Compressive strength of different composite restoration materials. An in vitro comparative study

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الاهداء

(وَآخِرُ دَعْوَاهُمْ أَنِ الْحَمْدُ لِلَّهِ رَبِّ الْعَالَمِين)

الحمدلله عند البدء وعند الختام، فما تناهى دربٌ، ولا خُتم جهد، ولا تم سعي إلا بفضله.

أؤمن بمقولة لكل نهاية بداية وها أنا أرى رحلتي الجامعية قد شارفت على الانتهاء بالفعل ..

من بعد تعب ومشقة لوقت طويل وها أنا اليوم أختم بحث تخرجي بكل ما لدي من همة وامتنان لكل شخص كان له الفضل في مسيرتي وقدم لي المساعدة ولو باليسر.

أهدي هذا النجاح الى نفسي أولاً ثم الى كل من سعى معي لإتمام هذه المسيرة ، دُمتم لي سنداً لا عُمر له.

الى من رسم لي المستقبل بخطوط من الثقة والحب الى من حصد الأشواك عن دربي ليمهد لي طريق العلم ملهم نجاحي " دكتور قاسم " وكافة تدريسيي كلية طب الأسنان المحترمين.

الى من أضاءوا بدمائهم لياليا الموحشة " شهداء العراق " نخلّد نجاحنا لأجل أرواحكم الزكيّة ، الى من أهدى بالجواب الصحيح حيرة سائليه الحي" دكتور علاء " فأظهر بسماحته تواضع العلماء وبرحابته سماحة العارفين.

الى ضلعي الثابت الى المبسم الدافئ " امي " يامن ساعدتني في النهوض كلما وقعت يامن اخذت بيدي لإكمال هذا الطريق الشاق أهديك تخرجي ونجاحي.

شكرًا لوالدي، ويمكنني أن أهدي ذلك البحث لهم تقديرًا لعطاءهم.

الى من شجعوني و واصلوا العطاء دون مقابل الى من كانوا داعمين بالأوقات الصعبة ومن شد الله بهم عضدي فكانوا خير مُعين " إخوتي".

ما كُنت لأصل لولا فضلكم من بعد الله تعالى..

ABSTRACT:

Aim: The aim of this study was to evaluate and compare the mechanical properties of three resin composites core materials.

Materials and methods: Beautifil-Bulk Shofu , Beautifil-Bulk Flowable and AURA Bulk Fill SDI resin composites were used during this study. Mechanical properties regarding the compressive strength. Data were statistically analyzed using one-way Analysis of Variance and Tukey's Post HOC Test.

Results: The Beatiful-Bulk Shofu type revealed the highest significant compressive strength values while the Aura Bulk fill SDI type showed the least hardness values. There was no significant difference between Beautifil-Bulk Flowable and AURA Bulk Fill SDI.

Conclusions: the tested Beatiful Bulk Shofu resin composite type is more appropriate for use as core material compared to the other tested types.

INTRODUCTION:

Mechanical properties of core build up restorative materials have important role in efficacy and longevity of the tooth and restoration. A badly broken down tooth in anterior or posterior region of oral cavity which has happened because of caries or root canal therapy, needs to be restored with a suitable restorative material which can resist complicated forces of mastication [1,2]. Since the majority of mastication forces in posterior region are particularly compressive, the restored endodontically treated tooth or the complex and extensive restoration should bear these kinds of forces [2, 3]. It is said that compressive strength is the most important mechanical property of core build up materials.

A restorative material with lower compressive strength than tooth, tends to fail, fracture and it ends with periodontal problems or extraction of the broken tooth [3, 4].

Compressive strength is a useful property to compare materials which are brittle and generally weak in tension such as amalgams, cements or composite resins. Amalgam has been the core material of choice in posterior region for a long time but in recent years core buildup glass ionomers and posterior composite resins have been introduced as a core build up material. During the past recent years many new composite resins have been introduced to market such as condensable composite resins, core build up types and fiber reinforced composite resins in order to restore the coronal portion of a vital or endodontically treated tooth with an adhesive restoration [2, 3].

Composite resins are improving every day because of their chemical ingredients, bonding ability, conservative preparation, preservation of tooth structure and esthetics. In anterior region composite resins are the materials of choice but in posterior region the composite resins should have mechanical properties like tooth structure and they should have a compressive strength equal or more than tooth structure to resist the mastication forces [2]. Many researches have been undertaken to evaluate the compressive strength of the different restorative materials. The studies in this area showed different results. In some studies amalgam showed the highest compressive strength [1], but in some of them composite resins had the higher strength [5], however, some have shown no significant difference between amalgam and composite resin.

