The Third International Symposium on Fibre-Reinforced Plastics in Dentistry
18th-19th October 2002
Manchester, UK

Bonding of composite resin luting cement to FRC root canal posts. A pilot study.

A.-M. Le Bell[1] *, M. Keski-Nikkola[1], J. Tanner[1], L.V.J. Lassila[1], I. Kangasniemi[2] and P.K. Vallittu[1]

[1] Department of Prosthetic Dentistry and Biomaterials Research, Institute of Dentistry, University of Turku, Finland; [2] Stick Tech Ltd, Turku, Finland

Introduction

In the 90's prefabricated, finally polymerized Fibre Reinforced Composite (FRC) root canal posts were introduced on the market. FRC posts have been claimed to have many benefits compared to metal posts. However, FRC root canal posts have been criticized regarding the flexural properties and adhesion to luting cements and core build-up composites. The highly cross-linked polymer matrix of finally polymerized FRC root canal posts may not provide an optimal substrate for bonding to composite resin luting cements. On the other hand, based on current information, inter-penetrating polymer network (IPN) bonding systems can be used to enhance the adhesion between polymer based materials, for example FRC posts and luting cements[1]. This sets some requirements for the composition of polymer matrix of FRC posts.

Aim

The aim of this study was to compare bonding of composite resin luting cements to FRC posts with IPN polymer matrix and FRC posts with highly cross-linked polymer matrix (prefabricated posts). Titanium posts with surface retentions providing mechanical interlocking served as reference.

Materials and Methods

Posts of seven different brands with diameters ranging between 1.4 mm and 1.8 mm were tested (Figure 1).

The tested posts were:

Brand	Type of post	Surface	Fibre	Polymer matrix
Stick	individually formed	smooth	glass	IPN
EverStick	individually formed	smooth	glass	IPN
Snowpost	prefabricated	smooth	glass	cross-linked
ParaPost FiberWhite	prefabricated	serrated	glass	cross-linked
C-Post	prefabricated	smooth	carbon	cross-linked
C-Post serrated	prefabricated	serrated	carbon	cross-linked
ParaPost XT	prefabricated	serrated	titanium	

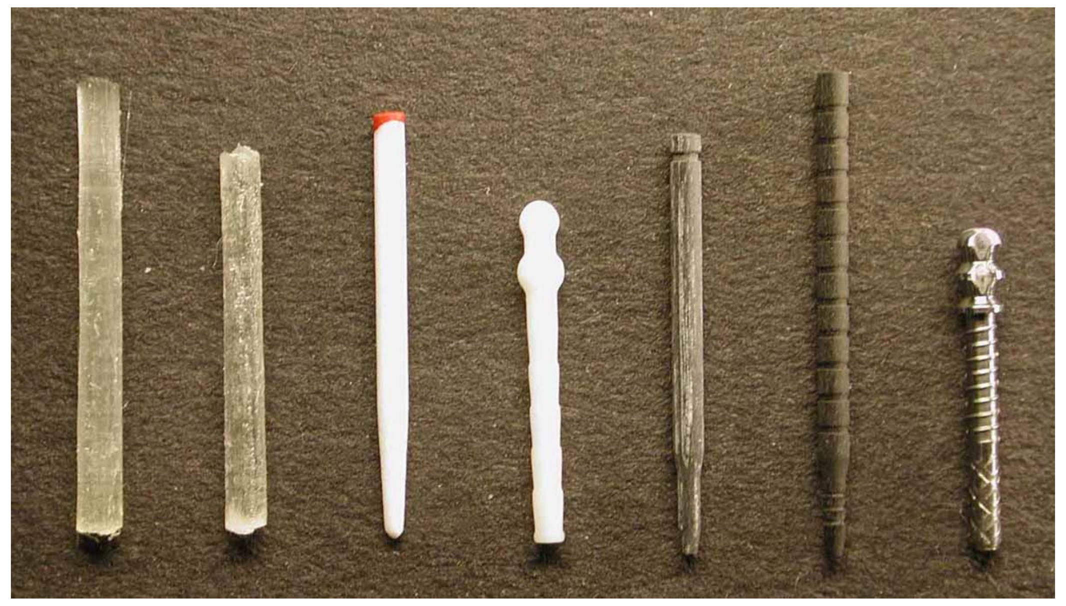

Figure 1. Posts used in the study. From the left: Stick, everStick, Snowpost, ParaPost FiberWhite, C-Post, C-Post serrated and ParaPost XT.

Material	Manufacturer	Type
everStick™	Stick Tech Ltd Turku, Finland	polymer-monomer gel preimpregnated E-glass fibre reinforcement
Stick™	Tech Ltd Turku, Finland	polymer preimpregnated E-glass fibre reinforcement
Stick™ Resin	Stick Tech Ltd Turku, Finland	light-curing BisGMA-TEGDMA resin

Figure 2. Materials of individually formed FRC posts with IPN polymer matrix.

