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EVALUATION OF BOND STRENGTH BETWEEN NANOHYBRID COMPOSITE TEETH AND TWO DIFFERENT DENTURE BASE MATERIALS (COMPARISON STUDY)

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ABSTRACT

Purpose: aim of the study was to compare the bond strength of nanohybrid composite artificial teeth (NHC) and two types of denture base material (acrylic denture base material and thermoplastic monomer free semi-rigid micro crystalline polymer denture base material (Karadent).

Material and Methods : nanohybrid composite teeth (premolars) was sliced equally, grooved for increasing contact surface and attached to 16 discs of denture base material (8 for each group), then the discs where grouped into two groups . The samples were subjected to tensile forces till failure by using the Instron Universal testing machine.

Results : bonded nanohybrid composite teeth (NHC) to conventional acrylic denture base disc specimens showed better results in comparison to thermoplastic monomer free semi-rigid micro crystalline polymer denture base materials ones.

Conclusion : it is recommended to use NHC teeth more often with conventional acrylic denture bases than thermoplastic monomer free semi-rigid micro crystalline polymer denture base materials.

KEYWORDS : Bond strength – teeth/denture base bonding – Nanohybrid composite teeth- Karadent

INTRODUCTION

Prosthetic teeth play an important role in restoring the form, function and esthetics of a completely and partially edentulous patient thereby enhance the quality of mastication, speech , and hence construction of a removable prosthesis requires selection of denture teeth with superior properties. [1]

Acrylic teeth have been the golden choice for most complete and partial cases, many modifications have carried out to improve the properties of artificial teeth.[2] With the revolution of nanotechnology, researchers developed the sialinized silicon inorganic nanofillers of less than 50 nm, for the composite matrix of Urethane dimethyl methaacrylate (UDMA) and PMMA which thereby led to the introduction of nanocomposite

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teeth without much enhancement in the mechanical properties and superior esthetics . [3]

The new nano-hybrid composite consists of a combination of UDMA matrix with three different fillers and PMMA clusters embedded in the structure. The first type of filler is inorganic densified silanized SiO2, used to strengthen the matrix and increase the material's wear resistance and hardness. The second type of filler is silanized SiO2 nanoparticle, used to strengthen the composite structure and help decrease the wear of the opposing tooth structure. The third type filler is inorganically filled DMA polymer, which is added to decrease polymerization shrinkage stress. [4]

Composite resin artificial teeth are have many advantages when used as the super structure for implants because of their greater shock absorbing capacity. These multilayered structures provide improved esthetic appearance. Adequate bonding of denture teeth to denture base.[5]

Debonding of denture teeth increases the appointment frequency and laboratory costs both patient and dentist disappointment with the prosthesis[6]. Failure of bond between the denture tooth and denture base resin may be caused by excessive stress failure or fatigue failures, it is probably caused by gap and crack propagation in areas of load concentration . Bond failure between denture base material and resin teeth remained a significant problem for treatment success . [7]

Several factors can influence bond strength between teeth and denture bases, including contamination with wax and thin foil [8], petrolatum and sodium alginate remaining on ridge-lap surface of artificial teeth [9] , improper use of separating mediums during curing, inaccurate use of monomers for curing, inadequate methods used for denture base curing, mechanical or chemical preparation of tooth surfaces, absorption of water by resins, differences in thermal expansion coefficient of artificial teeth and base material, and porosity on the border of denture base resin and teeth [10,11] .

Use of denture base resin has revolutionized the dental material sciences ever since their discovery, polymethyl methacrylate (PMMA) denture base resin is the first choice for denture construction because of its minimal cost, quite esthetic characterization, and easy manipulation. Within the eighties, to overcome allergic reactions and to revoke flasking, packing, and water bath polymerization, monomer free thermoplastic resins were introduced. [12]

The microcrystalline polymer as a thermoplastic resin (Karadent) produced several advantages over the traditional denture base materials, including highly aesthetic, maximum strength and durability, decreased volume shrinkage , exceptional fit, minimal water absorption, lower residual monomer content so it is a good alternatives to PMMA in allergic patients.

A number of national and international standards are available to determine bond strength, a wide variation in materials used, shape, size and construction techniques of test specimens and method of testing. In clinical conditions, the direction of applied load to the denture teeth during mastication may lead to separation of teeth by a combination of tensile, compressive and shear failure. Various methods have been used to estimate the adhesion bond strength between the teeth and denture base, and include tensile, shear, compression, flexural strength tests and finite element stress analysis. [13,14]

Hence the aim of this study was to compare between NHC artificial teeth and acrylic denture base and thermoplastic monomer free semi-rigid micro crystalline polymer denture base materials respectively.

MATERIAL AND METHODS

Teeth and denture base materials

Nano-hybrid composite SR Phonares II teeth were selected for this study from Ivoclar Vivadent-England.

