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Effect of ultrasonic instrumentation on the retentive strength of air abraded zirconia copings luted with glass ionomer and self-adhesive resin cements - An invitro study

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Abstract

Introduction: Great technical advancement in ultrasonic apparatuses over the last few years has permitted their increased use and dissemination among professionals of various specialties. This technological evolution was possible because of the piezoelectric properties of some crystals or metals. Accidental debonding of cemented crowns have been reported with the use of ultrasound. This occurs because in patients with fixed crowns the active tip of the ultrasound apparatus may come in contact with the border of the crown, altering the bond strength of the cement.

Aim & objective: The aim of this study is to analyse the retentive strength of zirconia crowns cemented with glass ionomer and adhesive resin cements subjected to air abrasion and ultrasonic instrumentation for various periods of time.

Methodology: Sixty recently extracted intact human maxillary & mandibular molar teeth will be selected. Teeth preparation will be standardized by giving 12◦ taper. Ceramic copings will be manufactured using

CAD/CAM. The sixty teeth are divided into two groups of 30 each (n=30). Each group will be subdivided into three groups of 10 each (n=10). After this procedure sixty Copings (n=60) will be sandblasted using alumina 100µm. Cementation with GIC & self-adhesive resin will be performed according to the manufacturer's instructions. After this procedure, the specimens will be submitted to ultrasonic instrumentation for different periods of time: Group1 (0min), Group 2(3min), Group 3 (5min). Tensile bond strength tests will be performed with an Instron testing machine. Statistical analysis will be performed using Post-hoc Tukey HSD analysis.

Result: The tensile bond strength of air abraded zirconia copings luted using dual cure self-adhesive resin cement shows highest bond strength than other groups.

Keywords: Ultrasound Vibration, Zirconia, Tensile Strength, Glass Ionomer Cement, Self-Adhesive Cement

Introduction

Fixed partial denture for replacement of missing teeth is preferred over removable dentures for various reasons such as strength, esthetics, physical and psycho logical comfort[5]. The search for the highly strength material without compromising esthetics has led to the introduction of zirconium oxide in dentistry. Zirconia named as ceramic steel due to its mechanical property similar to that of stainless steel. The CAD and CAM technology into dentistry led to the fabrication of machined zirconia restoration. The nature of bond between zirconia restorations and the underlying tooth structure is mostly influenced by the composition, film thickness, solubility, compressive strength and tensile bond strength of the luting agent. Great technical advancement in ultrasonic apparatuses over the last few years has permitted their increased use and dissemination among professionals of various specialties. This technological evolution was possible because of the piezoelectric properties of some crystals or metals. Accidental debonding of cemented crowns have been reported with the use of ultrasound scaler instrument. This occurs because in patients with fixed crowns the active tip of the ultrasound apparatus may come in contact with the border of the crown, altering the bond strength of the cement. Studies evaluating the efficiency of various luting agents on the bonding of zirconia crowns to natural teeth are relatively few.[4,14] and also studies related to subjecting the zirconia copings with ultrasonic vibration are hardly conducted. This study is to analyse the retentive strength of zirconia crowns cemented with glass ionomer and adhesive resin cements subjected to air abrasion and ultrasonic instrumentation for various periods of time. This study also may decipher how much precaution should be taken while doing ultrasonic scaling on the cemented ceramic crowns and also as a way to analyse ultrasonic debonding of cemented crowns.

Materials and methods

Freshly extracted sixty maxillary or mandibular molar teeth with crown height of 6mm and diameter 10mm were selected. Extracted molars with caries, fillings, hypoplasia and fracture were excluded. Extracted molars are grouped as group A(n=30) and group B (n=30) and each group subdivided into three subgroups (A1, A2, A3, B1, B2, B3) each group 10 samples. Group A Zirconia copings luted to the prepared natural teeth with glass ionomer cement and subjected to ultrasonic vibration for a period of A1 (0min), A2 (3min), A3 (5min) and Group B Zirconia copings luted to the prepared natural teeth with Self-adhesive resin cement and subjected to ultrasonic vibration for a period of B1(0min), B2 (3min), B3(5min).

