

# E-GLASS FIBERS REINFORCED COMPLETE ACRYLIC RESIN REMOVABLE DENTURE

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## REZUMAT

**Introducere:** Protezele acrilice mobile și mobilizabile armate cu fibre de sticlă reprezintă un domeniu de studiu al ultimilor ani. **Scopul studiului:** Performanța clinică a 20 proteze totale acrilice armate cu fibre de sticlă (Stick și Stick Net) a fost evaluată în cadrul unui studiu preliminar. **Material și metode:** Noile proteze totale armate cu fibre de sticlă au fost confecționate pentru a înlocui protezele totale vechi fracturate. Protezele vechi nu prezentau nici un fel de armătură. Numărul total al pacienților incluși în studiu a fost de 17 iar numărul noilor proteze armate a fost 20. Armarea totală cu plasă din fibre de sticlă (Stick Net) a fost folosită în cazul protezelor totale superioare. Protezele totale inferioare au fost armate parțial cu fibre de sticlă unidirectionale (Stick). Perioada de urmărire a pacienților purtători ai protezelor totale armate a fost cuprinsă între 6 luni și doi ani. Au fost evaluate vizual eventualele fracturi sau discromii care au apărut. De asemenea a fost evaluată starea generală a protezelor armate. **Rezultate:** La examinarea realizată la doi ani de la inserare doar două dintre protezele din grupul de control au suferit fracturi. Pacienții s-au declarat satisfăcuți de noile lor proteze în special din punct de vedere estetic. Perioada de urmărire a fost însă scurtă. Vom efectua în continuare urmărirea clinică a pacienților incluși în studiu. **Concluzii:** Fibrele de sticlă pre-impregnate (Stick și Stick Net) sunt utile pentru armarea protezelor totale acrilice în special în cazurile unde solicitările ocluzale sunt mari.

**Cuvinte cheie:** armătură, fibre de sticlă, fractură, proteze totale

## ABSTRACT

**Introduction:** Glass fiber reinforced removable acrylic dentures have been under development for some time. **Aim of the study:** The clinical performance of 20 Stick and Stick-Net reinforced complete acrylic dentures was evaluated in a preliminary study. **Material and methods:** The complete new dentures were made to replace old fractured unreinforced acrylic dentures. The total number of dentures was 23 and the number of patients was 17. Woven E-glass fibers (Stick Net) reinforcements were used as total fiber reinforcements in upper complete dentures. Unidirectional E-glass fibers (Stick) reinforcements were used as partial fiber reinforcements in lower complete dentures. Follow-up period varied from 6 month to two years. After the follow-up period, possible fractures and discoloring were visually inspected. General shape of the denture was also evaluated. **Results:** Only after two years of wearing the new dentures, two of the control dentures were broken. Patients were satisfied with their dentures especially because their good aesthetics. The follow-up period was relatively short so, it needs to continue. **Conclusions:** Pre-impregnated E-glass fibers (Stick and Stick Net) are useful in reinforcing acrylic complete removable dentures especially in cases where heavy occlusal forces are present.

**Key Words:** reinforcement, glass fiber, fracture, denture

## INTRODUCTION

In Romania, like in many other European countries, denture base fracture is a common problem. The Department of Prosthodontics, Faculty of Dental Medicine, Timisoara, Romania is involved in research on the prevention of acrylic denture base

fractures. Conventional heat cured acrylic resin is still the predominant denture base materials in use in our Department, due to its accessible price. These materials are typically low in strength, soft and fairly flexible, brittle in impact and fairly resistant to fatigue failure.<sup>1</sup> So, this material is still far from ideal in fulfilling the mechanical requirements of a removable denture.<sup>2</sup> Frequently, fractures in complete removable dentures results from flexural fatigue and sometimes from impact forces.

There were many attempts to reinforce the material. Metal strengtheners are useful for dentures which have a permanent resilient soft lining.<sup>2</sup> Some mechanical testing have proved that glass fiber reinforcements Stick and Stick Net are useful in reinforcing heat-curing denture base PMMA.<sup>3,4</sup> The denture base can be reinforced in two ways: the entire denture base

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can be reinforced with a fiber weave, or the fiber reinforcement can be accurately placed at the weak region of the denture. These reinforcements can be divided in total fiber reinforcement (TFR) and partial fiber reinforcement (PFR).<sup>5</sup>

Fatigue resistance, impact strength and flexural strength of acrylic resin were improved by glass fibers reinforcements.<sup>3,6-8</sup>

Stick™ and Stick™ Net are semi-manufactured products made of glass fibers and highly porous polymer matrix for reinforcing dental acrylic. Stick™ is made of unidirectional fibers which increase the strength of the final product perpendicular to the direction of the fibers. Stick™ Net is made of a thin fiberglass fabric, which increases the strength and toughness of the final product in all directions.

