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Marginal Accuracy of Machinable Monolithic Zirconia Laminate Veneers

Hamed Ratham Aldafeeri [1], Walid Abd El-Ghafar Al- Zordk[2], Mohamed Hamed Ghazy[3]
1Postgraduate student, Faculty of Dentistry, Mansoura University, Egypt
2Lecturer , Department of Fixed Prosthodontics, Faculty of Dentistry, Mansoura University, Egypt
3Professor, Department of Fixed Prosthodontics, Faculty of Dentistry, Mansoura University, Egypt
Corresponding Author: Hamed Ratham Aldafeeri

Abstract
Aim: *The aim of this study was to examine the role of different ultra-translucent monolithic zirconia on marginal gap values for laminate veneers.*
Materials and methods: *Thirty prepared fiber reinforced resin abutments were milled and used in this study. Thirty laminate veneers were milled from different ultra-translucent monolithic zirconia blanks and divided into 3 groups (n=10) [group D (DDcubex^2), group P (Prettau Anterior) and group K(KATANA UTML)] then sintered. All the veneers were sandblasted, treated by ceramic primer and cemented to the abutments. All specimens were collected for evaluation of marginal adaptation using scanning electron microscope (SEM).*
Results: *Statistical difference was found in marginal gap values between group D and the other groups (Group P and Group K).Statistical median load difference was found between group D and the other groups (group P and group K).*
Conclusion: *Type of monolithic translucent zirconia was found to significantly affect the marginal adaptation of DD cubex2, Prettau anterior and katana ultra-translucent multi-layer mono-lithic zirconia laminate veneers.*
Key words: *Monolithic translucent zirconia, laminate veneers, marginal adaptation, SEM*

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I. Introduction

Cosmetic dentistry has become one of the main areas of dental practice and growth for several years. Recently, the main reason for applying restorative dental materials is not only to restore dental tissues lost because of caries or trauma but also to correct the form and color of teeth for social acceptance. [1]

Porcelain veneers have been placed for more than 20 years meeting the esthetic desires of most patients.[2,3] Despite the overwhelming success practitioners have with porcelain, the profession to improve their strength, longevity, and esthetic as with all restorations. In the past few years, there have been significant advances with indirect esthetic materials melding higher levels of strength and esthetic than ever before.[4]

Zirconia has been widely used recently because of its non-metallic color, versatility, and exceptional fracture resistance with flexure strengths of more than 1000 MPa. It has proven to be reliable in a wide variety of clinical situations such as monolithic restorations without overlying porcelain [11-12] Bonding zirconium restorations cannot be done with the same methods of traditional glass porcelain.[5,6] Zirconia is a silica free, acid resistant, polycrystalline ceramic that does not contain amorphous silica (SiO_2), making it ineffective to traditional glass etching treatments such as hydrofluoric acid (HF) followed by silane.[7,8] Bond strengths using differing methods, including sand blasting with aluminum oxide, silane treatment, or other chemicals provided a weak bond at best that deteriorates significantly with time. [9,10] When preparation designs are retentive, as in the case of many full crowns bonding to the zirconia becomes less important and more traditional cementation with dual-cure resin cements.

In the cases with less retentive preparations, including veneers, the stable long-term bond of the restoration to the tooth becomes much more important to long-term success where primers that address the specific needs of non-silica oxides (zirconia, alumina, and metal) are highly beneficial and warranted when traditional retention/resistance form is lacking. [11,12] Some ceramic primers on the market today are ceramic primer (Kuraray), Metal/Zirconia Primer (Ivoclar Vivadent), and Z - Prime Plus® (BISCO). [13,14]

Laminate veneers are used in the anterior teeth to mask the discoloration and correction of contouring. The main advantage of this restoration is the conservation of the tooth structure. Hence this conservation results in reduced pulpal and periodontal damage. Another advantage is ease of seating the restoration that can be directly observed while luting. Good esthetics is main importance factor for the veneer [15].

