system, ProTaper Next, were used as controls. Reciproc Blue and WaveOne Gold have been recently introduced into the dental market. Therefore, the literature review informed that there was only one published study, which evaluated the apical extrusion with RB.[12] Only a limited number of studies[9-11] evaluated the apical extrusion potential of WOG. Before the introduction of these instruments to the clinical practice, it is important to test the novel systems in vitro and compare the results with those of well-studied file systems. Decreasing the amount of apically extruded debris is one of the needs to be met by the characteristics of the file systems in order to improve the apical healing process and to prevent flare-ups and postoperative pain.[5] Therefore, the present study evaluated the extrusion potential of the abovementioned file systems.

Only a limited number of studies have evaluated debris extrusion from the mandibular molars, which were instrumented with reciprocating files as in the present study.[16,17] In the previous studies, the mean weight of the extruded debris with the OS file was reported between 0.00018 and 0.00069 g.[3,17,18] This amount was reported to be between 0.00019 and 0.00085 g for PTN.[2,19-23] These values are relatively lower compared to the results obtained in our study. This finding might have occured primarily due to the use of single-rooted teeth in the extrusion studies.[2-4,9,19,22] Using single-rooted teeth might result in a lesser amount of debris because of the simple and larger roots in regards to the canal anatomy.[16] This could explain the larger amount of apically extruded debris in the current study, especially in the OS and PTN groups. The amount and the type of irrigant could also affect the weight of extruded debris.[24] Considering the reciprocating systems WO and R, the amount of extruded debris is consistent with the amounts reported in the previous studies.[9,25] A significantly more amount of debris was extruded by the WO instruments compared to the amount extruded with the R and PTN instruments. However, previous studies[3,4,21] have demonstrated no significant differences between WO and R. Conflicting results have been reported when the WO and PTN systems were compared. Pawar *et al*.[19] reported that WO resulted in the extrusion of a significantly more amount of debris compared to PTN similar to the result of the present study. In contrast, Ustun *et al*.[2] reported a significantly more amount of apically extruded debris with PTN compared to WO, whereas some studies[20,21,23] could not detect any significant difference between these instruments.

In the present study, a significant difference was not detected between the RB and R groups. A significantly less amount of extruded debris was obtained in the RB group compared to the OS and WOG groups. Uslu *et al*.[12] reported that Hyflex EDM (HEDM; Coltene/Whaledent, Altstaatten, Switzerland), extruded less debris compared to RB by its continuous rotary movements although there were no significant differences between these two systems. In the present study, RB extruded less debris than OS, continuous rotary system, which used as control. The differences between the results can be attributed to different design characteristics and raw materials of the continuous rotary file systems. Karataş *et al*.[9] reported that the WO group yielded a significantly more amount of extruded debris compared to the WOG group. However, in the present study, there was no difference between these two systems in terms of the amounts of apical extrusion. Dincer *et al*.[11] reported that PTN files produced a higher amount of debris compared to WOG. These results are not consistent with the current study. As mentioned earlier, different parameters such as the tooth type, the amount of irrigant used, the last file used for instrumentation could affect the results of the studies.

The extrusion set-up has few limitations including the absence of tissues mimicking the periodontal ligament. Today, there are some methods available to mimic periapical resistance such as agar jel [26] and floral foam.[27] However, while the foam used in simulating the periapical pressure may absorb some debris,[28] the agar jel

does not simulate periapical resistance sufficiently compared to the resistance of the periapical tissues.[29] There are no studies available in the literature, comparing different set-ups regarding the apical extrusion. In the future, the effect of different set-ups on the apically extruded debris might be investigated. The set-up in the present study was beneficial for comparing the amount of extruded debris using different NiTi systems.[10,30]

CONCLUSIONS

The null hypothesis proposed in this study was rejected under the experimental conditions of this in vitro study. The RB and WOG file systems produced amounts of extruded debris similar to the amounts obtained by using well-studied file systems. RB and WOG showed different results in terms of debris extrusion. However, both file systems were similar to their precursors in terms of this parameter and were safe for use in molar root canals.

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The authors declare that they have no conflict of interest.

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CONFLICT OF INTEREST

None

Farklı Nikel-Titanyum Sistemlerinin Apikal Debris Ekstrüzyonu Açısından Karşılaştırılması

ÖZ

Amaç: *Bu çalışmanın amacı, farklı nikel titanyum eğe sistemlerini apikalden taşan debris miktarı açısından değerlendirmektir.* ***Gereç ve Yöntemler:*** *Bu çalışmada mesial köklerinde iki ayrı kanal ve apikal foramene sahip toplam 30 adet mandibular molar diş seçildi. Kök kanalları (n=10) aşağıdaki altı eğe sistemine göre rastgele ayrılmıştır: ProTaper Next (PTN), WaveOne (WO), WaveOne Gold (WOG), One Shape (OS), Reciproc (R) ve Reciproc Blue (RB). İnstrümantasyon sırasında ekstrüde edilmiş debrisler önceden boş ağırlıkları ölçülmüş eppendorf tüplerinde toplandı ve sonra irrigantı buharlaştırmak için beş günlük bir süre boyunca 70°C'de bir inkübatörde saklandı. İnkübasyon sürecinden sonra, eppendorf tüpleri tekrar tartıldı. Bu iki ölçüm arasındaki fark hesaplandı. Veriler istatistiksel olarak analiz edildi ve anlamlılık düzeyi p<0,05 olarak belirlendi.* ***Bulgular:*** *R, WO ile karşılaştırıldığında daha az debris taşmasına sebep oldu. R ve PTN eğeleri, OS eğelere göre anlamlı derecede daha az debris taşımına sebep oldu (p <0,05). RB ve WO gruplarında apikalden taşan debris miktarı anlamlı ölçüde farklı değildi ancak RB WOG ve OS'den daha az debris taşmasına sebep oldu (p<0,05).* ***Sonuçlar:*** *Bütün eğe sistemleri apikalden debris taşırmıştır.*

Anahtar Kelimeler: *Endodonti, kök kanal hazırlama, kök kanal tedavisi.*

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Original research

THE IMPACT OF PLATFORM-SWITCHED IMPLANTS ON THE MARGINAL BONE LEVEL AND SOFT TISSUE DIMENSIONS

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ABSTRACT

Objectives: The objective of this study is to compare the characteristics of the concept of platform-switched implants (PSW) that have recently emerged in implant dentistry and its effects on the marginal bone loss (MBL) around the implant with platform-matched implants (PMI).

Data: In the study, PSW implant-abutment connection system, MBL, and peri-implant hard and soft tissue changes were examined. The research terms used in the study are dental implant, platform switching concept, switched platform, platform mismatch, platform-matched implants, and dental implant-abutment design.

Sources: In the electronic research, the language was selected as English and studies conducted until March 2018 were investigated without year limitation. The electronic studies include the National Library of Medicine, PubMed/Medline, Web of Science, Cochrane Oral Health Group Trials, and Cochrane Central Register of Controlled Trials.

Study selection: Studies, retrospective or prospective clinical human studies, either randomized systematic review and meta-analyses, and finite element analyses (FEA) were examined. Case reports and studies of animal experiments were excluded from the review.

Conclusions: It was observed that clinical trials consisted of short and medium-term follow-ups and biomechanical studies were limited. It was observed that PSW implant systems obtain positive results in reducing the MBL and are more aesthetic in terms of soft tissue formation compared to PMI systems, and interest has been gradually increasing in the PSW system in recent years. It was revealed that long-term clinical trials for the PSW system are required.

Keywords: Dentistry, platform-switching, dental implant-abutment design, dental abutments, dental implants, alveolar bone loss.

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INTRODUCTION

Implant treatment modalities offer standard, aesthetic, and functional approaches for cases of partial and complete edentulism.[1,2]

The presence of osseointegration, which is the close relationship between the implant and the peri-implant bone, and the preservation of the marginal bone level are necessary aspects for success in dental implants.[3] The bone resorption in the peri-implant region is the major cause of implant failures.[4,5]

Soft tissue inflammation, which occurs in the implant-abutment connection area, passes through the mucosal barrier and spreads from the implant interface to the bone tissue over time, and creates a biological gap around the implant. Therefore, resorption begins in the bone around the implant.[6,7] Stability of the bone loss, no or minimal resorption in the peri-implant marginal area during the loading phase and duration of oral use of implant-supported prosthetic restorations are important criteria for implant success.[5,8]

In the last thirty years, there have been significant developments in the field of prosthetic dentistry, the characteristics of dental implants, surgical procedures, and prosthetic restorations.[9]

It has been expressed that within a one-year period following the prosthetic treatment by providing the implant-abutment connection for both maxillary and mandibular implant treatments, the radiological crestal bone loss should be between 1.2-1.5 mm and vertical bone loss should be <0.2 mm every year during the functioning of implants.[3,10] New clinical techniques, various implant application techniques and designs have been developed.[6,11]

Marginal bone losses start in the implant-abutment connection areas and at the first groove of the implant. It is necessary to reduce the bone loss in order to increase the clinical survival rates of implants.[12,13] Factors affecting the marginal bone loss around the implant are presented in Table 1.[14-16]

Table 1. Factors effecting marginal bone loss around implants

Peri-implant marginal bone loss factors	**Researcher/year**
Occlusal overload; traumatic occlusion and combined with inflammation resulting in crater like bone defects lateral to the implants.	Hagiwara 2010, Misch 2009, Wu *et al.* 2016, Ferraz *et al.* 2012, Lindhe and Meyle 2008
Periimplantitis; was a site specific infection with microbial flora similar to chronic periodontitis.	Alvarez-Arenal *et al.* 2017, Lindhe and Meyle 2008, Lang and Berglundh 2011
Biomechanical factors	Hagiwara 2010
Implant design; macrodesign of the cervical area of the implant (i.e., platform-switching and platform-matching implants)	Freitas-Júnior *et al.* 2012, Strietzel *et al.* 2015
Implant diameter; using a small diameter implant may increase the stress and/or strain of bone around the implant neck	Wu *et al.* 2016, Baggi *et al.* 2008
Implant material properties	Freitas-Júnior *et al.* 2012
Implant surface configuration; surface topography of the implant neck	Wu *et al.* 2016, Hammerle *et al.* 1996
The width of the alveolar bone is insufficient	Freitas-Júnior *et al.* 2012
Concavity of the ridge is present (especially in the anterior regions of the jaws)	Wu *et al.* 2016
Implant-abutment micro-gap adversely affects the stability of the periimplant tissue. A microgap exists between the components of a 2-piece implant. This microgap may provide a place for bacterial colonization and food debris.	Hagiwara 2010, Singh *et al.* 2013
Implant crest module is the transosteal region of the implant- crestal stress during loading	Hagiwara 2010
Biologic width;	Hagiwara 2010, Singh *et al.* 2013, Lee *et al.* 2016
Surgical trauma; the heat generated during drilling may cause damage, inviting inflammatory and traumatic response.	Singh *et al.* 2013, Ferraz *et al.* 2012
İmproving the interface between soft tissue and implant-abutment junction	Freitas-Júnior *et al.* 2012
Type of implant–abutment connection	Palaska *et al.* 2016
Repeated connection/disconnection of abutments	Abrahamsson *et al.* 1997
İnterimplant distance	Rodriguez-Ciurana *et al.* 2009
İmplant positioning relative to the alveolar crest	Hermann *et al.* 2000
Micromovements of the abutment (prosthetic components)	Duyck *et al.* 2006
Smoking status	Clementini *et al.* 2014

In order to take the marginal bone loss around the implant under control, there are methods such as placing implants by single-stage surgical procedures and performing the implant-abutment restoration as a whole. However, there has not been an ideal method found yet.[8,17]

The platform-switching (PSW) implant configuration in dentistry was developed to prevent resorption in the cervical crestal bone by using an abutment with a diameter narrower than the implant diameter.[18,19] There are many studies in the literature that have been conducted on this subject in the past decade.[20-22]

It has been reported that the peri-implant bone loss in PSW implants is between 0.05 and 1.4 mm in the first year following the prosthetic loading.[5,23] PSW characteristics and application methods were first discovered in 1991. Wide implants 5 and 6 mm in diameter were produced by 3i implant system (Biomet) company in order to increase the bone connection surface and provide primary stability in implants. The marginal bone resorption was found to be lower in these implants with narrow platforms in clinical and radiological follow-ups of 1-5 years of restorations made using 4.1 mm diameter abutments compared to regular platform implants.[9,24] Primarily by using narrow-diameter abutments, the bacterial invasion to the neck of the implant is prevented and the implant is preserved. The other reason is suggested as the soft tissue's creating a barrier for microorganisms with aesthetic and full formation.[25] The principles of PSW are the use of an abutment with a diameter narrower than the implant diameter, the absence of the shiny surface in the implant neck region, the use of internal screw implant systems, enabling the bone-level implant placement, the use of an implant with a diameter as large as possible, the selection of abutment with high durability, immediate loading, and the resistance of peri-implant tissues to occlusal forces. [5]

However, some studies have stated that it is unclear whether the PSW configuration is better than platform-matching implants in terms of peri-implant bone stress distribution and peri-implant bone level changes.[6] In other studies, it has been reported that it prevents the marginal bone loss and soft tissue loss at a low rate.[26-29] However, there are more researchers who state the opposite.[30,31]

As stated by the researchers, the soft tissue size was approximately 3.6 mm and it contained a barrier epithelium of 1.9 mm and a connective tissue portion of 1.7 mm.[32] It is very important to maintain the crestal bone level to preserve soft tissue and therefore facilitate oral hygiene and sustain gingival esthetics. It has been suggested to place dental implants subcrestally in esthetic areas in order to acquire a perfect emergence profile for the prosthetic rehabilitation and to reduce the possibility of exposing the metal top of the implant or of the abutment margin.[9]

Therefore, the main objective of this review is to make a comprehensive literature assessment of the PSW concept and compare the advantages, disadvantages, and areas of use of the PSW implant concept with the marginal bone resorption, aesthetic and biomechanical characteristics of platform matching implants and to provide detailed information. Scientific data were compiled by examining controlled clinical prospective and retrospective studies, biomechanical analyses, systematic reviews, and results of meta-analyses conducted on this subject.

Advantages of PSW configuration: Table 2 contains information on the advantages of the PSW configuration in the substances below.

Disadvantages of PSW configuration: Table 3 contains information on the disadvantages of the PSW configuration in the substances below.

Table 2. Advantages of PSW configuration

	Researcher/year
Marginal bone is protected with platform switching concept	Wagenberg and Froum 2010
Reduces the stress at the bone-implant interface It provides a biomechanical advantage	Maeda *et al.* 2007
Have better periimplant bone stress distribution	Romanos *et al.* 2016, Liu *et al.* 2014
Lead to less periimplant bone level changes	Liu *et al.* 2014
Marginal bone loss decreases mesially and distally	Wagenberg and Froum 2010
Displacement of the intensity voltage of the implant-abutment	Freitas-Júnior *et al.* 2012
Implant-abutment combination is moved to the central axis of the implant	Tabata *et al.* 2010
The shift of the micro-gap between the implant and abutment	Freitas-Júnior *et al.* 2012
Force transmission is less than the standard implants from the crestal bone	Tabata *et al.* 2010
Clinical are preferred and the biologic and mechanical advantages	Wu *et al.* 2016, Cassetta *et al.* 2016
Crestal region of cortical bone by shifting the stress to cancellous bone during loading	Wu *et al.* 2016
Supported by several clinical and experimental studies	Freitas-Júnior *et al.* 2012
Platform switched implants had the least reduction in soft tissue	Barwacz *et al.* 2016, Liu *et al.* 2014
Can be applied together with immediate loading	Carinci *et al.* 2009
Maintenance of the gingival papilla are of importance in obtaining satisfactory esthetic results	Ferraz *et al.* 2012
PSW may keep away the micromotion between the implant and abutment from the bone.	Chrcanovic *et al.* 2015
PSW implants can increase the distance of inflammatory cells (micro-gap) from the bone margin, thereby maintaining bone tissue	Freitas-Júnior *et al.* 2012
Reverse conical implant neck	Carinci *et al.* 2009

Table 3. Disadvantages of PSW configuration

	Researcher/year
It may be associated with the infiltration of bacteria source platform switching	Gardner 2005, Baumgarten *et al.* 2005
It may increase the distance between marginal bone and implant	Gardner 2005, Baumgarten *et al.* 2005
Increasing stress intensity on the abutments screw	Tabata *et al.* 2010
Developing prosthetic failure due to a broken abutments screw	Maeda *et al.* 2007, Tabata *et al.* 2010, Canay and Akça 2009
Fixed and/or removable dentures in reconstruction challenges	Maeda *et al.* 2007, Tabata *et al.* 2010, Canay and Akça 2009
Patients economic losses due to screw breakage	Maeda *et al.* 2007, Tabata *et al.* 2010, Canay and Akça 2009
A greater risk of implant fracture may also be found	Maeda *et al.* 2007, Tabata *et al.* 2010, Canay and Akça 2009
Inconsistency between the implant and abutment platform in PSW systems may be between 0.3 mm versus 0.5 mm. Narrow abutment of neck to increase the risk of screw fracture produced consistent narrow screws	Maeda *et al.* 2007, Tabata *et al.* 2010, Canay and Akça 2009, Becker *et al.* 2007
It is increasing the stress density on the abutment screw and abutment	Maeda *et al.* 2007

Commercial platform switching systems

In recent years, many implant companies have been producing implants and abutments suitable for PSW systems. The most commonly used implant systems and companies are presented in Table 4.

Table 4. Commercial trademarkers PSW configuration

Commercial systems	**Manufacturer**	**Researcher/year**
Certain Prevail Implant	Biomet 3i, Implants Innovations Inc, Palm Beach gardens, FL, USA	Albrektsson *et al.* 1986
Osseotite Certain	Biomet 3i, Implants Innovations Inc, Palm Beach gardens, FL, USA	Albrektsson *et al.* 1986, Fickl *et al.* 2010, Sivolella *et al.* 2013
Global	Sweden & Martina	Crespi *et al.* 2009
Novel Active	Nobel Biocare	Wagenberg and Froum 2010
Ankylos Morse taper-type connections	Dentsply Friadent	Crespi *et al.* 2009
Camlog Screw-Line Promote plus surface	Camlog Biotechnologies AG, Basel, Switzerland	Guerra *et al.* 2014
3i, Implant Innovations	Inc. Palm Beach Gardens, FL	Desai and Patil 2013
Osstem GS III implant system	Osstem Implant Co., Seoul, Korea	Lindhe and Meyle 2008
NobelReplace™Tapered Groovy	Nobel Biocare AG, Zürich, Switzerland	Lee *et al.* 2016
BioPlatform, patent pending	GTB Plan 1 Health Amaro, UD, Italy	Girolamo *et al.* 2016
SIN implants	São Paulo, SP, Brazil	Freitas-Júnior *et al.* 2012
ITI Standard implants	Institut Straumann AG, Basel, Switzerland	Baggi *et al.* 2008

It has been reported that the use of internal hexagonal implant-abutment connections in PSW systems is more advantageous than external hexagonal connections from the biomechanical aspect.[33,44] Moreover, it has been emphasized that Morse taper-type internal connection systems can be preferred since they cause less resorption and MBL (marginal bone loss), less bacterial contamination, and less bacterial invasion at the implant-abutment interface than butt-joint connection systems.[55]

MATERIALS AND METHODS

The literature review was carried out electronically without a time limitation in PubMed/Medline, Web of Science, Cochrane Oral Health Group Trials Register, plus hand-searching and Google scholar until March 2018. The criteria for inclusion in the study were as follows: articles published in English. The keywords were selected as dentistry, dental implant, oral implant, platform switch, switched platform, platform mismatch, and dental implant-abutment design, platform-switching (PSW) implant concept, abutment, implant fixture, and platform matching (PM) implant. A total of 180 articles were reviewed. A total of 69 articles, including systematic reviews and meta-analyses, randomized retrospective and prospective clinical trials (at least 12 months of follow-up clinical studies in humans), and biomechanical in vitro studies, which were directly related to the subject, were included in the study. PSW implants were compared with platform matching implants (PMI), and evaluations were made. Information about commercial implant manufacturers, implants, and abutments suitable for the PSW method was evaluated in the light of the literature.

DISCUSSION

In-vitro studies of PSW configuration; finite element analysis and comparative analysis of platform matching implants and platform switching implants.

In a finite element analysis[5] performed to determine the PSW and PM abutment-implant stress distribution, the PSW abutment was compared with the Ankylos implant and PM abutment Anthogyr implant. In PSW implants, peri-implant bones were found to have lower stresses, and more uniform stress distribution was observed.

In a biomechanical analysis[15] performed by placing PSW-compatible abutments in narrow-diameter (3.25 mm) implants, marginal bone stresses were found to be 74.9% lower than those of PM implants. When immediate loading was performed with the PSW abutment in small diameter implants, marginal bone stresses around the implant were less common.

In a study[33] in which internal and external hexagonal platform-switched implant-abutment connections were evaluated biomechanically, while high stresses were observed in external hexagon implants, reliable results were obtained in internal hexagon implants.

In a finite element analysis[16] examining the effect of the PSW configuration on the stress distribution in angular abutments, it was found out that the PSW reduced stress in the cortical bone.

A regular implant (prosthetic platform of 4.1 mm) and a wide implant (prosthetic platform of 5.0 mm) were utilized for introducing PSW and PM implant systems in the studies in which they were compared with FEA.[47] The stress was determined over a broader area in the peri-implant bone tissue (159 MPa) and the implant (1610 MPa), while it was observed that the PSW reduced the stress distribution on bone tissue (34 MPa) and implant (649 MPa). It was found out that the PSW reduces stress distribution in the implant and bone by 80% and is biomechanically advantageous.

In a 3D-FEA analysis[64], in which the effects of the PSW on stress distribution were examined in long and short implants in the maxillary anterior region, it was observed that stresses were lower in long and PSW implants.

A 3D-FEA was performed for evaluating the load distribution and capability of various implant types to bear the same. Much greater cortical bone stress values (145% in tension and 290% in compression) were exhibited by the Nobel Biocare and ITI standard implants compared to the Anklyos system. As a result of the study, it was reported that PSW caused a decrease in overloading risk.[35]

The impact of implant design (in terms of diameter, length, and thread shape), in-bone positioning depth, and bone post healing crestal morphology on the load transfer mechanisms of osseointegrated dental implants was examined in the study of Baggi *et al.*[66] on the basis of PSW. A 3D-FEA was conducted by simulating static loading. The implant diameter represents a more effective design parameter in comparison with the implant length, in addition to the fact that thread shape and thread details may have a considerable effect on stresses at the peri-implant bone, particularly for short implants.

The PSW procedure has an advantage from the biomechanical aspect since it shifts the stress concentration area away from the cervical bone-implant interface.

