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MICROHARDNESS EVALUATION OF NANO- COMPOSITE DENTURE TEETH

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ABSTRACT

Background: New types of artificial teeth are commercially available. However, evidence - based information with respect to their physicomechanical properties is lacking.
Objective: The purpose of this study was to qualify and quantify relative micro hardness characteristics of three commercially available types of artificial teeth.
Materials and Methods: Three brands of three types of artificial teeth were examined. Vickers hardness was determined for each of the polished cross-sectioned teeth.
Results: Vicker hardness values ranged from 22.3 to 26.7 for microfilled composites,20.0 to 25.3 for dual cross linked acrylic & 15.9 to 19.6 for nano- composite teeth.
Conclusion: Within the limitations of this study, microfilled composite denture teeth exhibited superiority in terms of microhardness among all the specimens evaluated.
Keywords: Hardness, nanocomposite denture teeth, Vickers hardness test.

INTRODUCTION

Artificial teeth are often necessary for prosthodontic rehabilitation when natural teeth are lost. Acrylic resins and porcelains have been used for the fabrication of artificial teeth; however, neither type completely accomplishes the requirements for an ideal prosthetic tooth.[1] The amount of filler content, the geometry and size of the filler particles,and the properties of the polymer matrix have been reported to influence the properties of polymer materials.[5,8-16] A new type of denture tooth, fabricated of nano-composite resin, has recently been developed as a highly polishable, stain and impact resistant material.[22] Since recently introduced nanofilled composite denture teeth material contains PMMA, even cross-linked with UDMA and reinforced by inorganic fillers, excellent hardness might not be expected. Also, evidence-based scientific information regarding these new types of artificial teeth with respect to composition and physicomechanical properties is lacking. Therefore, studies critically discussing latest peer-reviewed reports and evaluating properties of commercial artificial teeth become necessary.

MATERIALS AND METHODS

Three groups of teeth including nano- filled composite {Veracia (Shofu, Kyoto, Japan) }, microfilled composite {Endura (Shofu, Kyoto, Japan)} and Dual cross-linked acrylic { SR-Postaris (Ivoclar / Vivadent, Lichenstein) } were analysed for study.

MICRO-HARDNESS ESTIMATION

For each type, fourteen maxillary first molars were prepared. A maxillary 1st molar was aligned to its tooth axis parallel to the horizontal plane in a brass cup and secured with an auto-polymerized acrylic resin[14]. The buccal surface of the cusp was wet abraded and finished with grit abrasive paper (600,1,000,2500 & 4000-grit SiC paper) under water irrigation and polished with wet alumina. TheVicker's micro-hardness tester (HMV 2000, Shimadzu, Japan) was used to determine the surface hardness of specimens. A diamond indenter was pressed into the specimens under a load of 50 g for 30 seconds[14]. The areas of indentation were then measured using a ruler under microscope. Vicker hardness number (VHN) was calculated as the load divided by the area of indentation. Fourteen specimens were evaluated for each material, and the mean values were calculated by averaging all results on each material.

$$\textbf{VHN} = \frac{\textbf{load (kgf)}}{\textbf{Impression area (mm}^{2})} = \frac{P}{C_p L^2}$$

Where:

L = length of indentation along its long axis

C_p = correction factor related to the shape of the indenter, ideally 0.070279

P = load

The data for Vicker hardness was analyzed by 1-way ANOVA, and the differences among the materials were determined by Scheffé's F-test ($p < 0.05$).

RESULTS

The surface hardness expressed in terms of VHN of the nano-composite tooth, Veracia, ranges from 15.9 -19.6 whereas microfilled composite tooth , Endura, was between 22.3- 26.7 & dual cross linked acrylic tooth was between 20.0 to 25.3.

Table 1 shows mean & standard deviation of microhardness among three groups. Mean VHN values of Group 1 (NC), Group 2 (MC) & Group 3 (DCL) were 18.057, 25.220 & 22.040 respectively which were stastically significant as 'p' = 0.0001 ($p < 0.001$).

Table 2 shows pair wise comparison of microhardness among three groups under 50 gm load by scheffe test analysis & significant difference in Vicker Hardness Number (VHN) ($p<.001$) in NC-MC(Gp1 –Gp2) is noticed whereas among NC-DCL(Gp1 –Gp3) & MC-DCL(Gp2 –Gp3) groups mean difference is not stastically significant as $p>.001$ ($p=0.009$ & $p=0.051$ respectively).

DISCUSSION

New materials, even if they are proved excellent, often have one or the other limitation, because they may be associated with a re - evaluation of the established systems of use and may not readily be amenable for use. Furthermore, there is an unavoidable time lag in establishing the precise relationship between their properties and clinical performance. Thus, the introduction of nanofilled resin systems has led to considerable controversy, both from the standpoint of the dentist and within the scientific community. However, it is possible to evaluate newer composite resins systems on the basis of their microstructure.

Results of this study clearly indicate that the hybrid (especially the nano-filled) resin composites are markedly superior to the traditional composites and acrylic resins in terms of hardness, surface smoothness and anti-staining tendency. Further, as the filler particle size is reduced, the polishability, permanence of surface smoothness, and esthetics of the nano-filled composites improve. It was hypothesized that the hardness of this material would be superior to the conventional acrylic. This hypothesis was totally confirmed as the results showed the hardness of nano-composite teeth to be not significantly different from conventional acrylic counterparts. Over all, this material has hardness, stain resistance and surface finish equivalent to most micro-filled composites with improved impact resistance and wear resistance. The generation of such essential information will enable the clinicians to consider these physical characteristics in addition to the mold and shade of artificial teeth

CONCLUSION

Judging by these results, it can be authentically concluded that the original macrofilled systems are now almost obsolete. In the same vein, the profession has hailed the nanofilled resins for the superior esthetic results that are possible. Nano-composite denture teeth may be one of the most promising and appropriate materials for denture teeth in near future. However, further investigation of other characteristics such as wear, impact resistance, and bonding to reparative autopolymerizing resins should be performed.

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CONFLICT OF INTEREST

None declared

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Table1: Mean and Standard Deviation of Microhardness Among Three Groups

	N	Mean Micro Hardness	Std. Deviation	Minimum	Maximum	‘F’’ value	‘p’ value
Nanocomposite (NC)	14	18.057	1.5633	15.9	19.6	22.155	0.000
Microfilled Composite (MC)	14	25.220	1.9766	22.3	27.2		
Dual Cross linked Acrylic (DCL)	14	22.040	1.9807	20.0	25.3		

Table 2: Scheffe Test Analysis of Microhardness Among Three Groups

Comparison	Mean Difference	Std. Error	‘p’ value
Nanocomposite (NC) - Microfilled Composite (MC)	-7.3200	1.1082	0.000
Nanocomposite (NC) - Dual Cross linked Acrylic (DCL)	-4.1400	1.1082	0.009
Microfilled Composite (MC) - Dual Cross linked Acrylic (DCL)	-3.1800	1.1575	0.051