The adhesive resin cement is subjected to dynamic loading thermal cycling and is influenced by the hydrolytic effect of water and different chemicals present in the mouth.[16,17] External marginal adaptation of ceramic veneers, which is defined as the vertical distance between the finish line of the prepared tooth and the margins of the fabricated veneers plays an important role for their success. Microleakage was defined as the distance the dye was able to penetrate at both the cervical and the incisal margin. Close proximity between the margin of the restorations and the tooth structure protects the adhesive resin cement from excessive exposure to the oral cavity leading eventually to slow process of gradual disintegration of its chemical, physical, and mechanical properties resulting in microleakage, recurrent decay, discoloration of the tooth structure, and fracture of the cemented veneers.[18]

Several definitions for marginal deficiencies have been proposed such as internal gap, horizontal marginal discrepancy, over-extended margin, seating discrepancy and others.[19] Although marginal opening alone does not directly correlate with microleakage, the accuracy of marginal fit is valued as one of the most important citeria for the clinical quality and success of prosthetic restorations. [20] The importance of precise marginal adaptation and the subsequent implications of marginal discrepancies, including microleakage, caries and periodontal inflammation, have been emphasized in many studies. [21,22]

The increased demand for safe and esthetically pleasing dental materials, have led to the development of the new high strength ceramic materials. New sophisticated processing technologies and systems have een anticipated for introduction into dentistry. One solution to this is the introduction of (CAD/CAM) technology. [23,24]

Several methods, both destructive and non-destructive, to measure marginal and internal fit have been discussed in the literature, including sectioning the crowns, replica technique, profilometry, SEM, image analysis and 3D scanning. [25,26] A technique used in vitro is the classic destructive method of sectioning the specimens and then studying them under an optical or scanning electron microscope. [27,28] The advantage of this technique is the accuracy and the precision in reputability of the measurements; however the obvious limitations of this method are the destruction of the specimens which creates the need for duplicates, the limited area that is evaluated since the sections have a minimum thickness and the additional steps that are required (embedding in resin and sectioning).

II. Materials and Methods

Materials:

The materials used in this study were presented in table 1:

Methods

1. Abutment preparation and replication

Thirty typodent (Acrylic) central incisors were selected to be the master abutment. An optical impression of the unprepared typodont tooth was taken using intraoral scanner (Omnicam Sirona Germany), which was saved in cad system file to be used as a reference to reproduce the veneers with an identical anatomy to the original typodont tooth**.**

The resultant images were opened and the cut tool of the CAD software (Ceramill Ammanngirrbach Germany) was used to remove 2 mm from the incisal edge. Facial reduction was conducted by marking the facial boundaries of the preparation to be 0.5 mm away from the CEJ cervically and about 1 mm beyond the mesio and disto buccal line angles. The palatal reduction was conducted by marking the palatal boundaries of the preparation to be 0.5 mm at the reduced incisal edge and 1 mm incisal wrapping. The marked areas facially and palatally were cut back by a uniform thickness of 0.55mm**.** Milling order was sent through the CAM software with an estimating time of 14 minutes for every abutment with the wet milling**.**

Specimens grouping:

The fiber reinforced abutments were randomly divided regarding the type of zirconia used into 3 groups (n=10). Group D: abutments receiving zirconia veneers milled from DDCubex2 blank, group K: abutments receiving zirconia veneers milled from Katana Ultra Translucent Multi-layered blank and group. P: abutments receiving zirconia veneers milled from Prettau Anterior blank**.**

Fabrication of the zirconia laminates:

The prepared veneer design in CAD software system and overlapped to each other to allow generation of the laminate veneers corresponding to the original typodont tooth outline and dimensions. The veneer shell was found to have a uniform thickness of 2.0 mm incisally and 0.5 mm on the facial and palatal aspects.

a) Group (D):

DDcubex[2] blank was fixed in the holder of the milling machine. The laminates with their sprues were arranged virtually on the blank. The CAM software was used to mill ten identical veneers by using the milling machine. Then sintered in a ceramic furnace (inFire HTC speed Sirona Germany) according to the manufacturer's recommendations. The temperature was elevated by a rate of 8°C/min till 900°C then holding time for 30 minutes, then heating up again to reach the final temperature 1450°C with the rate of 3°C/min then holding time for 120 min, then cooling to 200°C with a rate of - 10°C/min and finally the furnace was opened and the veneers were allowed to cool to room temperature.

b) Group (P):

Prettau Anterior blank was fixed and the laminate veneers were milled and finished with the same previous steps as group D. According to the manufacturer's recommendations sintering of the veneers was done by elevation of the temperature up to 1500°C by the rate of 9°C/min within approximately 3 hours and holding time for 2 hours, then cooling to room temperature within approximately 3 hours.

c) Group (K):

NORTAKI UTML blank was fixed and the laminate veneers were milled and finished with the same previous steps as group D. According to the manufacturer's recommendations sintering of the veneers was done by elevation of the temperature up to 1550°C with the rate of 10°C/min within approximately 3 hours and holding time for 2 hours, then cooling to room temperature with the rate of 10°C.