Preliminary studies revealed the importance of both the correct position of the partial fiber reinforcement in the denture and the use of accurate laboratory techniques.<sup>5</sup> The new partial fiber reinforcements can prevent recurrent fractures in acrylic resin dentures.

The aim of this study was to evaluate the function of Stick™ and Stick™ Net reinforced new complete dentures. Follow-up period varied from 6 month to 2 years.

## **MATERIALS AND METHOD**

The clinical study was undertaken in the Department of Prosthodontics of the Faculty of Dental Medicine, Timisoara. Subjects included in the study were patients with fractured acrylic complete upper or lower denture. The inclusion criterion was existence of a fracture line in the acrylic resin denture base or a fracture of the denture in two or many pieces. Clinical examination was made by one operator. Technical laboratory work was done by two technicians; they did not have previous experience in using fiber reinforcements. The number of dentures was 23 and the number of patients was 17. Patients were asked if they agree to participate to the study. Each of them has signed an informed consent.

New dentures were manufactured from a heat cure acrylic resin Meliodent (Heraeus Kulzer GmbH & Co KG). The heat cure resin was used in a compression - molded technique. Dentures were reinforced with Stick™ (preimpregnated unidirectional glass fibers) and Stick Net® (preimpregnated glass fabric) (Stick Tech Ltd, Finland).

Glass fibers Stick™ and Stick Net® were wetted with a powder liquid mixture.

All the cases selected for the study had a history of

recurrent fracture in the PMMA denture base. Some of the fractures in upper complete denture were midline fracture or nearby. Fractures of the lower complete dentures occurred in the midline or nearby. None of the fractured dentures were previously reinforced.

The type of new complete denture and the type of reinforcement used are shown in Table 1. The types of teeth opposing the dentures are shown in Tables 2 and 3.

**Table 1.** New complete dentures.

<b>Type of new complete denture</b>	<b>Number and type of glass fiber reinforcement</b>
Upper (maxillary) Stick™ Net reinforced dentures	<b>11</b> total fiber reinforcement (TFR)
Lower (mandibular) Stick™ reinforced dentures	<b>6</b> partial fiber reinforcement (PFR)
Control	<b>6</b> un-reinforced complete PMMA dentures

**Table 2.** Type of teeth opposing the new glass fiber reinforced complete dentures.

<b>Type of opposing teeth</b>	<b>Number of cases</b>
Natural teeth or artificial crowns/ fixed partial dentures (including traditional bridges and implant bridges)	7
Complete dentures	8
Removable partial denture of acrylic resin	2
Removable partial denture with metal frame	-

Clinical examinations were carried out at six month and two years after the treatment. Patients were asked to contact the operator in case the denture failure. Clinical examinations were conducted according to an evaluation form and include the following observations:

1. Fractured/broken denture;
2. Fracture line through fiber reinforcement;
3. Fracture line that stops at fiber reinforcement or discoloration of the reinforcement;
4. Protrusion of the fibers;
5. Irritation of oral mucosa by fibers.
6. Patient satisfaction.

The aspect of an upper Stick Net TFR acrylic denture is presented in Figure 1. In the Figures 2 and 3 are presented the intra and extra-oral aspect of a lower Stick Net PFR.

## **RESULTS**

The examinations carried out at six month showed lack of fractures in all the dentures. After two years of

wearing the new dentures, two of the control dentures (one with natural opposing teeth and one with an opposing complete denture) were broken. Both six month and two years clinical examinations revealed no fractures in PFR or TFR complete dentures. Also, no irritation of the oral mucosa by glass fibers was noticed. Patients were satisfied with their denture especially because their good aesthetics compared to metal reinforcements and metal bases or other fiber reinforcements (carbon fibers or Kevlar fibers). The follow-up period was relatively short so, it must continue. The patients will be called for check-up visit at two years and a half and at three years.

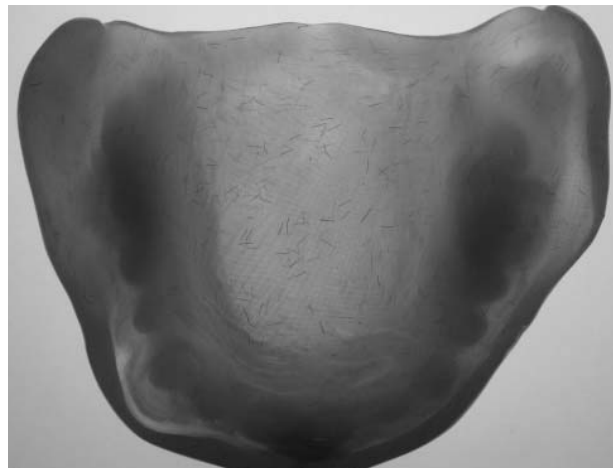
**Table 3.** Type of teeth opposing complete new dentures.

