



FRACTURE RESISTANCE COMPARISON OF CHAMFER AND SHOULDER FINISH LINES IN ALL CERAMIC POSTERIOR RESTORATIONS: AN IN VITRO STUDY

Dr. K. Sayed Akber Pasha

Prosthodontist, Salmar, Karkala, Karnataka, India

ABSTRACT **Introduction** The fracture of all ceramic restorations due to the occlusal and lateral forces is one of the major problems these days. This problem arises mainly due to high intensity of masticatory forces in the molar and premolar area along with the brittle nature of ceramic restorations. The aim of this present in-vitro study is to compare the fracture resistance of chamfer and shoulder margins under a cyclic load of Inceram crowns.

Material and methods First maxillary premolar without any cracks and caries extracted for orthodontic purposes were included in the present study. Using appropriate burs, 50 in. chamfer and 90 in. shoulder margins were formed on the tooth. Using polyvinylsiloxane, impressions were made and 10 epoxy resin dies were fabricated. Using a universal testing machine called Instron, mechanical testing was carried out.

Results The mean \pm standard deviation for the resistance of fracture came out to be 610.28 ± 58.56 for chamfer margin and 502.54 ± 105.45 for that of shoulder margin. The difference between the two groups was statistically significant as revealed by Student's t-test ($p = 0.011$).

Discussion Fracture caused by the occlusal and lateral masticatory forces seems to be one of the main problems of all ceramic restorations. These restorations can sometimes lead to unesthetic appearance and many biologic problems because of the metal present in these restorations.

Conclusion The results of the present study suggested that the chamfer margin is better as compared to the shoulder margin in case of all ceramic posterior restorations in terms of fracture resistance against the vertical and lateral masticatory forces.

KEYWORDS : All ceramic restoration, chamfer margin, shoulder margin, fracture

Introduction

The fracture of all ceramic restorations due to the occlusal and lateral forces is one of the major problems these days. Along with this problem, there is also the problem of allergic, chemical and toxic effects from the metal contained in these restorations. One more thing adding to these problems is the color difference these restorations and natural teeth.[1]

Most of the people these days go for tooth colored crowns and for that all ceramic crowns are the best as they provide better biocompatibility along with esthetics. Because of these properties, there has been an increased trend since last few years to use such restorations in posterior areas. But some of these crowns get fractured as a result of low mechanical resistance. This problem arises mainly due to high intensity of masticatory forces in the molar and premolar area along with the brittle nature of ceramic restorations.[2] These ceramic materials are also more susceptible to mechanical stress and tensile stresses because of the presence of superficial flaws and internal voids. These sites become the risk factors for the initiation of the cracks.[3] This entire phenomenon may be affected by factors like residual processing stress, direction and magnitude of applied force, thickness and marginal design of the restorations, cement-restoration interface defects, oral environment effects and elastic modulus of the components of restorations.[4]

One of the research included finite element analysis (FEA) so as to evaluate stress distribution in maxillary 2nd premolars restored with metal-ceramic crowns in comparison to non-restored teeth during mastication suggested that there was high amount of stress within ceramic-metal interface and dentin-metal interface at the cervical line of restored teeth. Another study was done in lower first molars which used the same FEA method to evaluate stress distribution. It also suggested the concentration of stress at cervical site.[5]

The effect of marginal design of the Inceram crowns on the improvement in the mechanical performance in clinical setup is the hypothesis in this present study i.e. chamfer margin should be prepared instead of shoulder margin. A study done by Sadan et al suggested that both types of finishing lines are appropriate for tooth preparation but another study by Di Lorio et al concluded that in alumina restorations, biomechanical performance is improved with the use of shoulder margin. Whereas another study conducted by De Jagger et al concluded that it is better to prepare chamfer with collar preparation in posterior teeth so as to increase the life of the restoration. Another study conducted by Cho et al suggested that chamfer finish line has greater fracture strength as compared to shoulder and round ended shoulder finish line. There was one more study done by Potiket et al

which suggested that the natural teeth prepared with 1mm deep shoulder finish line and rounded internal line angle for all ceramic crowns have good fracture strength. Rammersberg et al in their study concluded that the greatest stability for all ceramic crown is minimally invasive 0.5mm chamfer tooth preparation.

The aim of this present in-vitro study is to compare the fracture resistance of chamfer and shoulder margins under a cyclic load of Inceram crowns.