A 3D-FEA was carried out for assessing and comparing the stress distribution in the peri-implant bone of one single implant-supported crown with PSW and non-PSW. Models were formed with an implant (4, 9, 13 mm, platform 4.1 mm) in the jaw bone. The PM model was simulated in the computer environment by using a 4.1-mm diameter abutment, and the PSW model was simulated in the computer environment by using a 3.8 mm diameter abutment. The stress at the transitional cortical bone is reduced as a result of the PSW technique. In two models, as the load becomes more inclined, a gradual increase in the stress in question occurs. Lower stress values are observed in the transitional trabecular bone compared to the transitional cortical bone.[8]

According to the 3D-FEA results, the main concentration of the stress was at the bottom of the abutment and the top surface of the implant in two models. The von Mises stress values were determined to be considerably greater in the PSW model in a major part of the components, except for the bone. The highest von Mises values and stress distribution pattern of the bone were similar in the models.[67]

Clinical studies of PSW configuration; Marginal bone resorption, clinical follow-up and implant survival rates

In clinical trials that have been carried out in recent years, PSW and PMI implant systems are compared. Accordingly, 5-year randomized clinical trial one hundred subjects were chosen for the present study. The average MBL alterations for tissue-level implants restored with PMI were determined to be 0.26 mm at baseline to 1 year, 0.34 mm at 1 year to 5 years, and 0.61 mm at baseline to 5 years. The average MBL alterations for bone-level implants restored with PSW were determined to be -0.03 ± 0.74 mm at baseline to 1 year, -0.17 ± 0.67 mm at 1 year to 5 years, and -0.20 ± 0.75 mm at baseline to 5 years. The average difference between the two groups was found to be 0.31 mm at baseline to 1 year, 0.53 mm at 1 year to 5 years, 5 years: PSW; -0.20 ± 0.75. Good and similar survival rates were exhibited by both implant systems: 98% for PMI, 96.1% for PSW.[7]

The impact of subcrestal implant placement in comparison with the equicrestal position on hard and soft tissues around PSW was systematically reviewed. The systematic review in question included 14 articles in total. The findings obtained from the meta-analyses have demonstrated that subcrestal implants, in comparison with equicrestally placed implants, presented fewer MBL alterations, in subcrestal implants with regard to the implant shoulder.[9]

The comparison of PSW and non-platform-switched implants was performed following 12 months of loading. The mean mesial and distal marginal bone loss of the control group was determined to be considerably higher than twice that of the test group. The findings indicate that the shorter the abutment height is, the more significant the marginal bone loss is.[75]

In the current prospective study[24], it was aimed to assess the levels of the peri-implant bone crest in addition to soft tissue response, papilla height, and buccal mucosa recession, in bone-level implants that were restored with platform switching after 1-year and 5-year follow-ups. The average marginal bone level alterations were found to be as follows: -0.06 ± 0.32 mm from baseline to 1 year, -0.23 ± 0.38 mm from 1 to 5 years, and -0.28 ± 0.45 mm from baseline to 5 years. No statistically significant differences were determinedin bone-level outcomes between baseline and 1 year, whereas statistically significant differences were determined in the

average differences between 1 and 5 years and baseline and 5 years.

The literature review[5] covered 83 publications in total. The impacts of microgap and micromotion at the implant-abutment interface on marginal bone loss around the neck of the implant were summarized. It is necessary to choose appropriate Morse taper or hybrid connection implants and PSW abutments for the purpose of decreasing the corresponding detriment to the implant marginal bone.

In the study[3], 60 dental implants were placed in 51 patientsduring a 1-year period. In case of platform switching, a bone gain of 0.93 mm was determined in the vertical gap and 0.50 mm in the horizontal gap. The decrease in the vertical gap from the baseline until 12 months was found to be 0.92 mm in PSW and 0.29 mm in PMI. PSW was found to have a greater effect on a better peri-implant alveolar bone vertical and horizontal gap reduction in 1 year.

In a systematic review and meta-analysis[76], 26 publications in total including 1,511 PS implants and 1,123 RP implants were assessed. In comparison with PMI, PSW implants exhibited a small increase in vertical MBL and pocket depth reduction (differences were found to be -0.23 mm and -0.20 mm, respectively). An average VMBL (vertical marginal bone loss) of 0.36 ± 0.15 mm was determined within the first year in PS implants. There may be an indirect protective impact of PSW on implant hard tissue outcomes.

1439 implants and 642 patients in total were selected. Smaller mean marginal bone loss around PSW implants was determined in more studies, and no differences with regard to implant failure rates were detected in any of them. A great impact of the PSW technique on preventing marginal bone resorption was confirmed as a result of the review.[63]

Following an average loading time of 3 years, the implant survival rate was determined to be 98.74%. As indicated, the implants' stability is not impaired by the EML (early moderate loading) of implants.[46]

52 implants were placed in twenty-four patients. Bone preservation or gain was presented in a total of 71.7% of all implants. No implant was lost in 1 year, and 100% success rate was achieved. A high level of satisfaction was revealed as a result of the patient inquiry. A high rate of success and improvement or maintenance of marginal bone levels were determined following 1 year of loading in internal conical connection implants with PSW abutments.[77]

108 patients with 228 implants, 180 implants 4.5 mm in diameter and 48 implants 5 mm in diameter, were included in the retrospective study. OsseoSpeedTM implants with the internal tapered conical connection MBL higher at 18 vs. 6 months, for short vs. long abutments, for grafted vs. pristine bone, and for implants with a diameter of 5.0 vs. 4.5 mm were placed in all patients. The MBL is not reduced by higher mismatching.[78]

15 implants that were restored with platform switching PSW abutments and 15 implants that were restored with non-PSW (platform matched) abutments were selected. The placement of definitive abutments with conical connections was performed. After 12 months, it was determined that all implants remained osseointegrated at a 100% success rate. The marginal bone level alteration at 12 months was found to be 0.04 mm in the PSW group and 0.19 mm in the non-PSW (PMI) group.[79]

In a one-year evaluation of 89 implants placed in 36 patients, while the bone loss in PSW implants was between 0.30-0.07 mm after a year following the placement of permanent prostheses, it was between 0.68-0.17 mm in platform-matching implants.[59]

In a 5-year clinical trial[58], it was emphasized that PSW implants were stable for 5 years, had a total survival rate of 97.1%, and the marginal bone loss was low, being 0.08 mm. According to these results, it is stated that implant and abutment designs suitable for PSW configuration can be suggested.

In short-term clinical trials, it is reported that PSW implant systems reduce marginal bone loss and exhibit high survival rates, but it is emphasized that long-term studies are inadequate.[5,27-29]

An 11-year radiological follow-up of 94 platform switching implants was performed in a retrospective study. During the mentioned period,

75% mesial and 71% distal no bone destruction was determined. Bone resorption less than 0.8 mm was observed in 84% of implants.[44]

A meta-analysis[51] of 28 articles was performed in approximately a 3-year clinical follow-up study. A total of 1216 PSW implants (16 failures; 1.32%) and 1157 PM implants (13 failures; 1.12%) were examined. A smaller marginal bone loss was determined in implants with PSW compared to implants with PM.

A meta-analysis[80] investigated twenty-two clinical follow-up studies as 8-15 months. Crestal bone levels can be maintained more in PSW compared to PM during the placement of implants. However, there is insufficient evidence for avoiding debates.

It was observed that as a result of a 12-month follow-up in maxillary and mandibular implants, while the marginal bone loss was between 0.95-0.32 mm in implants depending on the PSW configuration, it was between 1.67-0.37 mm in the control group.[81]

25 studies were examined in the meta-analysis; of which there were 17 randomized controlled trials and 8 prospective studies including 1098 patients and 2310 implants. 12-24-month clinical follow-ups were performed. Therefore, a lower crestal bone loss was found in PSW implants in comparison with PM implants.[20]

A 24-month follow-up study was carried out in patients with and without type 2 diabetes mellitus. The study covered 45 male patients in total. However, no significant difference was detected in the peri-implant MBL in both groups.[82]

In a 6-month follow-up, 80 PSW implants, in the maxillary anterior and mandibular posterior region, were positioned and restored after two-stage surgical and progressive loading protocols. MBL was found to be significantly higher in the anterior group (1.2 mm) compared to the posterior group (0.7 mm). A significantly greater bone loss amount was detected in the maxillary anterior region than in the mandibular posterior region.[25]

The analysis[83] included 51 patients and 117 implants. Following 3 years of function, the PSW concept (0.33±0.19 mm) can cause a decrease in the marginal bone loss over time in comparison with the standardized one. PSW may be a practicable prosthetic alternative to the implant treatment of partial edentulism.

The limitations of this study include the short and medium-term follow-up period and the absence of long-term follow-ups in clinically controlled studies. Secondly, they include difficulties in comparing the results obtained from the FEA with one another due to different implants and modeling.

CONCLUSIONS

According to studies performed on PSW implant supported prostheses, crestal bone loss is lower in this method. Furthermore, the clinical survival rates of protheses increase by preventing soft tissue inflammation in the marginal zone. A lot of advantages will be ensured for patients as well as dentists as a result of the prolonged life of implants. Nevertheless, the narrower diameter of the abutment and abutment screw breakage occurring due to the usage of the abutment constitute the most significant complications and disadvantages.

Furthermore, according to the data obtained within the limitations of the study, it was concluded that the PSW system is a simple, functional treatment modality that preserves the crestal bone around the implant. It is obvious that more prospective studies and long-term controlled clinical observations on this issue are required. Therefore, it will become more safe and advantageous to use the PSW concept in question.

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CONFLICT OF INTEREST

There is no conflict of interest for this study

Platform Değiştirmeli Implantların Marjinal Kemik Seviyesi ve Yumuşak Doku Boyutlarına Etkisi

ÖZ

Amaç: *Bu çalışmanın amacı, implant diş hekimliğinde son zamanlarda ortaya çıkan platform-switch (değiştirmeli) implantlar (PSW) kavramının özelliklerini ve implant etrafındaki marjinal kemik kaybı (MKK) üzerindeki etkilerini platform-match (değiştirilmemiş) implantlarla (PMI) karşılaştırmaktır.*

Veriler: *Çalışmada PSW implant-abutment bağlantı sistemi, MKK ve peri-implant sert ve yumuşak doku*

değişiklikleri incelendi. Çalışmada kullanılan araştırma terimleri, dental implant, platform değiştirme konsepti, değiştirmeli platform, platform uyuşmazlığı, platform uyumlu implantlar ve dental implant-abutment tasarımıdır. ***Kaynaklar:*** *Elektronik araştırmada dil İngilizce olarak seçildi ve Mart 2018'e kadar yapılan çalışmalar yıl sınırlaması olmadan araştırıldı. Elektronik araştırmalar National Library of Medicine, PubMed/Medline, Web of Science, Cochrane Oral Health Group Trials ve Cochrane Central Register of Controlled Trials'ı içermektedir.* ***Çalışma seçimi:*** *Araştırmalar, geriye dönük veya ileriye dönük klinik insan çalışmaları, randomize sistematik derleme ve meta-analizler ve sonlu elemanlar analizi çalışmaları incelenmiştir. Vaka raporları ve hayvan deneyleri çalışmaları inceleme dışında bırakıldı.* ***Sonuç:*** *Klinik çalışmaların kısa ve orta dönem takiplerden oluştuğu ve biyomekanik çalışmaların sınırlı olduğu görülmüştür. PSW implant sistemlerinin MKK' nin azaltılmasında pozitif sonuçlar elde ettiği ve PMI sistemlerine kıyasla yumuşak doku oluşumu açısından daha estetik olduğu ve son yıllarda PSW sistemine olan ilginin giderek arttığı gözlenmiştir. PSW sistemi için uzun vadeli klinik çalışmaların gerekli olduğu görülmüştür.*

Anahtar Kelimeler: *Diş hekimliği, dental implant-kaide tasarımı, diş dayanakları, diş implantları, alveoler kemik kaybı*.

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Original research

EFFECT OF NUTRIENTS AND MEDICINES ON SURFACE OF COMPOMER

ABSTRACT

Objectives: The objective of this study is to examine the effect of nutrients and medicines frequently consumed by children on the surface roughness of the Polyacid-Modified Composite Resin (compomer), a restorative material typically used in pediatric dentistry.

Materials and Methods: VOCO Glasiosite® Caps compomer was used as the restoration material. Seven control groups consisting of nutrients and medicines frequently consumed by children from 0-6 years (Group 1: Ferro Sanol® B (150 ml) syrup, Group 2: Augmentin®-BID (400 mg/57 mg) suspension, Group 3: Calpol® (120 mg/150 ml), Group 4: Bebelac® Gold 5 follow-on milk, Group 5: Danino® strawberry yogurt, Group 6: Nesquik® chocolate milk, Group 7: Cappy® orange juice) were formed and their pH values were measured. Compomer discs were created and their initial surface roughness was measured by Bruker® Stylus Profilometer. Taking into consideration its annual usage period, compomer material was brought in contact with solutions. Then the roughness test was repeated. SEM images of each compomer material were taken and compared with the control group.

Results: The evaluation of the medicine group revealed that Ferro Sanol® B displays the highest level of surface roughness difference (23.3 nm). As to the nutrients group, Cappy® orange juice showed the highest surface roughness difference (21.4 nm). SEM images support these findings.

Conclusions: The effect of the solutions on the surface roughness of filling surfaces increases depending on their acidity. However, it is believed that pH solely does not have any impact. These studies should be supported by corrosion experiments.

Keywords: Surface properties, compomers, foods, drug utilization.

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INTRODUCTION

Surface properties of restorative materials used in dentistry that are in contact with the oral environment affect the endurance of restoration. Dental materials are used not only for treatment but also to provide long-term aesthetics. Thus, the materials are desired to be as durable and smooth as the tooth surface.[1-3] Not only the corrosion and roughness on the teeth but also surface irregularities of the restoration materials cause plaque retention and therefore secondary caries, damage to the opposing teeth, and periodontal diseases due to restorations incompatible with the gingiva.[4-6] Long-term success of the restoration depends on a variety of factors such as foreign materials on the surface, micro-mechanical properties of the material, way of implementation, duration of the polymerization, and porosity.[7] In addition, acidic foods and beverages cause porosities on the surface of the material in the long term.[8] Different types of fruit juice, yogurt, and formula in particular that are frequently used in childhood and medicines that are high in acidity were shown to be capable of affecting the restorative materials as well as causing corrosion on the tooth surface.[9-11] Surface hardness of the restorative materials used in pediatric dentistry were shown to decrease in case of contact with food having low pH values.[12,13]Since the nutrition of children differs from that of adults, the number of studies on the impact of food and medicines on the compomer material used in pediatric dentistry is not sufficient.[14]

Today, compomer material is widely used in pediatric dentistry. This material is capable of releasing fluoride, highly resistant to abrasion, fracture and bending, easily shaped, can be polished, and meets aesthetic expectations. The objective of this study is to examine the impact of food and medicines frequently consumed by children on the surface roughness of the compomer material.

MATERIALS AND METHODS

Medical suspensions and liquid nutrients that are frequently consumed by children between 0-6 years were selected. Seven groups consisting of 3 medicine groups and 4 nutrient groups were formed. Group 1: Ferro Sanol® B (150 ml) syrup, Group 2: Augmentin®-BID (400 mg/57 mg) suspension, Group 3: Calpol® (120 mg 150 ml), Group 4: Bebelac® Gold 5 follow-on milk, Group 5: Danino® strawberry yogurt, Group 6: Nesquik® chocolate milk, and Group 7: Cappy® orange juice. Ingredients of the nutrients and medicines are shown in Tables 1 and 2. pH values and annual usage periods (consultated with pediatricians) of the samples from nutrient and medicine groups are shown in Table 3.

Table 1. Nutrients used and their ingredients

Nutrients	Manufacturer	Ingredients
Bebelac® Gold 5 follow-on milk	Nutricia®	Skim milk, lactose, whey components, maltodextrin, prebiotic fibers, vegetable oils, tricalcium phosphate, calcium carbonate, tripotassium citrate, trisodium citrate, L-ascorbic acid, magnesium chloride, emulgator, taurine, choline chloride, sodium L-ascorbate, potassium chloride, iron sulfate, zinc sulfate, DL-α-tocopheryl acetate, nicotinamide calcium D-pantothenate, pteroylmonoglutamic acid, copper sulfate, DL-α-tocopherol, retinyl palmitate, D-Biotin, cholecalciferol, thiamine hydrochloride, pyridoxine hydrochloride, riboflavin, cyanocobalamin, potassium iodide, manganese sulphate, phytomenadione, sodium selenite.
Strawberry yogurt	Danino®	Pasteurized and homogenized cow's milk, strawberry preparate (10%) [strawberry, sugar, modified starch, black carrot juice concentrate, strawberry flavorant, stabilizer (carrageenan), acidity regulator (sodium citrates), sugar, strawberry puree (0.01%), yogurt culture.
Nesquik® chocolate milk	Nestle®	Pasteurized drinking milk, sugar, cocoa powder (1.1%),salt,stabilizer (carrageenan),minerals (iron phosphate, zinc sulfate), flavorant (vanillin), cinnamon
Cappy® orange juice	Coca-Cola®	At least 50% mixed fruit juice from concentrate (orange), water, sugar or fructose-glucose syrup, flavorants, acidity regulator (citric acid), vitamin A.

Table 2. Medicines and ingredients

Medicines	Manufacturer	Ingredients
Ferro Sanol® B (150ml) syrup	Adeka İlaç ve Kimyasal Ürünler San. ve Tic. A.Ş.	Ferrous(II)-glycine-sulphate complex, 43 mg riboflavin-sodium phosphate, 0.32 mg of Vitamin B1, 0.63 mg of Vitamin B6 (pyridoxine hydrochloride), Ascorbic acid, single refined sugar, glucose monohydrate, sorbitol, 95-98% sulphuric acid, orange oil, pear oil, deionized water.
Augmentin®-BID (400 mg/57 mg) suspension	GlaxoSmithKline	Amoxicilline 400mg/5ml , Clavulanic Acid 57 mg/5 ml
Calpol® (120 mg/150ml) suspension	Abdi İbrahim İlaç Sanayi ve Ticaret A.Ş.	Paracetamol, sorbitol solution, strawberry flavor, sucrose, Nipagin M (methyl parahydroxybenzoate), glycerol, Avicel rc 591, Carmoisine E 122**,** xanthan gum, purified water.

Table 3. Annual usage periods of the samples

Samples	pH	Usage time in a year	In-mouth duration time
Ferro Sanol® B (150ml) syrup	2	2×1 2.5 months Once a year	2 min
Augmentin®-BID (400 mg/57 mg) suspension	6.3	2×1 10 days 4 times in a year	2 min
Calpol® (120 mg/150ml) suspension	6	3×1 5days 6 times in a year	2min
Bebelac® Gold 5 follow-on milk	7	5×1 365 days	5 min
Danino® strawberry yogurt	5.5	1×1 365 days	5 min
Nesquik® chocolate milk	6.5	1×1 365 days	5 min
Cappy® orange juice	3.5	1×1 365 days	5 min

Distilled water was used as the control group. Glasiosite® Caps compomer (VOCO, Cuxhaven, Germany) was used as the restoration material. The composition for the compomer material determined by the manufacturer is as follows: BIS-GMA, diurethane-dimethacrylate, TEGDMA, BHT, 77.5% 2.6-bis (1.1-dimethylethly)-4-methylphenol filler. Acidity of all nutrients and medicines was measured by pH paper strip. Metal plates of 5 mm width and 2±0.1 mm thickness were produced to place the compomer material in. To ensure standardization, A3 was chosen as the color of the compomer material placed in the metal plates. The material was placed in the discs in a way to overflow a bit. Cellulose acetate matrix tape was used for insulation and pressure was applied on the glass plate. As recommended by the manufacturer, the material was polymerized from a single direction for 40 seconds through Monitex® Blue LEX LD–105 Led-C curing light (wavelength 450-470). Each compomer disc was polished for 10 seconds by the same person using 600, 800, and 100 grits silicon carbide discs, respectively. The procedure was repeated by preparing 80 compomer discs, 10 for each group. Each sample was kept at 37°C for 24 hours for rehydration. Roughness on the samples was measured over 100 lines with intervals of 10 micrometer through Stylus Profilometer (Dektak 150, Bruker,Santa Barbara, CA) with 2 micrometer probe tip and the values were recorded in nanometer (nm). The solutions were prepared as recommended by the manufacturers. Distilled water was used for solutions to which water should be added. Afterwards, an approximate annual usage period for the solutions was calculated (Table 3). Samples were kept in the solutions whereas the control group in distilled water at 37°C in closed containers. Once the soaking was completed, each sample was rinsed with distilled water for 10 seconds and left to dry.

Roughness measurements were repeated. The difference between the two roughness values was calculated and the statistical measurements were performed based on this value. The samples were examined in two separate groups, namely medicines and nutrients. Scanning Electron Microscope (SEM) images of the samples tested for roughness were examined in Inonu University Scientific And Technological Research Center (IBTAM). In SEM imaging, the entire compomer surface was scanned and samples magnified by 2.50 X and 10.00 X which show the best image were collected with 20.00 kV from the area providing the best image.

Statistical Analysis

Data concerning surface roughness were uploaded to SPSS (version 21.0) software. Shapiro-Wilk test and Paired Sample t-Test was used in the assessment of data. The data were recorded as arithmetic mean±standard deviation and level of error was taken as 0.05.

RESULTS

Despite being taken once a year on average, Ferro Sanol®-B, the most frequently used medicine in the medicine group, was found to have the longest in-mouth duration since it is used for 2.5 months. It is followed by Calpol® and Augmentin®, respectively. Considering its pH value, Ferro Sanol® B was found to be the most acidic (pH=2) medicine.

The evaluation of surface roughness revealed that Ferro Sanol® B displays the highest level of surface roughness difference (23.3 nm) ($p<0.01$), followed by Calpol® (5.3 nm) ($p>0.05$). Augmentin® displayed values close to the distilled water group (as 1.0 nm ($p>0.05$) (Figure 1).

