Original Article

INFLUENCE OF MARGIN DESIGNS ON FRACTURE RESISTANCE OF ENDODONTICALLY TREATED TEETH RESTORED WITH ENDOCROWNS

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Abstract

Aim & objective: The aim of this *in vitro* study was to study the effectiveness of two different margin designs on fracture resistance of endodontically treated teeth restored with zirconia endocrown restorations.

Material method: 20 samples of mandibular first molar was divided into 2 groups (Group B and Group S, n = 10) and endodontically treated followed by margin preparation in order to get endocrowns with 2 mm occlusal thickness fabricated with monolithic zirconia material. Group B represents teeth prepared with butt joint preparation designs. Group S represents teeth prepared with axial reduction & 1 mm shoulder finish line. Fracture resistance was observed for each sample using universal testing machine.

Results: Comparative evaluation of fracture resistance after application of Student 't' test between Group S (1114.2 ± 92.81) and Group B (962.8±101.58). shoulder finish line shows better fracture resistance as compared to butt joint. The t value obtained was 3.479 and the p value was found to be significant 0.0022($P<0.05$).

Conclusion: Preparation design with an axial wall and shoulder finish line of endodontically treated teeth restored with endocrown increases the fracture resistance. However, more studies and researches are needed to ensure the increase of fracture resistance especially considering the conservative preparation designs.

Keywords: Endo crowns, Fracture resistance, Zirconia

Introduction:

Long term prognosis of endodontically treated tooth is compromised by different biochemical changes taking place while endodontic therapy which aims at preserving the root canal affected teeth to prevent its inevitable loss.[1] The loss of integrity associated with caries trauma & extensive cavity preparation rather than dehydration or physical changes in dentin are considered as one of the primary reasons for reduction in stiffness & fracture of endodontically treated teeth.[2]

Review of available data does not reveal the optimal material for restoring the endodontically treated teeth. ***Bindl and Mörmann*** in 1999 proposed the endocrown as an alternative to the full post and core supported crown.[3]Earlier modalities for restoring the endodontically treated teeth included post and core utilizing adhesive and placement of full coverage crowns with a sufficient ferrule although it is fast and simple method but their adaptation is not always ideal also building the post space increases the risk of perforation within the roots. Alongside this the risk of root fracture is encountered commonly in cast metal post build ups rendered due to higher stiffness of metal alloys.[4] Hence, to overcome the limitations fiber post were introduced leading to the reduced risk of catastrophic fracture still debonding remains risk of failure. The endocrown is defined as a monolithic one-piece ceramic restoration, which restores a crown inclusive of a circumferential butt margin and an imperative retention hollow space within the pulp chamber. This approach utilizes the surface available in the pulp chamber to ensure the stability and retention of a restoration through adhesive bonding[5]. It additionally follows the idea of deterioration-oriented design mainstay to minimally invasive preparations.

Aim and objective:

The aim of this *in vitro* study was to study the effectiveness of two different margin designs on fracture resistance of endodontically treated teeth restored with zirconia endocrown restorations.

Material method:

• The study was approved by Faculty of Department of Conservative Dentistry and Endodontics (MCDRC, ANJORA, DURG). 20 Freshly extracted human mandibular first molars with completely formed roots apex without any carious lesion or visible fracture lines were selected. Teeth were cleaned with ultrasonic Scaler and then stored at room temperature in 37% formalin solution. For purpose of standardization, all teeth were endodontically treated with same sequence. The pulpal chamber of each tooth was opened following the pulpal chamber morphology using standard protocol for access cavity preparation. All the samples were divided in to 2 groups (Group B & Group S) (n=10) in accordance with margin designs. RCT was initiated & working length was established. Neo Endo file system was used. Master files-20 no. with 6% taper for mesial canal & 25 no. with 6% taper for distal canals. Obturation was done using resin-based sealer (AH Plus, Dentsply). Pulp chamber with retention cavity extending 5mm from central groove with divergent walls were prepared. 2 mm occlusal reduction was done for all the samples.Group B represents teeth prepared with butt joint preparation designs. Group S represents teeth prepared with axial reduction & 1 mm shoulder finish line (Fig.1) All the samples received endocrowns with 2 mm occlusal thickness fabricated with monolithic zirconia material. Each group of endocrowns were cemented. (Fig.2) The tooth surface was etched for 30 secs with 37.5% phosphoric acid, rinsed and dried. Dual cure resin cement was applied to the fitting surface of the endocrowns placed on the relevant preparations. All samples were loaded vertically on the central fossa of their occlusal surfaces in a universal testing machine (Fig.3) until fracture occurred (Fig.4) The loading piston was centered along the long axis of the specimens with 6mm in diameter steel ball and the thrust speed of the machine was 0.5 mm/min. The breaking load was recorded in Newton (N).

