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RESEARCH ARTICLE

A COMPARATIVE EVALUATION OF THE FRACTURE RESISTANCE OF DIRECT COMPOSITE VENEERS USING DIFFERENT RESTORATIVE MATERIALS - AN IN VITRO STUDY

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ABSTRACT

Aim: The aim of this study was to evaluate the fracture resistance of direct composite veneers using different restorative materials. **Setting and design:** This was an in vitro study. **Materials and Methods:** A total of 120 Maxillary central incisor's were selected and divided into four groups of 30 each. According to the restorative material used-Group A-Nanohybrid composite (Tetric n Ceram), Group B Microhybrid composite (Filtex Z 250), Group C- Nanohybrid composite(Ceram X Spheretec) , Group D-Submicron-hybrid (CHARISMAR smart). The tooth preparation selected for the study was window preparation. All specimen were mounted in an acrylic block embedded 2 mm apical to the CEJ. Compressive load was applied at an angle of 45 degree at the facial part of veneer using a universal testing machine. **Results:** The results of this study showed that Ceram X Spheretec (Nanohybrid composite) showed the highest fracture resistance score followed by Tetric N Ceram (Nanohybrid composite) and Charisma® Smart (submicron hybrid composite). While the specimen restored with Filtex Z 250 (Microhybrid composite) showed least resistance to fracture. Statistically analysis of fracture resistance showed a significant difference between the groups. **Conclusion:** It was concluded from the study that Ceram X Spheretec showed the highest fracture resistance amongst all the groups. Thus it was a favourable material for direct composite veneers on anterior tooth in comparison to Tetric N Ceram, Filtex Z 250 and Charisma® Smart.

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INTRODUCTION

Esthetic dentistry has become one of the main areas of dental practice emphasis and growth for several year. There are many ways to re-establish bio aesthetic relations and composite veneers is one of them (Zlatanovska *et al*., 2016). The variations in veneer preparation range from removing little tooth structure to removing all of the facial enamel and most of the mesial and distal enamel (Cherukara *et al*., 2005). The amount of tooth reduction of labial surface for laminate veneer should be 0.5/0.75 mm, which allows the preservation of enamel and enhances strong bonds (Hahn *et al*., 2000). Intraoral polishing of direct laminates veneers is also easy and any cracks or fracture on the restoration may be repaired intraorally and marginal adaptation is better than that of indirect laminates veneers' restoration. However the main disadvantages of laminate veneers are low resistance to wear, discolouration and fracture.

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The Materials selected for the study include micro hybrid composite (Filtex Z250), nanohybrid composites (Ceram X Spheretec & Tetric N Ceram) and submicron-hybrid composite (Charisma ® Smart). Ceram x Spheretic (DENTSPLY) is a nanoceramic light cured radiopaque universal nanohybrid composite with prepolymerized fillers. It has newer filler technology containing granulated spherical fillers in combination with an optimized resin matrix system (Tomer *et al.,* 2017). The microhybrid composite, Filtex Z 250 (3M), is a universal esthetic radiopaque restorative material. It contains BISGMA, UDMA and BISEMA resins. Zirconia/silica is used as filler. The inorganic filler loading is 60% by volume with a particle size range of 0.01 to 3.5 micron (Sowmya *et al.,* 2017). Tetric n Ceram (Ivoclar) is a nanohybrid composite based on Nano optimized technology. Nano additive have been incorporated in a targeted fashion. Its Nano optimized filler technology is responsible for the material's unique chameleon effect (Tomer *et al.* 2017). The CHARISMAR Smart (KULZER) is a radio-opaque submicron-hybrid composite. It is based on a BIS-GMA matrix and contains approximately 59% filler by volume with a particle size of 0.005- 10 micron. Barium aluminium fluoride

glass, highly dispersive silicon dioxide is used as filler. The most frequent failure mode associated with laminates veneers are fracture and debonding. Hence the aim of this in vitro study was to examine the fracture resistance of direct composite veneers using four different composites materials.