In a customised stainless-steel two-piece mold (FIG 1) mixed polymer and monomer resin (self-cure DPI) were poured into a mold space during early dough stage The natural teeth embedded into acrylic resin up to the CEJ junction. After polymerization the blocks along with the mounted natural teeth were retrieved by disassembling the two-piece mold by loosening the set screws then finishing and polishing done for acrylic resin. A dental surveyor was used to mount the natural teeth specimen in auto polymerizing acrylic resin blocks. The occlusal table of the surveyor was screwed in place and the custom-made stainless-steel mold was placed on the surveying platform. (FIG 1)

Fig 1: placing stainless steel mold on dental surveyor

The mounted teeth were prepared using a precision milling lathe (FIG 3) to receive a zirconia copings. All the teeth were prepared in a uniform configuration of a flat occlusal surface, 4mm axial length, 8mm outer diameter, 6mm inner diameter, 12° taper and shoulder finish line of width 1mm. (FIG: 2)

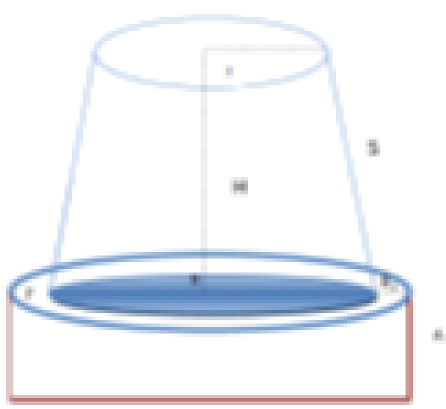


Fig 2: tooth preparation configuration

Zirconia copings were fabricated using ceramill system (AMANN GIRBACH, ceramill motion).

Fig 3: precision milling lathe

It consist of scanning system, a CAD software, a CAM machining system and a sintering furnace. Partially sintered zirconia (CERAMILL ZI) used which has got high strength and rigidity. Zeramill map 300 work station is used for scanning the prepared natural teeth. After scanning the scanned details were fed into the ceramill mind software for further designing of the coping. On the internal surface the thickness of the zirconia copings was set uniformly as 1.5mm throughout and 25µ spacer thickness for group A and 15µ spacer thickness for group B. Zirconia copings were designed to have an occlusal bar on the external surface to facilitate tensile bond strength testing. (FIG:3) This design can be stored and transferred to the ceramill milling unit. Sixty zirconia copings were milled. After milling zirconia copings were sintered at a temperature of 1450 °c at a heating rate of 5-10 k/min.

Fig 4: occlusal and intaglio surface

The intaglio surface of Group A and Group B zirconia copings was sandblasted with 50 µm aluminium oxide powder for 15 seconds using a sandblaster at a distance of 10mm with 80psi pressure. Thirty zirconia copings (Group A) were luted using GIC and other thirty copings

(Group B) were luted with self-adhesive resin cement with finger pressure for 10 seconds. Later the samples were placed on the surveying arm with the weight of 2kg for 10 minutes. After luting samples are subjected to ultrasonic vibration on all the teeth surfaces for a time period of 0 min (Group A1, B1), 3min (Group A2, B2) and 5 min (Group A3, B3). (FIG:4) Then the samples are subjected to tensile bond strength testing using universal testing machine (INSTRON, Llyod instruments U.K). (FIG:4)

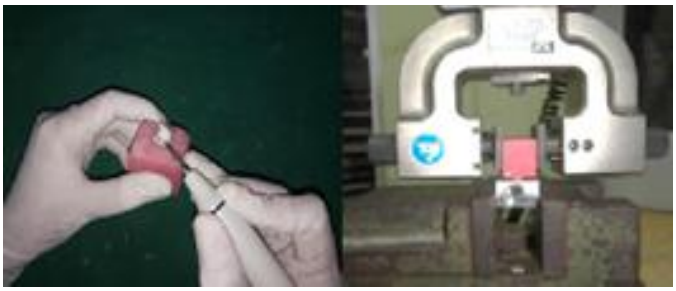


Fig 5: ultrasonic vibration & testing tensile bong Strength using UTM machines

pulled using the UTM at across head speed of 5mm/min, until the test coping debonded from the prepared natural tooth. The computer attached to the testing machine recorded the force at the debonding occurred.

