Cumhuriyet Dental Journal, 26(1): 28-32, 2023
DOI: https://doi.org/10.7126/cumudj. 1202436

Cumhuriyet Dental Journal

| cdj.cumhuriyet.edu.tr | Founded: 1998 Available online, ISSN: 1302-5805 e-ISSN: 2146-2852 Publisher: Sivas Cumhuriyet Üniversitesi

Evaluation of Flexural Strength of Different All-Ceramic Porcelain Systems

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Research Article

History

Received: 10/11/2022
Accepted: 01/02/2023

ABSTRACT

Statement of problem protective and restorative dentistry's basic function is to protect the continuity and integrity of the tissues and to restore function, phonation, and esthetics lost due to any cause. The success of dental ceramics is affected by flexural strength, but little data are available on their clinical performance.
Purpose: This study evaluated the flexural strength of the Finesse, In-Ceram Zirconia and In-Ceram Alumina press all-ceramic porcelain systems. The success of dental porcelains is partly related to their flexural strength. Flexural strength values of three porcelain Systems were measured to include Finesse, In-Ceram Zirconia and In-Ceram Alumina press all ceramic porcelain systems.
Material and Methods*:* The flexural strengths of the three porcelain systems were determined by employing the method ISO specification 6872. For the statistical evaluations of the flexure strength values, Mann-Whitney U and Kruskal Wallis tests were used.
Results: When the flexural strengths of Finesse, In-Ceram Zirconia and In-Ceram Alumina groups were compared, the diversity were found to be statistically significant.
Conclusions*:* The highest flexural strength was observed for In-Ceram Zirconia, followed by In-Ceram Alumina and Finesse porcelain system.
Clinical implications: In this study, Finesse, In-Ceram Zirconia, and In-Ceram Alumina all-ceramic systems were compared concerning flexural strength. The diversity between the groups are significant ($p<0.05$).

Key words*:* Flexural Strength, All-Ceramic Porcelain Systems, Finesse, In-Ceram Zirconia and In-Ceram Alumina.

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How to Cite: Coşkun A. (2023) Evaluation of Flexural Strength of Different All-Ceramic Porcelain Systems, Cumhuriyet Dental Journal, 26(1):28-32.

Introduction

In recent years, new porcelain treatment methods have been developed for prosthetic dentistry.[1] Porcelains used in dental practice are known for their natural structure, optical transmittance and most importantly their durability.[2] In addition to the aesthetic and physical properties of porcelain restorations, their resistance to physical bending is also important.[3]

Due to the low permeability of the metal structure that creates the durability in metal-supported porcelain used in dentistry, aesthetic problems and problems may be experienced on the durability of the porcelain part. Finesse all-ceramic porcelain systems are created using the hot press technique[4], slip-cast technique for Zirconia porcelain and another by a Alumina pocelain has recently been introduced to form all-ceramic structures for use in prosthetic restorations. In 1985, Dr. An all-ceramic structure known as slip cast was developed by Sadoon in his laboratory in Paris.[3]

Tests on flexural strength and durability are carried out on newly developed porcelain structures using in vitro test techniques without conducting clinical studies.[6] The main advantage of the bending test is that a pure tensile strength State can be created on one side of the sample. Three- and four-point bending stress tests have also been used for the strength evaluation of dental biomaterials.[7] Such tests are frequently used because samples with simple shapes (bars or rods) can be used, and no special grips are required.[8]

The success of dental porcelains is partly related to their flexural strength. This study evaluated the flexural strength of the Finesse, In-Ceram Zirconia and In-Ceram Alumina press all-ceramic porcelain systems.

Material and Methods

In this research, the bending strength of three metal-free porcelain systems with different structures was examined: In Ceram Zirconia (In Ceram Zirconia, Vita, Bad Säckingen, German), In Ceram Alumina (In Ceram Alumina, Vita, Bad Säckingen, German) and Finesse (Finesse, Ceramco, Burlington, NJ, German).

The porcelain samples were prepared by the method recommended in the ISO Standard 6872 (1995). A multiple-point stainless Steel mold having a rectangular cavity of 2 mm x 5 mm x 25 mm was used (Figure 1,2).