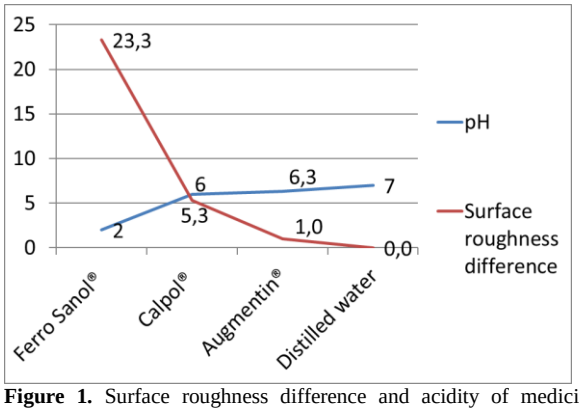

Figure 1. Surface roughness difference and acidity of medicine group

The in-mouth duration of the foods in the nutrient group was taken as 5 minutes when consumed at once. As to the nutrient group, Cappy® orange juice was found to have the highest level of acidity (pH=3.5) and followed by Danino® strawberry yogurt (pH=5.5), Nesquik® chocolate milk (pH=6) and Bebelac® 5 follow-on milk (pH=7) respectively. The evaluation of surface roughness revealed that Cappy® orange juice displays the highest level of surface roughness difference (21.4 nm) ($p<0.01$). Surface roughness and acidity of Danino® strawberry yogurt (13.4 nm) ($p>0.05$), Nesquik® chocolate milk (2.2 nm) ($p>0.05$), Bebelac® 5 follow-on milk (1.8 nm) ($p>0.05$) are directly proportional (Figure 2). The surface roughness difference caused by all of the solutions on the compomer material are shown in Table 4.

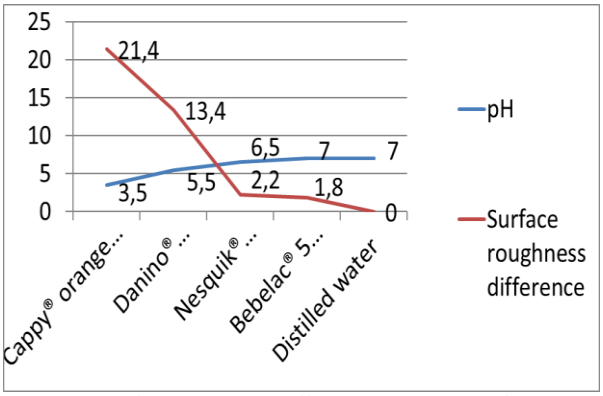

Figure 2. Surface roughness difference and acidity of nutritient group

Table 4. Surface roughness difference caused by all of the solutions

Samples	Before (average nm)	After (average nm)	95% Confidence Interval of the Difference		Difference mean	p value
			Lower	Upper		
Ferro Sanol® B (150ml) syrup	323.0±33.5	346.4±22.8	-33.5	-13.1	23.3	0.001
Augmentin®-BID (400mg/57mg) suspension	304.2±22.4	305.1±33.7	-10.5	8.50	1.0	0.817
Calpol® (120 mg/150ml) suspension	289.3±27.2	294.6±35.3	-16.7	6.1	5.3	0.320
Bebelac® Gold 5 follow-on milk	312.9±31.8	314.8±43.8	-14.9	11.3	1.8	0.764
Danino® strawberry yogurt	294.3±31.5	307.6±23.3	-27.3	0.5	13.4	0.057
Nesquik® chocolate milk	222.5±25.0	224.6±36.2	-13.1	8.7	2.2	0.658
Cappy® orange juice	213.0±33.6	234.6±43.1	-30.8	-11.9	21.4	0.001
Distilled water	302.1±22.2	302.1±22.2	-	-	0.0	-

SEM images of the samples kept in solutions were taken. SEM images support that acidity and surface roughness are in direct proportion. SEM images of the material on which Ferro Sanol® B was applied revealed a considerable degree of roughness compared to the ones on which Calpol® and Augmentin®-BID were applied. Ferro Sanol® B applied sample was observed to have pits on the surface and distortions in the flat surface form. The roughness ratio was observed to decrease with a significant difference in the Calpol®-applied sample. Surface properties of Augmentin®-BID-applied sample was similar to that of the control group. When SEM images of nutrients were examined, samples on which foods with low pH values were applied showed higher surface roughness. Cappy® orange juice-applied sample showed the highest surface roughness which is supported by SEM images. Acidity of Danino® strawberry yogurt (pH=5.5) destroyed

the integrity of the compomer material. SEM image of the Nesquik® chocolate milk-applied compomer material did not reveal an intense roughness. Surface roughness difference of 2.2 nm between samples and acidity (pH=6.5) close to that of the distilled water group was observed supported by SEM images. Having a neutral pH, Bebelac® 5 follow-on milk did not cause a significant roughness on the compomer material and showed values close to that of the distilled water group (Figure 1).

DISCUSSION

Compomer is undoubtedly the most frequently used material in restoration of the deciduous teeth.[15] Endurance and preventiveness of this material will both increase the patient's comfort and effect the dentist's long-term success. Acidic foods, which are mostly consumed by children, may harm not only the teeth and the surrounding tissues but also the filling material.[16] As to the medicines frequently used by children, Ferro Sanol® B, used in iron deficiency treatment, is prescribed for the children from 6 months- 15 years of age.[17] Correr *et al.*[18] showed that acidic foods effect the surface roughness of resin composites, compomer and resin-modified glass ionomer materials. In this study, highly acidic Ferro Sanol® B (pH=2) caused nanocracks on the surface of the compomer material. Ferro Sanol® B, which has the highest difference (23.3 nm) between initial and post-application surface roughness, can also affect the endurance of the compomer material. Therefore, patient's parents should be warned to take several measures as follows: the medicine should be swallowed without keeping in the mouth, nutrients to neutralize the acidity of the oral environment should be consumed afterwards, and the patient should rinse his/her mouth with water. On the other hand, Calpol®, frequently used by children as analgesic, caused roughness on the compomer material compared to the distilled water group (5.3 nm). Being acidic, Calpol® did not cause surface roughness as much as Ferro Sanol® B. However, SEM images reveal that due to its sucrose content, Calpol® leaves residuals on the compomer material. When consuming foods and medicines with sugar content, oral and dental health should be considered. Augmentin® is the most frequently used broad spectrum antibiotic. Santos *et al.*[19] also showed that pediatric syrup containing amoxicillin increased the surface roughness of compomer material. Performing oral cleaning after using this medicine, showing values close to the distilled water group when the surface roughness is taken into consideration (1.0 nm), will be appropriate.

The compomer samples showing the maximum surface roughness difference in the nutrient group were the Cappy® orange juice-applied samples. In the SEM images of the samples with high surface roughness difference (21.4 nm), fragmentations were observed in the attachment points. Cappy® orange juice, containing citric acid, caused damages on the compomer material due to high acidity (pH=3.5). Such food should be consumed less, and awareness should be raised among parents. It is believed that the connection between the treated teeth and the compomer material may be destroyed in case nutrients causing surface defects on the compomer material are consumed very often.

Defects were detected on the surface of the compomer material in contact with Danino® strawberry yogurt. Surface roughness difference was found to be high in the measurements performed using profilometer (13.4 nm). Due to its sugar content and thickness, this food left non-isolated and invisible residuals on the compomer material. When consumed frequently, such food may cause propagation of oral bacteria and both tooth tissue and compomer material be damaged.

Nesquik® chocolate milk, having an acidity close to distilled water group (pH = 6.5) showed a surface roughness difference of 2.2 nm, which was supported by SEM images. Bebelac® 5 follow-on milk with the same pH value as the distilled water group (pH=7) hardly damaged the compomer material (1.8 nm) but caused residuals due to its thickness and additives in its content. Residuals were observed in some samples although each of them was washed with distilled water for 10 seconds after nutrients and medicines were applied. Although it is recommended to consume water after feeding or taking medication,

a good oral cleansing thereafter will protect the oral and dental health and prolong the life of the restorative material.

CONCLUSIONS

Highly acidic medicines and nutrients cause corrosions in compomer restoration. Ferro Sanol B® and Cappy® orange juice effected the surface of compomer material most, compared in their group samples. However, more detailed studies should be conducted on this topic.

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CONFLICTS OF INTEREST

None

Besin ve İlaçların Kompomer Yüzeyine Etkisi

ÖZ

Amaç: *Bu çalışmanın amacı çocukların sıklıkla tükettiği gıda ve ilaçların çocuk diş hekimliğinde sıklıkla kullanılan bir restoratif materyal olan Poliasit Modifiye Kompozit Rezin (kompomer)'in yüzey pürüzlülüğü üzerine etkisini araştırmaktır.* ***Gereç ve Yöntemler:*** *Çalışmada kullanılan solusyonlar tablo 1'de verilmiştir. Restorasyon materyali olarak VOCO Glasiosite® Caps kompomerden diskler oluşturuldu Tüm besin ve ilaçların asiditesi ölçüldü. Materyal, üreticinin önerdiği doğrultuda Led-C ışık cihazı ile 40 sn süresince tek yönden polimerize edildi. Kompomer plaktan kontrol grubuyla birlikte 8 grup olacak şekilde, 10'ar örnek elde edildi. Örnekler üzerindeki pürüzlülük Bruker® stylus profilometre ile ölçüldü ve değerler nanometre (nm) cinsinden kaydedildi. Sonrasında solüsyonların 1 yıllık yaklaşık kullanım süreleri hesaplanarak örnekler hazırlanan solüsyonlarda, kontrol grubu ise distile suda ağzı kapalı şekilde bekletildi. Pürüzlülük ölçümleri tekrarlandı. Her iki pürüzlülük değerleri arasındaki fark hesaplanarak istatistiksel ölçümler buna göre yapıldı. Gruplar arası fark hesaplanırken Shapiro-Wilk test and Paired Sample t-Test testi kullanıldı.* ***Bulgular:*** *Ferro Sanol® B ilaç grubunun en yüksek yüzey pürüzlülüğüne neden olan ilaç olarak bulundu (23,3 nm). Cappy® portakal suyu ise besin grubunun en yüksek yüzey pürüzlülüğü gösteren besini oldu (21,4 nm). SEM görüntüleri de bu sonuçları desteklemektedir.* ***Sonuçlar:*** *Solüsyonların kompomer dolgu yüzeylerinde yüzey pürüzlülüğüne etkisi çeşitlilik sergilemekte olup, yüzey pürüzlülüğünün yanında aşınma miktarının da araştırıldığı ilave çalışmalara ihtiyaç vardır. Yüzey pürüzlülüğünü artıran solüsyonların tüketiminde daha dikkatli davranılmalıdır.*

Anahtar kelimeler: *Yüzey özellikleri, kompomerler, besinler, ilaç kullanma.*

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Original research

THE EFFECT OF HEAT APPLICATION ON FLUORIDE RELEASE FROM ANTIBACTERIAL AGENT ADDED GLASS IONOMER CEMENT

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ABSTRACT

Objectives: This study aimed to evaluate the effect of heat on the fluoride (F^-) releasing ability of glass ionomer cement (GIC) when used in the conventional form and when combined with 5% cetylpryridium chloride (CPC).

Materials and Methods: Twenty (n=5; each group) GIC samples were prepared, with the experimental group comprising GIC combined with 5% CPC and the control group comprising GIC without 5% CPC. The samples were prepared by non-heating (NH) procedures (n = 10) or by heating (H) for 60 seconds (n = 10) with a Light Emitting Diode (LED). Flouride releasing pattern was evaluated on days 1, 7, 15 and 30. Repeated measurements using two-way ANOVA and Fisher's LSD test were used for comparisons ($p < 0.05$).

Results: Interactions among the groups, application of heat, and the time at which F^- release was evaluated were analyzed ($p < 0.001$). There was no significant difference in F^- release in the NH control and experimental groups on days 1, 7 and 15; however a significant release was evident in the experimental group on day 30 ($p=0.01$). Significantly higher values were obtained in the H associated control group than in the experimental group on days 1 ($p=0.026$), 7 ($p = 0.001$), 15 ($p=0.005$) and 30 ($p=0.028$). Significantly increased values were obtained from days 1 to 30 by NH and H procedures for both the groups ($p<0.001$).

Conclusions: Heating in the control and experimental groups showed an increased F^- releasing pattern. The fluoride release on 60 seconds of heating GIC containing 5% CPC, can have acceptable values for up to 30 days. The increased F^- releasing pattern after the heating is believed to be promising for antibacterial GIC combinations.

Key words: Anti-bacterial agents, glass ionomer cement, fluorides, heating.

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INTRODUCTION

Although dental caries is one of the most common oral diseases worldwide, it can neither be treated completely in the underdeveloped societies nor can become a priority in the developing and industrialized countries over social, economic, political and other issues.[1,2] According to Blinkhorn and Davies[3], the main reasons for inability to provide dental care are expensive dental equipment and inability to meet the demand for a highly trained staff. In 1994, the atraumatic restorative treatment technique (ART) was discovered by the World Health Organization to overcome these difficulties.[4] In ART, which is a form of mostly painless restorative treatment, cavitations are restored with a biocompatible material that does not cause bacterial invasion. Glass ionomer cement (GIC) is generally preferred for this treatment because of its chemical attachment to enamel and dentin, fluoride release and the ease of use.[5] Despite numerous advantages of GIC as a restorative material, it has a few disadvantages in terms of secondary cavities and poor mechanical properties.[6]

There are numerous methods with modified properties used to overcome the disadvantageous of GIC. Materials such as routine hydroxyapatite, bioactive glass and strontium have been added to improve the physical and antibacterial (AB) properties of GIC.[7-9] It has been reported[10,11] that bactericidal materials such as chlorhexidine (CHX), have been used in a variety of studies, in which the AB efficiency of GICs has been observed to increase. In addition, the use of materials such as cetrimide (CT), cetylpyridinium chloride (CPC) and benzalkonium chloride (BC) from quaternary ammonium compounds (QAC) in combination with GIC are evaluated because their chemical properties are similar to those of CHX with AB activity.[10-14] The CPC, used in this study is a cationic QAC and an antiseptic.[15-16]

One of the most important advantages of GICs is the property of fluoride release. The fluoride ion (F^-) can increase the ambient pH and prevent acidity by inhibiting the carbohydrate metabolism of the surrounding bacteria. This process is called buffering and is believed to be useful in the prevention of dental caries in future.[17] It is stated that AB agents alter the physical properties of the glass ionomer and even reduce F^- release and that the interaction between cationic molecules and F^- causes less soluble salt precipitation. Therefore, studies aim to achieve the F^- releasing ability of the modified GIC similar to that of the original GIC.[18]

When an AB agent is added to contents GIC, its physical and chemical properties may weaken. During the curing process of the material, it is possible to shorten the initial period of the curing reaction by applying heat with a light-emitting diode (LED), thus keeping the process, in which it is susceptible to moisture, as short as possible. This aids in to preventing potential weakening of the physical and chemical properties of GIC after AB addition and to further strengthen its existing properties.[19]

The aim of this research was to evaluate F^- release of CPC added conventional GIC under the effect of heat application.

MATERIALS AND METHODS

In this study, 20 GIC samples (3M ESPE-Ketac™ Molar Easymix), with and without 5% CPC (Amresco, Ohio, USA), were used to prepare discs with 10 mm diameter and 2 mm thickness. The experimental group comprised GIC combined with 5% CPC in the powder form weighed using microbalances. Heat (H) generated by LED (3M ESPE, Germany) was applied to 10 samples for 60 seconds whereas no heat (NH) was applied to the 10 samples. The sample discs were placed in plastic cylindrical containers of diameter 32 mm, and height 50 mm, which contained 5 ml deionized water (pH of approximately 7). The samples were incubated at 37°C in the oven (Nüve-FN 500). Solutions of 100 ppm, 10 ppm, 1 ppm, 0.1 ppm, and 0.01 ppm were prepared by diluting 100 ppm of standard fluoride solution (Thermo Orion, Indonesia) with deionized water. A calibration procedure was performed on the F^- selective electrode (Thermo Orion, Indonesia) before measurement, and the values obtained by measuring these standards were recorded. To measure F^- in the test samples, GIC discs were transferred into a new plastic tube and put into a drying-oven by adding 5 ml deionized water; 0.5 ml ionic strength stabilizing total ionic strength

adjustment buffer (TISAB) III solution (Therme Orion) was added to the liquid of the other 5 ml test sample. Fluoride measurements were performed using an ion meter (Thermo Orion, Indonesia) at room temperature. Cumulative fluoride release values on the 1st, 7th, 15th and 30th days were observed. Calibration curves were generated by calculating the data obtained with the known standard values. The data obtained from the test samples were calculated according to this curve. The results were evaluated as µg /mm2 after calculating the amount of F^- released from the unit area on the sample surface.

Statistical Evaluation

Statistical Package for Social Sciences [(SPSS) 17.0 Windows (SPSS Inc. Chicago, Ill., USA)] was used for statistical evaluation. Two-way ANOVA and Fisher's LSD test were used for repeated measurements in statistical evaluation ($p < 0.05$). The confidence interval was set at 95%.

RESULTS

Interactions among the time, at which F^- release was recorded, application of heat and the study groups exhibited statistically significant values ($p<0.01$, Table 1).

Table 1. Interaction effects of repeated measurements of two-way ANOVA

	Type III sum squares	df	Mean square	F	p value
Time	2.687	3	0.896	436.279	***p< 0.001***
Time-Group	0.16	3	0.005	2.593	*0.063*
Time –Heating	0.147	3	0.049	23.946	***p< 0.001***
Time-Group-Heating	0.70	3	0.023	11.421	***p< 0.001***

When F^- release values on the 1st, 7th, 15th and 30th days were compared between the NH control and experimental groups, no statistically significant difference was found ($p>0.05$) on the 1st ($p = 0.33$), 7th ($p = 0.14$) and 15th ($p = 0.77$) days; however, on the30th day, the increase in fluoride release was statistically significant in the experimental group compared with that in the control group ($p = 0.01$; $p < 0.05$; Table 2).

Table 2. Differences between non-heated control and non-heated experimental groups at different time periods

	1st day mean±sd	7th day mean±sd	15th day mean±sd	30th day mean±sd
Control (n=5)	0.05±0.01	0.20±0.03	0.25±0.04	0.36±0.05
Experimental (n=5)	0.08±0.02	0.28±0.06	0.38±0.09	0.56±0.13
p value	*0.33*	*0.14*	*0.77*	***0.01***

*Significantly different values were obtained between control and experimental groups on the 30th day (p=0.01).

When changes between the H control and experimental groups were evaluated, it was found that the values were statistically significant (Table 3) on the 1st ($p = 0.026$; $p < 0.05$), 7th ($p = 0.001$; $p < 0.01$), 15th ($p = 0.005$; $p < 0.01$) and 30th ($p = 0.028$; $p < 0.05$) days. At all these times, more F^- was released in the control group than in the experimental group. Significantly higher values were observed after the H procedures than after the NH procedures on the 1st, 7th, 15th and 30th days for the control (for all; $p < 0.001$, Table 4) and on the1st ($p < 0.001$), 7th ($p = 0.003$), 15th ($p = 0.011$) and 30th days ($p = 0.029$) for the experimental groups, individually (Table 5).

Table 3. Differences between heated control and heated experimental groups at different time periods

	1st day mean±sd	7th day mean±sd	15th day mean±sd	30th day mean±sd
Control (n=5)	0.26±0.06	0.68±0.10	0.80±0.11	0.93±0.07
Experimental (n=5)	0.20±0.04	0.47±0.12	0.58±0.15	0.75±0.19
p value	***0.026***	***0.001***	***0.005***	***0.028***

*Significant differences were found between control and experimental groups on the 1st ($p<0.05$), 7th ($p<0.01$), 15th ($p<0.01$) and 30th days ($p<0.05$).

Table 4. Time-dependent variation in fluoride release in control groups

	Control				*p value*
	1st day mean±sd	**7th day mean±sd**	**15th day mean±sd**	**30th day mean±sd**	***p <0.001; for all comparisons***
Heated	$0.26\pm0.06^{A,a}$	$0.68\pm0.10^{B,a}$	$0.80\pm0.11^{C,a}$	$0.93\pm0.07^{D,a}$	$(p^{A-B,A-C,A-D,B-C,B-D,C-D}<0.01)$
Non-heated	$0.05\pm0.01^{E,b}$	$0.20\pm0.03^{F,b}$	$0.25\pm0.04^{G,b}$	$0.36\pm0.05^{H,b}$	***p <0.001; for all comparisons*** $(p^{E-F,E-G,E-H,F-G,F-H,G-H}<0.01)$

*A statistically significant increase was observed in non-heated control groups from day 1st to 30th ($p<0.01$).
*A statistically significant increase was observed in heated control group from day 1st to 30th ($p<0.001$).
*The fluoride release in the control group increased at a statistically significant level from day 1st to 30th with the application of heat (pa-b<0.001, p<0.05).

Table 5. Time dependent alterations in fluoride release for experimental group

	Experimental				*p value*
	1st day Mean±sd	**7th day mean±sd**	**15th day mean±sd**	**30th day mean±sd**	$P^{a-b}=0.002$ $P^{a-c}=0.002$ $P^{a-d}=0.001$ $P^{b-c}=0.003$ $P^{b-d}=0.001$ $P^{c-d}<0.001$
Heated	$0.20\pm0.04^{a,A}$	$0.47\pm0.12^{b,C}$	$0.58\pm0.15^{c,E}$	$0.75\pm0.19^{d,G}$	
Non-heated	$0.08\pm0.02^{e,B}$	$0.28\pm0.06^{f,D}$	$0.38\pm0.09^{g,F}$	$0.56\pm0.13^{h,H}$	$P^{e-f}=0.001$ $P^{e-g}=0.001$ $P^{e-h}=0.001$ $P^{f-g}=0.001$ $P^{f-h}=0.001$ $P^{g-h}=0.001$

*Statistically significant increase was observed in heated experimental groups from day 1st to 30th ($p<0.01$).
*The fluoride release in the experimental group increased at a statistically significant level from day 1st to 30th with the application of heat (pA-B<0.001, pC-D=0.003, pE-F=0.011, pG-H=0.029, p<0.05).

There was a statistically significant increase in F^- release from days 1 to day 30 in NH and H control groups ($p < 0.001$; Table 4) and experimental groups (Table 5, Figure 1).

