Research Article

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Evaluating & Comparing the Fracture Resistance of Heat Pressed Crowns on Shoulder & Chamfer Finish Lines: An In Vitro Study

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ABSTRACT

Aim: One of the major problems of all ceramic restorations is their probable fracture against the occlusal force. The aim of the present in vitro study is to compare the effect of finish lines i.e. (shoulder and chamfer) on the fracture resistance of all ceramic restorations.

Material and Methods: On an extracted maxillary central incisor chamfer & shoulder margin was prepared. Impressions were taken using a polyvinylsiloxane. The impressions were poured with stone to fabricate dies. Ceramic crowns were prepared by making wax pattern and press on technique. The crowns were then cemented on the tooth and underwent a fracture test with a universal testing machine and samples were investigated.

Results: Mean fracture resistance ranged from 120 to 270 N. Heat Pressed with shoulder finish line has highest fracture resistance.

Conclusion: Within the limitations of this study, preparations done in shoulder preparation was significantly higher as compared to preparations done in chamfer.

Keywords: Heat Pressed Crowns, Fracture Resistance of heat pressed crowns, Pressed crowns.

INTRODUCTION

Restorative treatment in prosthetic dentistry has made dental ceramics an often used alternative for both anterior and posterior restorations. A number of ceramic materials offering high strength are available and are stated as being indicated for use as posterior restorations. The strength of a clinical ceramic crown is influenced by several factors such as the shape of the prepared tooth[1], the final restoration, the way of luting[2], microstructure of the ceramic material and the loading conditions[3]. The mechanism for observed clinical failures is still unclear. The luting medium, the flexural strength of the ceramic material, the processing method and the brittle nature of the ceramics all are thought to play a role. Tooth preparation is one of the important aspects of restorative dentistry because it establishes the foundation for whatever restoration is being placed. Understanding of tooth morphology is essential for developing preparations that will permit the restorations placed upon them to be functionally durable, provide optimal esthetics, and be biologically compatible with the periodontal tissues. Finish lines plays an important role in resisting the force. The marginal preparations should produce an optimal peripheral seal from restoration to tooth and should be supragingival as possible, because achieving

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Fig 1: Press Ingots.

Fig 2: Pressable Ceramic Furnace.

Fig 3: UTM.

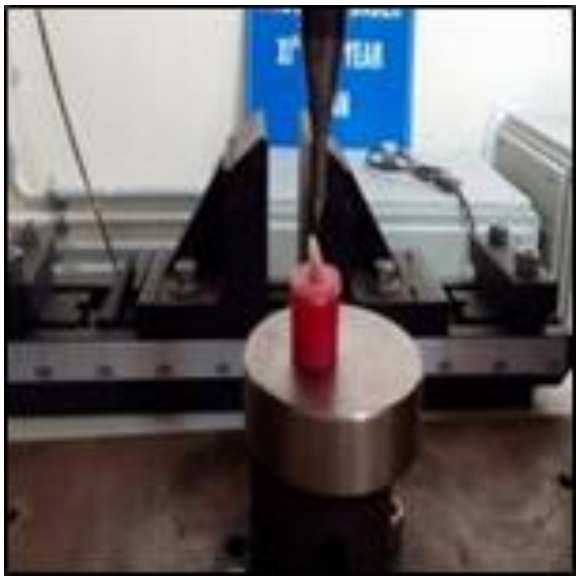


Fig 4: Load applied.

Fig 5: Crown fractured.

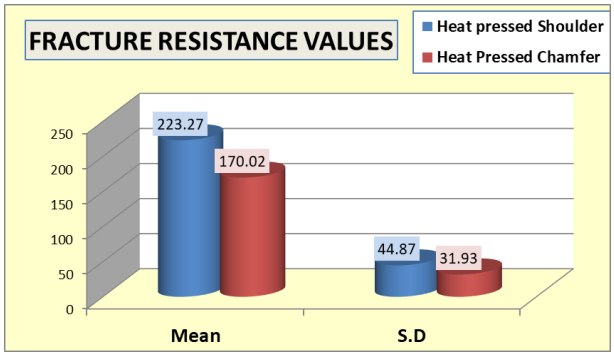
isolation for the bonding and luting procedure may be difficult in subgingival area, so crowns may get fractured easily. Furthermore, margins ideally should be on enamel, where marginal microleakage may be reduced compared with dentinal margins. Therefore, the margins should be well adapted, not deformed during function and be accessible to the dentist for finishing and for the patient for cleaning[4]. All finish lines should be smoothened and rounded off to reduce the risk of stress concentration areas in the ceramic. There are fewer studies which compared the fracture toughness of all ceramic anterior crowns & effect of the same on the finish lines.

Table 1: Description of all the fracture resistance of each sample of four groups recorded in the study.