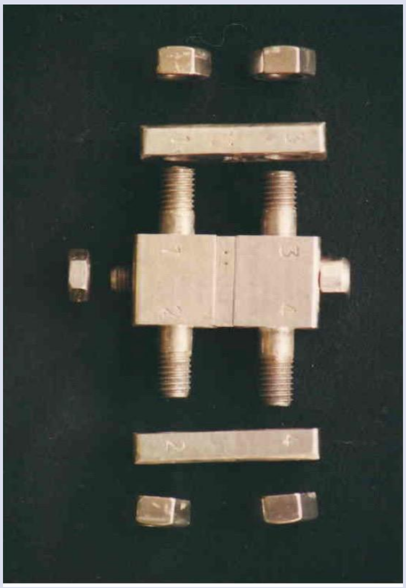

Figure 1.

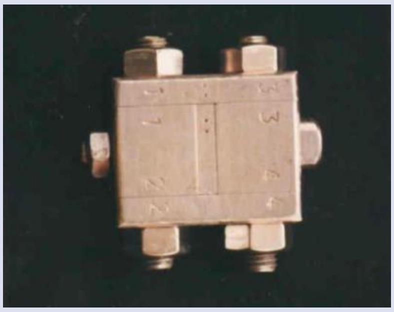

Figure 2.

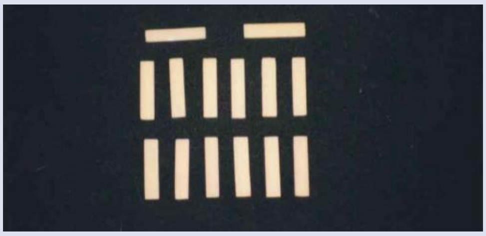

Figure 3.

To prepare the rectangular porcelain sticks obtained with the Finesse porcelain system, these wax molds were created in accordance with the instructions in the prospectus by melting the wax into the necessary wax molds with the heat printing technique. These wax molds formed were mixed in the Revetment mixing machine and pulled into the cylinder plastic casting path and taken to the cuff. These rings were placed first into the preheating oven with a rise of 5°C per minute and heated until the temperature reached 900°C, and the wax removal process was made for one hour. The manchets were taken to the oven without waiting and placed in the manchet anchorage.

According to the manufacturer's instructions, an initial temperature increase of 700°C was provided for 1 hour and a vacuum was activated at 925°C. The oven at 1180°C was kept at that temperature for 7 minutes and then continued to cool itself for 5 hours. All these 14 samples were prepared in the same way (Figure 3).

Following the leveling process, water emery (Nikon/ Japan, No. 400 with No. 600) was applied. It was subjected to abrasion so that its thickness 1.2 ± 0.2 mm, width is 4 ± 0.2 mm, and Length at least 20 mm. Samples were subjected to glazing processes by observing the directions suggested by the manufacturer firm.

Whereas for the porcelain sticks to be made with In Ceram Alumina and Zirconia porcelain systems without metal support, Zirconia porcelain powder for In Ceram Zirconia, Alumina ceramic powder for In Ceram Alumina and were mixed with glass rod in glass beaker according to the suggestions of the manufacturing firm and mixed in the Vita sonic Q device for 5-10 minutes. The mixture made was moved from the glass tube into the plastic tube. The ceramic liquid and ceramic powder the mixture created was applied over the mold made before like wax modeling by using a number 5 sable brush in form of coatings. For each coating, the same process was applied. During these processes, the over-folding sections were subjected to form corrections.