Material and methods

First maxillary premolar without any cracks and caries extracted for orthodontic purposes were included in the present study. A torpedo diamond bur was used to prepare 50 in. chamfer margin in the tooth (Fig. 1a). Cusp shaped tooth in the occlusal aspect was prepared so as to increase the strength resistance. Using polyvinylsiloxane, ten impressions were made and those impressions were poured using Epoxy resin CW2215 so as to fabricate 10 identical resin dies having 50 in. chamfer margin. Later on the 50 in. chamfer margin (Fig. 1b) in the retrieved tooth was converted to 90 in. shoulder margin with the help of cylindrical diamond bur. Using the same impression materials, impressions were made and 10 epoxy resin dies were fabricated.

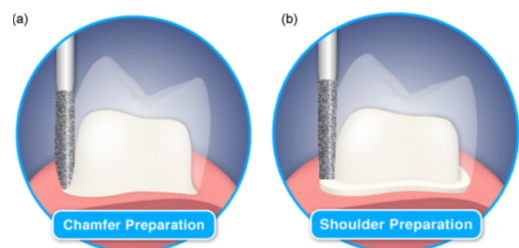


Fig. 1. (a) Chamfer preparation and (b) shoulder preparation.

Then using the polyvinylsiloxane impression material, impression was taken for each epoxy die and later on poured using die stone. Then using a stereomicroscope, fit of each alumina core was checked on their respective epoxy resin. Using Panavia F2.0 resin luting agent, each core was cemented on decontaminated epoxy resin dies. The excess luting agent was removed after cementation and samples were stored at room temperature for 24 hrs in a saline solution.

Using a universal testing machine called Instron, mechanical testing was carried out. A minimal load of 5N was applied using a stainless steel ball of 5mm in each specimen and the load was applied along the long axis of tooth at the center of occlusal surface with 1mm/min

crosshead speed till there was fracture. Nexigion software automatically recorded the fracture load data and the origin of failure in the samples was evaluated using stereomicroscope.

Results

The mean \pm standard deviation for the resistance of fracture came out to be 610.28 ± 58.56 for chamfer margin and 502.54 ± 105.45 for that of shoulder margin (Table 1). The difference between the two groups was statistically significant as revealed by Student's t-test ($p = 0.011$). There was 95% confidence interval in the mean fracture resistance of chamfer and shoulder margin as depicted by error-bar graph. There was more coefficient of variation in shoulder margin as compared to chamfer.

Table 1

Finish line	N	Mean	Std. Deviation	Std. Mean Error
Shoulder	10	502.54	105.45	33.42
Chamfer	10	610.28	58.56	18.12

Fracture resistance of alumina cores in shoulder and chamfer margins

Discussion

Fracture caused by the occlusal and lateral masticatory forces seems to be one of the main problems of all ceramic restorations. These restorations can sometimes lead to unesthetic appearance and many biologic problems because of the metal present in these restorations.[6,7] The present study that compared the resistance to fracture of all ceramic restorations under cyclic load applied to shoulder and chamfer margins of Inceram crowns depicted that 610.28 was the mean fracture resistance for the chamfer margin whereas it was 502.54 in shoulder margins. The fracture resistance of chamfer margin in all ceramic restorations was more than shoulder margin and this difference was statistically significant as depicted by student's t-test. In this study, epoxy resin dies were used rather than brass dies because the elastic modulus of supported materials had an effect on fracture resistance of core. Unknown nature of die material and luting agent bond is also a difference from the real clinical settings. The reasonable thought is to think that the biomechanical behavior of supporting die system is interfaced by a hybrid layer at dentin-cement interface. It is possible to compare between the two groups because both these factors equally affect the samples in this present study.

However both the marginal designs can be used successfully in posterior all ceramic crowns because of the higher fracture resistance than the biting forces and thus, can adequately replace the PFM crowns.[8] There is a strong unity in margins because of the use of resin cements for luting and thus giving good strength against forces causing fracture.[9] But still the results of present study show that the chamfer margin has more fracture resistance against biting forces as the difference between the two groups was statistically significant. This difference may be due to the curve in chamfer finishing line which can lead to better spread of forces by mastication but this is not the case with 90 in. shoulder finish line which has got sharp endings. These finish lines have got both the vertical and horizontal discrepancies between the restoration and the tooth. As we know that horizontal discrepancy is more important than vertical, so it seems that chamfer margin has a better marginal fit as compared to shoulder margin in all ceramic restorations. So the shoulder margin has got less unity between the tooth and the restoration along with the worst marginal fit making this restoration more vulnerable to fracture as compared to chamfer margin.[10]

Conclusion

The results of the present study suggested that the chamfer margin is better as compared to the shoulder margin in case of all ceramic posterior restorations in terms of fracture resistance against the vertical and lateral masticatory forces. However, both type of margins can be used in posterior restorations because the results also depicted that both the margins have higher fracture resistance against the posterior biting forces but it is better to use chamfer finishing line for a better biomechanical performance.

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