Also the compressive strength has changed with time of evaluation [6-7]. The aim of this study was to compare the compressive strength of different types of composite resins.

MATERIALS AND METHODS:

Materials instruments used in this study are listed in Table (1). Three different commercially available composite resin restoration materials have been used in current study which are Beautifil-Bulk Flowable, Beautifil-Bulk SHOFU and AURA Bulk Fill SDI as shown in Table (2) and Figure (1).

TABLE (1): Instruments used

Instruments used
1. Metal mold
2. Separating Medium
3. Composite Condenser
4. Clear celluloid strip
5. Dental Light curing device
6. A small graduated metal object (with two readings of 4 mm each)
7. Dental glass slab

TABLE (2): Types of composite resin restoration materials

Material	Manufacturer
a) **Beautifil-Bulk SHOFU**	SHOFU INC.
b) **Beautifil-Bulk Flowable**	SHOFU INC.
c) **AURA Bulk Fill SDI**	Made in Australia by SDI Limited

A split metallic mold has been prepared with a cylindrical split tube hole of a 6 mm diameter and 12 mm height (according to ADA specification No. 30) in order to make twelve cylindrical composite rod specimens for each type of the three composite materials used in this study (a total of 36 composite rods have been made).

A) Beautifil-Bulk SHOFU B) Beautifil-Bulk Flowable C) AURA Bulk Fill SDI

Figure (1): Types of composite resin restoration materials

The assembled split mold has been put on a glass slap then composite material applied into the cylindrical split tube incrementally (4 mm thickness per increment that adjusted with two pre-prepared 6 mm diameter plastic made rods of 8 mm and 4 mm length for composite increments thickness standardization inside the split tube. Each increment was light cured for 40 seconds with light cure tip perpendicular on the split tube and intensity of 2400 mW/cm2, a slide glass put on the third uppermost increment to ensure flattening of both sides of the composite rods, and a cellulose strip separating the composite material from the glass surface ate both sides to prevent composite adherence to the glass slap (Figure: 2). After that the bottom side of the composite rod is re-light cured to ensure perfect polymerization at both sides of the composite rods. The metallic split mold dissembled and composite rod removed and stored in perfectly sealed plastic container according to each of the three composite groups for testing.

Figure (2): Position of the glass slap under the metal mold

Instron testing machine (Figure: 3) with 20 mm diameter metallic rod and cross-head speed of 1 mm/ minute has been used to load each composite rod till it had been failed or cracked (Figure: 4). readings recorded then analyzed statistically with SPSS statistical program version 27.

Figure (3): Instron testing machine

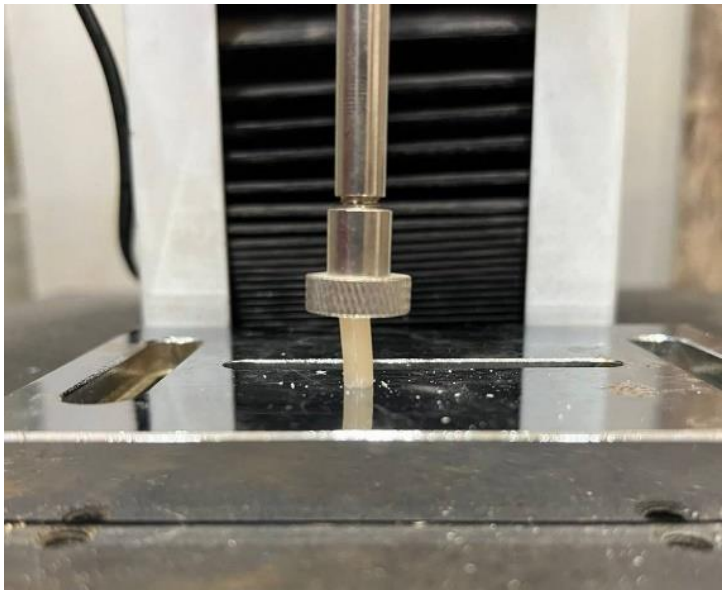


Figure (4): Applied load on composite rod

RESULTS:

Means and standard deviation of compressive strength in (Mpa) for each tested group were computed and listed in Table (3). One-way Analyses of variance test (with $p \leq 0.5$) showed that there is significant differences between tested groups as shown in Table (4).

