

# Comparative *In Vitro* Study of the Flexural Strength of Resin Provisional Fixed Partial Dentures, With and Without Glass Fiber Reinforcement

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*The aim of this study was to assess the flexural strength of provisional acrylic resin fixed partial dentures reinforced with glass fiber with the provisional restorations without reinforcement. Three groups of specimens were prepared for the flexural strength: Poly Methyl Metacrylate (PMMA) acrylic resin provisional restoration without glass fiber (control), acrylic resin provisional restoration reinforced with glass fiber between the abutments and acrylic resin provisional restoration reinforced with glass fiber including the abutment and the pontic of the fixed partial denture. The flexural strength was tested with a servo-hydraulic testing machine (Zwick Proline Z005 device), with a maximum 5kN force. The highest resistance to deformation and fracture was registered in acrylic resin provisional restoration reinforced with glass fiber including the abutments.*

**Keywords:** provisional restoration, glass fiber, flexural strength, acrylic resin

Provisional restoration is an important procedure in fixed prosthodontics and is used as an interim before fitting the definitive restoration. Properly constructed and accurate fitting provisional fixed partial dentures provide a protective coverage for teeth while the permanent restoration is being fabricated. The fabrication of an ideal provisional restoration is crucial for a successful outcome of the final restoration [1].

One of the most frequent problems of provisional fixed partial dentures is the fracture of the material. Mechanical forces such as: excessive occlusal forces, parafunctional habits, and bruxism, contribute to deformation and the fracture of the provisional restoration. This will lead to the necessity to fabricate a new provisional restoration with added cost in materials and dissatisfied patients.

Considering the high incidence of fractures, numerous studies have been conducted on individual reinforcement methods, to improve the strength of the provisional restoration [2-4, 20]. So, by including in their composition different types of fibers: carbon [5], aramid [6], woven polyethylene [7, 21] and glass fiber [8, 22], the researchers obtained different results.

Polymethylmethacrylate (PMMA) reinforced with carbon and aramid fiber was more resistant, but some clinical problems appeared, like difficult polishing and poor aesthetics [6, 7, 9].

Woven polyethylene fibers are more aesthetic, but the process of etching, preparing, and positioning layers is difficult to achieve in dental office [10].

The glass fibers, despite the difficulty of achieving adequate impregnation of the fiber with PMMA, have given some of the best results to increase the strength of provisional restorations [11].

Glass fiber (GF) was first tested as reinforcement for denture base PMMA as early as the 1960's [11]. Since then, many studies have investigated the strength of glass-fiber reinforced resins [12 -14].

The purpose of this study was to compare the flexural strength of different acrylic resin provisional restorations reinforced with glass fiber with resin provisional restoration without any reinforcement.

## Experimental part

On a typodont (Frasaco, Germany) we realized preparations of the both lower cuspids and simulate a situation of anterior edentulous space (the all four incisors missing). After the impression of the entire arch of the typodont, in the dental laboratory were fabricated several provisional restorations with six elements: two abutments and 4 elements on the pontic.

We used in experiment three types of provisional restorations: PMMA without glass fiber, PMMA reinforced with glass fiber between the abutments and PMMA reinforced with glass fiber totally, including the abutments.

The resistance of restorations to flexural strength was tested in Zwick Proline Z005 device (maximum 5kN force), an universal testing machine, at the Strength of materials Laboratory from University Politehnica Timisoara, which has experience in testing of plastic materials [14-17]. Each type of restoration was tested applying a load on the top of the provisional restoration, (fig.1). The deformation of the material occurred first, followed by the fracture of the restoration. The force was applied using a steel ball of 6 mm diameter on the middle of each sample. The loading speed of the forces applied was 1mm/min.

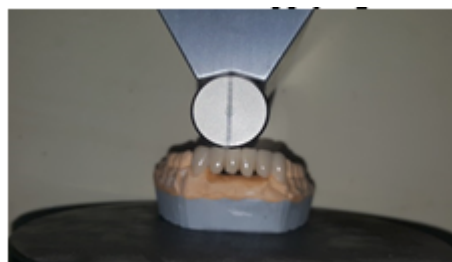


Fig. 1 - Acrylic resin provisional restoration tested in Zwick Proline Z005 device

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Type of acrylic provisional restoration	Sample number	Max. force applied until fracture (N)	Deformation of the restoration at Fmax (mm)
without glass fiber	1.1	92.0	1.05
	1.2	55.0	0.80
	1.3	81.7	0.90
	1.4	88.0	0.95
with glass fiber between the abutments	2.1	148	1.95
	2.2	142	2.0
	2.3	145	1.9
	2.4	141	2.1
with glass fiber	3.1	105	1.50
	3.2	102	1.63
	3.3	101	1.60
	3.4	107	1.20

**Table 1**  
EXPERIMENTAL  
RESULTS OF THE  
ACRYLIC  
PROVISIONAL  
RESTORATIONS WITH  
AND WITHOUT GLASS  
FIBER

## Results and discussions

In table 1 are represented the maximum force until every sample was fractured and the deformation corresponding to maximum force.