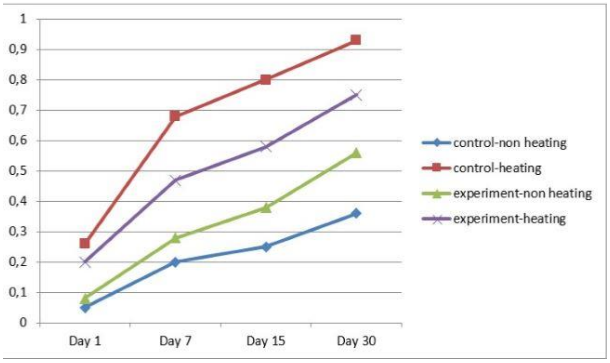

Figure 1. Time dependent alterations in fluoride release in all groups

DISCUSSION

Heating of samples in the control and experimental groups showed an increased F^- release pattern. The fluoride release from GIC containing 5% CPC on heating for 60 seconds could have acceptable increased values for up to 30 days. McComb,Ericson,[20] DeSchepper *et al.*[21] and Vermeersch *et al.*[22] suggested that GIC is antimicrobial because of F^- release and/or acidity, but the results of previous investigations about the AB effects of both F^- and low pH are controversial.[23,24] Furthermore, the reduction in bacterial counts obtained by placing conventional GICs in cavities is not reliable; therefore, AB agent-modified GICs would provide an alternative approach.[10,11,25] The combination of GICs and AB agents, particularly QACs, has been studied in previous studies.[11,12,26] However, it has been pointed out that the AB agents alter the physical properties of the glass ionomer.[27] The interaction between the cationic molecules and F^- ions has been reported to cause less soluble salt precipitation. Thus, studies aim to achieve a F^- releasing ability of the modified GIC, similar to that of the original GIC.[12,14,18]

In experimental studies, ion-selective electrodes are widely used in the analysis of F^- ions, because they are practical to use and yield accurate results when used in accordance with the rules.[18,28,29] Total ionic strength adjustment buffer solution is used in the studies on F^- ion analysis for GICs. The buffer solution is added to control pH and prevent the formation of F^- ion complex structure.[28,29]

In the NH control and experimental groups in our study, although more F^- was released in the experimental group at all the times, only the value

on the 30th day was statistically significant. The fluoride release in the experimental and control groups increased by a statistically significant level over time. Tüzüner *et al.*[30] evaluated the amount of F^- ions released on the 1st, 7th, 15th and 30th days in an experimental group using a mixture of Fuji IX, Ketac Molar powder, 2.5% CHX, and 2.5% CT powder and in the control group using Fuji IX and Ketac Molar with no AB agent. As a result, less F^- ions were released in the experimental groups that were combined with an AB agent at all the times compared with the control group, but this did not cause a statistically significant difference. In addition, there was a decrease in the F^- ion release in all the groups over time. Elsaka *et al.*[31] investigated the cumulative F^- release and AB properties of modified GIC on the 1st, 7th and 28th days in their study, in which they added AB-effective titanium-dioxide (TiO2) nanoparticles to conventional GIC. Similar release patterns were observed between the control group excluding titanium dioxide and experimental group. The highest release was observed during the first 24 hours, and the values declined over time. There was no statistically significant difference between the experimental and control groups in terms of the cumulative F^- release pattern. Hoszek and Ericson[18] found that F^- release was lower in the experimental group than in the control group on addition of 10% CHX to GIC. However, they reported no statistically significant difference between the experimental and control groups in terms of F^- ion release levels ($p>0.05$) and predicted that poorly soluble salt precipitates resulted from the interaction of cationic molecules and F^- ions resulting in this situation. The lack of statistically significant differences between the experimental and control groups in these three studies is consistent with the fact that the F^- release values on the 7th and 15th days in this study do not result in a statistically significant difference between the control and experimental groups; conversely, the decreasing F^- release values over time and increased F^- release in the control group contradicted the results of this study. Hu *et al.*[32] found that the F^- release values of GIC modified with epigallocatechin-3-gallate (EGCG) and CHX did not show any significant difference between the control and experimental groups, and reported that F^- release was the highest in the GIC + CHX group and lowest in the control group at the 24th hour after hardening, and this was parallel with the higher F^- release in the experimental group in our study. All the groups showed a decrease toward the 7th day. However, the F^- values on the 7th day were measurable. The decreasing F^- values contradicted the results of our study.

When we evaluated the effect of heat application on the groups in terms of the F^- release, the values in the control group were higher than those in the experimental group at a statistically significant level at all the times. As in the NH experimental and control groups, there was a significantly increasing F^- release over time in the H groups. On analyzing the control and experiment groups individually, we found that heat application caused significantly more F^- release. As far as we have reviewed the previous literature, there have been no studies investigating how heat application affects F^- release in GIC. However, there have been many studies exhibiting how the physical and chemical properties of conventional GICs and other dental materials are affected by radiant heat application.[33-35] Tolidis *et al.*[34] examined the effects of radiant heat and ultrasonic heat applied by LED on GIC in their study with working groups. No heat treatment was applied in the control group, and radiant heat with LED was applied for 2 minutes and ultrasound for 55 seconds in the experimental group. The fluoride release values on the 7th, 14th and 28th days was assessed. The radiant heat applied during hardening reduces the release of F^-. Furthermore F^- release decreased and surface hardness increased after ultrasonic treatment. Rafeek[35] applied only heat and heat along with pressure, both on conventional and resin-modified GICs and investigated the effect of these treatments on some physical characteristics of GICs and F^- release. The presence of heat was found to produce no significant result on conventional GIC; however, it reduced the release of F^- in resin-modified GIC. It is thought that the F^- release decreases whereas the physical properties of the resin modified by the heat application strengthen in accordance to the study limitations.

When we compared the unmodified control group of our study with all those of the studies mentioned above, we found that the reduced F^- release caused by heat application was not consistent with the results of our study. It may be considered that the differences in all F^- release patterns in the NH control/ experimental and H control groups that contradict with the literature are owing to the experimental variables in *in-vitro* studies, such as the internal structure of the material, including the composition, geometric structure, solubility, and porosity of the material used, the powder/ liquid ratio during the preparation, the amount and size of the sample, ambient temperature, surface applications, such as Vaseline or varnish on the material, ambient pH/ volume, different measurement methods, and other unknown factors.[18,25,36]

However, compared with the previous studies, it can be considered that heat application may increase F^- release from the GIC combined with antibacterial materials, and this may be beneficial and promising for future studies.

CONCLUSIONS

As a result of our research conducted under *in-vitro* conditions, a significant increase in fluoride release in both conventional and GICs modified with an antibacterial agent at all time periods, as a result of heat application, can be considered promising for the fluoride release levels of GIC materials and future research. According to the results, when GIC is used in the ART techniques 60 seconds of heat administration will reduce the decay level occurring at the bottom of the face and teeth with binding surface are promising in clinical be said.

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CONFLICT OF INTEREST

None

Antibakteriyel Ajan İlave Edilen Cam İyonomer Simanda Isı Uygulamasının Florür Salımına Etkisi

ÖZ

Amaç: *Çalışmanın amacı konvansiyonel yapıda olan ve %5 cetylpryridium chloride (CPC) ile kombine edilen cam iyonomer simanda (CİS) florür (F^-) salımına, ısının etkisini değerlendirmektir.* ***Gereç ve Yöntemler:*** *%5 cetylpryridium chloride (CPC) ile kombine edilen deney ve %5 CPC içermeyen kontrol grubundan oluşan yirmi adet (n=5; her grupta) CİS örneği hazırlandı. Örneklerden 10 tanesine ısı uygulanmadı (IU), diğer 10 tanesine ise 60 sn Light Emitting Diode (LED) ışık kaynağı ile oluşturulan ısı etkisi (IE) altında uygulama yapıldı. Bir, 7, 15 ve 30. günlerdeki F^- salımı gözlendi. Karşılaştırmalar için iki yönlü ANOVA ve Fisher's LSD testinin tekrarlanan ölçümleri kullanıldı ($p<0,05$).* ***Bulgular:*** *Florür salımının değerlendirildiği grup, ısı ve zaman değişkenleri arasındaki etkileşimler analiz edildi ($p<0,001$). Bir, 7 ve 15. günlerdeki IU kontrol ve deney gruplarında F^- salımı açısından anlamlı bir fark yoktu, ancak 30. günde deney grubunda anlamlı bir F^- salımı vardı ($p=0,01$). Isı etkisi altında kontrol grubu için 1 ($p=0,026$), 7 ($p=0,001$), 15 ($p=0,005$) ve 30. ($p=0,028$) günlerde deney grubuna kıyasla anlamlı olarak daha yüksek değerler elde edildi. Hem IU hem de IE altındaki her iki grupta da 1 ila 30 gün arasında anlamlı olarak artan değerler elde edildi ($p<0,001$).* ***Sonuç:*** *Isı etkisinin kontrol ve deney gruplarında F^- salımını arttırdığı gözlendi. 60 sn ısı uygulanan %5 CPC eklenen CİS F^- düzeyinde 30. güne kadar kabul edilebilir bir artış gözlendi. Isı uygulaması; antibakteriyel eklenmiş CİS'lerin florür salım düzeyleri için ümit vaat edicidir.*

Anahtar kelimeler: *Anti-bakteriyel ajanlar, cam iyonomer siman, florürler, ısıtma.*

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Original research

EFFECTS OF DIFFERENT SURFACE TREATMENTS ON THE BOND STRENGTH OF CAD/CAM RESIN NANO CERAMIC OR CEROMER TO RESIN CEMENT

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ABSTRACT

Objectives: The purpose of this study was to evaluate the effects of different surface treatments on the micro-tensile bond strength (MTBS) of two different indirect restoration materials (resin nano ceramic CAD/CAM material [Lava Ultimate, 3M ESPE]; ceromer material [Estenia C&B, Kuraray Medical]).

Materials and Methods: Specimens were prepared from each test material in dimensions of 3×10×10 mm. The specimens were divided into five different surface treatment groups: group 1 (control [C]), no treatment; group 2 (acid etching [A]); group 3 (acid etching + universal adhesive [AA]); group 4 (sandblasting [S]); and group 5 (sandblasting + universal adhesive [SA]). The prepared specimens were cemented to composite parts (Filtek Z250 Universal Restorative, 3M ESPE) of the same size using dual-cure adhesive resin cement (Panavia F2.0, Kuraray Medical). A total, 100 bar-shaped specimens (6×1×1 mm) were cut using a low-speed diamond saw (*n*=10 in each group). The MTBS test was performed in all groups (Shimadzu AG-50 kNG, Kyoto, Japan, 1 mm/min). Data were analyzed using a two-way analysis of variance (ANOVA) and Tukey's multiple comparison tests at a significance level of $p<0.05$.

Results: The MTBS values were significantly influenced by the type of restorative material and surface treatment ($p<0.05$). There were statistically significant differences between the materials and surface treatments procedures ($p<0.05$). For Lava Ultimate and Estenia C&B materials, the highest MTBS value was obtained in the SA surface treatment ($p<0.05$) and the lowest MTBS value was obtained in the control groups ($p<0.05$).

Conclusions: The application of silane-containing universal adhesive material after sandblasting was the ideal surface treatment for both materials.

Keywords: Ceromer, composite resins, tensile strength.

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INTRODUCTION

New-generation dental indirect restoration materials with improved physical and mechanical properties are widely used in response to aesthetic and biological demands of patients.[1] With the availability of computer-aided design and manufacturing (CAD/CAM), indirect restorations can be fabricated from ceramics and resin composites, in addition to resin-ceramic hybrid materials, which have been recently introduced to the market.[2] The elastic modulus of ceramic materials containing resin matrix is much closer to dentine than conventional ceramics. They are also more easily machined and repaired than glass ceramics (synthetic lithium disilicate) or polycrystalline ceramics.[3] Resin nano ceramic blocks, such as Lava Ultimate (3M/ESPE, St. Paul, MN, USA), are resin matrix ceramics that contain zirconia/silica nano ceramic particles (80% by weight) embedded in a cross-linked resin matrix (20% by weight).[4,5]

The use of new-generation dental composites with improved physical and mechanical properties in indirect restorations has increased with recent advances in resin chemistry.[6] Hybrid resin composites reinforced with nano ceramic fillers known as ceromers (i.e., ceramic-optimized polymers) are used in indirect restorations because of the elastic modulus of these materials is close to dentine tissues, and their wear resistance is similar to a natural tooth.[7] The matrix structure of ceromers is composed of inorganic and organic polymer chains, aliphatic or aromatic dimethacrylate and silicon oxide.[8] The filler component of a ceromer consists of glass and ceramic fillers and a high proportion of silica. The proportion of fillers content in ceromer, which are also referred to as second generation indirect composites, ranges from 70% to 90%.[9]

Effective adhesive bonding minimizes micro-leakage, provides marginal adaptation and increases the fracture strength, thereby enhancing the clinical success of indirect restorations.[10] Mechanical and chemical surface treatments are important to obtain high bond strength between resin ceramic material or ceromer to resin cement.[11] Bonding between the indirect restoration and resin cement is achieved in two ways: by ensuring micro mechanical retention through abrasive surface treatments (e.g. acid etching or sandblasting) of the restorations or by chemical bonding using a silane coupling agent.[12-14] Hydrofluoric acid is the most commonly used chemical agent for modification of the porcelain surface. The acid agent selectively dissolves the glass matrix and the crystalline structure is exposed resulting in the surface of the ceramic becoming rough, which is required for micromechanical retention.[13] Using the sandblasting method, the surface is blasted with aluminum oxide particles to roughen and increase the bonding surface of the restoration material.[14,15] Silane is applied as a bonding agent to improve the bond strength between the indirect restoration and resin cement. The application of silane increased wettability and surface energy by decreasing surface tension.[16] The most commonly used type of silane in dentistry is 3-methacryloyloxy propyl trimethoxysilane.[15,17] 'Universal' or 'multi-mode' silane-containing adhesive systems that contain a bifunctional monomer have been recently introduced to the market. These silane-containing adhesives enable chemical bonding of ceramic restorations, without the need for a ceramic primer. They can also be used as a bonding agent for dentine and enamel. Therefore, the use of silane-containing adhesive systems decreases the number of operation steps of adhesive cementation.[18]

A number of studies[5,9,11-13,16] have investigated the bond strength of indirect restorative materials to resin cement however there is a lack of literature[16,19,20] comparing the bond strengths of CAD/ CAM resin nano ceramic or ceromer to resin cement. The aim of this study was to evaluate the effects of various surface treatment procedures on the micro-tensile bond strength (MTBS) of two different indirect restoration materials to resin cement. The null hypothesis was that the material types and surface treatment procedures would not affect the bond strength.

MATERIALS AND METHODS

A resin nano ceramic (Lava Ultimate CAD/CAM Restorative, 3M ESPE, St. Paul, MN, USA) and a ceromer (Estenia C&B, Kuraray Medical, Tokyo, Japan) indirect restoration materials were tested in

this study and are detailed in Table 1. The specimen preparation design is schematically presented in Figure 1.

Table 1. The brand names, material types, manufacturers and compositions of the materials

Test Materials and Types	Manufacturer	Composition
Lava Ultimate (Resin nano ceramic block)	3M ESPE, St. Paul, MN, USA	80 wt% nanoceramic, 20 wt% resin, silica nanomers (20 nm), zirconia nanomers (4 - 11 nm), nano group particles (0.6 - 10 µm), silane bonding agent
Estenia C&B (Indirect composite resin)	Kuraray Medical Co., Tokyo, Japan	Monomer:Polyurethane methacrylmonomer and mathacrylic acid series monomer) Filler: Surface treated glass powder and surface treated aluminum micro filler) Photocuring catalyst, Colorant and others
Single Bond Universal (Universal Adhesive)	3M ESPE, St. Paul, MN, USA	10- MDP, dimethacrylate resins, HEMA, Vitrebond copolymer, filler, ethanol, water, initiators, silane
Panavia F 2.0 (Adhesive resin cement)	Kuraray Medical Co., Tokyo, Japan	Paste A: 10-MDP, silanated silica, hydrophobic aromatic and aliphatic dimethacrylate, hydrophilic dimethacrylate photoinitiator, and dibenzoyl peroxide Paste B: silanated barium glass, sodium fluoride, sodium aromatic sulfinate, dimethacrylate monomer, and benzoyl peroxide.
Bisco (Porcelain Etchant)	Bisco, Schaumburg, Illinois, USA	9.5% Hydrofluoric Acid Gel
Filtek Z250 (Universal Restorative System)	3M/ESPE, St Paul, Minnesota, ABD	Matrix: BisGMA, BisEMA, UDMA, TEGDMA Filler: Zirconia, silica (82 wt%)

Abbreviations: MDP: 10-methacryloxydecyl dihydrogen phosphate; HEMA: Hydroxyethyl methacrylate; Bis-GMA: bisphenol A-glycidyl methacrylate; Bis-EMA: ethoxylated bisphenol A-glycol dimethacrylate; UDMA: urethane dimethacrylate; TEGDMA: Triethyleneglycol Dimethacrylate; BPO, benzoyl peroxide.

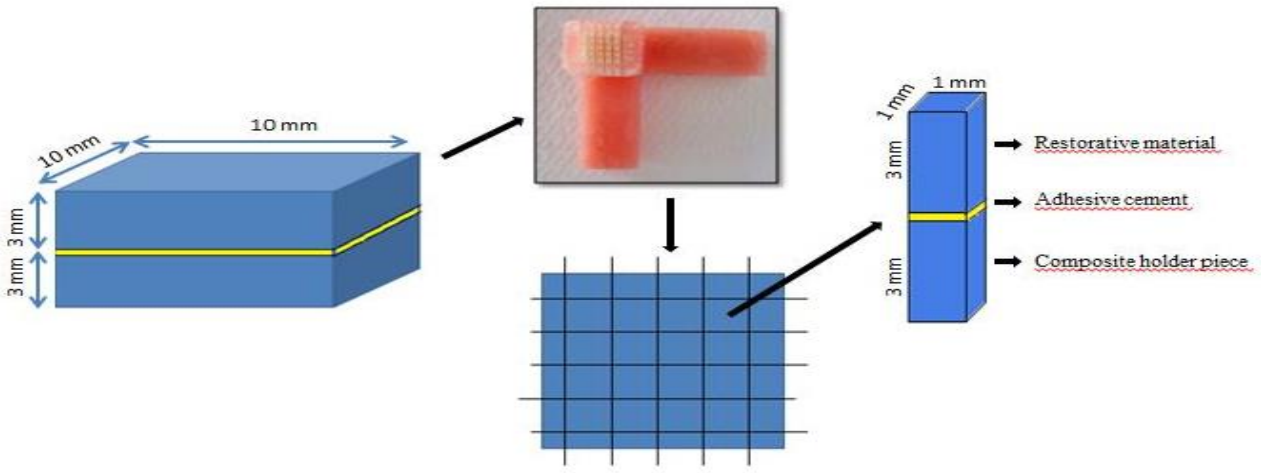

Figure 1. The specimen preparation

Lava Ultimate blocks were cut into 3-mm thick slices using a low-speed diamond saw (Micracut 201, Metkon, Bursa, Turkey). A custom made stainless steel mold was fabricated for the preparation of the specimens from the ceromer material (3×10×10 mm). The ceromer material was applied to the mould in two stages, with each layer allowed to cure for 180 sec in a light and heat curing polymerization unit (CS-110, Kuraray Dental, Osaka, Japan). The specimens were removed from the mold after polymerization and coated with an air-barrier paste (Kuraray Dental) and then cured at 160°C for 15 min. And then they were cleaned in an ultrasonic cleaner (Heatable Ultrasonic Cleaner JP-4820, Skymen, Guangdong, China) at room temperature and then divided into the following five surface treatment groups:

1. Control group (C): No surface treatment was applied.
2. Acid etching group (A): According to the instructions of the manufacturer, 9.5% hydrofluoric acid (Bisco, Schaumburg, IL, USA) was applied for 60 sec to the surface of each sample. After acid etching, the sample was rinsed with pressurized water for 60 sec and dried using an air spray.
3. Acid etching + universal adhesive group (AA): After acid etching, as described above,

Scotchbond Universal Adhesive (3M ESPE, St. Paul, MN, USA) was applied evenly in a thin layer to the cementation surface for 20 sec. According to the manufacturer's instructions, the specimens were air dried for 5 sec and light cured for 10 sec (T Led, Elca Technologies, Imola, Italy).

4. Sandblasting group (S): Sandblast (Renfert GmbH, Hilzingen, Germany) with 50 μm Al_2O_3 at 2.8 bar pressure for 15 seconds at a distance of 10 mm.

5. Sandblasting + universal adhesive group (SA): After sandblasting with 50 μm Al_2O_3 at 2.8 bar pressure for 15 seconds Scotchbond Universal Adhesive was applied evenly to the cementation surface of the specimens for 20 sec, and specimens were air dried for 5 sec and light cured for 10 sec, according to the manufacturer's instructions.

The specimens were bonded to 3×10×10 mm holder pieces prepared from a composite material (Filtek Z250 Universal Restorative, 3M ESPE, St. Paul, MN, USA). The bonding surfaces of the materials were grinded using 600-grit SiC sheet and a dual-cure adhesive resin cement (Panavia F 2.0, Kuraray, Tokyo, Japan) by applying 1 kg of pressure for 5 min in a metal device. After removing the residual cement, the cement application site was covered with an oxygen inhibiting gel (Liquid Strip, Ivoclar Vivadent, Schaan, Liechtenstein) to allow complete polymerization of the resin, and light curing was performed for 40 sec using device with a light output of no less than 550 mW/cm^2 to each surface. The specimens were stored in distilled water at 37°C for 24 h.

An acrylic carrier was prepared as proper for the holder apparatus of the saw to obtain 1 × 1 mm specimens, taken from the 10 ×10 mm specimens (Figure 1). The specimens were bonded to the upper section of the acrylic carrier using cyanoacrylate (Super Bonder Gel, Loctite, Sao Paulo, Brazil). After cutting the specimens, they were detached using a separator at a low speed (3,000 rates/min), first from the acryl carrier and then from each other. The specimens in the outer area were not included in the MTBS test, and the other specimens were checked under a stereomicroscope (M205C, Leica Microsystems, Wetzlar, Germany) at ×10 magnification.

In total, 100 specimens (n=10 in each group) were stored in distilled water inside an incubator (Nüve, Istanbul, Turkey) at 37°C for 7 days. The specimens were placed in a metal carrier in the testing device. To avoid any leakage of cyanoacrylate, the bonding area of the material-cement-composite resin was sealed with a thin layer of wax before gluing the specimens to the metal carrier. The MTBS test was performed with a universal testing machine (Shimadzu AG-50 kNG, Kyoto, Japan) at a crosshead speed of 1 mm/min. The results were expressed in megapascal (MPa) values. After MTBS test, the failure modes of specimens were examined under a stereomicroscope (Leica MZ12, Meyer Ins., Bannockburn, IL, USA) at ×20 magnification and recorded as adhesive (cement-resin nano ceramic/indirect composite), cohesive (inside resin cement) or mix (both adhesive and cohesive) failure type.

Statistical analysis

The statistical analyses were performed using SPSS for Windows (12.0, SPSS Inc, Chicago, IL, USA). Two-way ANOVA and Tukey-HSD multiple comparison tests were used for statistical analyses. In all tests, $p<0.05$ was considered as statistically significant.

RESULTS

Two-way ANOVA revealed that the differences among surface treatments and between the materials were statistically significant ($p<0.05$). There were interactions among surface treatments and the materials ($p<0.05$) (Table 2). The mean MTBS values and differences among the groups are presented in Table 3.

Table 2. Results of two-way ANOVA test

Source	Sum of squares	df	Mean square	F	Sig
Material type	159.567	1	159.567	101.550	.000
Surface treatment	1168.721	4	292.180	185.946	.000
Material type * Surface treatment	73.578	4	18.395	11.706	.000

*Significantly different at p<0.05.