The In Ceram Zirconia and In Ceram Alumina, ceramic samples were moved into the oven manufactured by the firm on the mold and kept there for 6 hours at 120°C with 8.35°C temperature rise per minute. Ceramic samples were kept for 2 hours and at 1120°C they were kept for 2 hours again. Thus, the samples were formed. The distilled water was mixed on the glass, with the glass structure, and applied by using the number 5 sable brush to apply to these structures. The samples were moved into the oven for oven Processing over platinum folio having a thickness of 0.1 mm Temperature of the oven was increased to 1120°C in 30 minutes for In-Ceram Alumina and at this temperature, they were kept there for 4 hours. When the oven temperature reached 400°C degrees, the oven was opened. It was left to cool at room temperature. For In Ceram Zirconia samples, the oven temperature was increased to 1000 °C in half an hour and kept at this temperature for four hours. The oven was opened at 500 °C and left at room temperature to cool down. On the samples taken from the oven, the leveling processes were applied by using diamond burs. This process was applied to each of the 14 samples for In-Ceram Zirconia and In-Ceram Alumina. After, leveling process, water emery (Nikon, No.400 and No. 600, Tokyo, Japan,) was applied and the samples were abraded to have a thickness of 1.2±0.2 mm, a width of 4 ± 0.2 mm and length of at least 20 mm. The samples made were cleaned by keeping them for 10 minutes in the distilled water in the ultrasonic cleaner (Brio Ultrasonics, BR-6 LAB, Barcelona, Spain) and these samples were made ready for measurement Measuring take Flexural Strength: Three-point bending test was used in our study as recommended in ISO standards (1995). The sample bars were loaded in the universal tester (LR 10 K Plus, Lloyd Instruments, Farnham, England) at 0.5 mm/ minute speed. The distance between the supporting tips was 15 mm and the loading end is centered between the supports.

The load values at fracture of the samples were obtained in kilograms and were converted into Newtons. The flexural strength values for each material were determined using the following equation.

M = 3.W.I/2. b. d2

M = Flexural strength (MPa)

W = Maximum load read before breaking (N)

d = Thickness of sample (mm)

b = Width of sample (mm)

I - Distance between the supports (mm)

Statistical Assessment of Flexural Strength The data obtained in our research were evaluated using the SPSS (Version 15) statistical program, and Mann-Whitney U and Kruskal-Wallis (KW) tests were used in these evaluations.

Results

After the surface Processing was applied to the samples prepared as Finesse, In Ceram Zirconia, and In Ceram Alumina systems the flexural strength values (Mpa) determined are indicated in Table 1.

When the bending strength values of Finesse, In Ceram Zirconia, and In Ceram Alumina groups (MPa) are compared (Table 2 the difference was found to be statistically significant) ($p<0.05$).

When these values of groups are compared in papers with each other, the difference between In Ceram Zirconia and In Ceram Alumina and between Finesse and In Ceram Alumina groups and the difference between Finesse and In Ceram Zirconia systems were found to be statistically significant ($p<0.05$).

All ceramic porcelain systems found to be the most resistant is the In Ceram Zirconia and in the second row, In Ceram Alumina porcelain system and in the third row, finesse porcelain system concerning durability (Figure 4).

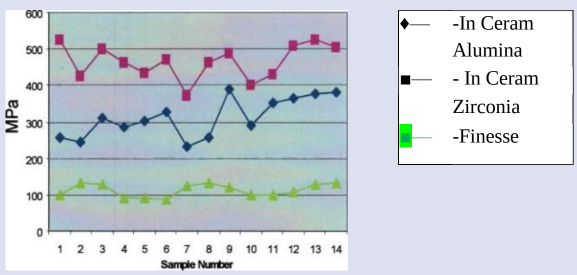

Figure 4. Graphic values of flexural strength values.

Discussion

There are many debates about the durability of ceramics. There are differences in these discussions. The values obtained in the studies on porcelain are affected by various factors such as thermal values, production speeds, technical changes, production, and thermal defects. The strength values may change depending on the micro cracks on the bottom surface of the rectangular bar obtained for the flexural strength test.[1,9]

The varied data range in the studies is due to differences in sample preparation procedures and test methods. Three-point bending tests, four-point bending tests, ring-on-ring tests, as well as piston-on-three ball tests were used in several different studies.[10]

The transverse resistances of brittle materials are generally evaluated using the bi-axial flexure test or three-point bending test (the one ISO 1995 suggests). Several investigators such as Williamson[11], Cattell[6], and Ohyama[12] have suggested using the three-point bending test because of its reliability, ease, and sensitivity. Thus, we used a three-point bending test in our tests.

