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Original Research

The effect of two marginal designs (chamfer and shoulder) on the fracture resistance of all ceramic restorations, inceram: An in vitro study

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ABSTRACT:

Aim: The aim of the present in vitro study is to compare the effect of two marginal designs (shoulder and chamfer) on the fracture resistance of all ceramic restorations, INCERAM. **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 prepared on the tooth. 10 impressions were taken using a polyvinylsiloxane and then dies were fabricated by pouring with epoxy resin. Again 10 polyvinylsiloxane impressions were made and ten epoxy resin dies were created from these impressions. After setting the stone dies were coated with a space liner and were sent to a dental laboratory where the alumina cores with 0.5 mm thickness were fabricated (Vita, Germany). The fit of each alumina core on their respective epoxy resin was verified under a 2.5 x stereomicroscope. Using a universal testing machine called Instron, mechanical testing was carried out**. Results:** The mean ±SD of fracture resistance were 616.20± 55.75N (chamfer margin) and 510.75 107.83N(shouldermargin). TheStudent's t-test revealed a statistically significant difference between the groups ($p = 0.015$).

Keywords: Chamfer; Shoulder; Fracture resistance; All ceramic; Inceram

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INTRODUCTION

One of the major problems of the all ceramic restorations is their probable fracture against the occlusal and lateral force.[1] The prominent restorations contain metal which brings about toxic, chemical and allergic affects. The difference between their color and natural tooth is another problem. Most of the people prefer tooth color crowns. All ceramic crowns have esthetics and biocompatibility.[2]

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. 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.[3]

In the past few years such restorations have been used in the restorations of posterior teeth. However, some crown fractures due to the relatively low mechanical resistance of ceramic crowns have become more apparent. This is mainly due to the magnitude of the biting forces applied on the premolar and molar teeth and to the inherent brittleness of ceramics.[3,4] Ceramic materials are particularly susceptible to the tensile stresses, andmechanical resistance is also strongly influenced by the presence of superficial flaws and internal voids.Such defects may represent the sites of crack initiation. This phenomenon may be influenced by different factors such as marginal design and thickness of the restoration, residual processing stress, magnitude and direction and frequency of the applied

load, elastic modulus of the restoration components, restoration–cement interfacial defects, and oral environmental effects.[5]

In one research, finite element analysis (FEA) was used to study the stress distribution during mastication in maxillary second premolars restored with metal–ceramic crowns and compared them to non-restored teeth. They registered high stresses at the cervical line of the restored teeth within the dentin–metal interface and within the ceramic–metal interface.[6]

The aim of the present in vitro study is to compare the effect of two marginal designs (shoulder and chamfer) on the fracture resistance of all ceramic restorations, INCERAM.

MATERIALS AND METHODS

A caries-free first maxillary premolar extracted for orthodontic reasons (without any crack) was selected for the present study. The tooth was prepared with a 50 in. chamfer margin (0.7 mm depth) using a torpedo diamond bur,[7,8] For more strength resistance occlusal surface was prepared with a cusp shaped.[9] Ten impressions were made using a polyvinylsiloxane (Zhermack, Italy). The impressions were poured using Epoxy resin CW2215 (Hunstman, Germany) [10] to create ten identical resin dies with a 50 in. chamfer margin. Afterwards, the tooth was retrieved and the 50 in. chamfer was converted into a 90 in. shoulder using a cylindrical diamond bur (1 mm depth).[7,8] Again 10 polyvinylsiloxane impressions were made and ten epoxy resin dies were created from these impressions.

Impressions of each epoxy resin dies were taken using a polyvinylsiloxane impression material and poured using die stone. After setting the stone dies were coated with a space liner and were sent to a dental laboratory[11] where the alumina cores with 0.5 mm thickness were fabricated (Vita, Germany).[12] The fit of each alumina core on their respective epoxy resin was verified under a 2.5 × stereomicroscope. Each core was cemented using a resin luting agent, Panavia F2.0 (Kuraray, Japan) on the decontaminated epoxy resin dies. After cementation, excess luting agent was removed and samples were stored in a saline solution at room temperature for 24 h.

Mechanical tests were carried out using a universal testing machine (Instron). Each specimen underwent a load with a minimal load of 5N with a 5 mm diameter stainless steel ball. The load was applied at the center of the occlusal surface along the long axis with a crosshead speed of 1 mm/min until fracture occurred.[13] The fracture load data were automatically recorded using Nexigion software. Samples were investigated from the point of view and steriomicroscope of the origin of the failure.

For statistical analysis data we collected, a mean ± SD was calculated for each group. The difference between groups was tested for statistical significance with the Student's t-test at a significance level $p < 0.05$.

RESULTS

Table 1: Fracture resistance of shoulder edge and chamfer edge alumina cores.

Finish line	N	Mean	Std. deviation	Std. error mean
Fracture Resistance				
Shoulder	15	510.7550	107.83250	34.48712
Chamfer	15	616.2000	55.75525	19.59250

Table 2: P-value

	t-Test for equality of means		Sig. (two-tailed)	Mean difference
	t	Df		
Fracture Resistance				
Equal variances assumed	-2.807	19	0.014	-107.4610
Equal variances not assumed	-2.807	15.072	0.016	-107.4610

The mean ±SD of fracture resistance were 616.20± 55.75N (chamfer margin) and 510.75 107.83N(shouldermargin). TheStudent's t-test revealed a statistically significant difference between the groups ($p = 0.015$). Table 1 and 2

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 unaesthetic appearance and many biologic problems because of the metal present in these restorations.[14,15]One of the major problems of all ceramic restorations is their probable fracture against the occlusal and lateral force.[1]

The present study that compared the resistance to fracture of all ceramic restorations under cyclic load applied toshoulder and chamfer margins of Inceram crowns depicted that 616.20 was the mean fracture resistance for the chamfer margin whereas it was 510.75 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.

The Student's t-test revealed a statistically significant difference between the groups and fracture resistance of chamfer margin was more than shoulder margin. Elastic modulus of the supported materials of the core affected the fracture resistance of the core.[16]For this reason, in this study, we use epoxy resin dies that are much better than brass dies.[17] Another difference from clinical conditions is the unknown nature of the bonding between luting agent and die material. It is reasonable to suppose that the presence of a hybrid layer at the dentin–cement interfaces the biomechanical behaviour of the core/supporting die system. However, both of these factors equally influenced the samples in the present study therefore it is possible to make a comparison between the two groups. Fracture resistance of the two groups are more than biting forces [18] so we could use both marginal designs successfully in the posterior all ceramic crowns, and it is a very good replacement for PFM crowns. We use resin cements for cementation, hence we have a strong unity in the margins that make strength against the fracture.[19]

The present study indicates that chamfer finishing line could have more fracture resistance than shoulder finishing line. Furthermore, good fitness on the occlusal surface would greatly enhance strength resistance against fracture force, and a gap directly under where the pressure is being applied (between the base die and the core) could influence the fracture resistance. This fitness is different from the marginal fitness and we have this vertical discrepancy (D) in the occlusal surface. In similar studies we found that fitness of the alumina cores in the occlusal surfaces is about 60 mm in both of the samples. So in our study this gap is the same in all dies because we did not change the occlusal surface therefore this factor equally influenced the samples hence it is possible to make a comparison between the two groups.

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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