2. Surface treatment of the zirconia laminates:

The internal surfaces of the laminates were sandblasted using tribochemical coating (3M ESPE CoJet Sand Blast Coating Agent Dental Porcelain Composite Repair 40 g) at 1.5 bar for 15 seconds from a distance of 10 mm perpendicular to the surface using sandblaster device (Microjato, bio.art. Brazil)**.** All the specimens were rinsed with air/water spray to eliminate any residuals then dried with air flow. The laminate veneers were held using ceramic holders (OptraStick Ivoclar U.S.A.) for more controllable handling, zirconia priming agent was applied to the internal surface of the restoration using micro brush then gently dried**.**

3. Surface treatment of the prepared abutments:

Phosphoric acid 37% (total-Etch Ivoclar Vivadent U.S.A) was applied to the prepared surface of the abutments and distributed to the entire surface using a micro-brush (adper single bond 2 /3 M Germany) for 15 seconds then rinsed with air/water spray and gently dried by air flow**.** Self-etch universal adhesive (adper single bond Germany) was applied to the prepared surface using a micro-brush and dried gently using air**.**

Plastic tubes with 12 mm length and 25 mm diameter was used as a block former to accommodate the whole length of the typodont tooth root. Epoxy resin (Kemapoxy 150, Kemapox Egypt) was used for fixation of the abutments into the plastic tubes**.** A surveyor was used to fix the abutments centrally in the epoxy blocks up to 2 mm below the CEJ**.** The blocks were left till complete setting of the epoxy resin which needs 24 hours for complete solidification**.**

4. Cementation of the veneers to the prepared abutments:

A mixture of the two pastes of the self-adhesive resin cement (TheraCem® Bisco Dental) was applied to the treated fitting surface of the veneers using automixing tips then a micro-brush was used to spread out the mix to assure a minimal thickness of cement. The veneers were then seated on the abutments in incisocervical and bucco-palatal directions with the aid of specially designed cementation device. Especially Tack curing was performed to the veneers margins for 2-3 seconds then the excess cement was removed using a scalpel. Light-curing for 20 seconds for the palatal and buccal surfaces was performed using light cure unit (Demi plus, Kerr U.S.A).

Collection of the samples and cleaning it by Ultrasonic and Acetone for one min.**.** The samples are coated by gold using sputter coating The samples are set by carbon tab**.**

5. Evaluation of marginal adaptation:

The marginal adaptation was evaluated by measuring the vertical gap between the cemented laminate veneers and the prepared tooth finish line, using scanning electron microscope SEM (JEOL, Tokyo Japan) and image processing software**.**

The marginal gap was evaluated by capturing all the specimens to visualize the marginal adaptation by increase magnification power to 200X measurement of four aspects for each tooth between resin cement and tooth structures of veneer cervical, distal, mesial and palatal margins under magnification. Then T Capture software (OLYMPUS Stream) was used to record the measures by measuring 3 points at each margin for accurate results by collecting 12 readings for each specimen.

III. Results

Kruskal Wallis test showed a non statistically significant difference between Cubex, Prettau Anterior and Katana in median incisial SEM (F= 1.1, P =0,08) with higher median value was obtained for followed by Prettau128.51 (122.41-185.42 μm) Katana 103.35 (54.67-146.11 μm) and then Cubex 92.09(79.69-161.64 μm) respectively.

Kruskal Wallis test showed a non-statistically significant difference between Cubex, Prettau Anterior and Katana in median mesial SEM (F=0.19, P=0.83) with higher median value was obtained for Cubex followed by Ktana and then Prettau (146.91 (96.0-187.23 μm), 99.73 (91.74-185.67 μm), 101.95 (87.2-186.43 μm), respectively.

Kruskal Wallis test showed a non-statistically significant difference between Cubex , Prettau Anterior and Katana in median distal SEM (F=0.46 , P=0.64) with higher median value was obtained for Cubex followed by Prettau and then Katana (104.88 (65.33-248.08 μm), 122.33 (57.41-172.74 μm), 85.59 (65.39-125.83 μm), respectively.

Kruskal Wallis test showed a non-statistically significant difference between Cubex, Prettau Anterior and Katana in median lingual SEM (F=2.76, P=0.10) with higher median value was obtained for Prettau followed by Cubex and then Katana (92.09 (79.69-161.64 μm), 128.51 (122.41-185.42 μm), 103.35 (54.67-146.11 μm), respectively.

