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Comparative evaluation of microhardness of Zirconomer, Cention N, FiltekZ350xt and Charisma Smart - An in vitro study

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Abstract

Aim: To compare and evaluate the microhardness of Zirconomer, Cention N, Filtek Z350XT and Charisma smart.

Materials and method: With the help of a straw, already cut to 3 mm in length, cylindrical plastic moulds were prepared. The Restorative materials were inserted in the moulds. Moulds filled with materials were covered with a glass slab to provide a flat surface. Composite resin and Cention N were polymerized with LED. All the samples were stored in distilled water for 24 hrs. The samples so prepared were divided into groups as follows and subjected to experimentation. The samples were randomly tested with Vicker"s microhardness indentor.

Result: Among all the restorative materials, Filtek Z350XT showed highest microhardness value followed by Charisma, Cention N and Zirconomer. There were significant differences amongst all the groups except Cention N and Zirconomer.

Conclusion: According to our results, the microhardness of restorative materials could withstand the masticatory forces in the clinical context. Filtek Z350 XT is the material of choice if strength is desired from the restoration.

Keywords: Composite resin, Charisma Smart, Cention N, Filtek Z350XT Microhardness, Zirconomer

Introduction

Resin-based composites are used worldwide in dentistry, mainly because of their esthetic quality and good physical properties. Since resin composites were first developed, many efforts have been made to improve the clinical behavior of this restorative material.[1]

Nano-hybrid composites are the newest addition to the pantheon of composite filling materials. A nanohybrid is a hybrid resin composite with nanofiller in a prepolymerized filler form, whereas nanofill is a composite resin that is composed of both nanomers and nanoclusters They are becoming popular, because they have superior esthetic and wear characteristics, high polishability, and superior handling characteristics. They are marketed as universal composites. Charisma smart and Filtek Z350XT handling and esthetic qualities make them suitable for anterior buildups, while their agglomerated nano-clusters interspersed with micro-sized particles give them acceptable wear characteristics.[2]

Zirconia is one of the tooth-colored materials with good dimensional stability and excellent strength and toughness, coupled with a Young's modulus in the same order of magnitude of stainless steel alloy and is the origin of the interest in using ZrO2 as a filler. It contains zirconium oxide, glass powder, tartaric acid, polyacrylic acid and deionized water as its liquid[3,4,5]

Cention N offers tooth-coloured esthetics together with high flexural strength. The new filling material belongs to the materials group of Alkasites. The patented alkaline filler increases the release of hydroxide ions to regulate the pH value during acid attacks. As a result, demineralization can be prevented. Moreover, the release of large numbers of fluoride and calcium ions forms a sound basis for the remineralization of dental enamel. The initiator system enables good chemical self-curing.[6]

Microhardness is a physical property valuable in comparing restorative materials. It gives indications of long-term durability and clinical performance parameters such as resistance and wear.[7,8] For microhardness testing, hardness is measured in a microscopic scale. Because of the good correlation observed between hardness measurements and the degree of monomer conversion, hardness tests are commonly used as an indirect assessment of the extent of polymerization of composites.[9] The hardness of composite resins is directly related to the conversion rate of polymerization depending on polymerization time, distance of polymerization light, irradiation power, and the type of material at the tip of the energy source.[10]

This study was done to evaluate the microhardness of Filtek Z350, Charisma Smart , Zirconomer and Cention N. The null hypothesis was that there is no difference in the microhardness of Filtek Z350, Charisma smart, Zirconomer and Cention N.

Materials and method

Sample preparation: In this *in vitro* study, four different materials- Filtek Z350, Charisma smart , Zirconomer and Cention N was taken .The details of the materials are given in [Table 1]. Forty specimens were prepared. Materials were inserted in different plastic moulds (height 2 mm; diameter 6 mm) and polymerized according to manufacturers' instructions; to obtain specimens of identical size.

Design of the study groups

All the prepared samples were divided into 4 experimental groups, with 10 samples in each group according to the restorative material used:

Group I- Filtek Z350 XT(nano-composite) was placed in the mould using a plastic filling instrument and condensed with the help of a condenser.

Group II-Charisma Smart (nano hybrid) was placed in the mould using a plastic filling instrument and condensed with the help of a condenser.

Cavities of these rings were slightly overfilled with the material, covered with Mylar strip, pressed between glass plates and polymerized for 40 s on each side using a curing unit. One light polymerization mode was used for each material standard: 1000 mW/cm^2 for 40 s. The upper surface of each specimen was then polished with fine and superfine polishing disks (Sof-Lex Pop On; 3M ESPE, St. Paul, MN, USA) to simulate clinical conditions.