Table (3): Means and standard deviation of compressive strength

Descriptives

Compressive Strength

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Beautifil-Bulk Flowable	12	342.8333	9.12373	2.63379	337.0364	348.6303	320.00	354.00
Beautifil-Bulk SHOFU	12	366.0833	28.39161	8.19595	348.0442	384.1225	276.00	376.00
AURA Bulk Fill SDI	12	330.5833	2.74552	.79256	328.8389	332.3278	326.00	336.00
Total	36	346.5000	22.46839	3.74473	338.8978	354.1022	276.00	376.00

Table (4): Significant differences between tested groups

ANOVA

Compressive Strength

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7803.500	2	3901.750	13.051	<.001
Within Groups	9865.500	33	298.955		
Total	17669.000	35			

Tukey's post hoc test (Table: 5 and Table: 6) showed that there is no significant difference between Aura bulk Fill SDI composite (330.58 ± 2.74 Mpa) and Beautifil-Bulk Flowable (342.83 ± 9.12 Mpa). While Beautifil-Bulk Shofu (366.08 ± 28.39 Mpa) is significantly higher than both other groups.

Table (5): Tukey's post hoc test

Post Hoc Tests

Multiple Comparisons

Dependent Variable: Compressive Strength

Tukey HSD

(I) Composite	(J) Composite	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Beautifil-Bulk Flowable	Beautifil-Bulk SHOFU	-23.25000*	7.05874	.007	-40.5707	-5.9293
	AURA Bulk Fill SDI	12.25000	7.05874	.207	-5.0707	29.5707
Beautifil-Bulk SHOFU	Beautifil-Bulk Flowable	23.25000*	7.05874	.007	5.9293	40.5707
	AURA Bulk Fill SDI	35.50000*	7.05874	<.001	18.1793	52.8207
AURA Bulk Fill SDI	Beautifil-Bulk Flowable	-12.25000	7.05874	.207	-29.5707	5.0707
	Beautifil-Bulk SHOFU	-35.50000*	7.05874	<.001	-52.8207	-18.1793

*. The mean difference is significant at the 0.05 level.

Table (6): Tukey's post hoc test

Homogeneous Subsets

Compressive Strength

Tukey HSD[a]

Composite	N	Subset for alpha = 0.05	
		1	2
AURA Bulk Fill SDI	12	330.5833	
Beautifil-Bulk Flowable	12	342.8333	
Beautifil-Bulk SHOFU	12		366.0833
Sig.		.207	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Group at same colum, don't difference significant.

DISCUSSION:

Demand for cosmetic restorations has begun in recent decades, which has contributed to the development of custom restored resin materials.

Renewable restorations from the diet as their physical and mechanical properties provide aspects and increase the durability of cosmetics. These restorations still suffer from some difficulties regarding their sensitivity to the application technique and the multi-stage process required to use. In addition, spasmodic contractions and thus an increase in these substances cause many negative effects. The technique of filling entire dental cavities in one go using bulk resins offers many advantages for both the patient and the clinician, but lacks what resin restorations require and thus has the potential to cause success rate few side-by-side and laboratory studies are available for bulk resins although many of these have been developed recently (2017) bulk resins represent the latest types of resins produced as these materials have been developed by many of companies after making adjustments specific to each of them. Manufacturers of this material claim that it has a depth of up to 6 mm it leaves behind mechanical build-ups of bulk resins in the amount and form of fillers used within article although the use of the bulk restoration technique is considered ideal, especially in the posterior region, but it must be noted that this region is subject to partially high occlusal efforts. Therefor it have been found that bulk resins must have mechanical properties to withstand stress in this region. The compressibility values of the required resin materials can be compared experimentally with their relationships in natural mineral tissues. Studies found that the overall compression ratio 384 MPa. These values necessarily require resin materials for dental restoration.

Current results Shofu Beautifil-II Bulk Fill Dental The newest member of Shofu's Giomer family, Beautiful-Bulk Restorative provides exceptional Delivering super shade stability, low shrinkage, stress and full polymerization at 4mm [8,9].

Light cured resin-based composite used for all types of cavity preparations. An ideal choice for both anterior and posterior applications. Easy to mold, sculpt and polish to a high luster.