Kruskal Wallis test showed a non statistically significant difference between different sides in cubex median SEM (F=0.52 , P=0.67) with higher median value was obtained for mesial followed by distal , then incisial and lingual (114.84 (63.14-248.08 μm), 146.91 (96.0-187.23 μm), 104.88 (65.33-248.08 μm), respectively.

Kruskal Wallis test showed a non statistically significant difference between different sides in cubex mean SEM (F=0.52 , P=0.67) with higher mean value was obtained for mesial followed by distal , then incisial and lingual (114.84 (63.14-248.08), 146.91 (96.0-187.23 μm), 104.88 (65.33-248.08 μm), respectively.

Kruskal Wallis test showed a non statistically significant difference between different sides in Prettau median SEM (F=1.67, P=0.21) with higher median value was obtained for incisial followed by lingual then mesial and distal, (171.07 ± 27.7 ,143.44 ± 26.1, 127.12 ±4 3.6 μm and 124.3 ± 46.5 μm), respectively.

Kruskal Wallis test showed a non statistically significant difference between different sides in Katana median SEM (F=1.7 , P=0.2) with higher median value was obtained for incisial , mesial followed by lingual and distal (111.09 (54.67-534.21 μm), 101.95 (87.2-186.43 μm), 85.59 (65.39-125.83 μm), respectively).

IV. Discussion

The usage of human extracted teeth as a natural dies has been found to simulate the clinical environment rather than resin dies. However, invisible cracks or inconsistent dentin structure that may cause the tooth to fracture at different loads during testing and cause some restrictions in the reproducibility and comparability between natural teeth specimens. Also standardization of natural dies is impossible with different age, dimensions, form and anatomy, time of storage after extraction and changes of elastic modulus that occurs as a result of different storage conditions.[29]

Free-hand preparation may lead to variances in veneer thickness. Therefore, milled resin abutments considered to be more accurate and standardized. In this study, fiber reinforced resin abutments were used instead of extracted natural teeth as a substrate for loading the laminate veneers because of their closer elastic modulus (E = 12 GPa) to dentin (E = 18.6GPa) than to steel (E = 200 GPa). [30] While typodont studies have the advantage of providing standardized conditions with respect to preparation design, technique, and experimental performance, resulting in more repeatable assessments. [31]

TRINIA™ CAD/CAM discs which are composed of multidirectional interlacing of fiberglass and resin were chosen as a supporting structures as their modulus of elasticity is 18.8GPa, [32] which is comparable to that reported for human dentin being 11.59 to 27.30GPa. [33]

Ultra-thin laminates generated from yttrium-stabilized zirconia, offers several advantages. They can be used in the treatment of diastema or badly destructed teeth as traditional feldspathic porcelain can't be used to restore large defects of tooth structure, while zirconia core can be used to support a 2mm thickness of laminating porcelain. Also parafunctional habits as edge to edge occlusion limit the usage of feldspathic veneers due to the highly generated stresses during function. [34] Fragility of feldspathic laminate veneers making difficulty for finishing and adjustment before cementation which is much easier with zirconia due to its higher strength.

The opacity of zirconia laminate veneers has an advantage of masking undesirable teeth discoloration as tetracycline stains with the minimum thickness of the restorative material and minimal amount of tooth reduction. On the other hand, to achieve the same result with the more translucent traditional feldspathic porcelain to mask staining, more reduction may be necessary even through dentin layer sacrificing bonding strength with the lost enamel layer. Also, the photo polymerization of luting cements can be impaired by increased thickness of traditional feldspathic porcelain. [35]

As a new alternative esthetic solution translucent zirconia has been introduced as new materials which combine the translucency of feldspathic porcelain and the strength of traditional zirconia, which enable it to be used as monolithic crowns anteriorly or posteriorly also as veneers and ultra-thin veneers.

Under these circumstances the defects such as voids, flaws and cracks of the resultant restorations and abutments were reduced to the minimum. The most achieved benefit by using this technique was to standardize all the specimens which were mandatory to get accurate results. Standardization of the zirconia veneers and resin-fiber dies was achieved by using the same STL (Standard Tessellation Language) file of both veneers and dies to duplicate the required number of specimens. [36]

STL file of the unprepared typodont tooth was taken using intraoral optical scanner (Omnicam, Sirona Germany) then, CAD/CAM software (Ceramill Mind – mmanngirrbach Germany) was used to cut back 2 mm from the incisal edge and the planned area of preparation was marked facially and overlapped to the palatal aspect. After that cut back about 0.55mm from the marked area, all these procedures gave a total of 0.55 mm reduction space at the facial and palatal aspects while the amount of clearance at the incisal edge was 2.05mm.