The first determination of the experiment shown that, in the case of acrylic resin provisional restoration without glass fiber, the restoration deformation occurred at a force of 92 N (fig. 2a), respectively 55 N (fig. 2b). In the first case, when applied a force of 92 N, restoration was deformed over an area of 1.05 mm, then was completely fractured between the central and lateral incisors (fig. 3).

For the Sample 1.2, the deformation appeared over an area of 0.8 mm, than the restoration was fractured between



Fig. 4. Acrylic resin provisional restoration without glass fiber, fractured when applied a 55 N force

the central incisors (fig. 4). At the force of 81.7 and 88 N, the deformation appeared over 0.9, respectively 0.95 mm area.

The second type of restoration used in this study, was the acrylic resin provisional restoration reinforced with glass fiber between the abutments. The force applied was 148 N; over this force, the corresponding deformation was 1.95 mm (fig. 5). Despite the higher force applied, only a fissure of the provisional restoration was observed (fig. 6).

Sample 2.2 resists to a force up to 142 N, and the corresponding deformation was 2 mm. In case of a 145 N

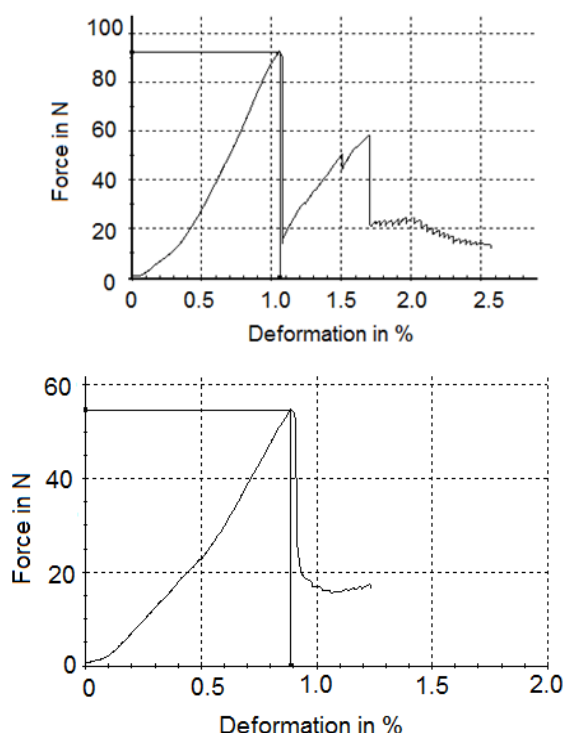


Fig. 2 .The flexural strength of acrylic provisional restoration without fiberglass, under a). 92 N force and b). 55 N force



Fig. 3 .Acrylic resin provisional restoration without fiberglass, fractured when applied a 92 N force

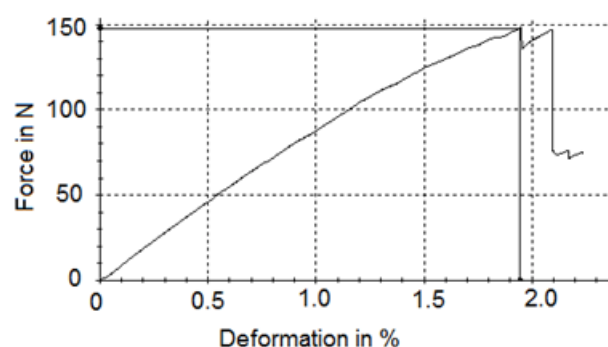


Fig. 5. The flexural strength of acrylic provisional restoration reinforced with glass fiber between the abutments resist under 148 N force



Fig. 6. Acrylic resin provisional restoration reinforced with fiber glass between abutments, fissured when applied a 148 N force

force, a deformation of 1.9 mm was observed. For a force of 141 N the deformation was over 2.1 mm (table 1).