Sr. No.	Heat Pressed Shoulder	Heat Pressed Chamfer
1	252.547	174.094
2	152.883	145.516
3	237.891	177.375
4	244.922	208.719
5	183.477	193.281
6	267.891	121.148

Table 2: Comparison of the influence of shoulder & chamfer finish lines on the fracture resistance of heat pressed all-ceramic crowns.

Finishing line	Mean (s.d)	Std.error	Student 't' test	'P' value, Significance
Heat Pressed Shoulder	223.27 (44.87)	18.31	2.368	p = 0.039, significant statistical difference
Heat Pressed Chamfer	170.02 (31.93)	13.03		



Graph 1: Fracture resistance values.

Most of the ceramic systems available today are mainly designed for complete crown coverage of anterior teeth. The use of porcelain is associated with the problems of ceramic fracture even prior to cementation. The role of cement in fixed prosthodontics is to preserve the integrity and health of the prepared tooth structure, providing a seal against microleakage at tooth–crown interface[5]. Precise well fitting cast metal restorations have some discrepancies between the margins of the restoration and the preparation of abutment tooth, luting cement fills space between a fixed prosthesis and the prepared tooth. Open margins cause the abutment teeth to become sensitive for prolonged period after final cementation. Inadequately sealed margins along with occlusal discrepancies causes the crowns to loosen prematurely[6].

Heat-pressed ceramics constitute another application of high technology to dentistry. This process relies on the application of external pressure at elevated temperatures to obtain sintering of the ceramic body. Hot-pressing classically helps avoid large pores caused by non-uniform mixing. It also prevents extensive grain growth or secondary crystallization, considering the temperature at which sintering is obtained. The mechanical properties of many ceramic systems are maximized with high density and small grain size. Therefore, optimum properties can be obtained by heat-pressing techniques[7].Earlier alumina and feldspathic were combined to obtain natural tooth-like appearance and also improves mechanical property.

Hence this study is designed to compare the fracture toughness of the heat pressed crowns on shoulder and chamfer.

MATERIALS AND METHODS

1. Dental Plaster(Kaldent).
2. Lithium Disilicate Press Ingots (Emax).
3. Investment Material (Wirovest,Bego).
4. Multilink Cement Kit (Ivoclar Vivadent, Schaan, Liechtenstein).
5. Auto polymerizing resin (DPI-RR Cold Cure).
6. Airotor with Diamond Burs.
7. Burnout Furnace.
8. Pressable Ceramic Furnace.
9. Sandblaster.
10. Ceramic Trimming and Finishing Burs.
11. Magnifying Lens with Light.
12. Universal Testing Machine (UTM) (Instron-5500R).

Twelve sound and extracted maxillary central incisor teeth, which were periodontally compromised, selected from the Department Of Oral & Maxillofacial Surgery, without carious. lesion. The teeth were assigned into two groups(six each) according to their type of preparation 1)Heat pressed shoulder finish lines.2)Heat pressed chamfer finish lines. Teeth were positioned along their vertical alignment with the cement-enamel junction 1 mm above the top embedded along the long axes using cold cure acrylic. Then maxillary central incisors were prepared using a high speed handpiece with air-water coolant. Uniform reduction should be carried out i.e.,1mm axially and 1.5 mm incisally. Tapering was achieved by the tapered diamond bur and was restricted within clinically acceptable limit. After the completion of axial preparation, the width of a shoulder preparation is 1.2 mm & width of chamfer preparation is 1 mm. All lines angles were rounded. The margin design was examined using magnifier lens with light for any irregularity. All preparation was done by a single operator.

Heat Pressing Crown Fabrication

For Heat Press crowns (E.max Press) ingots were used to make the full coverage crowns using heat pressing technique. Polyvinyl siloxane (putty) impression were made of the prepared tooth. Impressions were poured with stone. A layer of die hardener & die spacer was applied on the stone dies, extending 1 mm occlusal to the margin. The dies were lubricated and then dipped in hot dipping wax. A wax pattern for the full contoured crown was fabricated using wax addition technique on the stone casts. The wax patterns were sprued. The sprues were attached to the investment ring base. Crowns were invested in investment ring. The assembled investment ring was placed in the center of the hot press furnace. The recommended pressing program for ivoclar was used and ceramic was pressed into the mold. The ring was left to cool to room temperature for 60 minutes. The length of the plunger was marked on the cooled ring. The investment ring was sectioned using a separating disk. All the sprue area was smoothened and rounded using a polishing disk.

Cementation & Testing

Internal surfaces of crowns were etched with 5% hydrofluoric acid for 20 seconds following the manufacturer's instructions followed by silanization. All crowns were cemented on their respective teeth with dual-cure resin cement using finger pressure. Excess cement was removed. Light polymerization was carried out for 20 sec per surface following the manufacturer's recommendations. The specimens were tested on a Universal Testing Machine.

