



## Comparison of Various Mechanical Characteristics of Biostar Sheets with Heat-Cured Acrylic Resin

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### Abstract

**Background:** Duran foil, a type of Biostar foil, is utilized in splint therapy as a heat-cure acrylic substitute material. The Duran® gained popularity and broad use, and its strength and resilience to wear are its most important qualities that improve splint therapy.

This study aimed to investigate the surface roughness and fracture strength of heat-cured acrylic resin and Biostar sheets.

**Materials and Methods:** A total of 20 samples—10 heat-cured acrylic resin samples and 10 biostar sheet samples—were produced and split into two groups in order to measure fracture strength and surface roughness.

**Results:** The fracture strength of biostar samples had the lowest fracture strength. The surface roughness of the biostar samples was also less than that of the acrylic samples. There were statistically significant differences between the study groups.

**Conclusion** Duran Biostar is regarded as the material of first choice for removable orthodontic retainers due to its suitable mechanical properties.

## Introduction:

An excellent organic biocompatible polymeric substance used to make denture bases is poly (methyl methacrylate, or PMMA) <sup>(1)</sup>. Due to its excellent physical and mechanical qualities, it was utilized to make dentures for the first time in 1937 and has since become the material of choice. <sup>(2)</sup> The color resemblance of natural gum, good chemical retention with artificial teeth, simplicity of manipulation, and reparability are only a few benefits of PMMA. <sup>(3)</sup> When used alone, PMMA has insufficient surface hardness and mechanical strength. Additionally, it is readily fractured when there is a high impact event or when a patient bite down with a lot of force <sup>(4,5)</sup>. Due to several drawbacks with regard to its mechanical qualities, such as hardness, impact strength, and flexural strength,<sup>(6)</sup> this material is still far from perfect. Several additive approaches, such as fibers of various sorts, such as glass fibers, polyester, and polypropylene fibers in various lengths and concentrations, were used to improve the attempts to make (PMMA) material stronger and more usable <sup>(7,8)</sup>.

The use of powders or fillers such silica, titanium oxide, and aluminum oxide in various concentrations and adding techniques was the focus of other initiatives <sup>(9-11)</sup>. Another hard-elastic, abrasion-resistant, unbreakable material called (Duran®) is employed for all purposes in splint therapy in place of heat-curable acrylic <sup>(12)</sup>. A removable appliance known as a bite splint covers both of the occlusal and incisal surfaces of the teeth in the upper or lower jaw and is typically made of acrylic or composite. The majority of modern splints are manufactured of heat-cured acrylic, while soft acrylic and light-cured composite are also options <sup>(13-14)</sup>. A type of Biostar foil occlusal splint called Duran® is used as an occlusal splint. In general, occlusal splints can be made from a variety of materials and can cover the maxilla or mandible whole or partially. Acrylic resins are comparatively hard materials that are adaptable and durable enough to act as a

night guard. Vacuformed vinyl splints are another option, however they have significant drawbacks <sup>(15)</sup>.

## Materials and Methods

For this experiment, 20 samples were created and split into two groups: 10 samples of biostar sheets (Sinalldent,China)and 10 samples of heat-cured acrylic resins(Rodex, Turkey). These samples were used to gauge the surface roughness and fracture strength. The measurements of each sample were 65 mm in length, 10 mm in breadth, and 2.5 mm in thickness.

### Heat-cure Specimen Preparation

Wax patterns with the dimensions 65mm long by 10; 2.5mm wide; and 2.5mm thick were utilized <sup>(16)</sup>. Following the manufacturer's instructions, creamy stone was added to the dental flask's bottom section after being separated with Vaseline to allow easily removal of stone mold following deflasking. The stone's surface was then coated with a separating medium after the stone had dried. The upper portion of the flask was then placed on top of the lower portion after being filled with stone. After an hour, the flask was left to rest before being opened. The flask was opened, and the wax strips were gently removed from the mold. The acrylic liquid and powder were combined according per the manufacturer's instructions. It was kept in check by a mold. The flask was cured in a water bath machine. The acrylic samples were then taken out of the flask, polished, and completed (Fig.1).

### Biostar (Duran®) specimen preparation

One sheet of the Duran® foil shown in Fig (2), chosen to be 2.5 mm thick similarly to acrylic specimens, was clamped down using a specific ring to prevent any movement. After that, the sheet was put in a Biostar machine's pressure chamber and heated by setting the code in accordance with the directions. The pressure chamber (containing foil) is closed and clamped down firmly after the temperature has been raised to the requisite level of 220°C during machine operation. The heater is

then withdrawn once the foils have achieved the working temperature and may be plasticized. To further spread the thermoforming material, pressurized air is subsequently pumped down over the foil. It remains there until the cooling phase is complete before being eventually evacuated. The specimens were cut with a special Biostar bur, with no finishing necessary for the specimens shown in fig (3). A rectangular shape was drawn with a permanent pen over the prepared foil that had been processed to the requirements needed for the fracture test (65 mm length X 10 mm width X 2.5 mm thickness) and the surface roughness test (65 mm length X 10 mm width X 2.5 mm thickness).

### Testing Procedure

#### 1. Fracture Strength

Each individual sample underwent a 3-point bending test for fracture strength using an all-purpose testing device (Instron Model 4467, USA) with a 500 kg load and a cross-head speed of 5 cm/mm until failure was seen, as depicted in fig 4.

