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REINFORCEMENT OF COMPOSITE RESINS WITH UNIDIRECTIONAL GLASS FIBERS

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INTRODUCTION: Glass fibers have been introduced as reinforcement for composite resins in dentistry more than 20 years ago. They are available in different forms : unidirectional, braid, woven, mesh. They can also be found as pre-impregnated or as material to be impregnated with resin before use when needed. Among different clinical applications we can cite : dentures, overdentures, reinforced temporary/long-term (interim) bridges etc. Even after more than ten years of first clinical experiments the conclusion is that they can be used as long temporary solution (few months up to two years), in case of fixed partial denture (Vallittu[1], Vallittu and Sevelius[2]).

In current research on dental implants there are some intentions for immediate loading : « The results suggest that immediate loading of Branemark System implants at the time of placement in edentulous patients can be a valuable adjunct to therapy and as predictable as delayed loading, in both mandibular and maxillary arches. » Horiuchi K[3], Gatti et al[4] and Copper et al[5] have come to the same results in their own works. We therefore decided to point our research in that direction.

By selecting materials which have a lower rigidity than a cast metal alloy we might be providing better conditions for healing process in the bone surrounding the implant.

First we have decided to evaluate improvement in mechanical behavior, both with laboratory composite resins and with a provisional resin. Thanks to those preliminary results it seemed reasonable to continue our research in making samples shaped like real bridges and to evaluate them under loading.

The aim of this work was to evaluate reinforcement with glass fibers of two dental materials : laboratory composite resins and provisional resins, in order to obtain preliminary results for further studies of provisional bridges as a suprastructure for immediate loading of implants.

METHODS: We have used two different laboratory composite resins (Sinfony, *ESPE* and Cristobal+, *IDR*) and one provisional resin (Protemp Garant 3, *ESPE*) reinforced with unidirectional glass fibers (Stick, *Stick Tech Ltd.*). For all the materials we have used Sinfony Transparent, a flowable composite resin, for a 10 minutes impregnation of glass fibers, in a closed plastic bag. The samples with composite resins were prepared in a 25x2x2 mm mould and cured for 15 sec with a halogen curing lamp Elipar TriLight (*ESPE*), followed by additional curing in the Mpa 2000 light-curing unit for 90 sec, and at the end treated with temperature of 80 degrees C for 8 minutes in the Mpa 2000 Post Cure unit. The samples with provisional resins have been light-cured differently : 15 sec with the Elipar TriLight curing lamp, followed by a post-cure treatment in *ESPE* Beta-Unit, auxiliary program 1. Flexural strength and elastic modulus have been examined with 3 and 4 points bending tests, using an Instron Universal testing machine 1114, at a crosshead speed of 0.5 mm/min. Statistical analysis was performed by multifactorial ANOVA.

RESULTS:

Table 1. Modulus of elasticity of fiber-reinforced composite resins in GPa

4 points test	Without fibers	
	24 h	7 d
Cristobal	13.8 (1.8)	22.7 (6)
Synfony	7.2 (0.5)	7.1 (1.2)
	With fibers	
	24 h	7 d
Cristobal	17.2 (5.3)	15.4 (8.5)
Synfony	16.8 (1.3)	10.5 (1.1)

Table 2. Flexural strength of fiber-reinforced composite resins in MPa

4 points test	Without fibers	
	24 h	7 d
Cristobal	140 (28)	159 (22)
Synfony	163.4 (13)	162 (14)
	With fibers	
	24 h	7 d
Cristobal	460 (130)	340.3 (51)
Synfony	525.6 (36)	462.3 (91)

Multifactorial analysis has shown that glass fibers reinforce the laboratory composite resins but they do not have any influence on their elastic modulus. On the other hand samples become less resistant with time, but their modulus does not change.

Table 3. Flexural strength of fiber-reinforced provisional resins in MPa

4 points test	Without fibers	
Flex strength	24 h	7 d
Protemp Garant 3	134(60)	180(19)
	With fibers	
	24 h	7 d
Protemp Garant 3	110(24)	207(61)

Table 4. Modulus of elasticity of fiber-reinforced provisional resins in GPa

4 points test	Without fibers	
Flex modulus	24 h	7 d
Protemp Garant 3	2.2(0.6)	2.6(0.7)
	With fibers	
	24 h	7 d
Protemp Garant 3	2.9(0.8)	6(2)

Multifactorial analysis has shown that only aging in water has significant influence on flexural strength of provisional resins, but the reinforcement has not. For flexural modulus both, aging in water and reinforcement, give significant difference for tested material.

DISCUSSION & CONCLUSIONS: Post-curing provides better mechanical properties in a short period of time. Glass fibers reinforce significantly the flexural strength of the laboratory composite resins, but strength is more material dependent than condition specific (aging in water, reinforcement) – this is more obvious for Sinfony, a less charged material. On the contrary, flexural strength of provisional resins is condition dependent (aging in water). Also their flexural modulus has become more elevated in simultaneous action of aging and reinforcement.

The work is continuing by the evaluation of provisional reinforced resin characteristics and the development of bridges which simulate more closely the clinical situation.

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