Table 3. Mean and SD values for MTBS (MPa) and distribution of failure modes (adhesive/cohesive/mixed)

	Lava Ultimate		**Estenia C&B**	
	MTBS values (Mean ± SD)	**Failure Rates**	**MTBS values (Mean ± SD)**	**Failure Rates**
Control (C)	9.95 ± 1.14^{Aa}	9/0/1	12.54 ± 1.10^{Ba}	7/0/3
Acid Etching (A)	14.88 ± 0.99^{Ab}	6/1/3	15.93 ± 1.44^{Ab}	4/1/5
Acid Etching + Universal Adhesive (AA)	17.10 ± 0.86^{Ac}	2/4/4	17.34 ± 1.43^{Ab}	4/1/5
Sandblasting (S)	16.12 ± 1.07^{Abc}	5/2/3	20.01 ± 1.15^{Bc}	1/6/3
Sandblasting + Universal Adhesive (SA)	19.26 ± 1.26^{Ad}	1/6/3	24.11 ± 1.82^{Bd}	0/8/2

Capital superscripts correspond the same line, lower case superscripts correspond the same column.
*Significantly different at *p<0.05*.

Surface treatments significantly increased the MTBS of the materials compared to the control group ($p<0.05$). For Lava Ultimate or Estenia C&B materials, the highest MTBS values were obtained in the SA group and the lowest MTBS values were recorded in the C group ($p<0.05$). The MTBS values of the C, S and SA groups of the Estenia C&B were significantly higher than Lava Ultimate' groups ($p<0.05$).

For Lava Ultimate, the differences between S group and A, and AA groups were not statistically significant ($p>0.05$). The differences among the other groups were statistically significant ($p<0.05$). For Estenia C&B, there was no significant difference in MTBS values between A and AA groups ($p>0.05$). The differences among the other groups were statistically significant ($p<0.05$).

Failure pattern distribution of surface treatments and the materials are presented in Table 3. Adhesive fractures were mostly obtained in the C groups, whereas cohesive and mix fractures were mostly observed in all the groups in which the surface treatment procedures were applied. For both materials, cohesive fractures were mostly observed in the SA groups.

DISCUSSION

There are many factors that affect bond strength of indirect restorations to resin cement such as microstructure of restorative materials, type of cement materials, and chemical composition of silane, surface treatment procedures and cementation procedures.[21,22] It has been shown that micro-mechanical locking and chemical adhesion provides a durable bonding of resin-indirect restoration.[23] The present study evaluated the effects of different surface treatments on the bond strength of two types of indirect restorative materials to resin cement. According to the results of the current study, the null hypothesis that the types of materials and surface treatment procedures would not affect the bond strength of the indirect restorative materials to resin cement was rejected.

Surface treatments, including acid etching (9.5% hydrofluoric acid), sandblasting (50 μm Al_2O_3), application of a universal adhesive (silane containing) and their combinations were applied in the current study. These methods are commonly used for intraoral repair or cementation of indirect restorations.[24] Surface treatments are shown to increase the bond strength of resin to indirect aesthetic restoration materials, which was found similar with the results of the current study.[25,26] Some studies reported a linear relationship between bond strength and the elasticity modulus of the material.[22,27] In the current study, it was found that the MTBS values of the Estenia C&B, which has an elasticity modulus close to that of dentine, was higher than Lava Ultimate.

Hydrofluoric acid etching partially dissolved glassy and polymer phase of the ceramic and created micro-porosities by modifying the surface microstructure, thereby increasing mechanical locking between the surface area of the restoration and adhesive cement.[5,28] Previous studies revealed that 10% HF acid gel treatment had no effect on bond strength of resin based CAD/CAM materials

to resin cement.[29] The manufacturer of Lava Ultimate does not recommend roughening with acid etching as a surface treatment. Conversely, Loomans *et al.*[19] confirmed that the use of hydrofluoric etching was effective to increase the bond strengths for both Lava Ultimate and Estenia C&B. Similar to this result, in the current study, the use of hydrofluoric etching significantly increased the MTBS values for both Lava Ultimate and Estenia C&B materials compared to the C groups.

Frankenberger *et al.*[30] suggested sandblasting as an alternative to acid etching. For Lava Ultimate, acid etching has not been recommended by the manufacturer, presumably because of the zirconia nanoparticles in the material. Loomans *et al.*[19] stated that sandblasting had a positive effect on bond strength for Lava Ultimate the effect while for Estenia C&B was not statistically significant. In the contrary, in the current study, sandblasting for Lava Ultimate did not show a significant difference as compared to the A and AA groups, whereas the effect on Estenia C&B showed a statistically significant difference as compared to A and AA groups.

One of the surface treatments used in the current study was Single Bond Universal combination with 9.5% HF acid etching and sandblasting usage. Single Bond Universal is a universal adhesive containing silane has been introduced for use in surface treatments before adhesive cementation of indirect composite or ceramic restorations. The application of silane increases wettability and therefore enabled the formation of covalent bonds between the restorative material and resin cement.[22] Queiroz *et al.*[31] investigated the MTBSs of feldspathic ceramic and two different composites treated with acid etching and different ceramic primers. They reported that the use of silane following hydrofluoric acid etching resulted in higher bond strength. Ikemura *et al.*[32] reported that the addition of a silane-monomer mixture to various dental materials, including ceramic, resulted in high bond strength values. Kömürcüoğlu *et al.*[20] investigated the influence of different surface treatments on four point bending strength (FPBS) of novel CAD/CAM restorative materials to resin cement. They reported that application of silane following acid etching increased the FPBS values of Lava Ultimate. Similar to their result, in the current study, for Lava Ultimate, application of silane following acid etching (AA group) significantly increased the MTBS values compared with the A group, whereas for Estenia C&B, there was no significant difference between A and AA groups.

Previous studies[21,33,34] showed that the application of silane had a positive effect on the bond strength to direct composite restorations, whereas some studies could not find a beneficial effect.[35,36] However, the groups that applied Single Bond Universal after sandblasting showed statistically the highest MTBS among the surface treatment groups for both materials. Estenia C&B showed the higher MTBS values than Lava Ultimate. Based on the results of this study, the application of a universal adhesive following sandblasting can be recommended as an ideal surface treatment method for both materials.

Regarding the fracture types, previous research reported that reduced bond strength values were related to adhesive failure rates.[20,37] In the current study, the control groups with the lowest MTBS values regarding the surface treatment was the group with the highest adhesive failure. Toledano *et al.*[37] reported that mixed and cohesive failures were clinically more acceptable than adhesive failures. Cohesive failure of cement points to favourable bonding condition.[38] In the present study, among the surface treatment groups, the SA groups had the highest MTBS values, and these groups also had the highest rates of cohesive failures. For both materials, the use of a universal adhesive following sandblasting significantly increased both bond strength values and cohesive failure rates.

The current study has some limitations that make it difficult to compare the results directly with those of clinical studies. However, the results of the current study can still act as a guide for clinicians. One limitation was the use of only two types of materials and one type of adhesive resin cement. Similar to some studies using the MTBS test method[28,36,38], the lack of aging procedure may be another limitation of the current study. The use

of artificial saliva or thermocycling would ensure closer simulation of clinical conditions. To improve the clinical relevance of the findings, future investigations should be performed using different resin cements, different materials and aging procedures.

CONCLUSIONS

Within the limitations of this *in vitro* study, it can be concluded that the surface treatment procedures increased the MTBS bond strength of Lava Ultimate and Estenia C&B materials to resin cement. Estenia C&B had higher MTBS values than Lava Ultimate. The application of a universal adhesive following sandblasting of Lava Ultimate and Estenia C&B materials results in appropriate bond strength values.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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Farklı Yüzey İşlemlerinin CAD/CAM Rezin Nano Seramik ve Ceromerin Rezin Simana Olan Bağlanma Dayanımı Üzerine Etkileri

ÖZ

Amaç: *Bu çalışmanın amacı, farklı yüzey işlemlerinin, iki farklı indirekt restorasyon materyali (CAD/CAM rezin nano seramik [Lava Ultimate, 3M ESPE]; ceromer [Estenia C&B, Kuraray Medical]) ile rezin siman arasındaki mikro çekme bağ dayanımına (MÇBD) etkilerinin değerlendirilmesidir.* ***Gereçler ve Yöntemler:*** *Her test materyalinden 3x10x10 mm boyutlarında örnekler hazırlandı ve beş farklı yüzey işlem grubuna ayrıldı: Grup 1: herhangi bir işlem uygulanmayan kontrol grubu [C]; Grup 2: Asit uygulanan grup [A]; Grup 3: Asit + Silan içeren adeziv uygulanan grup [AA]; Grup 4: Kumlama uygulanan grup [S]); ve Grup 5: Kumlama + Silan içeren adeziv uygulanan grup [SA]. Örnekler, aynı boyutta hazırlanmış olan kompozite (Filtek Z250 Universal Restorative, 3M ESPE) dual-cure adeziv rezin siman (Panavia F2.0, Kuraray Medical) kullanılarak yapıştırılmıştır. Yapıştırılan bu parçalar düşük hızlı bir elmas separe ile kesilerek 100 adet bar şeklindeki (6×1×1 mm) örnekler elde edildi (n= 10). MÇBD testi tüm örneklere yapıldı (Shimadzu AG-50 kNG, Kyoto, Japan, 1 mm/dk). Veriler, iki yönlü varyans analizi (ANOVA) ve Tukey'in çoklu karşılaştırma testleri kullanılarak p<0,05 anlamlılık düzeyinde analiz edildi.* ***Bulgular:*** *MÇBD değerleri restoratif materyallerin tipi ve yüzey işlemlerinden önemli ölçüde etkilendi (p<0,05). Materyaller ve yüzey işlemleri arasinda istatistiksel olarak anlamlı farklılık bulundu (p<0,05). Lava Ultimate ve Estania C&B materyalleri icin, en yüksek MÇBD değeri SA yüzey işlem grubunda ve en düşük MÇBD değeri kontrol grubundan elde edildi (p<0,05).* ***Sonuçlar:*** *Kumlama sonrası silan içerikli universal adezivin uygulanması, her iki materyal için de ideal yüzey işlemidir.*

Anahtar Kelimeler: *Ceromer, bileşik rezinler, gerilme direnci.*

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Original research

EVALUATION AND COMPARISON OF TWO COMMERCIALLY AVAILABLE MOUTHRINSES IN REDUCING AEROLISED BACTERIA DURING ULTRASONIC SCALING WHEN USED AS A PREPROCEDURAL RINSE

ABSTRACT

Objective: To compare and evaluate the effect of 0.2% chlorhexidine gluconate and commercially available herbal mouthrinse in reducing aerosolized bacteria when used as a preprocedural mouth rinse.

Materials and methods: A total of 45 patients were selected and randomly divided into three equal groups. As the preprocedural rinse, patients belonging to group I, group II and group III rinsed with distilled water, 0.2% chlorhexidine mouthwash (Clohex®) and herbal mouthwash (Hiora®), respectively, for 60 seconds. Aerosols produced during the oral prophylaxis procedure were collected on blood agar plates by exposing the plates to the patient's and dentist's chest area, and the plates were incubated at 37°C under aerobic conditions for 48 h. The number of colony forming units (CFU) in the aerosol were counted and statistically analyzed.

Results: At both the locations the mean CFU were highest in Group I followed by Group III and Group II. The 0.2% chlorhexidine gluconate mouthwash was superior in significantly reducing the aerosolized bacteria during scaling, followed by herbal mouthrinse and distilled water ($p \leq 0.0001$).

Conclusions: The results of the present study clearly indicate that preprocedural rinsing with 0.2% chlorhexidine gluconate was significantly more effective than herbal mouthrinse in reducing the aerosolized bacteria during ultrasonic scaling. Therefore a preprocedural rinse can significantly reduce the risk for cross-contamination.

Keywords: Aerosols, chlorhexidine, colony count, herbal preparation.

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INTRODUCTION

The oral cavity is a unique environment which can provide an ideal medium for bacterial growth. Most of the procedures performed by dentists have the potential for creating contaminated aerosols and splatter, which contains bacteria, fungi, protozoa, and even bloodborne viruses produced during dental operative procedures; thus, promoting an increased risk of cross-infection.[1] In dentistry, the ultrasonic scaler and the air polisher are considered to be the greatest producers of small-particle aerosol contamination. Aerosols can remain airborne for extended periods of time and may be inhaled. It was found that the microorganisms like bacteria and viruses could survive in the aerosol produced for as long as six days.[2-6] The association of these aerosols with the respiratory infections, ophthalmic and skin infections, tuberculosis, and Hepatitis B have been reported.[7]

Current literature suggests that the use of an antimicrobial rinse by the patients before treatment may decrease microbial aerosols.[3-5] Chlorhexidine is considered as the "Gold standard" among antimicrobial rinse because of broad-spectrum antibacterial activity and high substantivity.[3-5] However, it also has some side effects, like tooth staining, altered taste perception, enhanced supragingival calculus formation, and less commonly, desquamation of the oral mucosa.[8] On the other hand, herbal mouth rinses with their natural ingredients can offer a safe and effective alternative to chlorhexidine, which should be optimally made use of due to their over-the-counter availability and minimal adverse effects.[9,10] The benefit of using herbal preparations is that they do not contain alcohol or sugar, which are present in over-the-counter products and can cause bacterial growth resulting in halitosis or bad breath. Moreover, Hiora® mouthwash used in the current study is a formulation containing active ingredients from extracts of *Salvadorapersica,* Piper betel, and *Terminalia bellerica* which have proven to be anti-plaque agents. The current study is aimed at determining and comparing the efficacy of chlorhexidine (0.2%) and Hiora® mouthwash in reducing the aerosol contamination produced during ultrasonic scaling.

MATERIALS AND METHODS

The present study is a double-blinded randomized clinical trial. The research protocol was approved by the institutional ethical review committee (KIMSDU/IEC/03/2015). Participants were informed about the purpose and design of the investigation and written informed consent was obtained. The patients for this study were selected from the Outpatient Department of Periodontology, School of Dental Sciences, Karad.

The subjects in the age group of 25-55 years, diagnosed with moderate form of chronic periodontitis, showing more than 30% of sites with clinical attachment loss >4mm, and fulfilling the following criteria were selected for the study; patients having a minimum of 20 teeth and have not received any periodontal therapy during the past 6 months. Subjects with known systemic disease or conditions, using mouthwashes, having a history of antibiotic/anti-inflammatory therapy for three months prior to the study, pregnant and lactating women, and patients hypersensitive to chlorhexidine mouthwash were excluded.

In this study, 45 patients were randomly divided into three groups, 15 patients each, by using a computer-generated table.

Group I (control group), group II and group III patients were given distilled water, 0.2% chlorhexidine gluconate (Clohex® mouthwash, Dr Reddy's laboratories) and herbal mouthwash (Hiora® mouthwash, Himalaya), respectively, as the preprocedural rinse.

All the selected cases were subjected to ultrasonic scaling by a single operator. Prior to oral prophylaxis, a patient's periodontal status was recorded using the Gingival index [11] and clinical attachment level using William's graduated periodontal probe.

The selected operatory area was fumigated prior to the study to reduce the chances of a false positive culture of airborne microorganisms. Blood agar plate was used to collect the airborne microorganisms as it is a valid medium for culturing airborne bacteria. Out of the two blood agar plates, one plate was positioned at the patient's chest area and the other at the dentist's chest area with the help of double-sided adhesive tape. An average distance of approximately 12

inches from the patient's mouth to agar plate was maintained. Scaling was carried out with piezoelectric ultrasonic scaler along with a motorized suction. Each treatment session of ultrasonic scaling lasted approximately 30 min.

All the patients were instructed to use the preprocedural rinse 10min before the treatment as per the group they were assigned to. Blood agar plate was left uncovered at the designated site to collect the samples of aerosolized bacteria. After collecting the sample, the blood agar plates were incubated at 37°C for 48h. The evaluation of colony forming units (CFUs) on each plate was carried out in the Department of Microbiology, Krishna Institute of Medical Sciences. The results were statistically analyzed using the Statistical Package for the Social Sciences (SPSS) software (version 20; IBM SPSS Inc., Chicago, IL, USA 2011). P-value < 0.05 was considered significant. The significance in the difference in means was tested by ANOVA test.

RESULTS

The average age of the patients having distilled water, herbal mouthwash, and 0.2% chlorhexidine gluconate as a preprocedural rinse was 53.33 years, 54.67 years, and 54.60 years, respectively. The distribution of subjects according to their gender is mentioned in table1.

Table 1. Gender wise distribution of patients under three groups

Gender	Distilled Water		Herbal Mouthwash		0.2% Chlorhexidine Gluconate	
	No.	%	No.	%	No.	%
Males	9	60	9	60	7	46.67
Females	6	40	6	40	8	53.33

Patient's chest

It was found that the mean aerosol contamination was significantly higher in patients having distilled water (611.33CFUs) as a preprocedural rinse compared to patients having herbal mouthwash (380.67CFUs), followed by patients having 0.2% chlorhexidine gluconate (256.67CFUs) (F= 281.12, p <0.0001, table 2).

Table 2. Comparison between reduction of aerosol contamination by pre procedural rinsing with distilled water, Herbal mouthwash and 0.2% chlorhexidine at both patients and doctors chest by ANOVA test

Descriptive statistics	Patients chest			Doctors chest		
	Distilled Water	Herbal Mouthwash	0.2% Chlorhexidine Gluconate	Distilled Water	Herbal Mouthwash	0.2% Chlorhexidine Gluconate
Mean (CFU'S)	611.33	380.67	256.67	314.33	173.33	128.00
Std. Deviation	47.49	28.15	46.24	52.67	29.20	21.11
Minimum	500	350	200	245	120	100
Maximum	675	450	350	400	200	150
F statistic		281.12			104.34	
p value		<0.0001*			<0.0001*	
t statistic	16.22	19.8	9.8			
p value	<0.0001*	<0.0001*	<0.0001*			

*statistically significant

The Tukey's multiple comparison test was performed to compare the difference between two pairs of means. A significant difference was observed between the groups using distilled water and herbal mouthwash (p<0.001); distilled water and 0.2% chlorhexidine gluconate (p<0.001); and herbal mouthwash and 0.2% chlorhexidine gluconate (p≤0.001*).

Dentist's chest

The mean aerosol contamination was significantly higher when distilled water (314.33CFUs) was used as the preprocedural rinse compared to the herbal mouthwash group (173.33CFUs), followed by patients having 0.2% chlorhexidine gluconate (128CFUs) (F= 104.34, p <0.0001, table2).

The Tukey's multiple comparison test was performed, and a significant difference was found

between the groups using distilled water and herbal mouthwash ($p<0.001$); distilled water and 0.2% chlorhexidine gluconate ($p<0.001$); and herbal mouthwash and 0.2% chlorhexidine gluconate ($p <0.01$).

DISCUSSION

Dental plaque is considered as one of the etiological agents in the development of periodontal disease comprising complexes of microorganisms, both bacterial and viral origin in the gelatinous matrix.[1] Dental calculus is porous in nature, and it can absorb various toxic products that can damage the periodontal tissues. Hence, calculus should be accurately detected and thoroughly removed for adequate periodontal therapy. Conventional non-surgical therapy is considered to be the cornerstone of periodontal treatment[8,9], including hand instruments and ultrasonic scaling. Ultrasonic produces high-frequency vibrations that lead to a phenomenon of cavitation and microstreaming. This phenomenon aids in the disruption of the bacterial cell wall as well as calculus removal. Despite the advantages of ultrasonic, there are disadvantages like tactile insensitivity and the production of aerosols. The ultrasonic scalers produce aerosols that are heavily contaminated with microorganisms and can cause a serious health threat to the patients, clinician, and the surrounding in the form of systemic conditions like common cold, influenza, tuberculosis, and severe acute respiratory syndrome (SARS).[1]

It is well-known that the personal protective equipment like mouth masks, head cap, eye and face shields, gloves, and gowns are most commonly used to minimize crossinfections in the dental office. However, they are not completely effective in reducing the levels of microorganisms in the environment. Furthermore, the most important drawback is that the clinician and patient remove the protective barriers shortly after completion of the treatment, whereas the aerosolized bacteria remain in the environment for up to 4 h.

As the oral pathogens show a high probability of bypassing the host defense, adjunct therapy in the form of chemical plaque control is required to reduce the bacterial load in the aerosol. Studies have shown that ultrasonic scaling in conjunction with a preprocedural rinse containing plaque control agents was more effective in reducing bacterial loads when compared with the use of distilled water orsaline.[5,12]

Various mouthwashes like Listerine, Peridex, Chlorhex plus have been used in reducing the aerosol count while performing ultrasonic scaling, but, chlorhexidine is considered as a gold standard for chemical plaque control because of its good substantivity.[3,5,13,14] Chlorhexidine is a bisbiguanide molecule that binds strongly to hydroxyapatite, the organic pellicle of the tooth, oral mucosa, salivary proteins, and bacteria. Chlorhexidine-containing mouth rinses, due to the strong binding, exhibit high substantivity with 30% of the drug released after rinsing and slow release for a long time. The 0.2% chlorhexidine was the first clinically effective mouthwash that inhibited supragingival plaque formation and is highly effective against gram-positive and gram-negative organisms, yeasts, dermatophytes, and some lipophilic viruses due to its broad-spectrum antimicrobial activity.[5,13,15] Several studies have indicated that chlorhexidine mouthwash is superior to herbal and essential oil mouthwashes.[5,13,16]

HiOra mouthwash is a nonalcoholic herbal rinse prepared from natural herbs with antibiotic, anti-inflammatory, anti-carcinogenic, and anti-plaque activities.[17] The use of 0.2% chlorhexidine gluconate mouthwashes as a preprocedural mouth rinsing for the duration of 60 s can cause a substantial reduction in bacterial counts.[1,3,5] However, a study reported that herbal mouthrinse produced the largest zones of microbial inhibition compared to Listerine and 0.12% chlorhexidine.[18]

In the present study, blood agar plates were used to collect the airborne microorganisms as it is a valid non-selective medium for culturing airborne bacteria. Our study revealed that both the dentist and the patients were exposed to high amounts of bacteria due to aerosols produced by ultrasonic scaling. The highest number of colonies was seen on the plates positioned on the patient's chest area. The larger salivary droplets generated during dental procedures settle down rapidly with

heavy contamination of the plates placed on the patient's chest area, followed by the contamination on blood agar placed on operator's chest area, placed 12 inches from the operating area.

