ORIGINAL ARTICLE

Compare the Impact of Degree of Conversion on Microhardness of commercially available Hybrid Dental Composites

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Abstract

Objective: To compare influence of degree of conversion on microhardness of nano-hybrid composites

Methodology: Two nano-hybrid composites i.e., Tetaric N Ceram by Ivoclar Vivadent, AG, Liechtenstein and Nexcomp by Meta Biomed, Korea, were chosen, and degree of conversion and hardness was calculated. T-test was used to statistically analyse the data.

Results: The degree of conversion and hardness of tartaric N Ceram was more as compared to Nexcomp and there was statistical difference between them.

Conclusion: Although the values of Nexcomp are in a lower than acceptable range, it can be used for restorative purposes.

Keywords: Composites, hardness, Degree of conversion

Introduction:

Teeth are the product of over 300 years of evolution and are considered the aged tissue present in living creatures. [1] Almost 20% of the area in the oral cavity is occupied by the teeth.[2] Dental caries can affect teeth in every age of life effecting the crown or roots when they are exposed in old age. Within tooth structure, continuously remineralization and demineralization take place, when the demineralization exceeds it results in dental caries.

Dental caries is a multifactorial disease which depends upon biofilm formation, sugar intake and time taken. [3] Usually the major loss of tooth is associated with dental caries. In a study in U.S.A, children in the age group of 6-11 years, one out of five children were reported with dental caries and this ratio increased to three out of five when the age range is increased to 12-19 years. [4] Some of the current commercial dental restorative material which are currently being used by current dental clinician are glass ionomer cement, resin modified glass ionomer, composites, cements and amalgam. [5]

Dental composites emerged in 1950 and continuously new advancements are being done to improve their drawbacks. [6] It immediately became the material of choice because of ease in manipulation, time saving, fast setting and good esthetics properties. [7, 8] Some of the major drawbacks include polymerization shrinkage and stress produced due to this shrinkage, leading to fracture of the restoration, abrasion and wear of restoration, thermal mismatch, and toxicity produced by monomer. [9] Dentists prefer a restoration which can produce a longevity of at least ten years in oral cavity. In means of toughness dental composite is comparable to amalgam and better than glass ionomer cement but the major drawback of includes restoration fracture, polymerization shrinkage, secondary caries and to some extent wear. [10]

When a composite restoration is cured some of the monomer is left uncured. This monomer is leached in the oral cavity and can cause allergic reactions. [11] The degree of conversion is the measure of unreacted monomer left in the composite restoration. [12] Degree of conversion is a measure of the double bond present in the cured sample in comparison to the double bond in uncured sample. [13] The acceptable range of degree of conversion of dental composites are between 35% - 75% and the resultant are monomers, dimers, and oligomers. [14, 15] The mechanical properties of composites are dependent on the conversion rate i.e higher the degree of conversion higher will be mechanical properties. Hardness is one of the properties of composite which is highly dependent on degree of conversion. For wear evaluation, hardness testing is done. Hardness is measured by the indentation mark caused by diamond tip on the surface of testing sample and calculated by using a microscope. The load is applied for 10 to 15 seconds and the indentation obtained is divided by the load applied on the sample. [16, 17] Literature search showed that degree of conversion and hardness is positively associated with each other. In contrast, one published data showed that polymers having same degree of conversion had different values of hardness, Moreover, there was no linear association between degree of conversion and hardness of numerous dental composites.

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Methodology:

Two hybrid composites i.e. Nexcomp (Meta Biomed, Korea) and Tetaric N Ceram (Ivoclar Vivadent, AG,

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Liechtenstein) were purchased from local market.
For evaluation of degree of conversion, three specimens having 2mm diameter and 2mm thickness were made from each hybrid composite using a Teflon mold. The surface of composite was covered with a Mylar (cellulose acetate) strip supported by glass slab. Then specimens were light cured for 20s by bringing the tip of light emitted diode (Rainbow LED) device closer to the glass slab. Fourier Transform Infrared Spectroscopy, FTIR (Thermo Fisher Scientific iS50 FT-IR, Waltham, MA, USA) was performed to analyze the infrared spectrum of both uncured and cured specimens. The spectrometer was operated at 32 scans at resolution of 4 cm^{-1}. The spectral range scanned was in between 350 to 4,000 cm^{-1}. Each uncured and cured specimen was evaluated for degree of conversion by comparing the ratios of aliphatic and aromatic components.
For microhardness test, five disc-shaped specimens having 8mm height and 4mm diameter were prepared in Teflon mould. This mould was initially positioned on a glass slab and specimens were made through incremental technique. They were then covered with Mylar strip to inhibit formation of oxygen layer. Curing of specimens was done bilaterally with Rainbow LED device following the instructions given by manufacturer. After curing, specimens were taken out from mould and polishing was accomplished under continuous flow of water. Specimens were dried and stored in dark environment for 24h at 37°C. Microhardness was evaluated in accordance with ASTM E384-11e using hardness tester (HVS 1000) for application of 100g load for 15 seconds to make three indentions on each specimen.

