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# COMPARISON OF THE FLEXURAL STRENGTH OF THREE COMMERCIALLY AVAILABLE HEAT CURE DENTURE BASE MATERIALS AS AN INDICATOR OF THEIR FRACTURE RESISTANCE

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**Abstract**

PMMA (poly-methyl-methacrylate) has been widely favoured for the production of denture bases. Its popularity as a polymeric material stem from its functional properties, which make it a preferred choice over other available options. However, conventional PMMA denture bases are relatively brittle and weak, making them prone to mechanical failure and fractures. The aim is to investigate the flexural strength properties of three commercial conventional heat cured PMMA that are used to fabricate denture bases. Three PMMA groups were made 15 samples to each group with dimensions of 65mm × 10mm × 3mm (according to ADA No 12), the first group (A) represents (Respal NF CE0068, Italy), the second group (B) represents (BMS dental, Italy), the third group (C) represents (everall7 H plus). The FS test was conducted using (Metrotech MTE-25 universal testing machine, Spain), each sample was subjected into the 3-point bending test with the load to 250 kg applied on the centre of the suspended samples. The samples were supported from each side with jigs of 3mm and vertical spam was 55mm.The mean FS in group C is the highest with 75.0427MPa, while group B is higher than group A with FS mean 71.1407, 65.5415 MPa respectively. In conclusion, there is no significant difference between the three tested PMMA groups (P-value 0.2546).

**Keywords:** Poly-Methyl-Methacrylate, Flexural Strength, Denture Bases.

## INTRODUCTION

Since its introduction in the 1930s, PMMA (poly-methyl-methacrylate) has been widely favoured for the production of denture bases [1,2]. Its popularity as a polymeric material stem from its functional properties, which make it a preferred choice over other available options [3,4]. Key factors contributing to its widespread use include ease of manipulation and processing, cost-effective fabrication equipment, aesthetic appeal, and biocompatibility [1,3-7]. However, conventional PMMA denture bases are relatively brittle and weak, making them prone to mechanical failure and fractures [6]. PMMA dentures often fail under complex loading conditions [1], and pre-existing surface flaws, scratches, or cracks can propagate, leading to eventual failure [8,9]. Daily activities such as

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brushing, chewing, or cleaning can cause scratches on softer materials, which may ultimately result in fractures [10,11].

When creating a denture base using polymers, specific physical and mechanical properties of the finished material are crucial. The hardened polymer must be rigid enough to maintain proper tooth alignment during chewing and prevent uneven pressure on the underlying gum tissue. Additionally, it should be biocompatible and resistant to bacterial buildup when exposed to oral microorganisms. These properties can be affected by the curing process and the materials selected during denture fabrication [12-14].

Strength measurement is a key physical characteristic of acrylic resins, allowing these materials to be utilized in producing durable denture bases. These bases can withstand occlusal forces and the mechanical stresses of cleaning, ultimately enhancing the lifespan of dental prostheses for elderly patients [15-16]. Flexural strength (FS) is particularly important as it simulates the complex forces such as compressive, tensile, and shear forces that dentures encounter during clinical use [9,17]. Therefore, developing denture base materials with superior FS remains a key objective in dental research.

Flexural strength (FS) is the mechanical property that can give prediction on the clinical performance of the acrylic resin denture base material. As almost every product in the market meets the ISO specification of FS to (>65MPa), dental practitioners and technicians are buzzled to choose the product with the most advanced property and efficiency. Evaluating the FS of several available denture base materials can give an insight to their clinical performance [18,19,20].

Currently, a number of commercial heats cured acrylic resins are present in the Libyan markets and their flexural strength has not been evaluated well. Therefore, the aim of this study was to investigate the flexural strength properties of three commercial conventional heat cured PMMA that are used to fabricate denture bases. The hypothesis was that the tested available conventional PMMA values in the Libyan market will be accepted clinically in terms of flexural strength of the denture bases.