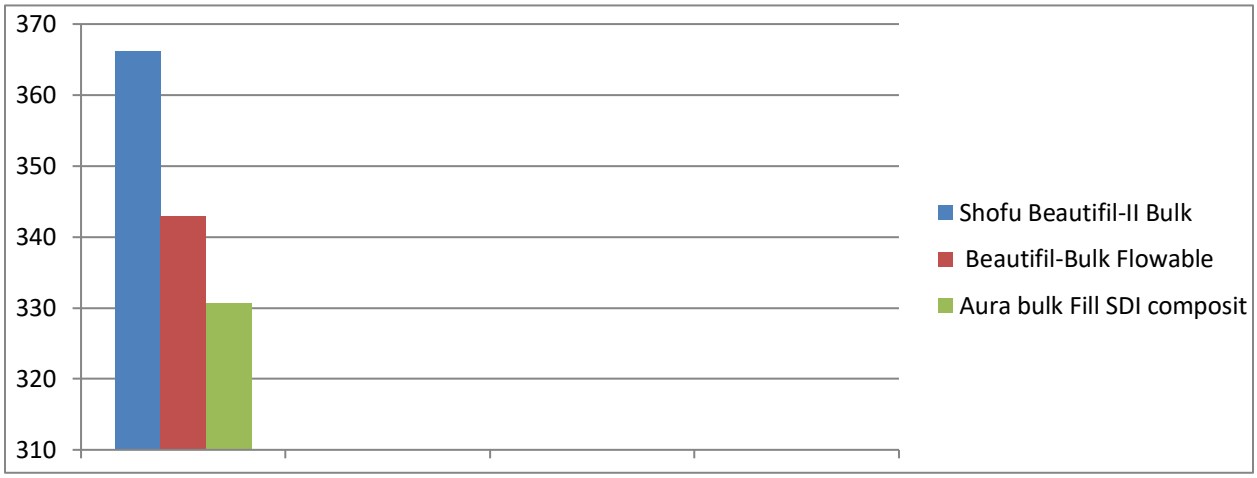
Shofu Beautifil-II has high compressive strength as well as low shrinkage and resists staining. Radiopaque for easy identifications in radiographs .High fill ratio (87.0wt% 74.5vol%) reduces polymerization shrinkage and shrinkage stress while increasing compressive and flexural strength .Shofu Beautifil-II the ideal balance of light diffusion and transmission ensures complete polymerization at 4mm depth of cure outstanding Vickers hardness value optimum translucency creates esthetic shades unaffected by surrounding intraoral color sustained fluoride release and rechargeability.

Aura Bulk Fill Tukey's post hoc test showed that there is no significant difference between SDI composite (330.58 ± 2.74 Mpa) and Beautifil-Bulk Flowable (342.83 ± 9.12Mpa). While Beautifil-Bulk Shofu (366.08±28.39Mpa) is significantly higher than Beautifil-Bulk Flowable incorporates Shofu's bioactive, Giomer filler technology, an S-PRG material demonstrating many years of clinical success, within a fast and easy bulk fill composite [10]. Designed to deliver aesthetic results, low shrinkage stress high filler ratio (73 wt%) helps to reduce volumetric and complete polymerization at 4 mm depth of cure Aura bulk fill shrinkage (3.5 %) and shrinkage stress while increasing compressive and flexural strength is a light cured, radiopaque, high strength, composite designed to eliminate time consuming layering for posterior restoration [11].

The Aura Bulk Fill has a 5mm depth of cure allowing fast and easy placement when restoring deep cavities.

Beautiful Bulk Flowable 342.8333 and Aura Bulk Fill SDI 330.5833 while Beatiful Bulk Shofu 366.0833 so Beatiful Bulk Shofu is higher compressive strength than other groups.

The result of current study strongly support that the compressive strength of composite resins depends on the specific type of material used and it's composition rather than it's classification, whether it's a Bulk Fill or traditional resin.



CONCLUSIONS:

From the findings of the present In vitro study; It was observed that Beautifil-Bulk Shofu have higher compressive strength as compared to Beautifil-Bulk Flowable and Aura Bulk Fill SDI.

No significant difference between Beautifil-Bulk Flowable and AURA Bulk Fill SDI.
Since there are differences in the results of one type of composite resin material , the dependence is on the type of materials used and their compositions rather than it's classification..

SUGGESTIONS:

Compare composite compressive strength and other mechanical properties of Bulk Fill composite resin with other traditional composite materials.

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Thank you!