The results demonstrated that the patient, operator, and people present in the operatory are exposed to a high amount of bacteria during the ultrasonic scaling procedure. The microbial load of aerosol reduced significantly in both the groups after preprocedural mouthwash usage in comparison to the control group. The analysis of the CFUs revealed that chlorhexidine was most effective in reducing the bacterial counts in the aerosol, followed by herbal mouthwash (Hiora). This could be due to the better penetration capacity of chlorhexidine into the dental plaque. These results were in accordance with other studies where the blood agar plate positioned at the patient's chest area received a greater number of microorganisms and demonstrated the efficacy of pre-procedural rinsing with chlorhexidine in reducing the aerosol contamination produced by ultrasonic scaling.[16,19,20]

The use of a high-volume evacuator attachment and aerosol reduction device can synergistically aid in the effective reduction of aerosol contamination without increased heat transfer to the tooth and is effective in reducing the number of microorganisms generated during ultrasonic scaling, therefore decreasing the risk of disease transmission.[21,22] The results of the present study clearly indicate that preprocedural mouthrinse with 0.2%chlorhexidine gluconate was significantly effective in reducing the aerosol contamination during ultrasonic scaling in dental practice. Various studies support the results of this study, demonstrating the excellent antimicrobial effects of 0.2% chlorhexidine as a preprocedural mouth rinse in aerosol reduction.[23,24] One of the limitations of the present study was considering only aerobic organisms that could be cultivated on blood agar.

CONCLUSIONS

In the present study, we found that 0.2% chlorhexidine, as an antimicrobial preprocedural mouth rinse, significantly reduced the number of microorganisms in the aerosols produced by the ultrasonic scaling units in comparison with the herbal mouthrinse. Using a preprocedural rinse significantly reduces the viable microbial content of dental aerosols.

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CONFLICT OF INTEREST

The authors declare to have no conflict of interest.

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Original research

EXPLORE AND COMPARE THE KNOWLEDGE, ATTITUDE, AND ACCEPTANCE OF DENTAL IMPLANT AS A TREATMENT OPTION AMONG SUB-POPULATION OF SAUDI ARABIA

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ABSTRACT

Objective: Implant therapy has gained wide popularity in the recent years. A complete information on implant therapy should be provided to patient by the dentist. The aim of present study is to evaluate the knowledge, attitude, source of information and acceptance of dental implants among the general population in the Southern region of Saudi Arabia.

Materials and Methods: A total of 712 patients were randomly selected from the OPD of dental hospitals across the southern region of Saudi Arabia. The designed questionnaire comprised of 15 open-ended questions. Only Saudi national population was selected for the survey. The questionnaire was divided into demographic data, knowledge, attitude and participant's acceptance towards implant therapy. The collected data were statistically analyzed using the Statistical Package for Social Sciences.

Results: Out of 712 participants, 675 complete the survey. 59.1% were male and 41.9% were females with an average age of 39.6 years old. All variables except for age showed statistically significant difference in the knowledge about implant among the study groups ($p<0.05$). The knowledge score was directly related to education and professional status of the participants. Majority of the patients (66%) with a history of implant therapy were satisfied with the placed implant. 41% of the participants reported high cost as a limiting factor for selecting an implant treatment.

Conclusions: Population from the southern region of Saudi Arabia has moderate knowledge about dental implant treatment. Dentists were found to be the most important source of information to the patient. The major barrier for not selecting implant treatment was the high cost of the implant therapy.

Keywords: Implant, knowledge, acceptance, attitude, Saudi Arabia.

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INTRODUCTION

The objective of advanced dental practice is to restore the patient to normal function, aesthetics, and phonetics.[1] The increasing use of dental implants is an attempt to fulfill these objectives in dental practice since last few decades.[2] In the recent years dental implants has gained popularity within the dental community and extensively recognized as a prosthetic treatment option of complete or partially edentulous and completely patients.[3] Many longitudinal studies have confirmed the long-term success and survival of dental implant as a prosthetic option, which has increased the prevalence of dental implant treatment exponentially.[4] Most of the patients treated by dental implants have revealed improvement in the quality of lifestyle and confidence.

Studies in recent years have revealed that the acceptance of implant therapy is increasing in both partially edentulous and completely edentulous patients. Nearby et al has conducted a study in Sweden in two parts over the course of ten years. At the time of the first survey in 1989, about 32% of participants stated a desire for implant therapy, which was dramatically increased to 95% in the second survey i.e in 1999.[5,6] A study on patient's attitude after dental implant therapy revealed that the majority of patients were ready to accept implant treatment again if needed and their oral health and self-confidence had increased significantly.[7] Another study conducted among Saudi population showed that about 76% willing to undergo the same treatment again and 79% would recommend it to the others.[8]

Many surveys are available in the literature, to evaluate a patient's awareness of dental implants therapy. The level of awareness and knowledge is varied among several surveys conducted across different countries. A survey conducted by Zimmer et al, in the American population, revealed a high awareness rate and positive attitude towards oral implant treatment. participants for the survey also agreed that esthetic results are better with implant therapy.[9] A survey conducted on 379 participants in Riyadh, Saudi Arabia revealed that 66.4% of the participants were aware of the dental implants as a treatment option.[10] Another study conducted in Malaysian population showed that, among 1013 participants, 772 (76%) were aware of dental implant as a treatment option.[11] A study conducted in Finland showed that, the level of awareness of implant treatment among selected groups was 29%[12], whereas survey from Australia showed a higher level of awareness of about 64%.[13]

Implant therapy is an elective procedure. Complete information on implant therapy and all other treatment options should be provided to the patient so that they can make a decision to choose the most appropriate option.[14] A survey on the Australian population disclosed that dentists are the principal source of information on dental implants to the patients followed by friends and print media and the general practitioners. Also, of those interested in gaining more information regarding implants, a majority of them wanted it from the dentists.[15] In another nationwide survey of the Indian population, it was concluded that information about dental implants was mainly provided by the dental surgeon.[16] Results from the other studies showed that the subject's friends and their relatives were the main sources of information about dental implants, whereas dentists were the secondary source of information.[10,11]

To the best of author's knowledge, there is no existing literature regarding the patient's knowledge, awareness about dental implants in the Southern region of Saudi Arabia. Therefore-the aim and objectives of the present study are to-

1) evaluate the knowledge regarding dental implants among the selected populations-
2) evaluate the sources of information concerning the dental implant as a treatment option-
3) evaluate the level of acceptance of dental implants as a treatment option.

MATERIALS AND METHODS

The present one-point, cross-sectional survey was conducted from 15th October 2016 to 26th February 2017. A total of 712 patients were randomly selected from the outpatient department of various government dental hospitals. A self-explanatory standardized questionnaire

comprising of 15 questions was designed to assess and compare patient's knowledge, acceptance and attitude towards dental implants in the Southern region of Saudi Arabia.

The questionnaire comprised of four main domains: **1)**Demography-age, occupation and educational status of the participants. **2)**Knowledge of the participants towards dental implant treatment. **3)**The attitude of the participants towards implant therapy- **4)**Participant's acceptance of implant therapy. A pilot test was performed on 15 participants to evaluate the efficacy of the questionnaire. The questionnaire was prepared in English as well as Arabic language considering the population in the area. Only Saudi national population was selected for the survey while other nationalities were excluded from participating.

The sample size was calculated depending on the following formula;[12]

$$\frac{\frac{Z^2 \cdot p(1-p)}{e^2}}{1 + \left(\frac{Z^2 \cdot p(1-p)}{e^2 N}\right)}$$

Where:

Z = *Z* value (1.96 for 95% confidence level)

p = percentage of picking a choice expressed as a decimal (0.5)

This was found to be 50% for the present study which was expressed as 0.50.

e = confidence interval, expressed as decimal (0.05)

N = total population of the region

By using the above formula- the minimum sample size calculated was 384.

The study protocol was presented to the Institutional Ethics Committee (IEC) and ethical clearance was obtained from them. The importance of the study was explained verbally to the participants and written informed consent was obtained before completion of the questionnaire form. The questionnaire did not contain the name of the participants; thus the confidentiality of the participants was maintained. The questionnaires were distributed among the participants during their hospital visits, and the research team members coordinates were around to answer any queries related to the questionnaire.

All the hypotheses were formulated using two-tailed alternatives against each null hypothesis (hypothesis of no difference). The entire data was statistically analyzed using the Statistical Package for Social Sciences (SPSS)- version 21.0- (IBM Corporation, USA) for MS Windows. Chi-square test was executed to compare the descriptive data. P value- <0.05 was taken as statistically significant.

RESULTS

Out of 712 participants, 685 completed the survey with a response rate of (96.20%). Among the 685 responses received, 10 were incomplete and thus excluded from the survey. Therefore 675 complete responses were selected for the final statistical analysis. Table 1 provides a detailed summary about the demographic data of the surveyed individuals. Out of 675 participants, 59.1% were males and 41.9% were females with an average age of 39.6 years old. Majority of the participants (48%) belonged to a young adult category. Figure 1 presents the distribution of overall knowledge of the surveyed participants.

Table 1. Demographic distribution of the participants.

	Frequency (n)	Percentage (%)
Gender		
Male	392	58.1
Female	283	41.9
Age		
Adolescence (10-19)	140	20.7
Young Adult (20-35)	324	48.0
Middle Age Adult(36-49)	189	28.0
Old Age Adult (50-onwards)	22	3.3
Education		
Primary School	42	6.2
Secondary School	284	42.1
Bachelor degree	302	44.7
Master degree	47	7.0
Occupation		
Students	219	32.4
Housewife / Unemployed	137	20.3
School / University Teacher	115	17.0
Professionals	59	8.7
Business	29	4.3
Government Employee	115	17.0

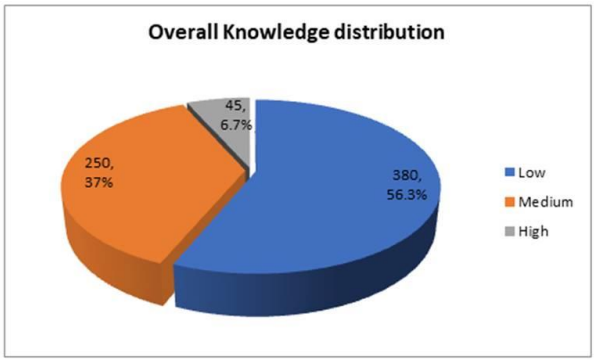

Figure 1. Overall distribution of knowledge among the participants.

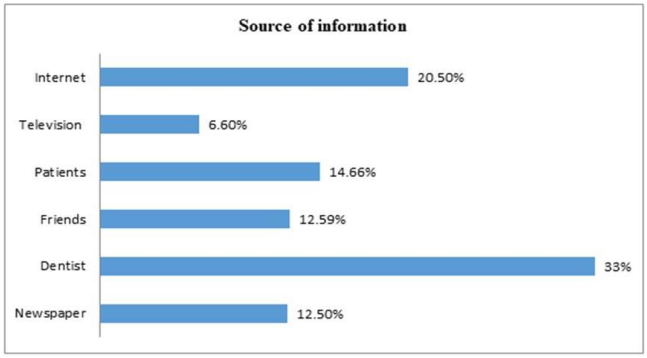

Figure 2. Distribution of source of information related to implant therapy among the participants.

In response to the question about alternatives to replace missing teeth, 94.8% of the participants were aware about one of the modality used for the replacement of missing teeth. Majority of them were aware about removable and fixed partial denture. For the question about advantages of fixed over removable prosthesis, 60.4% of the participants opted that fixed prosthesis has more esthetic outcome and they resembles natural teeth. Out of all participants, 69.33% had heard about the dental implant terminology, and they were aware of it as a treatment option. The dentists were the main source of information about dental implants in 31.5% of the questioned participants-followed by internet in 20.5% and patients in 14.6% (Figure 2).

Table 2 represents a detailed distribution and comparison of knowledge with respect to gender, age, education, and occupation.

Table 2. Distribution and comparison of knowledge category with respect to different variables among the participants

Variable categories			Knowledge category			p Value
			Low	Medium	High	
Gender	Male	% within Gender	56.4%	34.4%	9.2%	0.005*
		% of Total	32.7%	20.0%	5.3%	
	Female	% within Gender	56.2%	40.6%	3.2%	
		% of Total	23.6%	17.0%	1.3%	
Age	Adolescence	% within Age	63.6%	31.4%	5.0%	0.119
		% of Total	13.2%	6.5%	1.0%	
	Young Adult	% within Age	52.5%	41.0%	6.5%	
		% of Total	25.2%	19.7%	3.1%	
	Middle Age Adult	% within Age	55.6%	35.4%	9.0%	
		% of Total	15.6%	9.9%	2.5%	
	Old Age Adult	% within Age	72.7%	27.3%	0.0%	
		% of Total	2.4%	0.9%	0.0%	
Occupation	Students	% within Occupation	55.7%	37.4%	6.8%	0.000*
		% of Total	18.2%	12.2%	2.2%	
	Housewife / Unemployed	% within Occupation	70.4%	27.4%	2.2%	
		% of Total	14.2%	5.5%	0.4%	
	School / University Teacher	% within Occupation	53.9%	42.6%	3.5%	
		% of Total	9.3%	7.3%	0.6%	
	Professionals	% within Occupation	35.6%	40.7%	23.7%	
		% of Total	3.1%	3.8%	2.6%	
	Business	% within Occupation	55.6%	25.9%	18.5%	
		% of Total	2.2%	1.0%	0.7%	
	Government Employee	% within Occupation	53.9%	31.3%	14.8%	
		% of Total	9.3%	5.4%	2.5%	
Education	Primary School	% within Education	81.0%	19.0%	0.0%	0.000*
		% of Total	5.0%	1.2%	0.0%	
	Secondary School	% within Education	64.8%	28.2%	7.0%	
		% of Total	27.3%	11.9%	3.0%	
	Bachelor Degree	% within Education	48.3%	45.4%	6.3%	
		% of Total	21.6%	20.3%	2.8%	
	Master Degree	% within Education	34.0%	53.2%	12.8%	
		% of Total	2.4%	3.7%	0.9%	

**p* Value <0.05 =Significant

Knowledge was divided into 3 categories; low, medium and high- depending on the percentage of correct response to the questions. Knowledge was considered as high, medium or poor, if the correct response selected by respondents were more than 70%, between 50-70% and less than 50%- respectively. All the variables except for age showed- statistically significant difference in the knowledge about implant among the study participants ($p<0.05$). When asked about the previous exposure to implant therapy, 19.6% of the participants provided a positive response. Out of 123 participants who have received implant therapy in the past, 66% were satisfied, 26% were partially satisfied and 8% were unsatisfied with the results of therapy (Figure-3). Figure 4 shows the detailed distribution of the perception among the participants towards dental implant therapy.

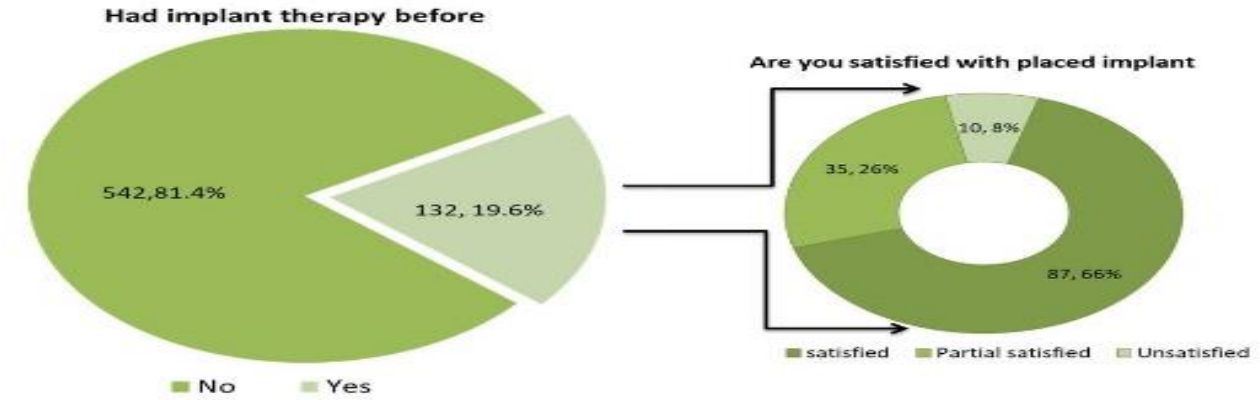

Figure 3. Acceptance and satisfaction related to implant therapy among participants.

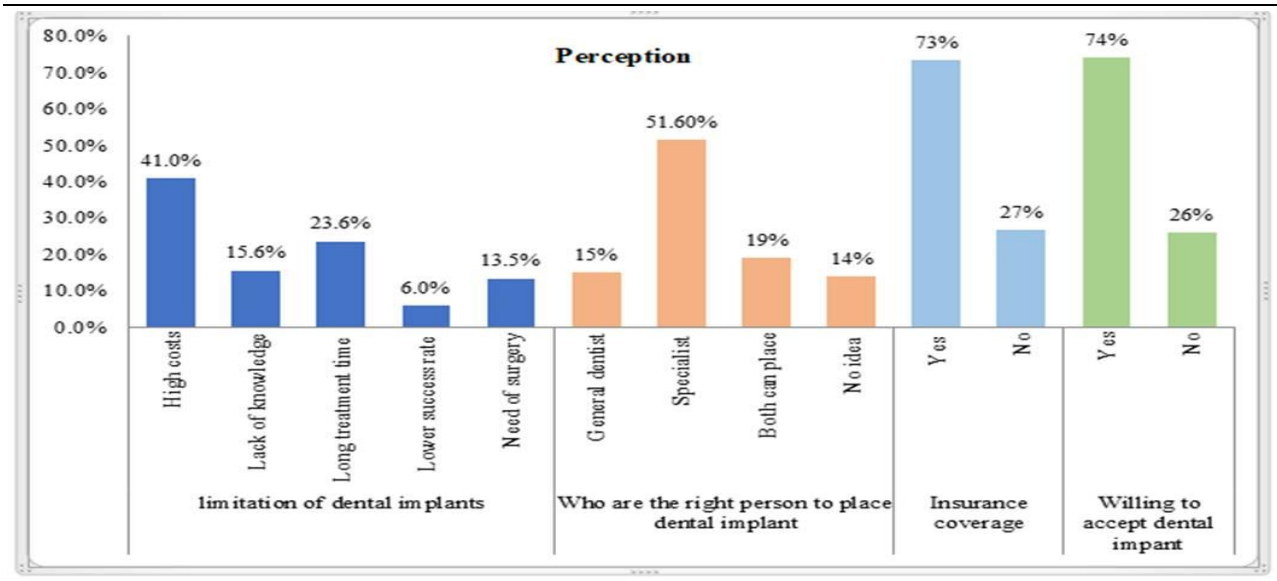

Figure 4. Distribution of participants' perception regarding dental implant therapy.

DISCUSSION

In the recent years dental practice has changed enormously due to the incorporation of dental implant as a treatment option. Dental implant is becoming a popular treatment modality in the general population with a long-term of success and higher patient satisfaction. In the last few years- a dental implant is gaining popularity and acceptance in the Southern region of Saudi Arabia. To the best of author's knowledge, this is the first survey conducted in the Southern region of Saudi Arabia to evaluate the knowledge, perception, and acceptance of dental implant.

In the present study, 69.33% of the participants were aware of the dental implant as a treatment modality. This findings is in accordance with the other studies conducted by Shivani *et al.*[11]- Tepper *et al.* [17], and Sulieman *et al.*[10], which reported awareness about 76.2%, 72%, and 66.4%- respectively. A study conducted by Ceyda *et al.*[18], in the Turkish population had contradicting results, with an awareness of only 45%. Most of the patients from the study group felt that fixed prosthesis is better and appears more natural than a removable prosthesis. These findings are in consistent with the study done by Tepper *et al.*[17], and Ceyda *et al.*[18] In the present survey- the major source of information dentists (33%)- followed by internet (20.5%) and patients (14.66%). The present information sources resemble those reported by Ceyda *et al.*[18], and Pommer *et al.*[15] However, Zimmer *et al.*[9], reported news media and Sulieman *et al.*[10], reported friends and their relatives as the main source of information.

The knowledge of the participants was evaluated by asking six questions with a score range of 0-6. Knowledge was considered as high if correct answers were more than 70 %, medium if between 50-70% and poor if less than 50%. The results of the survey showed that the difference in the knowledge between gender was statistically significant ($p<0.005$), males reported higher knowledge score than females. While considering age as a variable, there was no statistically significant difference among the different age group ($p>0.119$), but young age adults showed better knowledge score compared to other age groups. This can be related to the fact that the younger generation has more interest in dental implant treatment. A significant difference was reported related to the knowledge of implant in educational and occupational groups ($p<0.05$). The knowledge score was higher in the professionals and highly educated participants. Similar results were observed in the study conducted by Ceyda *et al.*[18], and Chowdhary *et al.*[16], in which they found that high level of education coupled with a reasonably higher income have a positive influence on the knowledge.

This survey showed that about 19.6% of the patients have had implant therapy in the past. There was a significant difference in gender where, 12.6% of the male and 7% of the female patients have received implant therapy for

replacement of their missing teeth. Young adults and high educational group participants (10.2%) received significantly more implant therapy as related to the other comparable groups. Out of 132 participants who received dental implants, 66% were satisfied, 26% were partially satisfied and 8% were unsatisfied with the therapy. A similar result was observed in studies conducted by Moghadam *et al.*[19], and Al- Radha *et al.*[20], which showed 85-96% and 86% satisfaction rate-respectively.

In response to a question about the limitation to receive implant therapy, the high cost of the implant was opted by the majority (41%) of the participants, followed by long treatment time (15.6%) and lack of knowledge (13.5%). A study conducted by Ceyda *et al.*[18], in Turkish population concluded high coast of the treatment as the strongest argument factor for not choosing implant therapy. A study by Sulieman *et al.*[10], found fear as a major barrier against implant therapy. When participants were asked about the right person to place a dental implant, the majority (51.6%) of them believed that it should be done by specialists. Among the entire respondent, 73% believed that dental implant treatment should be covered under insurance. A study conducted by Chowdhary *et al.*[16], found in their study that, 96% of the participants were in favor of insurance of dental implant. Male patients favor of insurance coverage for the dental implant more compared to the female patients. Almost three fourth of the studied populations were willing to accept dental implant as a treatment option in the future. In addition patients with young age and high education group showed more interest in receiving the implant therapy in the future

CONCLUSIONS

Within the limits of the present study, it can be established that population from the Southern region of Saudi Arabia has medium/moderate knowledge about the dental implant treatment. Dentists were found to be the most important source of information to the patients, thus indicating the importance of dentists in spreading the information and give counseling to the patients regarding dental implant treatment. The high charge for implant treatment is one of major barriers for not choosing dental implant therapy. To overcome this barrier, dental implant should be covered under the insurance company so that the majority of the population may get benefit out of this advanced treatment option. Spreading awareness in the general population regarding dental implants can help in abolishing any negative perception of the treatment that may have been due to inadequate knowledge and information.