Group III- Cention N was placed in the mould using a plastic filling instrument and condensed with the help of a condenser.

Group IV- Zirconomer (zirconia reinforced GIC) powder was mixed with liquid on a mixing pad with a plastic spatula according to manufacturer's instructions (powder-to-liquid ratio: 8.0:1.0 g) for 30 seconds.

All the samples were stored in distilled water for 24 hrs at 37°C.

The samples were randomly tested with microhardness indenter.

The microhardness test was carried out with a digital Vickers microhardness tester (SCTMC, 1000Z, China) using a load of 300 g with a dwell time of 15 seconds. To measure Vickers hardness number (VHN), three Vickers tests were carried out on each surface of specimens and the mean value was calculated and determined as VHN. Distances between indentation points and disc borders were not less than 1 mm.

Table 1: Materials used in the study

Material	Company	Composition
FILTEK Z350	3M ESPE	Bis-GMA, UDMA, TEG-DMA, Bis-EMA, silica filler, zirconia filler, zirconia/silica cluster filler (78.5/59.5)
CHARISMA SMART	KULZER	Bis-GMA, barium aluminium fluoride glass, silicon dioxide
CENTION N	IVOCLAR VIVADENT	Cention N Liquid contains dimethacrylates, initiators, stabilizers, additives and mint flavour. Cention N Powder contains calcium fluoro-silicate glass, barium glass, calcium-barium-aluminium fluoro-silicate glass, iso-fillers, ytterbium trifluoride, initiators and pigments.
ZIRCONIA-REINFORCED GLASS IONOMER (ZIRCONOMER)	SHOFU INC	Powder alumino-fluoro-silicate glass, zirconium oxide, tartaric acid Liquid: polyacrylic acid, deionized water

Statistical Analysis

The mean value and standard deviation were calculated. VHN data were subject to ANOVA. All data were analyzed with SPSS. Significant differences were considered at $p<0.05$. All the statistical analysis was performed.

For statistical analysis data were entered into a Microsoft excel spreadsheet and then analyzed by IBM SPSS statistics for windows, version 22.0. Armonk, NY:IBM corp. and for Graphs we used M.S office 2010 software. One-way and two-way analysis of variance (ANOVA) was used to analyze the data for significant differences among the groups. Tukey's post hoc test for multiple comparisons was used to analyze the data for significant differences between the groups.

Results

In this experimental and comparative in vitro study, all data showed normal distribution. The mean values of Vickers hardness are summarized in Table 2. According to our results Filtek Z350XT exhibited the highest microhardness with a value of 114.14 followed by charisma with a value of 92.71, followed by cention N with a value of 73.06 and the last being Zirconomer with a value of 62.24. There was significant difference between all groups except between Cention N and Zirconomer.

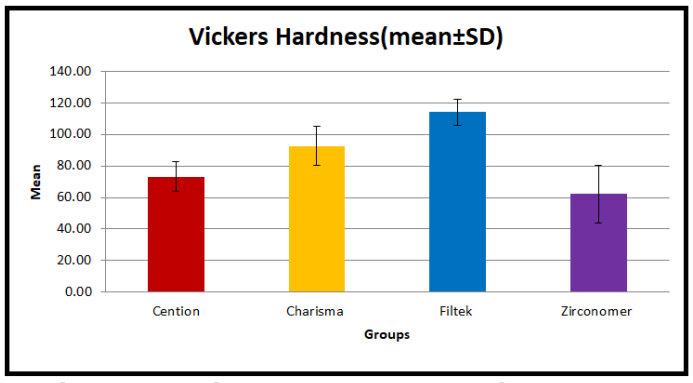
On inter-comparison among the groups the result were statistically significant as illustrated in table 1. Graph 1 illustrated below shows the inter group microhardness among the materials used in this study.

Table 2: Mean comparison of Vickers Hardness between Cention N group, Charisma group, Filtek group and Zirconomer group.

Group	Mean	SD	Mean difference	P value
Cention N	73.06	9.45	19.65	0.007 S
Charisma	92.71	12.25		
Cention N	73.06	9.45	41.08	0.000 S
Filtek Z350XT	114.14	8.33		
Cention N	73.06	9.45	10.82	0.246 NS
Zirconomer	62.24	18.42		
Charisma	92.71	12.25	21.43	0.003 S
Filtek Z350XT	114.14	8.33		
Charisma	92.71	12.25	30.47	0.000 S
Zirconomer	62.24	18.42		
Filtek Z350XT	114.14	8.33	51.90	0.000 S
Zirconomer	62.24	18.42		

Statistical Analysis: Tukey's post hoc test. S: The mean difference is significant at the 0.05 level.