For the acrylic resin provisional restoration totally reinforced with glass fiber, the maximum force applied

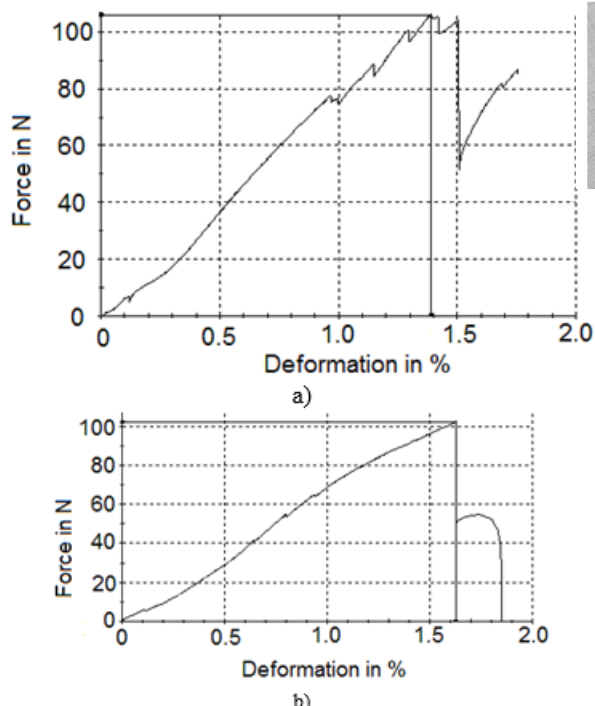


Fig. 7. The flexural strength of acrylic provisional restoration reinforced with glass fiber including the abutments, under a). 105 N force and b). 102 N force

was 105 N and 102 N. In the first case, the fracture occurred after 1.5 mm, and in the second case after 1.63 mm. (fig. 7). For the last samples, we obtain a maximum load of 101 N and 107 N and the deformation occurred after 1.6mm, respectively after 1.2 mm (table 1).

In both cases, the results of forces applied was only a small crack, between the canine and lateral incisor in the first case (fig. 8a), and between central and lateral incisors in the second one (fig. 8b).

Vallittu's [18] and Hamza [19] studies evaluated the effect of fiber reinforcement on the fracture toughness and flexural strength of provisional resin. The conclusion of this experiments were that impregnated fibres were an effective method to increase fracture toughness and flexural strength of provisional resins.

The analyses of this experiment showed that the glass fiber reinforced restoration acrylic presented a higher flexural strength, than the uninforced specimens. The fracture present in the case of the restoration without glass fiber) and the fissure (the restoration with glass fiber) occurred perpendicularly to the trajectories of the most tensile stress, applied to each specimen.

The impact of the forces applied on the specimens studied was different:

- for the restoration without glass fiber, the average value of maximum force was 79.2 N and the complete fracture of the restorations was observed;

- applying the flexural loads on the glass fiber reinforced restorations, only a fracture line occurred. Also, higher values of maximum load average were obtained 144 N for reinforcement with glass fiber between the abutments, respectively 103.8 N for complete glass fiber reinforcement.

From the practical point of view, in this study it could be observed that the reinforcement with glass fiber between the abutments give the higher flexural strength of the provisional restoration.

The optimized design was able to significantly reduce stress throughout the entire structure, especially in the loading point regions. The fracture risk was reduced for the fixed provisional partial denture reinforced with fiber



Fig. 8 a,b. Acrylic provisional restoration reinforced with glass fibre including the abutments fissured when applied a 105 N force (a), 102 N force (b)

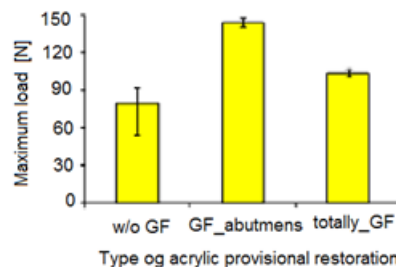


Fig. 9. The influence of glass fiber reinforcement on the maximum load

glass; when maximum force was applied, only the deformation and the fissure of the restoration was observed.

### Conclusions

This study demonstrated the effect of glass fiber reinforcement on the flexural strength of the acrylic provisional restorations (fig. 9).

When using reinforced provisional resin materials clinically, it may be the optimal choice to prevent the fracture of the restoration. This might prevent the patients discomfort and unscheduled appointments in dental office. All unreinforced specimen showed undesirable complete separation. The reinforced specimen showed only small fissure only, that stopped at the level of the fiber location, suggesting that use of these fibers may be beneficial in reinforcing fixed provisional restorations, which may be used for extended periods.

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