Acrylic denture base material (Acrostone Heat Cure Denture base Material. Egypt)

Thermoplastic monomer free semi-rigid micro crystalline polymer denture base materials (Karadent) by TCS,INC,USA)

Sample fabrication :

Eight premolars from sheet of NHC teeth sheet were picked and sliced in equal diameter and grooved using metal disc. Figure (1)

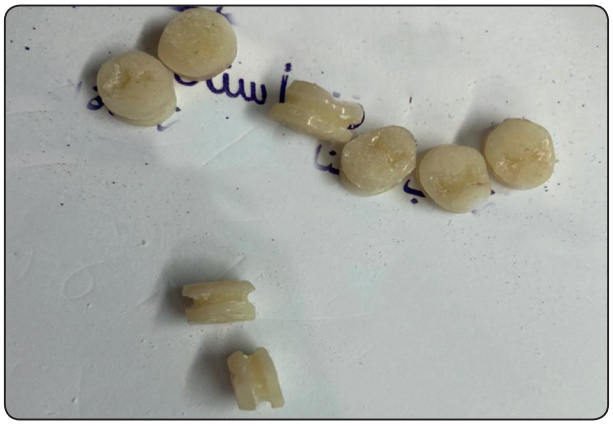

Fig. (1): sliced nanohybrid composite premolars with groovs for increasing contact surface

18 Denture base disc shaped samples with diameter (15 mm x 2mm) were constructed eight for each group .

Acrylic denture base samples were fabricated The disc shaped silicon patterns has been covered with separating medium and inserted in lower half of the flask that was filled with mixed dental stone. After stone set, it was painted by separating medium, then other part of flask was applied with insuring tight sealing of the two parts, flask was vibrated for removal of air bubbles. The polymer and monomer of heat cure acrylic materials were mixed following the manufacturer's directions. Acrylic resin dough packed into the stone mold that created by removal of silicon patterns, then cured by long cycle (70° for 9hours). After samples curing and deflasking, they were finished and polished.

Thermoplastic monomer free microcrystalline polymer samples was fabricated by Teeming of gypsum paste into one part of the flask was done. Investing the spurred wax patterns of the samples have been done in a vaselinezed aluminum flask. After investment setting, the other half of the flask was assembled on the top of the deposed gypsum surface. Teeming the hard dental stone into the upper flask chamber was done to cover the wax pattern and sprues. The flask was immersed into warm water of a thermostatic container after setting of the gypsum. When the wax was boiled and the mold was created. Injection was carried out with (Sabilex, Microinjection machine, Argentina) injector. The cartridge of injecting material was introduced into the heating cylinder. Preheating processes was then activated. Figure (2)

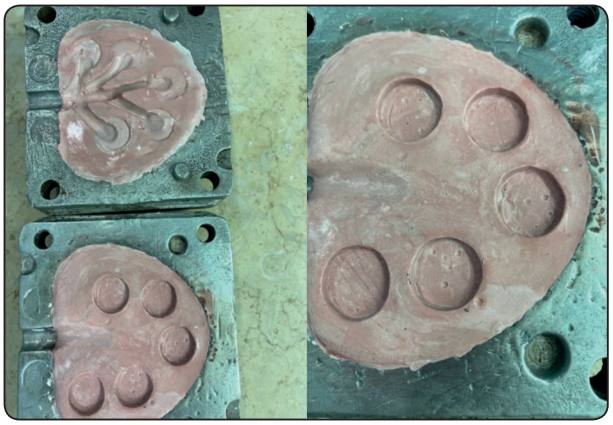

Fig. (2) : spruing for karadent sample fabrication

The parts of the flask had been congregated and mounted by screws. The flask was inserted and secured in its congruent position of the injecting unit. Squirting was launched after pressing the monitoring panel's key. The temperature was maintained at 280o and a pressure of seven barat for twenty minutes consistent with the manufacturer's instructions. To plasticize the material in the cartridge to be injected into the flask. The cylinder was then moved and the cartridge separated. The flask was released and pulled out. The flask was

left to chill down and investment was removed, finishing and flourishing were carried out utilizing soft brushes and flourishing paste. Figure (3)

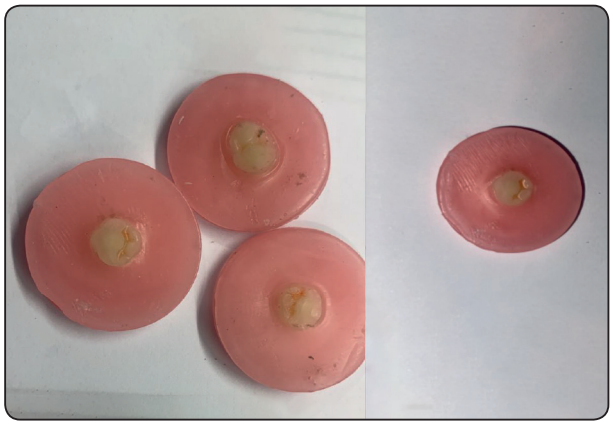

Fig. (3): finished Karadent samples with NHC teeth

Samples were devided in two groups, group (A) acrylic denture base material and group (B) Thermoplastic monomer free microcrystalline polymer.