Statistical analysis

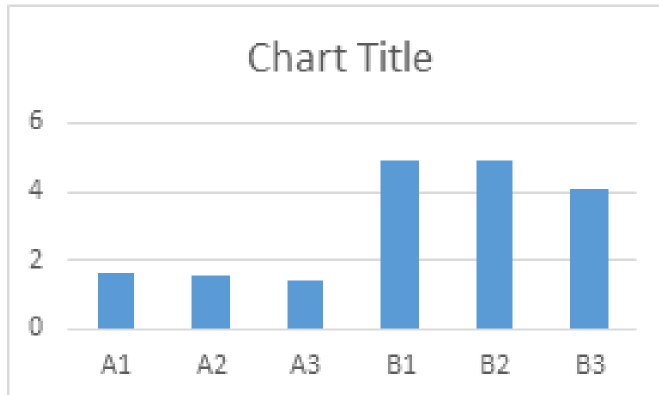
The data were analysed with a single factor analysis of variance (ANOVA) and pair wise comparison of mean values by pot hoc tukeys HSD analysis.

Result

On comparison of mean value of tensile bond strength of zirconia copings to natural teeth between two test groups using one way ANOVA. Group B1 exhibited the highest tensile bond strength followed by B2 and the least bond strength seen in group A3. One way analysis of variance yielded a P value of <0/05 (P=0.000). hence there is statistically significant difference in the tensile bond among the two test groups.

The multiple comparison of tensile bond strength bet ween three groups (group A to group A2, group A1 to group A3, group A2 to group A3). Post hoc test showed statistically significant difference in the tensile bond strength (group A1 to group A2)

The multiple comparison of tensile bond strength bet ween three groups (group B1 to group B2, group B1 to group B3, group B2 to group B3). Post hoc test showed statistically significant difference in the tensile bond strength within groups (group B1 to group B2) (FIG: 5)



Graph 1:

Discussion

In this study it is clearly inferred that zirconia copings luted with self-adhesive resin cement exhibit the highest tensile bond strength. This finding was in concurrence with similar studies by Oman ridan[16]S.D. Henntze[9] , claus peter ernest[4]Palacis[14]done earlier. The maximum bond strength value of 4.96 Mpa was obtained for zirconia copings luted with self-adhesive resin cement in the present study.Many authors have reported that conventional luting agent glass ionomer cements can also be used with zirconia copings.[17,27,44] .Glass ionomer cement has been the most popular traditional luting agent with an overall success rate of 74 ± 2.1% for FPDs luted with it.25 Also the low film thickness (<25μ), adequate compressive strength (Max.70Mpa) and ease of manipulation are some of the advantages of glass ionomer cement.[33]The maximum bond strength value of

4.96 Mpa was obtained for zirconia copings luted with self-adhesive resin cement in the present study. This was in agreement with almost all of the similar studies done earlier.[4,14.] The higher bond strength achieved with self-adhesive resin cement can be attributed to the greater adhesive capability of such cements, especially those which contain an adhesive phosphate monomer. In addition, the formation of a hybrid layer due to the penetration of dentinal tubules by hydrophilic resins improves the bond between the cement and the tooth structure.[2,24]Thus it can be safely concluded that dual cure self-adhesive resin bonded luting is the best choice for zirconia restorations. This stand is indicated by numerous studies done previously.4,14. But one should also keep in mind that resin-based bonding requires a dry field and hence will be successful only in situations where a high degree of isolation can be achieved. The findings of the present study suggest that zirconia copings luted to natural teeth using a dual cure self-adhesive resin cement with no additional pretreatment except for sand blasting of the intaglio zirconia surface provides maximum retention. Hence this can be recommended for luting of zirconia crowns and bridges in clinical situations.

Conclusion

The tensile bond strength of air abraded zirconia copings luted using dual cure self-adhesive resin cement shows highest bond strength than other groups. It can be re commended that dual cure self-adhesive resin cement can be used for the cementation of zirconia crowns in clinical situations in order to achieve a more durable bond with the tooth structure. And also debonding of crowns from the tooth while ultrasonic scaling can be minimized by this cement as luting agent. And also can be used as one of the easiest crown removing method in future when in need

Further long-term clinical trials are needed to accurately evaluate the criteria measured in this study. Zirconia being a relatively newer material, long term in vivo studies are lacking. Hence the results obtained from laboratory studies like the present one serve as valuable guide lines for clinical decision making until the time prospective clinical data becomes available

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