Case No.	Complete new denture	Opposing teeth
1.	Stick Net TFR upper complete acrylic denture	Natural teeth, implant fixed partial denture (Kennedy II )
2.	Stick Net TFR upper complete acrylic denture	Fixed partial denture (Kennedy I mod 1)
3.	Stick Net TFR upper complete acrylic denture	Stick PFR complete lower denture
4.	Stick Net TFR upper complete acrylic denture	Stick PFR complete lower denture
5.	Stick Net TFR upper complete acrylic denture	Fixed partial denture (Kennedy III mod 2)
6.	Stick Net TFR upper complete acrylic denture	Fixed partial denture
7.	Stick Net TFR upper complete acrylic denture	Implant fixed partial denture
8.	Stick Net TFR upper complete acrylic denture	Natural teeth
9.	Stick Net TFR upper complete acrylic denture	Complete denture
10.	Stick Net TFR upper complete acrylic denture	Complete denture
11.	Stick Net TFR upper complete acrylic denture	Complete denture
12.	Stick PFR complete lower denture	Removable partial denture of acrylic resin (Kennedy I)
13.	Stick PFR complete lower denture	Stick Net TFR upper complete acrylic denture
14.	Stick PFR complete lower denture	Stick Net TFR upper complete acrylic denture
15.	Stick PFR complete lower denture	Natural teeth, fixed partial denture (Kennedy III, mod 2)
16.	Stick PFR complete lower denture	Removable partial denture of acrylic resin (Kennedy I)
17.	Stick PFR complete lower denture	Upper complete denture
18.	Control	Fixed partial denture (Kennedy III, mod 1)
19.	Control	Natural teeth
20.	Control	Complete denture
21.	Control	Fixed partial denture+ Removable partial denture of acrylic resin (Kennedy II, mod 1)
22.	Control	Fixed partial denture (Kennedy III), natural teeth
23.	Control	Fixed partial denture (Kennedy III, mod 2)

## DISCUSSION

There are a lot of mechanical studies regarding impact and flexural strength of glass fiber reinforced

acrylics.<sup>9-13</sup> All these studies showed that glass fibers are efficient in reinforcing PMMA. There are also some clinical studies which revealed the importance of both the correct position of the partial fiber reinforcement in the denture and the use of accurate laboratory techniques.<sup>5,14</sup>



**Figure 1.** Extraoral aspect of an upper Stick Net TFR complete acrylic denture (case 9).



**Figure 2.** Stick Net TFR complete denture.



**Figure 3.** Extraoral aspect of a lower Stick PFR complete acrylic denture (case 2).

E-glass fibers (Stick<sup>TM</sup> and Stick Net<sup>®</sup>, Stick Tech, Ltd, Turku, Finland) were used to reinforce complete dentures fabricated with heat polymerized high impact acrylic resin Lucitone (Lucitone 199; Dentsply). In this case, the impact strength of maxillary complete denture fabricated with high impact acrylic resin increased by a factor greater than 2 when reinforced with woven E-glass fibers.

There are only a few clinical studies regarding the clinical behavior of removable acrylic reinforced dentures. Narva et al found that polymer pre-impregnated partial fiber reinforcement seems to be useful in eliminating fractures of acrylic resin removable dentures.<sup>14</sup> However, the study emphasizes the importance of correct positioning and accurate laboratory technique when partial fiber reinforcement is used.

Valittu evaluated the clinical usefulness of continuous E-glass partial fiber reinforcement of acrylic resin removable dentures an average 13 months after the insertion of the fibers.<sup>5</sup> Twelve removable complete dentures and ten removable partial dentures with a history of recurrent fracture were selected for the study. The partial fiber reinforcement was incorporated into the denture at the time of repair. One complete denture and one removable partial denture fractured in the region of reinforcement during the examination period. These fractures were most likely caused by faulty placement of the fiber reinforcement in the denture in the dental laboratory. In six dentures, new fractures occurred in regions without partial fiber reinforcement. The results revealed the importance of both the correct positioning of the partial fiber reinforcement in the denture and the use of accurate laboratory techniques.

Laboratory procedures with heat polymerized acrylic resin reinforced with pre-impregnated glass fibers have to be accurate. We used in upper complete dentures Stick Net (TFR) on the entire base of the denture. It was a little difficult, but the results were encouraging. The aesthetics was also very good. In some cases we used Stick PFR. This type of reinforcement proved to be competitive although the follow up period was only two years.

## **CONCLUSIONS**

With the limitations of the study, the following conclusions were made:

1. Glass fibers (Stick Tech Ltd, Finland) are efficient in reinforcing complete heat cured acrylic dentures when necessary.
2. Both total fiber reinforcement (TFR) and partial fiber reinforcement (PFR) are useful.
3. A longer follow up period is essential to show the clinical usefulness of glass fiber PFR and TFR.

## **COMPETING FINANCIAL INTEREST**

The sponsor of the study was the company Stick Tech Ltd, Turku, Finland.

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