Fig. 1 (A) Endocrown with butt joint preparation (B) Endocrown with shoulder margin before cementation

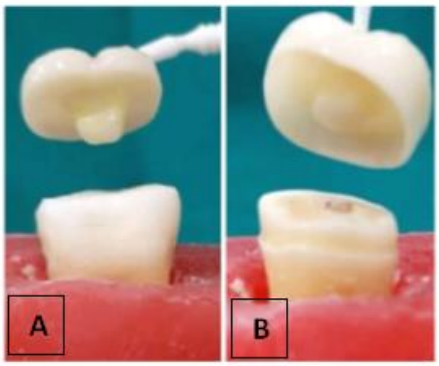


Fig. 2 (A) Endocrown with butt joint preparation (B) Endocrown with shoulder margin after cementation

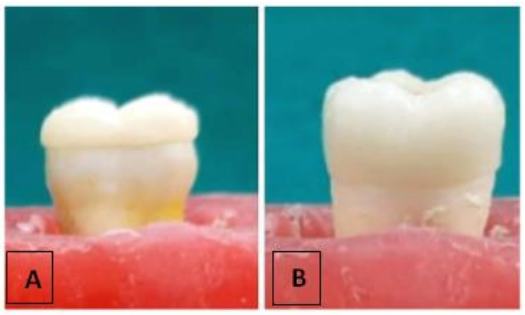


Fig. 3 Universal Testing Machine

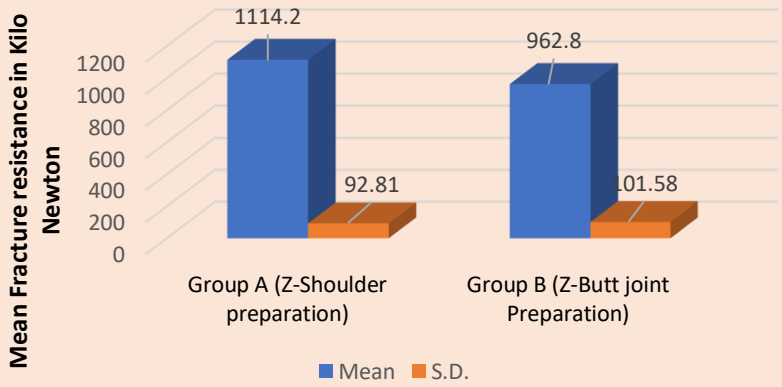
Fig. 4 Fractured Specimen

Results:

The mean and Standard deviation of Fracture resistance (in Kilo Newton-kN) in Group S - 1114.2 ± 92.81 and Group B - 962.8±101.58. (Table 1).