Chong et al. compared the bending strengths of In Ceram Zirconia and In Ceram Alumina Systems. They found that the bending strength of In Ceram Zirconia is higher than that of In Ceram Alumina.[10]

Wagner et al. tested In Ceram, Empress, and Procera All Ceram ceramics to compare their biaxial flexural strength. In the study performed with ceramics, the average bending strengths of All Ceram 687 MPa, In Ceram 352 MPa and Empress 134 MPa were found, respectively.[13]

Chong et al. In their study, In Ceram Alumina, they obtained different data between 236.15 and 530 MPa in three- and four-point bending strength tests. In their study with In Ceram Alumina, they reached data between 174.2 and 240 MPa.[10]

Zeng et al. tested the failure stresses in flexural tests of Procera All Ceram, IPS Empress, In-Ceram systems and found that Procera All Ceram had consistently higher fracture stress than the other two materials[14].

Yoshinari et al. Compared the fracture strength of premolar crowns of In-Ceram, Vita-Dur, IPS-Empress and Dicor porcelain systems. Fracture durability of all-ceramic crowns bonded using zinc phosphate cement after applying distilled water Vita In-Ceramda1060N; 770N in Vita Dur porcelain; It is determined as 891N in IPS-Empress porcelain system and 840N in Dicor porcelain.

Strub et al. They were made with 5 different all-ceramic crown systems (Empress, In-Ceram staining technique, Celay feldspathic System, Celay In Ceram and porcelain systems obtained with the Empress coating technique) and evaluated the fracture resistance before and after cyclic preloading used in the artificial jaw. As a result, they found that chewing simulation and thermal cycling significantly reduced the fracture resistance of all tested crown systems.[16]

In dental practice, an ideal restorative structure should have excellent flexural strength. The results of this study show that all-ceramic porcelain systems do not improve the wear of hardness properties. However, long-term clinical data should be examined to understand the properties of these all-ceramic porcelain systems. Flexural strength values should be considered when using all-ceramic porcelain systems for prosthetic restorations in clinical practice.Lin WS et al. They stated in their research that zirconia coated ceramics exhibit greater bending strength than monolithic leucite reinforced and lithium-disilicate ceramics.[17].

Coşkun et al. Finesse, In Ceram Zirconia, and In Ceram Alumina stated that microleakage and marginal adaptations in porcelain systems have no effect on the durability ratio. [18].

In our research, a minimum value of 87.40 Mpa and a maximum value of 132 Mpa for the Finesse porcelain system, a minimum value of 373.10 Mpa and a maximum value of 526.90 Mpa for the In-Ceram Zirconia porcelain system, and a maximum value of 230.00 Mpa for the In-Ceram Alumina porcelain system. The minimum value and the maximum value of 380.80 Mpa were determined (Table 2).

Conclusions

When the bending strengths of Finesse, In Ceram Zirconia and In Ceram Alumina groups, which are three different all-ceramic systems we used in our research, were compared, the difference was found to be statistically significant (p<0.05). The order of bending strength of the porcelain ceramic systems was found as In Ceram Zirconia, In Ceram Alumina and Finesse porcelain ceramic systems, respectively.

Acknowledgments

VITA Inc. for advice and cooperation. I want to thank Corp.

Table 1. Flexure strength of three porcelain systems (MPa)

	All Ceramic Systems		
Sample	In Ceram Alumina	In Ceram Zirconia	Finesse
Number	n-14	n=14	n=14
1	2583	526.9	98.9
2	243.1	426.9	132.4
3	311.8	501.8	127.1
4	287.3	4633	90.8
5	3023	434	90.8
6	326.9	473.1	87.4
7	230	373.1	124.6
8	2583	4633	130.5
9	387.5	487	120.4
10	290.6	399.6	97.6
11	3503	430	99.6
12	362.5	5103	106.5
13	374.6	5243	129.6
14	380.8	502.8	132.4

Table 2. Trans verse strength of three porcelain systems-means, Standard errors and range obviates (Mpa).

Porcelain	Flexure Strength	
Systems	Mean ± Standart error	Renge (Min-max)
In-Ceram Alumina n=14	304.58 ±13.07	230.00 - 380.80
In-Ceram Zirconia n-14	465.65 ±12.59	373.10-526.90
Finesse	112.04 ±4.69	87.40-132.40

KW- 36.10 P<0.05

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