Specimens were tested by introducing them into Instron Universal Testing machine (3345 model, England). Tensile load (5000 N) was applied until debonding of the samples occurred . The failure point was recorded by the system's software.

RESULTS

Results from Tensile strength of samples were collected , tabulated and statically analyzed using ANOVA test. Table (1)

Table (1) : Shows difference in mean and standard deviation of the two groups

Material	Mean	Standard deviation	P value
Group (a) : Nonohybrid composite teeth with acrylic denture base material	136.2	2.81	P ≤ 0.001
Group (b) : Nanohybrid composite teeth with Karadent	80.6	1.65	

The table shows the Mean and Standard deviation between the two groups, group (A) nanohybrid composite teeth with acrylic denture base material and group (B) with Thermoplastic monomer free microcrystalline polymer (Karadent). Figure (4)

There was significant difference in the two groups in bonding to teeth, group (A) showed greater bond strength result than group (B), P- value ≤ 0.0001

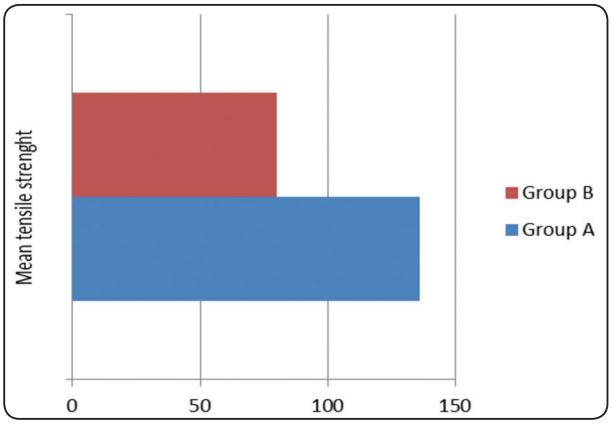

Fig. (4): diagram shows the different in means between group (A) and (B)

DISCUSSION

Different artificial teeth and denture base materials have been produced to improve properties of both and quality of the prosthesis, although debonding of artificial teeth from the base resin is still a problem. As the force on prosthetic components increases, deboning of teeth from the acrylic base of prostheses becomes a major clinical challenge. [15]

Micro-tensile (μTBS) test is the first-selected method for estimating the bond strength of interfaces between different dental materials. [16]

Today, researchers have found ability to increase the bond strength of artificial teeth to denture bases through physical and chemical changes in structure of artificial teeth and polymers. Some physical changes include creating fine holes in the base and in the ridge-lap surface of artificial teeth.

The chemical changes include the addition of monomers to the base of teeth before packing acrylic resins, complete removal of wax, rinsing artificial teeth with detergents, changes in the chemical structure of polymers and polymerization reactions. [17]

This study investigated the effect of using the nanohybrid composite teeth with acrylic denture base material and Thermoplastic monomer free microcrystalline polymer on bond strength, Mechanical retention techniques such as grooves were applied to increase the contact surface area between the tooth and denture base in order to form an effective interlocking system. The results showed better bonding records between the NHC artificial teeth and acrylic denture base material , in contrast findings with researches that stated acrylic artificial teeth had a significantly higher bond strength compared to composite and nanocomposite artificial teeth, while the difference in bond strength between composite and nanocomposite artificial teeth was not significant. [8]

Other studies stated that changes in the type of resin base material, the type of artificial teeth, artificial tooth preparation methods, and copolymerization may affect the bond strength. [18] Many studies investigated the bond strength of several types of multilithic composite artificial teeth to heat-cure resins. The findings showed that the mean bond strength was the higher in the Apple group followed by Yaghut, Glamour, and Ivoclar artificial teeth, respectively. [17]

Studies showed that Composite denture teeth (Endura) showed greater bond strength to denture base resin in the control group over nanocomposite teeth (Veracia) and cross-linked denture teeth (Acry rock). Vitacoll (methyl methacrylate-based bonding agent) application provided greater bond strength in all the three groups. Nano composite denture teeth (Veracia), after application of Vitacoll bonding agent, showed highest shear bond strength to denture base resin among all the groups. [5]

Tensile bond strength values available in literature cannot be directly compared with the reported studies due to the difference in materials or mechanical properties of the artificial denture teeth, denture bases, methods of polymerization used and type of evaluation method applied and less studies applied on thermoplastic monomer free microcrystalline polymer.[19]

CONCLUSION

With the limitation of this study , nanohybrid composite teeth (NHC) showed better bonding with acrylic denture bas material than thermoplastic monomer free microcrystalline polymer, further investigations are needed for enhance bonding of artificial teeth to Thermoplastic monomer free microcrystalline polymer.

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