MATERIALS AND METHODS

The study was conducted on 120 non carious, maxillary incisors extracted for periodontal reasons to be collected from the Department of Oral and Maxillofacial surgery, Government Dental College and Hospital Patiala. The extracted, teeth were cleaned and soaked in 5% sodium hypochlorite solution for 24 hours to remove any remaining surface debris. Teeth were inspected for defects or cracks and any external debris was removed by ultrasonic tips and teeth were stored in distilled water at room temperature.

Tooth preparation method: The tooth preparation selected for the study was window preparation. In accordance to this preparation the facial surface was prepared without involving the incisal edge. The tooth reduction was done approximately to the facial depth of 0.5-0.75 mm and gingivally 0.3-0.5 mm. The finish line created was chamfer by using round ended tapered diamond. Proximally, the contact area was not be included. The preparation was extend to the point just facial to the proximal contact. The facial contour was assessed by inspecting from the incisal view with a mirror before proceeding to composite restoration.

Veneer preparation method: The prepared tooth was cleaned then acid etched with 35% phosphoric acid (ScotchbondTM etchant, 3M ESPE, USA) for 15 seconds, rinsed for 10 seconds with distilled water and air dried gently for 5 second. This was followed by bonding agent application. The bonding agent (3M ESPE, USA) was applied in two layers and polymerized for 20 seconds with light curing unit (MINI LED SATELEC PVT.LTD). The veneers was incrementally built up using composite resin. Each layer applied was cured for 20 sec.Care was taken that as the facial contour was being restored and the tooth did not give bulky appearance. Finishing and polishing was done with composite finishing kit (3M ESPE Sof- Lex finishing & polishing system kit).

Teeth were then randomly divided into four groups of 30specimen each.

Group A: 30samples Restored with Nanohybrid Composite (Tetric N Ceram)

Group B: 30 samples Restored with micro hybrid Composite (Filtex Z 250)

Group C: 30 samples Restored with Nanohybrid Composite (Ceram X Spheretic)

Group D: 30 samples Restored with submicron-hybrid composite (CHARISMAR smart).

Procedure for testing fracture resistance: For evaluation of fracture resistance the thirty teeth samples from each of these four groups were mounted in acrylic block upto 2 mm apical to the CEJ, with the long axis of the prepared teeth perpendicular to the base of the block. Universal testing machine was used.

The acrylic block containing the restored tooth was tightly fixed to the custom made inclined metal base to provide a 45 degree angle to the horizontal plane. Load were applied at a crosshead speed (5mm/min) with a stainless steel rod having diameter of 2mm mounted on the facial part of the veneer. The maximum load to produce fracture for each sample was recorded and analysed using Kruskal- Wallis H test.

Fig 1. Selected samples for direct veneer (Window preparation)

Fig 2. Materials used in the study

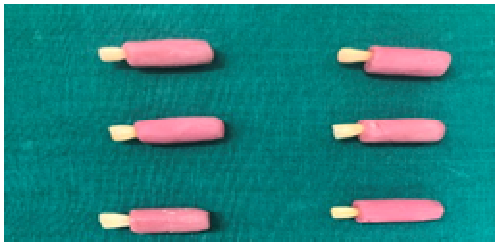


Fig 3. Restored sample mounted in acrylic blocks

Fig 4. Sample subjected to universal testing machine

RESULTS

Fracture resistance results: The mean fracture resistance of teeth in Group 1 restored with Tetric N Ceram was 41.69 kgf. The mean fracture resistance of the teeth in Group 2 restored with Filtex Z 250 was 31.91kgf.The mean fracture resistance of the teeth in Group 3 restored with Ceram X was 42.49 kgf. The mean fracture resistance of the teeth in Group 4 restored with CHARISMAR smart was 34.62kgf. Statistically analysis was performed on the collected data. Since the data was normally distributed, Kruskal- Wallis H test or One Way ANOVA was applied to compare the fracture resistance of the groups .Results showed a significant difference between the groups. All calculations were performed using SPSS (statistical package for social sciences). P value≤0.005 was considered to indicate statistical significance.