Results:

The highest degree of conversion was obtained for Tetaric N Ceram whereas lowest for Nexcomp. The mean curing values were 56.33±2.51 and 40.67±3.51 respectively.

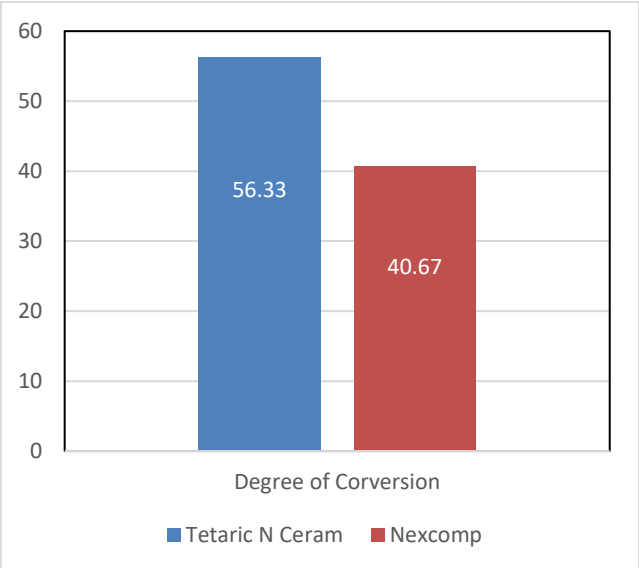

Figure 1: Mean Degree of Conversion

The mean microhardness of Tetaric N Ceram was more when compared with Nexcomp. The t-test showed statistically significant difference between both hybrid composites with p-value of 0.00. The mean microhardness value achieved for Tetaric N Ceram was 76.2±3.03 whereas it was 48.6±4.12 for Nexcomp. The details of which are given in table 1.

Discussion:

The Nexcomp is being retailed in the local market due to its low cost as compared to other composites. Nexcomp showed inferior properties when compared with Tetaric N Ceram in this study. The findings indicate that although this hybrid composite has the same packing and thus cannot marketed easily as a replicated product, The composition and quality of composites are notably different. Degree of conversion is a crucial parameter of composite resins as it influences all the properties. [18] Thus, properties are efficiently improved with increased degree of conversion thus increases the longevity of composite restorations. [19] The unreacted monomer can leach out in the oral environment due to inadequate conversion acting as plasticizer and consequently reduces the mechanical strength. Besides this, material may degrade due to hydrolyzation or oxidation due to presence of reactive double bonds in uncured composites. [20] It is yet unknown exactly how much degree of conversion is needed to achieve a clinically acceptable degree of restoration. According to published research, the degree of conversion of commercially available composites ranges from 50% to 75%. [21] The results of this study showed that Tetaric N Ceram had degree of conversion in this range as compared to Nexcomp. Among the several factors, the filler content may influence the degree of conversion as higher proportions make difficult for light to pass through resin composite affecting the properties of final restoration. Literature advocates that composites having microhardness values of more than 50 VHN are ideal. Although Nexcomp had lower value of degree of conversion but several factors such as polishing and sample preparation influence the microhardness results. Moreover, the lower mean microhardness value of Nexcomp could be due to lower filler content than Tetaric N Ceram. The higher the filler content the higher will be the hardness. The microhardness results of the current study were in accordance with studies conducted by Liu et al [22] and Partap et al [23] in which increased filler content significantly increased hardness. The dental composites in the current investigation were tested using a protocol that was defined and documented in the literature. The clinically expected scenario may differ from the provided results, though, as this experiment was carried out in vitro in an ideal laboratory setting. [24]

Conclusion:

The results showed practices of self-medication for all health-related problems in 60% of the patients, and 52% in the patients for oral health problems. Severity of pain, poor access to dental care and availability of drugs at pharmacies in the proximity were found the

associated factors for practices of self-medication. The health authorities and health awareness and promotion interventions need to be focused on this issue.

Table 1: T test for hardness

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	.646	.445	12.319	8	.000	28.20000	2.28910	22.92132	33.47868
Equal variances not assumed			12.319	7.349	.000	28.20000	2.28910	22.83876	33.56124

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Author Contributions

1. Saadia Bano Loner- Literature Review, and Experimentation,
2. Aiman Khan- Manuscript Writing
3. Munazzah Ejaz- Manuscript review, and Data Analysis
4. Muhammad Zeeshan- Conceptualization and Methodology of Study
5. Hafiz Muhammad Owais Nasim- Interpretation of Results