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International journal of applied dental sciences An *in vitro* comparative study of mechanical properties between bulk-fill composite and conventional composite

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Abstract
Abstract: compare compressive strength and hardness between bulk-fill composite and conventional composite.
Materials and Methods: The research sample consisted of 60 molds of composite resin (30 samples of conventional composite - 30 samples of bulk-fill composite). The sample of each material was divided into two groups (15 samples for the hardness test and 15 samples for the compressive test).
Properties: The results showed that the compressive strength of the conventional resin is more than the compressive strength of the bulk composite resin. There are no statistically significant differences between hardness of conventional composite resin and bulk composite.

Keywords: conventional resin composite, bulk-fill, compressive strength, microhardness

Introduction
Considerable evolution of polymer and filler technology in composite resin restorative materials since their inception has led to the availability of wide range of materials to the dental practitioner for varied clinical scenarios [1]. The improvement in their chemical composition as well as various filler reinforcements has led to more frequent use of the material extending to deep and large cavities albeit with variation in success. Layering techniques and multiple curing regimens of the composite restorative material are time-consuming. As a consequence, the dental material market is driven by consumer demand for rapid and uncomplicated procedures by reducing the curing time and using thicker composite layers [2]. Recently, a newclass of resin-based composite, the so called "bulk-fill" composites have been introduced into the dental market with the purpose of time and thus cost savings [3]. The unique advantage of this new material class is stated that it can be placed in a 4 mm thickness bulks to be cured in one step instead of the current incremental placement technique, without adverse effect on polymerization shrinkage, cavity adaptation, or degree of conversion. Furthermore, the manufacturers stated that the polymerization shrinkage of those materials is even less than that of commonly used flowable and conventional resin-based composites [4]. Consequently, problems arise from polymerization shrinkage could be reduced.
Tetric N-Ceram bulk-fill contains bisphenol A-diglycidyl dimethacrylate (Bis-GMA), ethoxylated bisphenol. A dimethacrylate (Bis-EMA) and urethane dimethacrylate (UDMA). The organic matrix accounts for approximately 1% of the mass. Several different types of fillers are incorporated in the material. Barium, aluminium silicate glass
Tetric® N-Ceram Bulk Fill in its composition contains nanohybrid filler and there are also diluent monomers in its matrix. In addition, Tetric® N-Ceram Bulk Fill has an additional photoinitiator that is Ivocerin (derivatives dibenzoyl germanium) in addition to other photo initiators such as champhorquinone and acyl phosphine oxide.
contains Ivocerin that absorbs blue-visible light with a range of 370-460 nm and is much more reactive than camphorquinone or acyl phosphine oxide that increases the degree of conversion so that polymerization becomes adequate and faster with deeper depth [5].
Surface hardness is one of the most important properties used to compare restorative materials, and is defined as the resistance to permanent indentation or penetration. It is a mechanical property of the restorations that should always be taken into account, especially when they are

Faced with large areas of masticatory force [6]. The most common hardness tests are used to determine the hardness of dental materials KNOOP, VICKERS, BRINELL, and the test is selected based on the material whose hardness is measured, in this study used konop.
HK = 14230 (F/d2)
D is the sample radius

F: force applied
The compressive strength plays in important role in the mastication process. Among the various mechanical properties compressive strength is of importance because bulk-fill materials replace a large area of the tooth structure. Compressive strength represents the resistance of the material provided against intraoral compressive and tensile forces produced in function and para function [7].
$P= F/3.14*R^2$
F: force applied
R: Radius

2-Materials and Methods
Sample preparation
Microhardness test
Samples were prepared for the hardness test divided into two groups (15 samples - Tetric N-Ceram Bulk - 15 tetric n-ceram samples
Using a special custom Metal mold (5 mm in di¬ameter and 4 mm depth) [8] the materials were condensed in 4 mm Tetric N-Ceram Bulk in the mold over the glass slab or incremental for tetric n-ceram (Fig 1).
After the materials were inserted into the mold, a transparent plastic matrix strip was placed over the material and a glass plate with 1.00 mm thickness was secured over it to flatten the surface. Each sample was light cured for twenty seconds using light cure device (VRN, Guangzhou, China) following manufacturer instructions within the range of 1000 Mw/cm2. [9] The tip of the curing device was kept in direct contact to the glass plate to maintain standardized distance from the tip of the device to the top surface of the specimen.
All specimens were kept inside an oven at 37°C for 24 hours in a light-proof container. After that, the top and bottom surfaces of each specimen were subjected to the Vickers hardness testing machine) Micro Hardness Tester MHT 10, Zeiss) Fig.2. The specimens were placed on a platform and a square diamond pyramid indenter was utilized to apply load of 300g to the surface for a 15 seconds dwell time.