For intergroup comparison, Mann Whitney U test was used (Table 6A, 6B, 6C, 6D, 6E, 6F). When mean difference between Group 1(Tetric N Ceram) was compared to Group 2 (Filtex Z 250) the result was significant (p=0.014). The mean difference between Group 1 (Tetric N Ceram) and Group 3 (Ceram X) was non-significant (p≥0.05). The mean difference between group 1 (Tetric N Ceram) and Group 4 CHAIRSMAR smart was no significant (p≥0.05). When mean difference between Group 2 and 3 were compared, they were found to be highly significant (p≤.001).The mean difference between Group 2 and Group 4 was non-significant (p≥0.05).The mean difference between Group 3 and Group 4 was significant (p≤0.05).Results of the study showed that samples in which Ceram X Spheretec was used as a restorative material showed highest resistance to fracture. The fracture resistance of restored groups in descending order is Ceram X Spheretec, Tetric N Ceram, Charisma® smart, Filtex Z 250 Table showing intergroup comparison between all groups using Mann Whitney U test.

Statistical analysis of comparison of force required to fracture samples restored with Tetric N Ceram (Group 1) with samples restored with Filtex Z 250(Group 2).

Table 6a.

Groups	N	Mean	S.D	P value	Significance
Group 1	30	41.69	17.451	0.014	S
Group 2	30	31.91	10.387		

Table 6b

Statistical analysis of comparison of forces required to fracture samples restored with Tetric N Ceram (Group1) with samples restored with Ceram X Spheretec (Group 3).

Table 6c

Groups	N	Mean	S.D	P value	Significance
Group 1	30	41.69	17.451	0.838	NS
Group 3	30	42.49	20.757		

Statistical analysis of comparison of forces required to fracture samples restored with Tetric N Ceram (Group1) with samples restored with CHAIRSMA^{R} Smart (Group 4).

Table 6d

Groups	N	Mean	S.D	P value	Significance
Group 1	30	41.69	17.451	0.076	NS
Group 4	30	34.63	9.365		

Statistical analysis of comparison of forces required to fracture samples restored with Filtex Z 250(Group 2) with samples restored with Ceram X Spheretec (Group 3).

Table 6e

Groups	N	Mean	S.D	P value	Significance
Group 2	30	31.91	10.387	0.008	HS
Group 3	30	42.49	20.757		

Statistical analysis of comparison of forces required to fracture samples restored with Filtex Z 250(Group 2) with samples restored with CHARISMA^{R} Smart (Group 4).

Table 6f TITLE MISSING

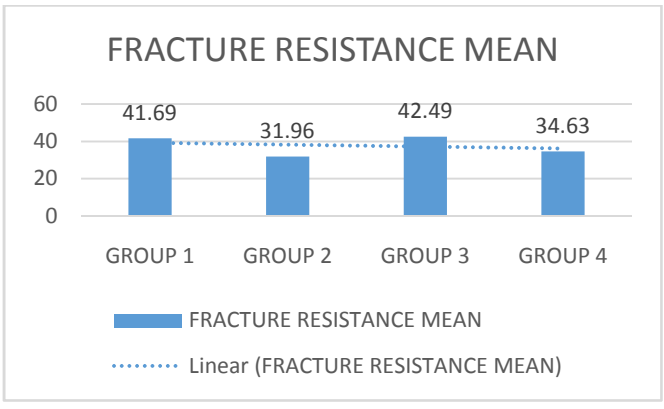
Groups	N	Mean	S.D	P value	Significance
Group 2	30	31.91	10.387	0.492	NS
Group 4	30	34.63	9.365		

Statistical analysis of comparison of forces required to fracture samples restored with Ceram X (Group 3) with samples restored with CHARISMA^{R} Smart (Group 4).

Groups	N	Mean	S.D	P value	Significance
Group 3	30	42.49	20.757	0.048	S
Group 4	30	34.63	9.365		

Thus the results of the study showed that samples in which Ceram X Spheretec was used as a restorative material showed highest resistance to fracture. The fracture resistance of restored groups in descending order is

Ceram X Sphertetec, Tetric N Ceram, Chairsma® smart, Filtex Z 250 (Group 3> Group 1> Group 4> Group 2).