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CONFLICT OF INTEREST

Nil

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Review

NATURAL PRODUCT AS THE STORAGE MEDIUM FOR AN AVULSED TOOTH – A SYSTEMATIC REVIEW

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ABSTRACT

Dental avulsion is considered as one of the most severe types of traumatic tooth injuries because it causes damage to several structures and results in the complete displacement of the tooth from its socket in the alveolar bone. The ideal situation is to replant the tooth immediately after avulsion because the extra oral time is an important determinant for the success of the treatment and for a good prognosis. The aim of this systematic review was to identify the recommended natural storage m to store and transport avulsed tooth based on the survival capacity of periodontal ligament cells.

This paper reviews the different storage media that have been evaluated for avulsed teeth based on full-length research papers retrieved from PubMed/Medline, Lilacs, BBO and SciELO electronic databases using the key words 'storage medium', 'avulsion', 'tooth avulsion', 'replantation', 'tooth replantation', 'milk' and 'propolis'. Based on the application of inclusion and exclusion criteria, about 14 papers have been selected and critically reviewed with respect to the characteristics, efficacy and ease of access of the storage media. The review of this study shows and includes a wide array of wet storage media that have been evaluated in laboratory-based studies on PDL cells found on adult permanent teeth.

Among the natural products other than milk, propolis, coconut water, green tea extract, egg white, green tea extract, Alovera gel, pomegranate juice, salvia officinalis followed by dragon blood sap (Croton Lechleri) were recommended based on the cell viability and its longevity. In an emergency, it is important for dentists to consider the circumstances of the accident, the location and suggest an appropriate transport media.

Key words: Avulsion, cell viability, periodontal ligament cell.

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INTRODUCTION

Tooth avulsion is defined as the complete loss of tooth from the alveolar socket as a result of trauma[1] and it may result in the early loss of teeth, leading to functional, psychological and aesthetic problems. Avulsion of permanent teeth is the most serious of all types of traumatic tooth injuries because the complete dislodgement of the tooth from its socket causes severe damage to the supporting tissues and vascular and nerve structures.[2,3] It corresponds between 1% and 16% of all types of tooth injuries involving the permanent dentition.[4-6] This wide variation can be explained by the differences in the evaluated population, including the levels of interpersonal violence, involvement in vehicular accidents and other road accidents related to traffic, which are caused especially due to the negligence of using helmets, and practice of contact sports, especially without using of mouthgaurds.[7]

The age group between 7-10 years is the most affected one by this injury due to their excessive involvement in sport activities because of their playfulness, the characteristic of that age stage. The prognosis of a replanted tooth and its maintenance on the dental arch for the longest possible time depend on the viability of the periodontal ligament (PDL) cells remaining on root surface, integrity of root cementum and minimal bacterial contamination[8], which are the conditions directly related to the extra-alveolar time, type of storage after avulsion and root surface alterations. The ideal treatment for the avulsion of permanent tooth is its immediate replantation into the socket.

In most situations, important factors for the success of replantation cannot be controlled. Studies have shown that this scenario can be improved significantly with educational campaigns on dentoalveolar trauma and storage media, to create awareness among common people and non-dental health professionals, especially for those working in emergency assistance services[9] to obtain a positive behavioural change to obtain successful treatment. Immediate tooth replantation leads to a better PDL repair and reduces significantly the occurrence of root resorption. Therefore, shortening the time is required between trauma and tooth replantation and maintaining the avulsed tooth in a suitable transport medium, well increase the prognosis Considerably.[10] As replantation of avulsed teeth occurs more frequently between 1 and 4. after avulsion, degeneration of cemental PDL fibers is a common event and the presence of necrotic PDL remnants on root surface stimulates the occurrence of inflammatory root resorption, which is the major cause for the loss of replanted teeth. In this way extra-alveolar time, taken for endodontic therapy is to administration of syc and adequate handling and maintenance of the tooth until the moment of replantation are the conditions leading to a better prognosis.[11]

However, adverse situations may occur, such as ankylosis and different types of root resorption, depending especially on the storage time and the characteristics and temperature of the storage medium. In fact, the capacity of the storage medium to maintain the viability of PDL cells has been considered more important than the extra-alveolar time.[12] Different types of wet storage media for avulsed teeth have been investigated, which may vary from cell and tissue culture solutions like propolis, green tea, Morus rubra (red mulberry), egg white and coconut water.[13] This paper reviews the different storage media that have been investigated for avulsed teeth based on full-length research papers retrieved from electronic databases considering their characteristics, efficacy and accessibility.

MATERIALS AND METHODS

Using the key words ‘storage media’, ‘tooth replantation’, ‘tooth avulsion,’ ‘milk’ and ‘propolis’, PubMed/Medline, Lilacs, BBO and SciELO, electronic databases were searched for research articles, reviews of literature, animal laboratory studies and laboratory studies which had been published in English between 2004 and 2017 involving cell counting in human teeth assessing the PDL cell viability after storage of avulsed teeth with different substances. Papers without an abstract and those that evaluated pulp cell Viability and root surface treatment were not included. The PubMed Advanced search was conducted using keywords. From a total of 206 papers, 14 articles were selected after application

of the inclusion criteria (table 2) and were critically reviewed for comparison of the outcomes.

Sources Used

For identification of studies included or considered for this review, detailed search strategies were carried out on the following databases.

-PubMed
-PubMed Advanced search
-MEDLINE
-Cochrane Database of Systemic Review

Language

There was no language restriction for the electronic search.

Hand Searched Journals

The following journals were hand searched

1) Journal of Interdisciplinary Dentistry
2) Journal of Khyber College of Dentistry

Types of Participants

Tooth with avulsion.

Type of Intervention

Natural storage medium.

Types of Outcome Measures

Periodontal ligament cell viability

EXCLUSION CRITERIA

The following studies were excluded,

- Case reports / case series
- Studies involving primary teeth
- Systematic reviews

INCLUSION CRITERIA

-In vitro study
-Natural storage medium
-Therapeutic Extraction

To assess the quality of the included studies, each item in the data extraction form was assigned a specific value, according to the amount of information that could be obtained from the individual study. The details of the studies included in the present systematic review are presented in table 2.

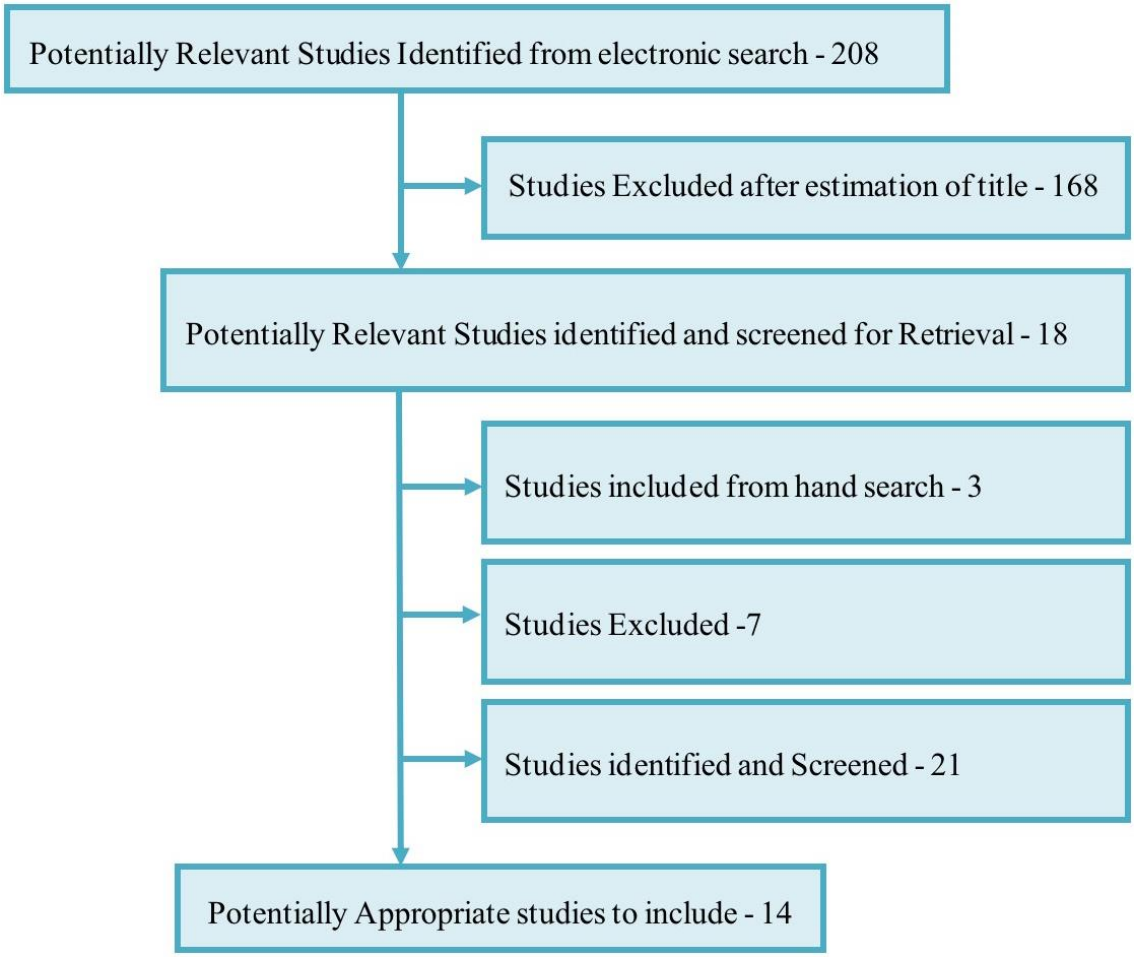

Figure 1. Search flow chart

Table 1. Included studies of Natural Storage medium

AUTHORS, YR	TYPE OF TEETH	NATURAL PRODUCTS	STORAGE TIME	ASSAY FOR EVALUATION	RESULTS	LEVEL OF EVIDENCE
D'Costa et al[9] (2017)	Forty sound human premolars undergoing extraction for orthodontic purpose	coconut water, milk, and saline	45 min	Trypan blue stain	Coconut water preserved significantly had more PDL cells viable ($p<0.05$) compared to milk and saline.	Very low
Irem BAG et al[25] 2017	Orthodontic extraction	MILK	30-60min or 12hrs	MIT assay	In the HBSS groups, RUNX2 expression increased showing a direction to osgenic differentiation of PDL fibroblasts.	low
V. V. Kokkali et al[17] 2017	Orthodontic extraction	Milk, coconut water, butter milk	75mins	Collagenase-dispase assay	The milk group has the maximum average number of viable PDL cells compared to coconut water or Buttermilk which was the least effective.	Low
Babaji et al[4] 2017	Orthodontic Extraction	Propolis, Aloe vera and pomegranate juice	45 mins	Hemocytometer	Propolis showed the more viable PDL cell followed by HBSS, aloe vera and pomegranate juice	Very low
Christine Men Martins et al [26] 2016	The human periodontal ligament cells were provided by the Laboratory of Applied Virology	Dragon blood sap, milk and PBS	1, 2, 3, 6, 10 and 24 hrs of incubation.	MIT assay	The dragon's blood sap showed better results than all storage media, even better than milk ($p<0.05$)	Moderate
Divya Saini et al[27] 2016	Orthodontic extraction	coconut milk or probiotic milk) and a Hanks' Balanced Salt Solution (HBSS)	20 minutes and then immersed for 30 minutes in one of the storage media	collagenase-dispase assay	there was a significant difference ($p<0.001$) between Coconut milk and probiotic milk as well as HBSS.	Very low
Souza et al[24] 2016		skimmed milk (S Milk), whole milk (W Milk), natural coconut water (Coconut), propolis, and egg white	3, 6, 24, 48, 72, 96, and 120 hours	MTT Assay	Coconut, Propolis and Egg, were less effective than S Milk, W Milk, and HBSS	High
Ahangari et al[2] (2013)	Extracted anterior teeth	Propolis,Hank's Balanced salt solution, milk and egg white	3 hrs	Dispase collagenase assay	Propolis significantly is found better than egg white and milk ($p<0.05$)	Low
Hwang et al[15] 2011	Freshly extracted premolar	Tap water, milk, GTE, and commercial green tea.	1, 3, 6, 12, and 24 hours	Collagenase-Dispase assay	GTE showed higher cell viability than other media ($p<.05$).	Moderate
B. D. M. Souza et al[18](2010)	Third molar extraction	skimmed milk, whole milk	3, 6, 24, 48, 72, 96 and 120	MTT assay	The greatest number of viable cells was observed for MEM. Skimmed and whole milk, followed by natural coconut water and HBSS, which were the most effective media in maintaining cell viability ($p<0.05$).	High
Ozan, Fatih et al[22] (2008)	healthy third molars	Salvia officinalis solutions, Hank's balanced salt solution (HBSS), phosphate buffered saline (PBS), and tap water	1, 3, 6, 12 or 24 hours.	trypan blue exclusion	The results showed 2.5% Salvia officinal is a more effective storage medium than the other experimental solutions ($p<0.05$).	Moderate
Khademi et al[16]2008	Extracted premolar teeth	egg white, and milk	1, 2, 4, 8, and 12 hours	trypan blue staining	There was no difference in the cell viability between egg white and HBSS ($p<0.05$)	Moderate
Gopikrishna et al[12] 2008	Fifty freshly extracted human teeth	coconut water (CW) and milk	30 minutes	MIT aasay	Coconut water kept significantly had more PDL cells viable compared to either HBSS or milk.	Very low

Table 2. Natural storage media groups as reported in the included studies.

Natural Products	Total search	Inclusion criteria
MILK	**103**	**3**
COCONUT WATER	**19**	**2**
EGG WHITE	**13**	**1**
PROPOLIS	**14**	**1**
GREEN TEA EXTRACT	**04**	**1**
POMEGRANATE JUICE	**03**	**2**
RED MULBERRY	**02**	**1**
ALOVERA GEL	**01**	**1**
BLOOD DRAGON SAP	**01**	**1**

RESULTS

The search identified 208 publications, out of which many were excluded after careful review and finally it is found that only 14 publications have fulfilled all criteria for inclusion. Henceforth, we conclude that the skimmed milk has shown higher level of evidence based on the storage time, followed by Green tea Extract, coconut water and blood dragon sap.

DISCUSSION

There are numerous studies that have been reviewed and compared to find out the best storage medium for avulsed tooth.[14] The systematic review compared the various natural storage media in terms of their ability to maintain PDL cell viability with particular storage time. To determine the actual physical state of the PDL cells after they have been placed in different natural storage media, only laboratory-based studies have been selected. The present systematic review demonstrates that milk is considered as the best storage medium for avulsed tooth.[15] Milk has a unique combination of nutrients, capable of maintaining the PDL cell viability, and with physiological pH range of 6.5-7.2. The PDL cells have been shown to survive for 2-6 hours when immersed in milk. Sour milk should not be used as it harmful to the PDL cells.[16]Recent studies have favoured other natural media for avulsed tooth.[17]The low cost, presence of nutrients and easy availability make milk a more practical choice than any other medium. HBSS is a specially designed storage medium containing essential nutrients.[18] Although it is not easily available in most parts of the world, it is marketed in some countries as 'Save-a-tooth'. To maintain PDL cell viability, the clonogenic as well as mitogenic capacity of the PDL fibroblast has to be analysed and demonstrated. PDL cell viability has been studied and documented by sustaining its ability for about 48 hrs. It has been recommended that the avulsed tooth should be placed in HBSS for 30 minutes before replantation into the socket, regardless of which storage medium the tooth was placed in, prior to this procedure.[19]

The most common method reported that the viability of the PDL cells can be assessed by Trypan blue exclusion or staining test.[20] Trypan blue solution in the strength of 0.4% is routinely used as a cell stain to assess cell viability using the dye exclusion test. A disadvantage of using Trypan blue is that the dye is cytotoxic to some degree, and also stains the background which can result in inaccuracy when counting the cells.[21] Another method that was used to determine PDL cell viability was MTT assay (3-[4,5-dimethylthiazol-2-yl]-2,5 diphenyltetrazolium bromide) which is basically a colorimetric test determining the metabolic activity of cells. This tetrazolium-based assay is useful because of its rapid results, objectivity, and ease of manipulation as well as immediate identification of viable PDL cells.[22]

Parameters indicating a good prognosis for the replanted avulsed tooth such as the lack of replacement resorption, external inflammatory resorption, external invasive resorption, pain, and swelling can only be assessed clinically over a long follow-up periods.[23] However, the clinical application of the investigated storage media can only be established after their use in clinical trials. Hence to standardize the inclusion criteria dictated by the dry time of the PDL cells would be very difficult.[24] Thus, identification of the most recommended storage medium for avulsed teeth in the context of clinical survival rate is difficult. This could be considered the primary shortcoming of the present review, in which no studies assessing the clinical survival of teeth were included.[25] This was mainly because the

parameters for the assessment of clinical success were different to those of laboratory-based studies. The inferences of the investigation would be much expressive henceforth the method to control such biases has been applied. Ideally, the most recommended storage medium should not only be able to maintain PDL cell viability but also enhance it.

However, this enhancement of PDL cell viability was observed only in few Studies.[26] The actual number of cells that remained viable after being placed in the storage medium could not be compared in the selected studies because of the great variability in the methodology of studies. The best medium encompassing all the ideal characteristics may yet to be identified, but this systematic review has managed to identify the most recommended natural storage medium that can be used to store or transport the avulsed teeth.[27]

Table 3. Criteria used for grading quality of Evidence

GRADE range	Quality of evidence	Interpretation
0- 1hours	**Very low**	**PDL cell viability assessed (less than 1 hour)**
1-12 hours	**low**	**PDL cell viability assessed (less than 12 hours)**
12-24 hours	**Moderate**	**PDL cell viability assessed (less than 24 hours)**
>24 hours	**High**	**PDL cell viability assessed (more than 24 hours)**

This systematic review has identified many storage media that have been used to preserve avulsed teeth, including coconut water, soy milk, whole milk, saline solution, saliva, propolis. However, we conclude that the best storage media for avulsed tooth is skimmed milk followed by green tea extract, coconut water and blood dragon sap based on storage time and they were used to assesses the cell viability (Table 3). 'High level of evidence' studies indicate proof that the true effect lies close to the estimated effect (figure 2).

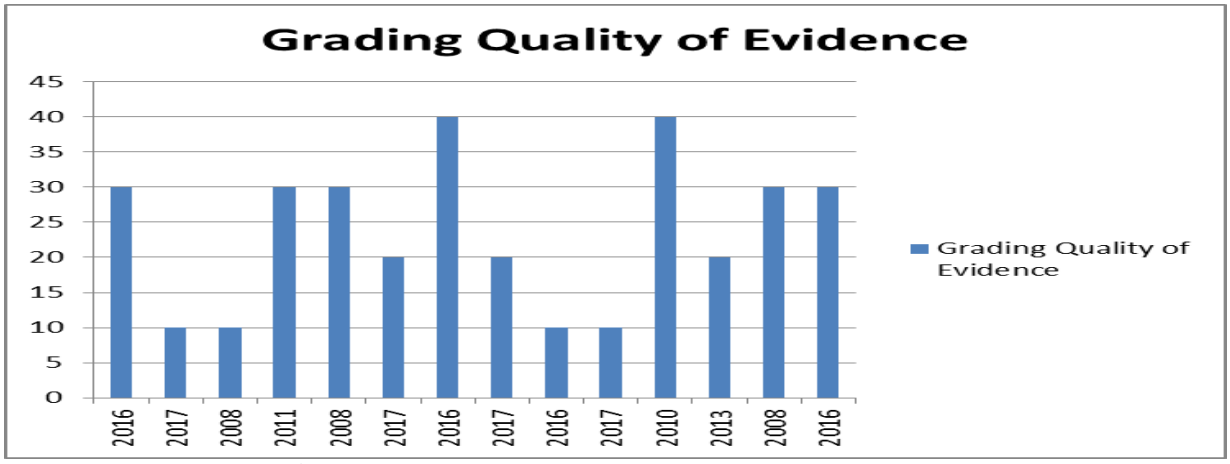

Figure 2. Showing the evidence of included studies

CONCLUSIONS

Although HBSS with its osmolality and pH similar to plasma is probably the best transport media for avulsed teeth, it may not necessarily be available at the site of accident. Any appropriate media prevents desiccation of the periodontal ligament cells following trauma and improves chances for successful replantation. Natural transport media like skimmed milk, coconut water, blood dragon sap and egg white score over HBSS based on their storage time, ease of availability and economical price. In case of emergency, it is important for dentists to consider the circumstances of the accident, the location and suggest an appropriate transport medium for the avulsed tooth.

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CONFLICTS OF INTEREST

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

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Case Report

POST HERPETIC OSTEONECROSIS OF THE MAXILLA

ABSTRACT

Herpes Zoster (HZ) is caused by the secondary reactivation of Varicella Zoster virus. It is characterised by presence of severe pain and unilateral vesicles along the distribution of the affected nerve. Osteonecrosis is one of the rare complications of Herpes Zoster which is seen after the acute phase of the illness has subsided. We report a case of osteonecrosis of the maxilla in 35-years–old female. The subject gave a history of Herpes Zoster of the maxillary branch of the trigeminal nerve. After healing of the lesions, she then developed osteonecrosis of the maxilla. Further investigations revealed her HIV positive status. The clinical features, pathogenesis and management of this rare condition are described. Further, the occurrence of HZ induced osteonecrosis lead to the diagnosis of HIV in the present case.

Keywords: Herpes zoster, osteonecrosis, HIV.

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INTRODUCTION

Osteonecrosis, also known as ischemic necrosis, avascular necrosis, aseptic necrosis and osteochondritis dessicans, is characterised by in situ death of bone.[1] Herpes Zoster is a caused by the reactivation of Varicella Zoster virus in sensory ganglia. It leads to painful vesicles of the skin and oral mucosa along the distribution of the affected nerve.[2] Complications are seen commonly in immune suppressed individuals and include post herpetic neuralgia, Herpes Zoster ophthalmicus, meningitis, VII th nerve palsy, myelitis and encephalitis.[2] Osteonecrosis of bone after herpes zoster infection is a rare complication, often associated with tooth exfoliation and needs rapid identification and management.[3]

In this report, we present the case of an HIV positive patient with osteonecrosis of the maxilla secondary to Herpes Zoster of the maxillary division of the trigeminal nerve.