Fig 1: Metal mold

Fig. 2: Micro Hardness Tester MHT

Compressive strength test
Samples were prepared for the hardness test divided into two groups (15 samples - Tetric N-Ceram Bulk - 15 tetric n-ceram samples).
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Fig 3: Metal mold

Fig 4: Testometric AX

Results

Microhardness test

Table 1: Results of the T-Student test for independent samples to study the significance of differences in the average amount of microhardness

microhardness (kHN)					
Indication of differences	**P-Value**	**Standard error**	**Mean Difference**	**Degrees of freedom**	**The value of t**
No	0.926	3.779	0.356	28	0.094

In the table that the value of the significance level is much greater than the value 0.05, so that at the 95% confidence level there are no statistically significant differences in the hardness value values between the Tetric N-Ceram Bulk Fill and the Tetric N-Ceram in a sample Hardness study

Compression test

Table 2: Results of the T-student test for independent samples to study the significance of differences in the average amount of compressive strength

compressive strength(MPA)					
Indication of differences	**P-Value**	**Standard error**	**Mean Difference**	**Degrees of freedom**	**The value of T**
YES	0.006	14.21	-42.49	28	-2.990

The value of the significance level is much smaller than the value 0.05, that is, at the 95% confidence level, there are statistically significant differences in the values of compressive Strength(MPA) between the Tetric N-Ceram Bulk Fill and the onvemtional Tetric N-Ceram in the compressive strength study sample, since the algebraic signal for the Mean Difference is negative we conclude that the values of the compressive strength amount (in Mpa) in the Tetric N-Ceram Bulk Fill group were smaller than that of the conventional Tetric N-Ceram resin group in compressive strength study sample

Discussion

The mechanical properties of the material play an important role in understanding the biomechanical properties during the job in the chewing forces, the most significant changes in commercial composites in recent years were modifications of the filler system [6]. The size of filler particles incorporated into the resin matrix of commercial composites has continuously decreased, resulting in nanohybrid and nanofilled materials with improved material properties [7].

Mechanical properties of dental composites are related to filler particle density in the mix. It is generally assumed that, as the filler loading increases, the mechanical properties also increases [10].

In general, filler volume is positively correlated with several properties of the resin composite materials, including the elastic modulus, strength and hardness [10], The reduction in the size and the increase in the volume of fillers are directly proportional to the increase in compressive strength of a material [11] Consequently, nano-composites have shown better compressive strength than micro hybrid composites , The result of a decrease in the size of the particles and the increase in the number of particles in nano-composites [11].

The results of the current study showed that the compressive strength of the Tetric N-Ceram bulk resin sample was greater than the compressive strength of the Tetric N-Ceram Bulk Fill and the reason is that the amount of filling particles can play a role in the properties of this type of Tetric N-Ceram bulk- fill, where the quantity of Ceram bulk-fil particles is 75% by weight [12] while Tetric N-Ceram is composed of 80% by weight. 1]

This finding was in agreement with study (Abuelenain 2015) It has been also evident that the nano-hybrid Tetric N-Ceram has higher compressive and flexure properties than the micro-hybrid Tetric N-Ceram Bulk Fill, and it could be attributed to the higher filler loading and nano-filler dimensions in Tetric N-Ceram [13].

A (Pradeep 2016) study showed when comparing the compressive strength of both the nanohybrid resin and the bulk resin of 6 mm height and 4 mm diameter and his study showed that the compressive strength of the bulk resin have greater compressive strength than the Nanohybrid resin and the reason for the difference can be due to a large volume of particles of the filling material (Zirconium fillers) that increase compression strength [14].

In (Alkhudhairy 2017) study, compared the mechanical properties of conventional and bulk composite resin and sonic fill resin between that the compressive strength of conventional resin was lower than that of bulk composite resin due to the type of resin and particle size [8].

In this study showed that there were no statistical differences in the hardness of the conventional composite resin sample and the Tetric N-Ceram Bulk Fill sample due to d be: According to the Ilie *et al*., 2013 study, the low hardness properties were not due to the increase in the amount of filling particles However, due to a decrease in the total size of the filling particles, which is a key factor in the decrease in hardness [15].

This finding was in agreement with study (Abuelenain 2015) compare the Tetric N-Ceram hybrid resin with the Tetric N-Ceram bulk-fill and the hardness of the two types of resin were similar [13].

Alrahlah *et al*., 2014 that there is a direct relationship between the number of filling particles and hardness, as increasing the proportion of filling particles while reducing the size of the resin mold leads to increased hardness [16, 17].

the results of this study differ from that of the Hahnel study in 2012, when the researcher compared Hahnel between the conventional resin with several types of the Bulk, it was found that the conventional resin was greater hardness than the bulk resin bulk due to the size and distribution of the filling particles that affect the properties [18].

Conclusions

The current study showed that the compressive strength of a conventional composite resin was greater than the compressive strength of the Tetric N-Ceram Bulk Fill resin. There were no significant differences between the hardness of the conventional Tetric N-Ceram resin and the Tetric N-Ceram Bulk Fill resin.

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