NS: Not significant.



Graph 1: Bar diagram representing the inter group microhardness.

Discussion

The primary goal of dental restorative material is to replace functional, biological and esthetic harmony of the lost tooth structure. Stronger restorative materials resist fracture and deformation and provide equal stress distribution, greater stability, and greater clinical success.[11] Hardness of the restorative material can predict the wear resistance of the material and its ability to abrade or to be abraded by the opposing tooth structures.[12]Microhardness testing provides a quick and practical assessment of material and is performed in a microscopic scale. The most commonly used unit is VHN as it is more accurate and convenient over Knoop hardness measurement. Vickers indentations also allow us to group indentations closer to each other, allowing for a tighter grouping of measurements. Microhardness measurements are employed using test loads in the range of 1gF–1000gF based on the material under study.[13]The load determined for this study is 300gF for 15 seconds.

In the present study the null hypothesis was rejected as there was difference in microhardness of different restorative materials. In this study we found that specimens showed significantly different microhardness values according to the different composition and filler particles of composite resins. Kundie et al., mentioned that; the filler particle size and the filler content can affect the hardness of restorative material.[14]

When compared with other groups, Filtek Z350XT showed highest value for surface microhardness and the difference was statistically significant. In the present study Filtek Z350XT composite resins showed the highest mean values of VHN (114.14) which is similar to previous reports which have revealed that the Vickers microhardness values of Filtek Z350 are from 74.9 to 120 VHN.[15,16] Our results are in accordance with the study done by **Rene Garcia-Contreras et al.**[17]The filler

particles in Filtek Z350XT are zirconia and silica which when coupled improve filler attachment to the matrix, thereby improving its physical properties. Also Filtek Z350 is considered as nanofill and nanohybrid resin that can display better mechanical properties than the others resins tested.[18,19]Our results are also in accordance with the study done by **Shetty et al** [20] where Filtek Z350XT exhibited the highest values for surface microhardness, followed by cention-N and zirconomer. Higher microhardness values correlate with lower material wear, and thus durability and biocompatibility of composite fillings.[21,22,23] In a study done by **Raluca Baciu et al** [24] it was concluded that highest value of microhardness was obtained from the Filtek Z550 followed by Charisma . According to the authors the presence of Zirconium/Silica nanoparticles resulted in the increase of microhardness of the nanohybrid composite diacrylic resin, Filtek Z550.

In the present study Charisma showed higher surface microhardness value than Cention-N and Zirconomer and the difference was statistically significant amongst the groups. There are very few studies where microhardness of Charisma has been tested. Contrary to our finding **Mazumdar et al**[25] observed highest microhardness with Cention-N compared with nanohybrid composite resin.

When compared with Zirconomer, Cention N showed higher surface microhardness value however the difference was statistically insignificant. In accordance with our study similar results were obtained by **Shetty et al**[20]. Cention-N is a subgroup of composite resin class material available in powder and liquid forms. The powder contain alkaline ions like fluoride and calcium which neutralizes the surrounding acidic ions of restoration, whereas liquid contains monomer that. improves the flowability of the material and adaption to smear layer. It contains 78.4% inorganic filler which gives better compressive and flexural strength with lower shrinkage and reduces stress on cavity walls.[22,23]It has been observed that liquid part of Cention-N has four different dimethacrylates (urethane dimethacrylate, tricyclodecan- dimethanol dimethacrylate, aliphatic-UDMA, and polyethylene glycol), and an initiator which helps in the formation of cross-link during polymerization and polymer density which, in turn, improves its mechanical properties.[26] **Sadananda et al** [27]also found superior compressive and flexural values of Cention-N over Zirconomer. Our results are in accordance to findings of **Meshram et al**[26]**.,** who found mechanical properties of Cention-N was higher than GIC but lower than composites.

Zirconomer is a ceramic and zirconia reinforced glass ionomer cement. It exhibits the strength of amalgam and at the same time maintain the fluoride releasing capacity of GICs. However in the present study the microhardness of Zirconomer was found to be inferior than other materials used.

Conclusion

On the basis of our results it can be concluded that FiltekZ350 XT has the greatest microhardness followed by Charisma, Cention-N and the least being Zirconomer. FiltekZ350 XT is the material of choice if strength is desired from the restoration and charisma can be an alternative. Cention N can be used as a bulk fill restorative material. However further in vitro studies are obligatory to clinically evaluate the success of these materials.

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