The resultant STL file of the prepared tooth was then overlapped by the STL file of the unprepared abutment using another CAD/CAM software (InLab, Sirona Germany) resulting in a veneer design with the same dimensions and form of the originally captured typodont tooth. Thus, the veneer thickness was uniform at the whole surface by 0.5 mm except at the incisal edge with 2.0 mm.

All these steps were performed in order to achieve a highly standardized abutments and restoration with the same parameters and least possibility in comparison to conventional manual preparation as the abutments and veneers considered to be mirrored rather than prepared.

Hydrofluoric acid etching (4-10%) of translucent zirconia considered to be impossible as zirconia is chemically inert, especially with preparations with impaired mechanical retention, having effective adhesion lower than silica-based ceramics. [37]

Regarding to the different types of zirconia laminate veneers used in this study the marginal gap median of Group D recorded as the lowest result 114.84 (63.14-248.08 μm) followed by Group P 147.37 (57.41-216.54μm) with the highest marginal gap in Group K 111.09 (54.67-534.21μm).The inconsistency between the results might be due to divesting with_aluminum_oxide abrasive may account for inadvertent abrasion of the delicate_inner porcelain surface and causes larger marginal discrepancies.

Marginal adaptation can be assessed by several methods as stereomicroscope, [38,39] SEM [40] or replica technique. [41] In this study, as well as those by Sim and Ibbetson, [42] Groten et al., [43] Nakamura et al. [44] external marginal gap was measured using stereo microscope. The advantages of this method were to keep the specimens intact, which permit to employ the specimens in other investigations.Marginal gap evaluation can be assessed before or after cementation, with thermocycled loading or without. Measurement after cementation drawback is the overlapping of excess cement over the margins. While adaptation before cementation does not reflect an accurate results of marginal adaptation clinically because of alteration of marginal discrepancy after cementation. [45]

All of the fiber reinforced resin abutments were fixed at a zero angle inside an epoxy resin (Kemapoxy 150, Kemapox Egypt) blocks using a surveyor and fixed in place. The abutments were fixed 2 mm beneath the cementoenamel junction (CEJ). [46]This study utilized the SEM to observe marginal discrepancy. The SEM used in this study, (SEM: Scanning Electron Microscope, Jeol Ltd) magnification ×100,000, is a high precision instrument which can accurately record the amount of discrepancy at various levels with remarkable precession. [47]Aboushelib et al., [48] found that vertical and horizontal marginal discrepancies, internal discrepancies, and microleakage were significantly less in the pressable PLVs group than in the CAD-CAM group.

Lin et al., [44] found smaller vertical gaps in conventionally sintered feldspathic PLVs than in the CAD-CAM PLVs.Nakamura et al., 2005,[49] evaluated the marginal and internal adaptation of all ceramic crowns fabricated using the CAD/CAM system. A master die of maxillary first bicuspid was prepared, and experimental crowns were fabricated. Four conditions were simulated by combining two convergence angles (4° and 12°) of the abutment with two different luting space configurations (15 pm and 55 μm, respectively). The results revealed that the experimental crowns showed a marginal gap of 42–56 pm. When the luting space setting was 15 μm, the internal gap was 85–88 pm; when the setting was 55 pm, the internal gap was 126–138 pm. The marginal gap for all experimental crowns met the clinically acceptable criteria.Quintas et al. [50] have reported an increase in the marginal discrepancy following luting with resin cements. Borges et al. [51] also evaluated in vitro marginal fit of three all-ceramic crown systems before and after cementation and observed that both resin-modified glass ionomer and resin cements induce increase in marginal discrepancy.

Rinke et al. [52] proposed a study to compare the marginal adaptation and fracture resistance of conventional and copy milled InCeram crowns. The marginal accuracy of the copy-milled units ranged from 6 to 153 μm and that of the conventionally fabricated units ranged from 1 to 153 μm.