#### 2. Surface Roughness Test

Utilizing a Profilometer (TR220, China) with a 5 mm/s measuring length, the specimens' surfaces were assessed. Prior to the measurement, the instrument was adjusted in accordance with the instructions. Ra's gained surface roughness values (three reading) and the average reading was taken for each sample, these are in microns ( $\mu\text{m}$ ) (Fig. 5).

### Results

SPSS version 20 was used to analyze the data. According to the findings, as shown in Table (1), the fracture strength of acrylic resins was higher than that of biostar samples. The surface roughness of the biostar samples was also less than that of the acrylic samples. As presented in Table (2), all the variables in this study were statistically significant between the study groups.

### Discussion

After fabrication, Duran, a specific variety of Biostar foil, is employed as an occlusal splint. Occlusal splints come in several varieties; they can be created from a range of materials and can provide full or partial occlusal coverage, maxillary or mandibular, occlusal repositioning or stabilization. Laboratory-processed acrylic resin is the recommended material for occlusal splints; it is a relatively hard substance that is versatile and strong enough to serve as a night guard. Excellent physical characteristics of the Vacuformed Vinyl Splints include volume stability, good form, and low susceptibility to moisture. Although they have some drawbacks, they are nonetheless useful.<sup>(17)</sup> Additionally, these resources are straightforward to use and save time. The dental assistant can use these materials in the dental office to make splints that patients can wear right away and are agreeable to them<sup>(18)</sup>.

The results of the investigation show that Duran has lower fracture strengths than heat-cure acrylic resins, which may be because the major ingredient in Duran, poly (ethylene terephthalate), has been treated with glycol to enhance its mechanical properties<sup>(18)</sup>. Another explanation is that the Duran, unlike the other two varieties of acrylic resin, was a thermoplastic material with fine particles that could be used right away after being remolded under high pressure and temperature. The findings of this study demonstrated that thermoplastic Biostar and heat-cure acrylic resins have the greatest roughness values. The introduction of the cross-linking agent diethyl glycol dimetacrilat 1-2% in the heat-cured acrylic resin results in a rougher surface than the thermoplastic Biostar<sup>(19)</sup>. Surface hardness may be raised by the cross-linking agent. Polymers will be stronger and more solvent-resistant with more cross-linking than with less. A single cross-linking material is used to cross-link homopolymers to form a polymer cross-linking tie, which eventually evolves into a three-dimensional structure with strong ties between the chains<sup>(19,20)</sup>.

### Conclusions

The results of the current investigation concluded that the fracture strength of acrylic samples was greater than that of biostar samples.

Regarding the surface roughness, the biostar samples were less than that of the acrylic samples. Due to its ideal mechanical qualities, Duran Biostar is regarded as the material of choice for removable orthodontic retainers.

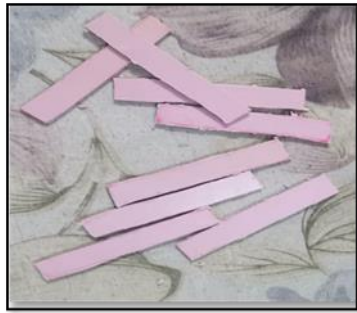


**Fig. (1 A, B, C):Heat cure specimen preparation**

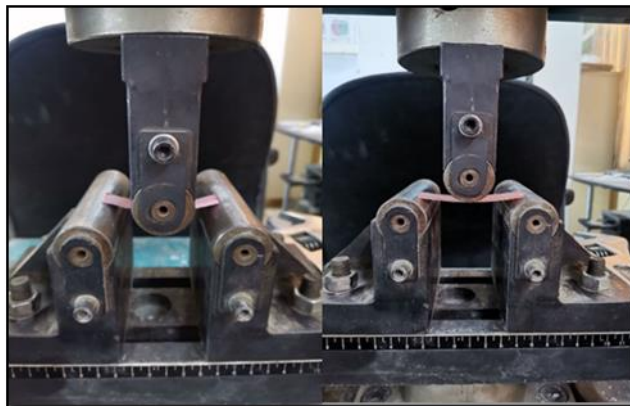
- A. Wax patterns invested within the mould B. specimens before finishing C. specimens after polishing.**



**Fig. (2): Duran® foil**



**Fig. (3): Biostar specimens preparation.**



**Fig. (4): Fracture Tester**



**Fig. 5: surface roughness tester**

**Table (1): The Descriptive Statistics of the Variables**

Variables	Groups	Number	Mean	Standard deviation	Standard error of mean	95% CI		Minimum	Maximum
						LB	UB		
Fracture Strength (MPa)	Acrylic	10	53.4	1.14	0.51	51.98	54.82	52	55
	Biostar	10	16.4	1.14	0.51	14.98	17.82	15	18
	Total	20	34.9	19.53	6.176	20.93	48.87	15	55
Roughness measurement R	Acrylic	10	1.912	0.001	0.000	1.911	1.914	1.911	1.913
	Biostar	10	0.097	0.001	0.000	0.097	0.098	0.097	0.098
	Total	20	1.005	0.957	0.303	0.321	1.689	0.097	1.913

**Table (2): The ANOVA analysis of the variables**

		Sum of Squares	Degree of freedom	Mean Square	F value	Sig.
Fracture Strength (MPa)	Between Groups	3422.5	1	3422.500	2632.692	0.000
	Within Groups	10.4	8	1.300		
	Total	3432.9	9			
	Total	8.223	9			
Roughness measurement R	Between Groups	8.236	1	8.236	14973750 .000	0.000
	Within Groups	0.000	8	0.000		
	Total	8.236	9			

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