## MATERIALS AND METHODS

### 1. Sample preparation:

In this In vitro study a silicon mold was used to fabricate identical samples, this mold was used to pour 45 wax samples (TYPE PF WAX), the modeling wax was liquefied completely and poured into the mold, this would guarantee no lumps or air trapped inside. Three groups were made 15 samples to each group with dimensions of 65mm × 10mm × 3mm (according to the American dental association specification no 12), figure 1.

The wax samples were then put in flasks using convectional compression method, the first group (A) represents (Respal $^{NF}$ CE0068, Italy), the second group (B) represents (BMS dental, Italy), the third group (C) represents (everall7 H plus), the mixing and the manipulation of each heat cure resin in the previous groups were conducted according to the manufacturing instructions.

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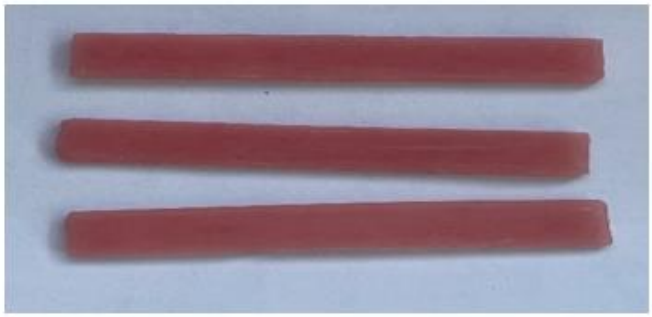

**Figure 1: Wax samples with ADA dimensions.**

## 2. Flexural strength testing:

The testing of each sample was conducted using (Metrotech MTE-25 universal testing machine, Spain), each sample was subjected into the 3-point bending test with the load to 250 kg applied on the centre of the suspended samples. The samples were supported from each side with jigs of 3mm and vertical spam was 55mm, figure 2.

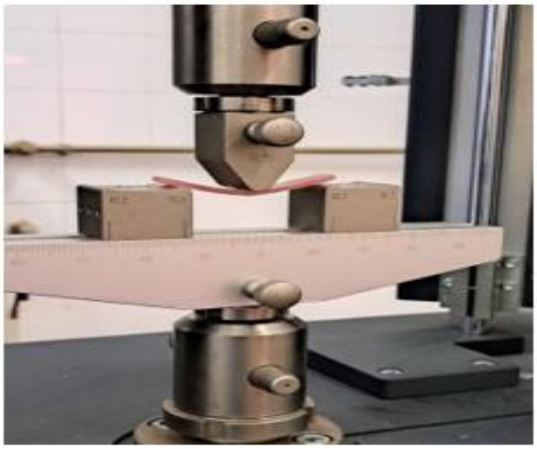

**Figure 2: The 3-point bending test using Metrotech MTE-25 universal testing machine**

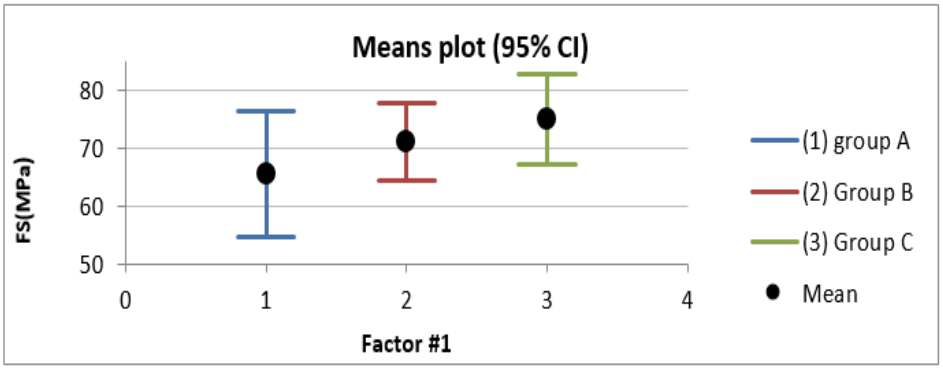


**Figure 3: Flexural strength mean within each group and between the three groups.**

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## RESULTS

The results of the study were statistically analyzed using one way ANOVA test to make comparison between groups and establish whether there is a statistically significant difference between the groups.