DISCUSSION

Earlier studies have evaluated the fracture resistance for posterior teeth and underwent trials and came to conclusion that there is slight significant variation in crowns prepared by different processing methods[8].In the present study tooth preparation was made by maintaining anatomic form of the tooth. Axial walls were made parallel thus preventing all undercuts. In this study, the natural tooth was used and 1mm axial reduction and 1.5 mm incisal reduction, with the tapering which was clinically acceptable. Overall, the preparation should be as conservative as possible, in case of severe wear or discoloration, minimum reduction maybe insufficient to provide adequate porcelain depth to cover the discoloration[4].The dual-cure resin cement was used as it has been widely indicated for luting crowns. The polymerization reaction of dual-cure resin cement is chemically and photo-initiated which ensures higher conversion rate of curing, leading to better mechanical properties and such cements promoted more reliable micro-shear bond strength and micro-hardness values than the flowable resin for cementation of all ceramic restorations.

Ideally, finish line position should be placed supragingivally on sound tooth structure, but in reality this is often not possible. Sometimes aesthetics dictates a margin to be placed subgingivally. However, subgingival finish lines frequently are required in cases of inadequate occluso-cervical dimension needed for retention and resistance form. Sufficient axial reduction is important to provide structural durability for the restoration and avoid over reduction. The use of depth orientation groove burs would be a useful method to ensure adequate axial tooth reduction. In addition, overpreparation of the teeth negates the

advantages that demonstrate and may lead to loss of pulpal vitality and peri-radicular pathology. However, underpreparation will result in inappropriate labial and palatal contours, leading to compromised aesthetics. Overbulking of the crown at the gingival margin may be necessary to allow for adequate material strength, which results in a poor emergence profile. Several studies considered an improper emergence profile as a significant etiologic factor in the marginal inflammation associated with crowns. Insufficient labial reduction, particularly near the finish line, may also result in distortion of the ceramic during fabrication and clinical service which leads to poor marginal adaptation, debonding, and long-term cement failure, all of which have been cited as major factors in the failure of ceramic crowns[4].However, when resin cement was used with internally etched all-ceramic crowns, there was no significant strength reduction in a laboratory study or in a longitudinal retrospective clinical evaluation of all-ceramic crowns compared with non etched all-ceramic crowns. Therefore, a shoulder or definitive chamfer finish lines are recommended for all-ceramic crowns that are not etched and bonded to the teeth.

On comparison of the influence of different finishing lines (shoulder & chamfer) on the fracture resistance of heat pressed all ceramic crowns, using student 't' test, it was observed that there was highly significant statistical difference ($p< 0.005$) (Table 2).Preparations done in shoulder group have significantly higher fracture resistance as compared to chamfer.

The fracture toughness of both the restorations is also enhanced as they have been adhesively bonded to the tooth structure as the restoration and tooth behave like a monoblock. In similar studies for determining the fracture toughness, composite replicas of the teeth were used. In the present study extracted natural teeth were used and the bonding of the restorations is been done with resin cement. Previous studies have yielded adequate power to detect clinically important differences using a sample size of twelve. Some limitations exist in the methodology of this study. The thickness of the specimens tested was 1.5 mm, because the test requires standardization of the specimen thickness, diameter, and shape. Further we can reduce the thickness and check for the fracture toughness. It is important to note that mechanical tests, used in this study, are only a first step toward predicting clinical performance.

In 2002, Charles et al. evaluated the maximum clenching load. They compared the clenching load of 44 adults with posterior edentulous with maximum clenching load of 20 subjects with sound dentition. They estimated that the mean clenching load of 44 adults suffering from posterior edentulous was 462N (range 98 to 1031N); this value was 720N in the 20 healthy subjects (range 244-1243N). In the present study the fracture resistance of all ceramic heat pressed crowns with chamfer and shoulder finish lines was evaluated, the results showed that the mean fracture resistance was 223.27 N in the heat press shoulder group and 170.02 N in the heat press chamfer group. Statistical significant difference was found among shoulder and chamfer preparation. Shoulder finish line was found to be superior than those with chamfer finish lines.

CONCLUSION

This study was conducted to evaluate and compare the fracture toughness of all ceramic crowns using heat press technique. Crowns of ceramic were fabricated using heat press on maxillary central incisor teeth with uniform reduction of 1.2 mm axially and 1.5 mm incisally. The internal surface of all copings were subjected to conditioning: etched using 5% hydrofluoric acid followed by the application of silane coupling agent and the application of resin cement on the surfaces of prepared teeth. The crowns were bonded to their corresponding tooth using cement. After cementation specimens were loaded on a universal testing machine with the application of compressive load along the long axis of the specimens at a crosshead speed of 1mm/min until fracture. Fracture load were recorded in newtons. Student 't' test was used for statistical analysis of the data. Statistically significant difference in fracture toughness with respect to the mean value ($p<0.05$) was observed. Heat pressed shoulder fracture resistance (223.27 ± 44.87), Heat press chamfer fracture resistance (170.02 ±32.88). Preparations done in shoulder group have significantly higher than preparations done on chamfer.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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