DISCUSSION

Various treatment options are available to improve the esthetics. However the least invasive and most conservative option is veneers. If the situation permits they are preferred over crowns as they don't possess drawbacks such as extensive tooth preparation and damage to the gingival tissues. (Aristides and Dimitra, 2002). Therefore, in recent years veneer restorations have gained popularity in the field of dentistry. They are of two different types: Direct and indirect Veneers. In this study direct veneers have been used. They were prepared by layering technique. In this technique, the veneer was incrementally built up while maintaining the facial contour. The material used was composite resins. In today's scenario of conservative preparations, the most preferred and deliberately used material is composite resin. They can be described as inorganic particles packed within an organic matrix and joined together by a silane coupling agent.

The success of the restorations depends on a strong and durable adhesion between the enamel and dentine, and restorative material. Hagberg C 1987, states that the physiologic biting forces in adults are between 108 and 230 N. The maximum biting force 18kgf (176N) has been observed in incisor region (EHelkimo *et al.* 1977). In this study these value were determined to be 18.4 Kgf (180.4N) to 95.6 Kgf (937.51 N) all groups. The material and the methods used in this study may be superior as the data obtained in all the types was higher than the biting force of adult. Therefore, they can be suitably used for clinical practice. Turkaslan *et al*. 2008 have proven that fracture resistance can reach 552-790 N, in a study concerning the fracture resistance of laminate veneers prepared using different restoration techniques and materials. The most significant changes in commercial composites in recent years were modifications of the filler system (Ferracane J L, 1995). It has been observed that all the important properties of composites are improved by using higher filler levels and reducing the particle size. Based on this observation four different composite materials were used in this study to observe their longevity while being used as direct veneers.

The results of this study showed that Ceram X spheretec showed the highest fracture resistance. While the specimen restored with Filtex Z 250 showed least resistance to fracture. A study conducted by Tomer AK *et al* 2017, demonstrated that the Ceram X spheretec showed the higher mean fracture resistance when compared to Tetric N Ceram. Similarly in a study conducted by Hegde NM *et al*, 2014, the higher mean fracture strength was recorded by Ceram X. In another study conducted by Raina AA & Ayub FB, 2020 direct veneers restored with Nanohybrid composite (Ceram X Spheretec) showed higher mean of fracture strength in comparison to microhybrid composite (Tetric N Ceram) . All these results are in concurrence with the present study. This may be due to the formation of a continuum between tooth surface, adhesive and restorative material, which is accomplished by the demineralization and penetration of resin in enamel and the formation of a unique body between restoration and tooth structure. Hegde *et al*, 2011 performed a study to assess and compare compressive strength of newer nano composite (Filtex Z 350, Ceram X mono and Ceram X duo) with microhybrid and to compare difference in compressive strength of newer nano composite. They concluded that Nanohybrid composite had better compressive strength than microhybrid composite and Nanohybrid composite showed optimal compressive strength of 312-417 Mpa. This study also supports the finding of the present study. Where Ceram X nanohybrid composite showed compressive strength of 416 Mpa (42.49 Kgf). A study done by Xu HH *et al*, 2004 has concluded that micro hybrid composite has 50 wt. % of inorganic phase compared to 80 wt. % for the nano filled. Nano filler have higher contact surface with the organic phase when compared to mini filled composite, consequently improving material strength. Mechanical behaviour depends upon the concentration and particle size of the inorganic filler. An increased filler load can be achieved in nano composite (Ceram X), without increasing their viscosity and increasing the mechanical properties such as tensile strength, compressive strength and other mechanical properties. Similar study has also be done by Ruddell DE *et al*,Ilie N *et al* and Atai M *et al*. The results of the present study are both encouraging and clinically significant. The present study favours direct veneer restoration with Ceram X spheretec (nano hybrid composite). However, in oral environment the restored teeth are subjected to variety of challenges in addition to masticatory load, including prolonged exposure to moisture, temperature and pH fluctuation with intake of different foods along with exposure to variety of bacteria and enzymes. Further studies taking the above challenges into account are needed.

Conclusion

It is concluded from the present study that Ceram X spheretec showed the highest fracture resistance amongst all the groups. Thus, it is favourable materials for direct composite veneers on anterior tooth, better than Tetric N Ceram, Filtex Z 250 and Charisma® Smart. However, long term clinical trials as well as in vitro studies on a larger scale need to be undertaken, before drawing any definitive conclusion.

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