Sulaiman et al. [53] reported the mean marginal discrepancy of all-ceramic crowns was in descending order: In-Ceram (161 ± 46 μm), Procera (83 ± 41 μm), and IPS Empress (63 ± 46 μm). Both Procera and IPS

Empress met the criterion for acceptable marginal discrepancy of 120 µm.Nakamura et al. [47] reported that the alumina cores fabricated had mean gaps of 30–40 µm at the margins on the labial and lingual sides, which was significantly smaller than the gaps produced by the conventional method (67–130 µm).

Lee et al. [54] in their study found that internal gaps of conventional all-ceramic crowns were within the range of 123–154 µm. CEREC 3D crowns (109.5 + 4.7 µm) showed significantly larger gaps than the Procera System (copings 71.4 ± 5.3 µm, crowns 68.8 ± 6.9 µm).The other factors which can influence marginal discrepancy in laminate veneers in clinical situations include influence of the luting cement, salivary pH, brushing technique, errors in tooth preparation, and oral hygiene maintenance.[55] Fluctuation in salivary pH, quantity of gingival crevicular fluid and plaque accumulation, and microbial colonization subsequently lead to dissolution of luting cement inducing microleakage and aggravating the existing marginal discrepancy.

Resin cements by virtue of their chemical structure are more resistant to dissolution by water, beverages, saliva, and gingival crevicular fluid and offer better resistance to plaque accumulation and microbial colonization whereas other cements are prone to dissolution and subsequently secondary caries of the abutment could occur with time. [56]

Resin cements have been modified to release fluoride to prevent secondary caries. Improper brushing technique and aggressive brushing techniques using powered electrical tooth brushes can damage the cervical enamel rods and thin edges of the laminate veneers in the cervical region and could facilitate additional marginal leakage.

Compromised oral hygiene resulting in the accumulation of plaque and calculus induces inflammatory changes in the adjoining areas which lead to subsequent pathogenic microbial colonization; this also can play a major part in the marginal discrepancy of the veneers. [57] Insufficient tooth preparation in the cervical region may lead to over contoured restorations which could cause mal overlap of the veneers and could increase marginal discrepancy. The clinical significance of this study supports the choice of veneers fabricated with pressable ceramic systems than the CAD/CAM milled veneers.

The zirconia was examined in this study due to its strength and opaque nature especially when used in laminate veneers as it has an advantage that it can mask discoloration and tetracycline stains with minimal tooth reduction and minimal thickness of the restorative material. [34]

So according to our results the null hypothesis was accepted and no statistically significant differences between groups was found. This was probably due to small differences in the nature of materials in different groups. Also no statistically significant differences was found between the mesial, distal and cervical. This was probably because they have the nearly similar surface topography and nearly the same amount of reduction.

V. Conclusion

Within the limitations of this study the following conclusions could be drawn:

1) Marginal adaptation of the tested translucent zirconia is within the accepted clinical range with superior adaptation for DDcubeX2 group.
2) The tested translucent zirconia could be used clinically as laminate veneer restoration.

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Table (1): product name, batch numbers, main composition and their manufactures:

Materials	Product name	Batch number	Main composition	manufacturer
Yttria Fully Stabilized Zirconia (YFSZ)	DDcubex[2]	8031615012	ZrO_2,HfO_2>90% Y_2O_3<10% Al_2O_3<0,01 other oxides < 0,15	Dental Direkt GmbH, Germany
	Prettau ® Anterior	ZB5258B	ZrO_2:Maincomponent Y_2O_3:<12% Al_2O_3:<1% SiO_2:Max.0.02%	Zirkonzhan, Gais/South Tirol, Italy
	Katana		Fe_2O_3:Max.0.02% Na_2O: Max. 0.04%	kuraray, Japan
Ceramic Primer	Z-Prime™ Plus	160000460	Ethanol75-85% MDP 1-5%	Bisco, U.S.A
Self-adhesive resin cement	TheraCem®	1800001640	Catalyst:Glassfiller50-75 MDP10-30% AmorphousSilica1-5% Base:Calciumbasefiller20-50% Glassfiller30-50% Dimethacrylates20-50% YtterbiumFluoride5-15% Initiator1-10% Amorphous Silica 1-5%	Bisco, U.S.A

Table (2) : Comparison of median lingual SEM between Cubex, Prettau and Katana.

	Cubex	Prettau	Katana	Test of significance
Lingual Median (range)	92.09 (79.69-161.64)	128.51 (122.41-185.42)	103.35 (54.67-146.11)	KW P=0.08

KW: Kruskal Wallis test p:probability

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