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COMPARATIVE ASSESSMENT OF HARDNESS OF TWO NANO-HYBRID RESIN-BASED DENTAL COMPOSITES

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ABSTRACT

Objectives: To compare the hardness of two nano-hybrid resin-based dental composites.

Materials and Methods: Two nano-hybrid composites i.e., Nexcomp by Meta Biomed, Korea, and Tetaric N Ceram by Ivoclar Vivadent, AG, Liechtenstein were selected, and hardness was evaluated according to ASTM E384-11e. T-test was used to statistically analyze the data.

Results: The mean hardness value (VHN) of Tetaric N Ceram (78.4 ± 3.14) was high when compared with Nexcomp (50 ± 4.12). The statistical analysis showed a significant difference with p-value of 0.00.

Conclusion: Both composites had adequate hardness values and dental practitioners may select the material subject to the clinical situation and patient's affordability.

Key words: Resin based dental composites, hardness, hybrid

INTRODUCTION

Dental caries is a chronic pathological disease which occurs when there is an interaction among acid producing bacteria, fermentable carbohydrates and many host factors including saliva and teeth¹. Due to this interaction demineralization of hard tissues of the tooth occurs and consequently cavities are produced in the tooth. Dentists advise removing dental caries and using the suitable restorative materials such as dental amalgam, glass ionomer cements, resin based dental composites (RBCs) to fill these cavities in order to treat the affected tooth². In recent years, the use of dental amalgam has declined, as there are aesthetic concerns as well as health and environmental issues due to presence of mercury in them³. Similarly, the use of glass ionomers as restorative material has also declined because of its inherent brittleness, lack of strength, poor resistance to wear on occlusal surfaces of teeth and moisture instability⁴.

RBCs are now frequently used as dental restoration materials due to better properties over tradi-

tional filling materials including biocompatibility, aesthetics, antibacterial capabilities, and good mechanical, physical, tribological, and, thermal properties⁵. The mechanical and physical properties of these materials depend on their composition. They are primarily composed of an dispersed phase (inorganic fillers), dispersion phase (organic matrix) and inter-phase (coupling agent)⁶. Methacrylates, epoxy, and polyethylene are usually the building blocks of the organic matrix. The filler is made up of various ceramic or glass particles, fibers, whiskers, nanotubes, and nanoclusters in varying compositions, sizes, and size distributions. It is added to polymers to improve their properties. The performance of composites is improved by the coupling agent, such as silane, by creating a solid link between the matrix and filler⁷.

As RBC's are material of choice so they should have properties alike to natural tooth structure. Microhardness, surface roughness and wear resistance are important for clinical longevity and aesthetics of the restorative materials⁸. If materials are not resistant to scratch they will develop micro pores on their surface or will abrade if they come in contact with any hard material in the oral cavity⁹. In order to achieve these desired properties manufacturers,

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add various materials in dental composites¹⁰. Usually fillers are modified in dental composites as the type and shape of filler particles, affect the micro hardness of dental composites. As, rigid inorganic particles generally have significantly higher stiffness than polymer matrix, hardness can be readily increased by adding either micro- or nanoparticles¹¹.

Particles in the nano size range are increasingly been used as fillers in polymeric composites. Nano-composites have shown superior mechanical and aesthetic qualities needed for anterior and posterior restorations¹². Since nano particles have high specific surface area to volume ratio, their presence enhances the materials mechanical properties. Due to interfacial interactions, which involves both organic and inorganic groups the utilization of nano particles can result in a material with a new behavior¹³.

The hardness of human enamel is 275 while that of dentine is 66¹⁴. It is crucial to use restorative materials both superficially and deeply, that have hardness values at least comparable to dentine to ensure an optimal clinical performance of restorations. As, low hardness negatively impacts the mechanical properties and eventually marginal integrity¹⁵. Although the hardness values of commercial RBCs are given in literature, however many factors such as polishing of samples, intensity of curing lights, storage technique and indenter used influence the final outcome of results¹⁶. Therefore, in this study we investigated the microhardness of two available marketed dental composites containing nano particles to affirm the results. The main objective was to compare the microhardness of two materials so that dentist can select the best composite material.

MATERIALS AND METHODS

Two nano-hybrid composites i.e. Nexcomp by Meta Biomed, Korea and Tetaric N Ceram by Ivoclar Vivadent, AG, Liechtenstein were used. The hardness was assessed by using disc-shaped (4 mm

diameter and 8mm height) specimens. In each group, 5 samples were made in Teflon mould. The mould was placed onto the glass slab and the samples were poured in a single increment into it. After pouring, they were covered with a cellulose acetate strip to avoid the development of oxygen inhibition layer. Then curing of the samples from both sides was performed with Rainbow LED light according to the manufacturer's instructions. Samples were retrieved from the mould for polishing under continuous water flow. Hardness was evaluated according to ASTM E384-11e via HVS 1000 hardness tester by applying a load of 100 g for 15 seconds. Three indentions were made on each sample¹⁷.