The comparative evaluation of fracture resistance between Group S (Z-Shoulder preparation) 1114.2 ± 92.81 and Group B (Z-Butt joint Preparation) 962.8±101.58after applying Student't' test. The *t* value obtained was 3.479 and the *p* value was found to be significant 0.0022(P<0.05) which indicated that Group S had more fracture resistance when compared with Group B. (Table .2, Graph 1)

Graph 1: Comparison of Fracture resistance between Group A (Z-Shoulder preparation) and Group B (Z-Butt joint Preparation)



Discussion:

The introduction of endocrown in the adhesive dentistry has served the purpose of restoration of endodontically treated teeth with a great resistance to dislodgment there by reducing the risk of fracture to the remaining crown structure, for serving the purpose best the present study was conducted to check the influence of margin design. According to this study, endocrowns with axial reduction and a shoulder finish line had higher mean fracture resistance values than endocrowns with butt margin design and the mean difference was statistically significant **(**0.0022(P<0.05**)** which was in parallel with the study conducted by ***Benli M and Gokcen R*** B.32 Mandibular

first molar used for crown restorations reported that fracture strength values were statistically significantly influenced by material thickness (p<.001)but not material type. Zirconia-reinforced ceramic materials with 1.5 mm occlusal thickness have significantly higher strength values and may be a good choice for crown restoration.[6]

From a minimally invasive standpoint, the anatomic occlusal preparation margin shows the maximum preservation of the tooth structure [7]. However, from the results of the FEA, higher-stress concentrations were observed in the restoration and tooth remnants, particularly occurring in the irregular and sharp angles areas, making them more susceptible to fracture. For the shoulder margin design, stress was observed in the cavity walls of restoration and the enamel of the cervical region, as well as at the margin interface between the dental tissue and restorations. This is in accordance with previous studies that proposed the addition of short axial walls with a shoulder finish line could counteract the shear stresses through the walls, and provide a better load distribution through the margin[8,9]. Nevertheless, in the meantime, owing to such a stress distribution, there is a greater likelihood of fractures occurring at the margin of the endocrown or in the enamel and leakage around the affected restoration.

Duvall et al. The 2- and 4-mm chamber extension groups demonstrated the highest fracture resistance stress, with the 3-mm group similar to the 2-mm group. The 3- and 4-mm chamber extension group specimens demonstrated nearly universal catastrophic tooth fracture, whereas half the 2-mm chamber extension group displayed non restorable root fractures. Extension group specimens demonstrated nearly universal catastrophic tooth fracture, whereas half the 2-mm chamber extension group displayed non restorable root fractures. They concluded that under the conditions of this study, mandibular molars restored with the endocrown technique with 2- and 4-mm pulp chamber extensions displayed greater tooth fracture resistance force as well as stress.[10]
Taha, Sebastian et al. Fracture resistance of endodontically treated teeth group Group S3.5 showed the highest mean fracture load value (1.27±0.31 kN). Endocrowns with shoulder finish line had significantly higher mean fracture resistance values than endocrowns with butt margin ($p < 0.05$). However, the results were not statistically significant regarding the restoration thickness. Evaluation of the fracture modes revealed no statistically significant difference between the modes of failure of tested groups. They concluded that for the restoration of endodontically treated teeth, adding a short axial wall and shoulder finish line can increase the fracture resistance.[11]
The result was opposed with by ***Khemakhem, et al*** Who reported that no statistically significant difference in failure load among the four tested subgroups (at $P< 0.05$). Endocrowns recorded statistically significant mean higher fracture load values (1729.91N±407.9) compared to post retained crowns, (1435.84±405.2). they Concluded that lithium disilicate based endocrown restorations increase the fracture resistance of endodontically treated molars compared to conventional crowns associated with glass fiber posts and resin composite filling cores.[12]

Several limitations of this study should be mentioned. The polymerization shrinkage effects of the cement layer were not performed in this FEA. As reported in the literature [13], cement polymerization shrinkage is a centrifugal contraction and may cause a stress concentration in the bonding interface. However, from the FEA results, it seems that polymerization shrinkage of the cement layer has a smaller influence than the endocrown or dental structure for producing stresses, owing to its normal thickness of 120 μm in our study [14].

Conclusion:

Considering the limitations of the present study a preparation design with an axial wall and shoulder finish line of endodontically treated teeth restored with endocrown increases the fracture resistance. However, in the present study further investigation are needed to ensure the increase of fracture resistance as there was a violation of rule of conservative preparation principles to increase occlusal thickness of restoration more than standard thickness.

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