CASE REPORT

A 35 years-old- female patient reported to the Department of Oral Medicine and Radiology with a complaint of pain in the upper right back tooth region for 3 months. She gave history of multiple fluid filled vesicles localized to the right middle third of the face 9 months ago which was associated with severe pain and burning sensation. The lesions resolved on their own within 2 weeks with scarring. From the past three months she had developed pain in the right maxillary posterior region with loosening and exfoliation of the teeth and pus discharge. Extraoral examination showed scarring over the right middle third of the face. The skin over the area was erythematous with mild rise in temperature. Depigmentation was noted on the right side of the upper lip. (Figure 1A)

Figure 1A: Extraoral photograph showing unilateral scarring over the right middle third of the face and areas of depigmentation.
Figure 1B: Intraoral photograph showing ulceration extending from maxillary right lateral incisor to maxillary right second premolar region and presence of necrotic bone.
Figure 1C: Occlusal radiograph showing unilateral bone loss and missing teeth.
Figure 1D: Panoramic radiograph showing ill-defined bone loss extending from maxillary right central incisor to maxillary right first premolar with loss of the associated teeth.

Intraoral examination revealed an ulcerated area extending from maxillary right lateral incisor to maxillary right second premolar region. Necrotic bone could be seen at the base of the ulcer and pus discharge was present. Teeth from maxillary right central incisor to maxillary right first premolar were missing and maxillary right second premolar and first, second and third molar teeth were mobile. (Figure 1B) Palatal gingiva was edematous and tender on palpation. There were no decayed teeth. Pus Culture was negative.

Occlusal (Figure 1C) and Panoramic radiographs (Figure 1D) showed ill-defined bone loss extending from maxillary right central incisor to maxillary right first premolar with loss of the associated teeth. Serological investigation showed that she was HIV positive. Due to financial constraints, she was unwilling for any further investigations. A final diagnosis of osteonecrosis of the maxilla secondary to herpes zoster was given. Saucerization and decortication was done along with antibiotic coverage of amoxicillin and metronidazole for 5 days. Histopathology with hematoxylin and eosin stain (H&E, 10X magnification) showed granulation tissue with evidence of numerous chronic inflammatory cells. Bone fragments (H&E, 40X) showed empty bone lacunae without any evidence of osteocytes suggestive of necrotic bone. (Figure 2 A and B)

Healing was uneventful and the patient was subsequently lost to follow up.

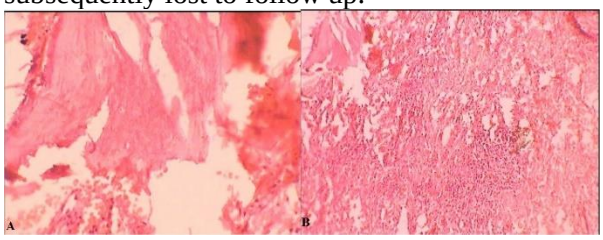

Figure 2: A: Photomicrograph H&E (40X) showing necrotic bone and **B:** Photomicrograph H&E (10X) showing granulation tissue.

DISCUSSION

Herpes Zoster is a reactivation of latent Varicella Zoster virus.[3] The commonly affected dermatomes include the thoracic (45%), cervical (23%) and trigeminal (15%).[3] Advanced age, physical trauma, stress, malignancy, radiation therapy and well as immunocompromised individuals such as transplant patients, patients on steroid therapy and HIV positive patients have increased risk of developing Herpes Zoster.[4] Herpes Zoster occurs around 15 times higher in HIV positive patients on comparison with patients who are HIV negative and is often the first manifestation of AIDS. In 20% cases, Herpes Zoster affects the trigeminal nerve.[5]

It was Gonnet in 1922 who first described alveolar bone necrosis and tooth loss as a consequence of Herpes Zoster infection.[2,6] Herpes Zoster is considered as an early manifestation of HIV infection. The first report of post herpetic osteonecrosis in a patient with AIDS related complex was by Srisuwan in 1999.[2]

Herpes Zoster is a common infection in HIV-infected patients with incidence up to five cases per 100 persons per year.[7] The incidence of HZ of the trigeminal nerve is more common in an older age group, however, the affected HIV positive patients are generally younger.[3] Siwamogstham *et al.*[2] mention that in India, Herpes Zoster was found to be an early manifestation in HIV infected patients and was seen in the age group of 12– 45 years. The clinical presentation of HZ includes unilateral severe pain and burning sensation and vesicle formation along the area of distribution of the affected nerve.[3] Diagnosis of HZ is primarily based on the clinical presentation. Laboratory diagnosis is required in unusual presentations as is seen in immunocompromised patients and includes Tzank smear, viral culture, direct immunofluorescence, serum immunoglobulin levels and polymerase chain reaction.[4]

Various hypotheses have been proposed to explain HZ induced osteonecrosis of bone. These include local vasculitis, infection of terminal nerves, denervation of bone and osteoblast injury.[2] Mintz and Anavi[8] suggested that pre-existing pulp or periodontal inflammation may exacerbate tooth exfoliation and bone necrosis. Mahajan *et al.*[9], however, reported three cases of osteonecrosis which had no immunodeficiency, no tobacco habits, and minimal periodontal disease, suggesting that Herpes Zoster may be the primary cause of osteonecrosis.

Osteonecrosis after Herpes Zoster commonly occurs once the acute phase has subsided.[6] The time period from the onset of HZ and osteonecrosis varies from immediate appearance to 42 days with a mean of 21.2 days. Among the 45 cases of HZ reviewed by Cloarec *et al.*[7], osteonecrosis developed in 14 cases with a mean interval of 5 weeks. Other authors suggest as much as 3-24 weeks.[10] In our case, the patient reported HZ infection 9 months earlier though the symptoms of osteonecrosis started 6 months after HZ infection. Osteonecrosis of the hip has been associated with HAART therapy in HIV positive patients but the data is not conclusive.[1]

Kim *et al.*[10] state that a patient with history of Herpes Zoster of the trigeminal nerve, vesicles restricted to a unilateral jaw quadrant and clinical features of osteonecrosis after a proper interval, can be diagnosed as having osteonecrosis caused by herpes zoster. It is difficult to differentiate Osteonecrosis of the jaw from osteomyelitis. Magnetic resonance imaging has been used in diagnosis, however, there no studies which have described the radiographic differences between osteomyelitis and osteonecrosis. The major difference appears to be that osteomyelitis of the jaw bone occurs as an extension of odontogenic infection.[11] Histological findings in osteonecrosis are similar to those in osteomyelitis. Necrotic bone and inflammatory cell infiltration is seen as in our case.[10]

Use of antiviral agents is known to reduce the severity and duration of pain in Herpes Zoster. However antiviral therapy must be given within

the first 72 hours after the appearance of the lesions.[5] Prevention of complications is by immediate use of antiviral agents and painkillers.[10] In the present case, the patient did not receive any medication for HZ.

Once osteonecrosis occurs, antibiotics can relieve the pain temporarily but stoppage of the medication causes pain recurrence.[5] The diseased marrow must, therefore, be surgically removed.[5] Thus, antibiotic administration, sequestrectomy and extraction of involved teeth leads to healing which was the management used in the present case.[2,5] Early treatment recommendations for osteonecrosis discouraged use of surgical therapy. However, recent reports recommend resection of the affected bone till the appearance of healthy, bleeding bone. Other treatment recommendations include use of laser therapy, platelet rich plasma, platelet derived growth factor and hyperbaric oxygen.[12]

In the present case, diagnosis of osteonecrosis secondary to HZ was made based primarily on the history and clinical features. Advanced investigations could not be done due to financial constraints and this represents the main limitation of this report.

To conclude, osteonecrosis secondary to Herpes Zoster is a rare complication. However, due to increasing numbers of HIV positive patients in the population who are susceptible to various infections, it is important to identify such cases promptly and institute effective treatment without any delay. The present report highlights the features of Herpes Zoster associated osteonecrosis of the jaws. Further, the occurrence of HZ induced osteonecrosis lead to the diagnosis of HIV in the present case.

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Case Report

SMITH-LEMLI-OPITZ SYNDROME (SLOS): CASE REPORT AND SYMPTOMATIC TREATMENT

ABSTRACT

Smith-Lemli-Opitz syndrome is a rare syndrome with multiple congenital anomalies after birth and characteristic with mental retardation. Hereditary cholesterol diseases are an autosomal recessive form of metabolic disturbances. There are two types: Type I with mild clinical signs (classical form) and Type II with severe clinical signs. The Type I form with a higher chance of survival is more common. There are typical craniofacial findings such as microcephaly, low-set ears, micrognathia, flattened nasal root and bitemporal narrowing. Cleft palate and/or deep palate enlarged alveolar bones, small-sized tongue and swallowing strength are noticeable mouth-related findings. Patients recover at a certain rate with early medical treatment. Early dental treatments are based on eliminating symptomatic problems. A 3-week-old male patient presented with a deep palate, swallowing difficulty, a problem of nourishment, and SLOS Type I was presented.

Keywords: RSH-SLO syndrome, maxillary diseases, alveolar bone, palatal expansion technique.

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INTRODUCTION

Smith-Lemli-Opitz Syndrome (SLOS) is an autosomal recessive disorder characterized by multiple congenital anomalies and seen with the prevalence of 1/20,000-60,000 in Hispanics.[1-5] The syndrome, where insufficient growth, developmental retardation and congenital defects are seen, was first described by Smith et al.[1] This syndrome is caused by a mutation on the enzyme level at the last stage of cholesterol biosynthesis (7-dehydrocholesterol; 7-DHC)(5-7).[1] Thereby, the cholesterol levels are low in SLOS cases.[6-10] According to clinical observation and prognosis, there are two types as the classical form (Type I) and the severe form (Type II). In Type I SLOS, clinical manifestations are milder, and life span is more prolonged.[1,11]

The craniofacial findings are microcephaly, ears positioned below the normal level and facing backward, dysmorphic facial findings, bitemporal narrowing, ptosis, flattened nose root, outward nostrils, micrognathia, (isolated) cleft palate, deep palate, bifid uvula, enlarged alveolar bone sclerosis, enamel hypoplasia, oligodontia - hypodontia and small tongue.[1,2,9,11-17] It was reported that 40-50% of patients with SLOS have an isolated cleft palate deformity, and newborns with SLOS suffer from swallowing difficulty due to cleft or deep palate.[12,14,18] For this reason, feeding infants with SLOS may be inadequate for a normal growth pattern. Other clinical findings include prenatal and postnatal developmental retardation, moderate-severe mental retardation, polydactyly, congenital heart diseases, pulmonary vein disorders, urogenital disorders accompanied by inadequate external genital organs, hypotonicity and syndactyly between the second and third toes.[1,12-19] Despite the limited number of case reports, a symptomatic treatment approach to facilitate nutrition has not been previously presented. The aim of this case report is to present a newborn with SLOS, review the information in the literature and discuss the current treatment options. This method will be the first method applied to the upper jaw for the symptomatic treatment of a patient.

CASE REPORT

Informed consent: Written informed consent was obtained from the parents of the patient who participated in this study.

A 3-week-old newborn male patient was admitted to the Department of Orthodontics at the Faculty of Dentistry at Erciyes University with complaints of deep palate dome, swallowing difficulty, nourishment and constant vomiting problems (Figure 1).

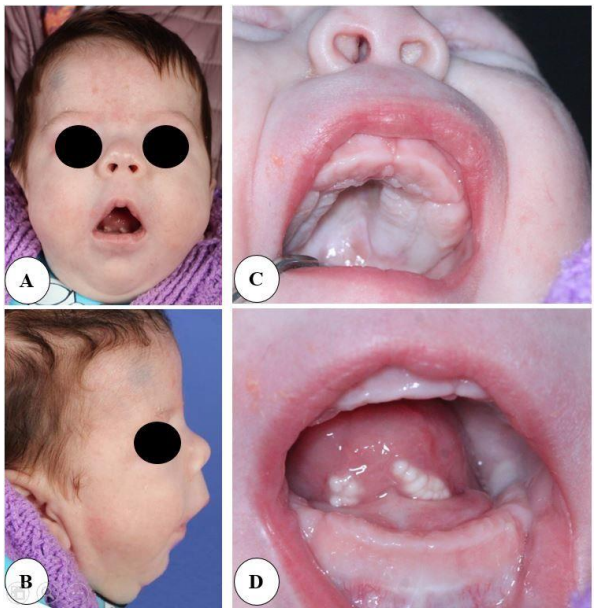

Figure 1. Extra-oral and intra-oral photographs of SLOS patient. A)Frontal view. B) Profile view. C)Appearance of maxilla and deepened palate dome. D) Appearance of mandible and sublingual nodule-like formations.

The diagnosis of SLOS Type I in the patient was made according to the results of his blood cholesterol levels and the clinical examination by the Endocrine Science Department of Child Metabolism at Erciyes University, Faculty of Medicine. The patient was recommended to use medication for correction of cholesterol levels, had an operation on the heart and soft tissue syndactyly between the right second and third toes. Because the circumference of the head was measured as 36 cm, it was found below the 3rd percentile according to the Turkish population, and therefore, the patient was diagnosed with microcephaly. Other physical examination findings (height: 48 cm, weight: 3.3 kg) also indicated that the patient was below the 3rd percentile, because the percentile values such as a head circumference of about 41 cm, 58 cm of height and 4.2 kg of weight of normal male patients without the syndrome were accepted to be

normal values.[20] Along with this, other clinical findings of the patient with SLOS were reported as ambiguous genitalia, syndactyly, bitemporal narrowing, hypotonicity in the neck muscles, flattened nasal roots, low-set ears, deep and narrow palate, broad upper and lower alveolar edges (Figure 2), yellow nodule formation under the tongue, difficulty in swallowing, nutritional problems and vomiting by the Endocrine Science Department of Child Metabolism, the Faculty of Medicine and the Department of Orthodontics, the Faculty of Dentistry at Erciyes University.

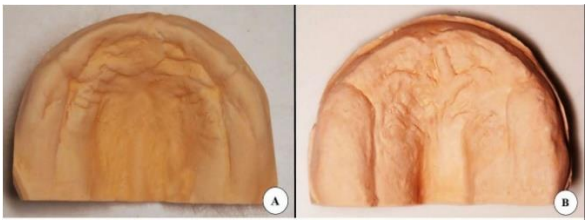

Figure 2. A) Maxillary dental model of normal new-born. B) Maxillary dental model of patient with SLOS.

Symptomatic treatment approach

A symptomatic treatment approach was planned to enlarge the oral chamber, expand the tongue chamber, reduce the deepness of the palate by decreasing the depth of the palate and allowing negative pressure formation in the mouth during swallowing. A maxillary dental model (Figure 2) was prepared by using hard dental gypsum from the maxillary dental impression, which was obtained with a silicone impression material. A removable appliance was applied to the maxilla in order to help the patient nourish and enlarge the narrow maxillary dental arches (Figure 3).

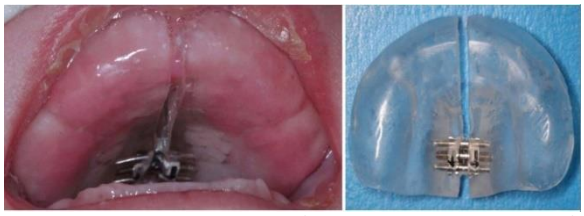

Figure 3. Maxillary expansion of SLOS patient, using a modified acrylic feeding plate with a widening screw.

The expansion screw was activated for a ¼ turn per week (1 turn=1 mm; ¼ turn=0.25 mm). Screw activation was continued for the first 4 months. The analysis of the maxillary dental models was performed on the images obtained by a 3D model scanner (3Shape, Copenhagen, Denmark) and the OrthoAnalyzer (3Shape, Copenhagen, Denmark) software (Figure 4).

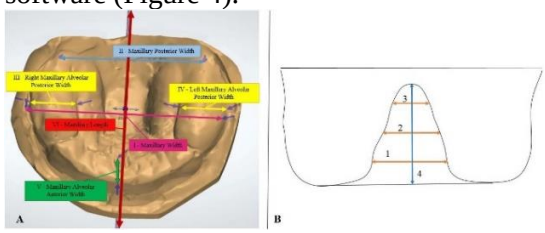

Figure 4. A)I. Maxillary Width, II. Maxillary Posterior Width, III. Right Maxillary Alveolar Posterior Width, IV. Left Maxillary Alveolar Posterior Width, V. Maxillary Alveolar Anterior Width, VI. Maxillary Length. B)1. Palatal dome width (Maximum width between alveolar crest peaks), 2. Palatal dome low level 1 width (at the midpoint of the maxillary depth), 3. Palatal dome low level 2 width (close to 1/4 of the maxillary depth), 4. Maxillary Depth (distance between the highest point of the alveolar crest and deepest point of the palatal dome).

An increase of 4.49 mm in maxillary width was found in the treated SLOS case, while the developmental increase of the maxillary width of a control subject who was born at the same time as the syndromic new-born had normal development within its percentile. As seen in the change of maxillary depth, a decrease of -0.44 mm in the SLOS case and an increase of 2.13 mm in the normal new-born were detected (Table 1).

Table 1. Evaluation and comparison of maxillary development of SLOS case and control subject

	Patient with SLOS			**Control subject**		
	T0 (3rd week)	**T1 (7th month)**	**Differences**	**T0 (3rd week)**	**T1 (7th month)**	**Differences**
Maxillary length	32.50 mm	33.15 mm	*0.65 mm*	37.62 mm	40.15 mm	*2.53 mm*
Maxillary depth	13.57 mm	13.13 mm	*-0.44 mm*	9.12 mm	11.25 mm	*2.13 mm*
Maxillary width	36.40 mm	40.89 mm	*4.49 mm*	39.50 mm	41.26 mm	*1.76 mm*
Anterior alveolar width	5.15 mm	6.40 mm	*1.25 mm*	6.19 mm	7.01 mm	*0.82 mm*
Posterior alveolar width (right)	8.30 mm	10.21 mm	*1.91 mm*	7.12 mm	8.15 mm	*1.03 mm*
Posterior alveolar width (left)	8.50 mm	11.49 mm	*2.99 mm*	7.8 mm	8.6 mm	*0.8 mm*
Palatal dome width	17.15 mm	20.67 mm	*3.52 mm*	17.95 mm	19.26 mm	*1.31 mm*
Palatal dome low level 1 width	8.30 mm	9.87 mm	*1.57 mm*	9.92 mm	10.56 mm	*0.64 mm*
Palatal dome low level 2 width	7.60 mm	8.42 mm	*0.82 mm*	9.11 mm	10.26 mm	*1.15 mm*
Weigth	3.4 kg	4.7 kg	*1.3 kg*	4.2 kg	7.4 kg	*3.2 kg*
The head circumference measurement	36 cm	38 cm	*2 cm*	41 cm	48 cm	*7 cm*

Although the amount of vomiting decreased during the treatment, the swallowing difficulty continued partially in the patient, and there was insufficient weight gain (from 3.4 kg to 4.7 kg in 6 months) as expected, because his syndrome was very severe, and the parents of the SLOS patient did not show co-operation for both the medical and orthodontic treatments of the patient. During the monitoring period, the sublingual nodule-like structures previously reported by Merrer[21] disappeared, which indicated regulation of the cholesterol metabolism. However, despite the fact that expansion of the maxilla was achieved, he was still fed by a nasogastric probe.

DISCUSSION

SLOS is a congenital cholesterol metabolism disease which manifests various intra-oral findings and needs to be intervened with in the early period.[1, 11, 12] It is necessary to help improvement of nutrition in cases with cleft palate and/or deep palate. However, these patients usually have difficulty in swallowing. Providing early cholesterol regulation may substantially reduce the symptoms of this syndrome.[21,22] Medical treatment may increase the rate of retarded growth, accelerate the developmental process and decrease the rate of dermatological, gastrointestinal and infectious diseases.[23] A normal male new-born with the same age as and similar weight to the patient with SLOS was selected as the control subject and was followed for 6 months. The increase in the alveolar crest width of the SLOS patient was greater than that in the normal patient. Weight gain in the normally developed new-born was 20% (from 4 to 7.5 kg), while the weight gain in the SLOS patient was about 10% (from 3.4 to 4.7 kg) (Table 1). Moreover, the weight gain and growth values were similar to those reported by Lee et al.[24] Individuals with this disease are usually found to be below normal developmental stages.[1, 2, 20, 24] Therefore, the development of our patient was below the 3rd percentile. The increase rate of the maxillary width was greater than the normal patient because an expansion appliance was used.

The variation of medical and dental history should be considered to describe the factors that may be effective in terms of dental treatment, since various complications may occur in patients affected by SLOS. A symptomatic approach of primary orthodontic treatment in the early period was presented in this report. A nutritional plaque beside an expansion screw was applied to the SLOS patient to improve the nutritional status of the patient. In the case of a deep palate, placement of a widening screw in the nutritional plaque may provide additional benefits to reduce the existing depth. The improvement under expectation with the nutritional expansion plaque was thought to be due to the incompliance of the parents with the use of the appliance as instructed and retention problems in the mouth. Further practices may focus on solving the retention problem of appliances in toothless new-born mouth. In our patient, there were difficulties in swallowing and use of the appliance since the restraint and undercuts of the maxillary alveolar bone were insufficient. Because of these reasons, the patient could not get enough benefit from nutrition.

CONCLUSIONS

It is important to know the characteristic findings of SLOS and other rare syndromes, on which the level of knowledge is low, to provide treatment options for such patients. Determination and interpretation of intra-oral and extra-oral clinical findings would be sufficient for the necessary consultations with the department of child metabolism and the department of medical genetics for the accurate diagnosis which is extremely important for the detailed orofacial and dental treatment of the patient.

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CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

Smith-Lemli-Opitz Sendromu (Slos): Olgu Sunumu ve Semptomatik Tedavisi

ÖZ

Smith-Lemli-Opitz sendromu, doğum sonrası multipl konjenital anomaliler ve mental retardasyon ile birlikte karakteristik bulguları olan nadir görülen bir sendromdur. Kalıtımsal kolesterol metabolizma bozukluklarının otozomal resesif geçişli bir formudur.

Hafif klinik özelliklerle seyreden (klasik form) Tip I ve şiddetli klinik özelliklerle seyreden (Tip II) olmak üzere iki tipi vardır. Yaşama şansı yüksek olan tip I formu daha sıklıkta görülmektedir. Mikrosefali, düşük kulaklar, mikrognati, basık burun kökü ve bitemporal darlık gibi tipik kraniofasial bulguları mevcuttur. Yarık damak ve/veya derin damak, genişlemiş alveolar kemikler, küçük boyutlu dil ve yutkunma güçlüğü dikkat çeken ağız bulgularıdır. Hastalar erken dönemde aldığı medikal tedavi ile belirli oranlarda iyileşme göstermektedirler. Erken dönemde uygulanan dental tedaviler semptomatik problemlerin giderilmesi üzerine olmaktadır. Derin damak, yutkunma güçlüğü, beslenememe problemi ile getirilen ve SLOS tip I tanısı konmuş 3 haftalık erkek hastanın sunumu yapıldı. ***Anahtar Kelimeler**; RSH-SLO sendromu, maksilla hastalıkları, alveol kemiği, damak genişletme tekniği.*

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