RESULT

The mean Vicker's hardness of Tetaric N Ceram was more as compared to Nexcomp. The t test showed that there was a statistically significant difference between them with p-value of 0.00. The mean VHN obtained for Tetaric N C Ceram was 78.4±3.14 while for Nexcomp was 50±4.12. The details of the result are given in figure 1 as well as table 1.

DISCUSSION

In recent years there has been a significant increase in the use of RBCs because of rising patient demands for aesthetic results as well as new technologies in the dental industry¹⁸. The clinical performance of a composite restoration is dependent on many factors, however the most important characteristics for dental restorations are mechanical properties such as hardness, strength, and wear resistance¹⁹. It is suggested that dental restorative materials must have physical characteristics that are as like those of tooth structure as much as possible⁸. Hardness of material is described as resistance of a material to indentation. In comparison to conventional micro-composites, RBCs containing nanoparticles have better physical and mechanical properties, including hardness, compressive strength, and wear

Table 1: Independent T Test showing Significant Difference between the Groups.

Hardness	Groups		Mean	Std. Deviation	
		Tetaric		78.40	3.04
	Nexcomp		50.00	4.12	
	P value	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
				Lower	Upper
	0.001	28.40	2.29347	23.11125	33.68875

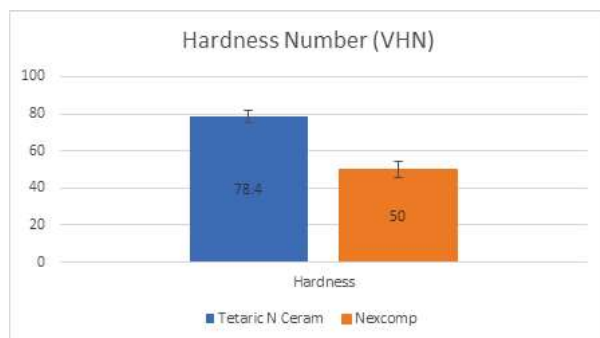


Fig 1: Vicker's Hardness Number of Tetaric N Ceram and Nexcomp

resistance²⁰.

The presence of filler particles in the resin matrix of RBCs enhances mechanical properties, such as hardness²¹. An in vitro analysis was done to evaluate the microhardness of two different RBCs available in market. In the present study, Tetaric N Ceram had significantly higher mean microhardness value as compared to Nexcomp. This may be because Tetaric N Ceram has higher filler (80%) loading as compared to Nexcomp (75%). As, it is well-known fact that the size, shape, and proportion of the inorganic phase of the filler have an impact on the hardness of a resin composites and it increases with higher filler percentages⁷. As, discussed earlier that the restorative materials should have hardness values close to dentine. Therefore, the results for both RBCs are acceptable for restorations to have stability in the oral environment. Although, there was significant difference between both.

The outcomes of this research are in line with studies done by Liu et al²² and Partap et al²³. In these studies, when the filler loading was increased hardness increased significantly. Moreover, the results of this study are also in correspondence with research conducted by Shahwani and Elbatany²⁴, and Azmy et. al²⁵, in which hardness of Nexcomp was evaluated. In contrast to other studies, done by P. Singh and K. Singh²⁶ and Alrahlah²⁷ the hardness results of Tetaric N Ceram are better in our study. This may be due to reason that many factors such as polishing, testing conditions, and intensity of curing affect the final values of hardness. Beside this, the type of fillers used also have impact on the mechanical properties as these particles may have tendency to form strong ionic interatomic bonds with resins. Moreover, if combination of different filler sizes is incorporated into dental composites than properties

are increased due to close packing. The Tetaric N Ceram used in this study is a nano-hybrid composite containing combination of several fillers including barium glass, ytterbium trifluoride, and oxides in different sizes. Therefore, hardness value of this dental composite is higher as compared to Nexcomp which contains only barium borosilicate in various sizes. The hardness of dental composites can therefore be influenced by filler particle size and filler content, in addition to other considerations²⁸.

In the present study the overall findings showed that the type, size, loading and combination of fillers had a significant impact on hardness values¹⁶. Therefore, this could be the possible reason for decrease in hardness of Nexcomp. In present study, the dental composites were tested according to established procedure given in literature. However, this experiment was in vitro and was conducted in ideal laboratory environment, therefore, the clinically expected scenario might differ from the results that are presented²⁹.

CONCLUSION

The results obtained in this study were statistically significant, though nano-hybrid composites showed acceptable results as there VHN number was close to values of dentine. Therefore, they can be used both for anterior and posterior restorations and dental surgeons may select the material keeping in view the need and affordability of the patient as cost of these composites differ widely.

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