To compare the mean FS amongst the three groups, mean FS in group C is the highest with 75.0427MPa, while group B is higher than group A with FS mean 71.1407, 65.5415 MPa respectively. Table 1.

**Table 1: Flexural strength mean within the three groups**

| *Groups* | *Sample size* | *Sum* | *Variance* | *Std Dev* | *Mean* | *95% Confidence Interval** | |
|---|---|---|---|---|---|---|---|
| *group A* | 15 | 981.9700 | 389.0640 | 19.7247 | 65.4647 | 54.5415 | 76.3878 |
| *Group B* | 15 | 1,067.1100 | 146.8916 | 12.1199 | 71.1407 | 64.4289 | 77.8524 |
| *Group C* | 15 | 1,125.6400 | 202.4936 | 14.2300 | 75.0427 | 67.1623 | 82.9230 |
| | | | | | | | |
| *Total* | 45 | | 250.7771 | 15.8359 | 70.5493 | | |

There was no statistical difference in the FS means of all groups as the p-value which was > 0.05 (Table 2).

**Table 2: Statistical analysis of one-way ANOVA test.**

| ***Source of Variation*** | ***d.f.*** | ***SS*** | ***MS*** | ***F*** | ***p-value*** | ***F crit*** | ***Omega Sqr.*** |
|---|---|---|---|---|---|---|---|
| *Between Groups* | 2 | 695.9033 | 347.9517 | 1.4136 | 0.2546 | 3.2199 | 0.0180 |
| *Within Groups* | 42 | 10,338.2902 | 246.1498 | | | | |
| *Total* | 45 | 11,034.1935 | | | | | |

## DISCUSSION

PMMA has a number of desirable properties that account for its widespread popularity in removable prostheses. However, it is not without its drawbacks. Denture fracture due to patient handling or masticatory loads is a significant problem. Improving the material's flexural strength can enhance its clinical performance; thus, most manufacturers strive to improve their products and enhance their flexural strength.

The hypothesis of this study was accepted, as there was no significant difference between the three groups (p-value = 0.2546). Group C, which represents Everall7 H Plus, had the highest FS, with an average of 74.04 MPa. In contrast, Group A had the lowest FS, at 65.46 MPa.

Regarding the results of this study, which compared three different conventional products, other studies have compared conventional products to reinforced types, which showed increased FS. For instance, the study by Secil Ozkan et al. (2023) [21] showed that the FS of a conventional type (74.20 MPa) increased significantly after reinforcement with titanium nanoparticles (84.99 MPa). On the other hand, the same study found that reinforcing conventional PMMA with copper nanoparticles resulted in no significant difference (76.58 MPa).

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Another study compared the FS of conventional PMMA to a glass-fiber-reinforced PMMA, finding that the addition of glass fiber significantly increased the FS to 144.45 MPa [22]. A different study also compared the addition of glass fiber to conventional materials, resulting in a significant increase in FS from 87.74 MPa to 226.53 MPa [23]. The same study also measured the addition of a stainless-steel mesh to conventional PMMA, which also resulted in a significantly increased FS of up to 185.16 MPa [23].

The results of the three groups in this study (65.46, 71.14, and 74.04 MPa) are within the range reported in the previously mentioned studies and also meet the ISO specification of 65 MPa for denture base materials.

This study has its limitations, as it does not accurately simulate real oral conditions. Given that acrylic resin can be affected by factors such as saliva, temperature, and pH changes in the oral cavity, it is difficult to predict the material's clinical performance based solely on in vitro results.

## CONCLUSION

Within the limitations of this study, it can be concluded that all three tested groups met ISO specification No. 20795-1, with a flexural strength higher than 65 MPa, suggesting an acceptable clinical performance.

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