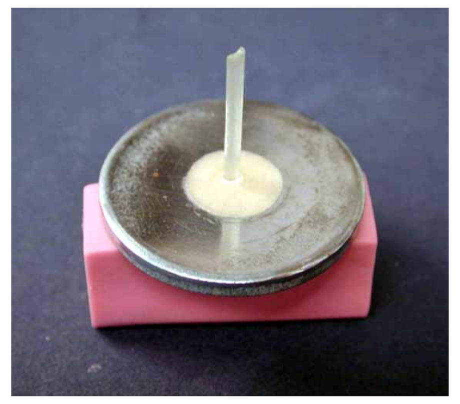

Figure 3. EverStick post cemented into the disc.

Figure 4. The custom-made jig for measuring the Pull-out force for posts.

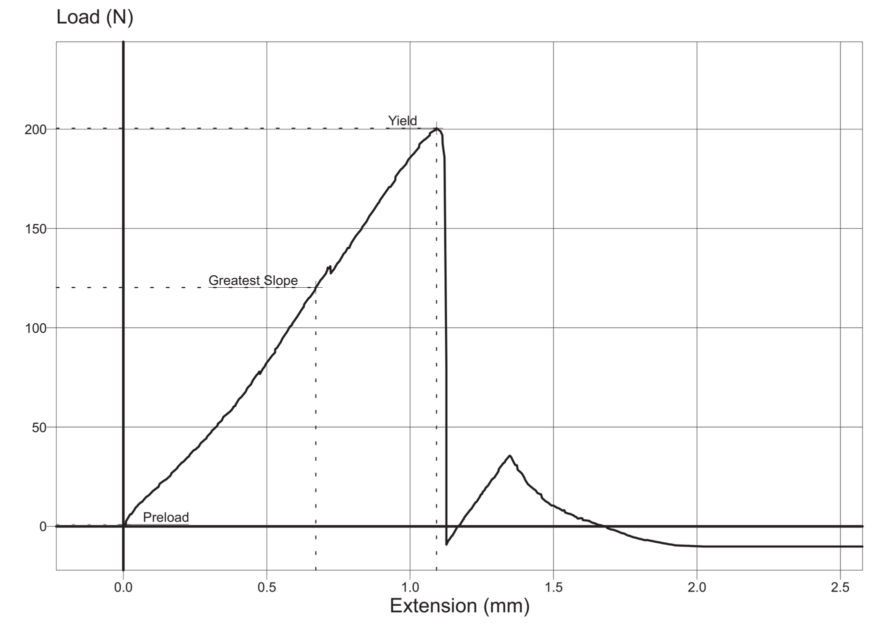

Figure 5. The loading curve for measuring the Pull-out force of everStick post.

Two types of posts with IPN polymer matrix were individually formed from preimpregnated continuous unidirectional E-glass fibre reinforcement, 1) either impregnated with a polymer-monomer gel (everStick™, Stick Tech Ltd, Turku, Finland) or 2) further-impregnated by hand for approximately one hour with light-polymerizable dimethacrylate monomer resin (Stick™ + Stick™ Resin, Stick Tech Ltd, Turku, Finland) (Figure 2).

The individually formed posts were light-polymerized for 40 seconds (on two different sides of the post) before cementation. A light-curing device (Elipar® Highlight, 3M-Espe, Seefeld, Germany) with a halogen lamp radiating blue light, with an intensity of 740 mW/cm^2 (Optilux 501, Danbury, USA) was used. Discs of composite with a thickness between 2.10 mm and 2.30 mm were cemented into metallic molds. Holes, with a diameter of 2 mm, simulating post spaces, were drilled into the discs. The seven various types of posts were cemented with an auto-polymerizing cement (ParaPost®Cement™, Coltène Whaledent, Konstanz, Germany) into the 2 mm spaces of the composite material (Figure 3). No treatment of the posts with resin was done before cementation. The samples were stored in room temperature for 15-20 hours. Eight posts of each type were tested dry and eight after thermocycling in water (6000 x, 5 ºC/ 55 ºC, dwelling time of 30 s). The pull-out force was measured by pulling the post from one end using a universal testing machine (Lloyd LRX, Lloyd Instruments Ltd, Fareham, UK) with a custom-made jig using a cross-head speed of 1 mm/min (Figure 4). The force at the point of interfacial failure between the post and the cement could be observed at the loading curve (Figure 5).

Statistical Analysis

The data was subjected at first stage to ANOVA and subsequent comparisons between post groups were performed with Dunnett T3 Post Hoc Tests. The level of statistical significance was considered to be $P \leq 0.05$.

Results

The highest pull-out force was obtained with metal posts (Figure 6). One of the two types of FRC posts with IPN polymer matrix (Stick™) performed superiorly in comparison with the other FRC posts. The analysis of ANOVA revealed that both the type of post and thermocycling had a significant effect ($P < 0.001$ and $P < 0.007$, respectively) on the force needed to break the bond between the post and the cement. Post hoc analysis revealed that both types of FRC posts with an IPN polymer matrix (Stick™ and everStick™) gave significantly higher pull-out force values than the prefabricated FRC posts with smooth surface and a crosslinked polymer matrix ($P < 0.004$).

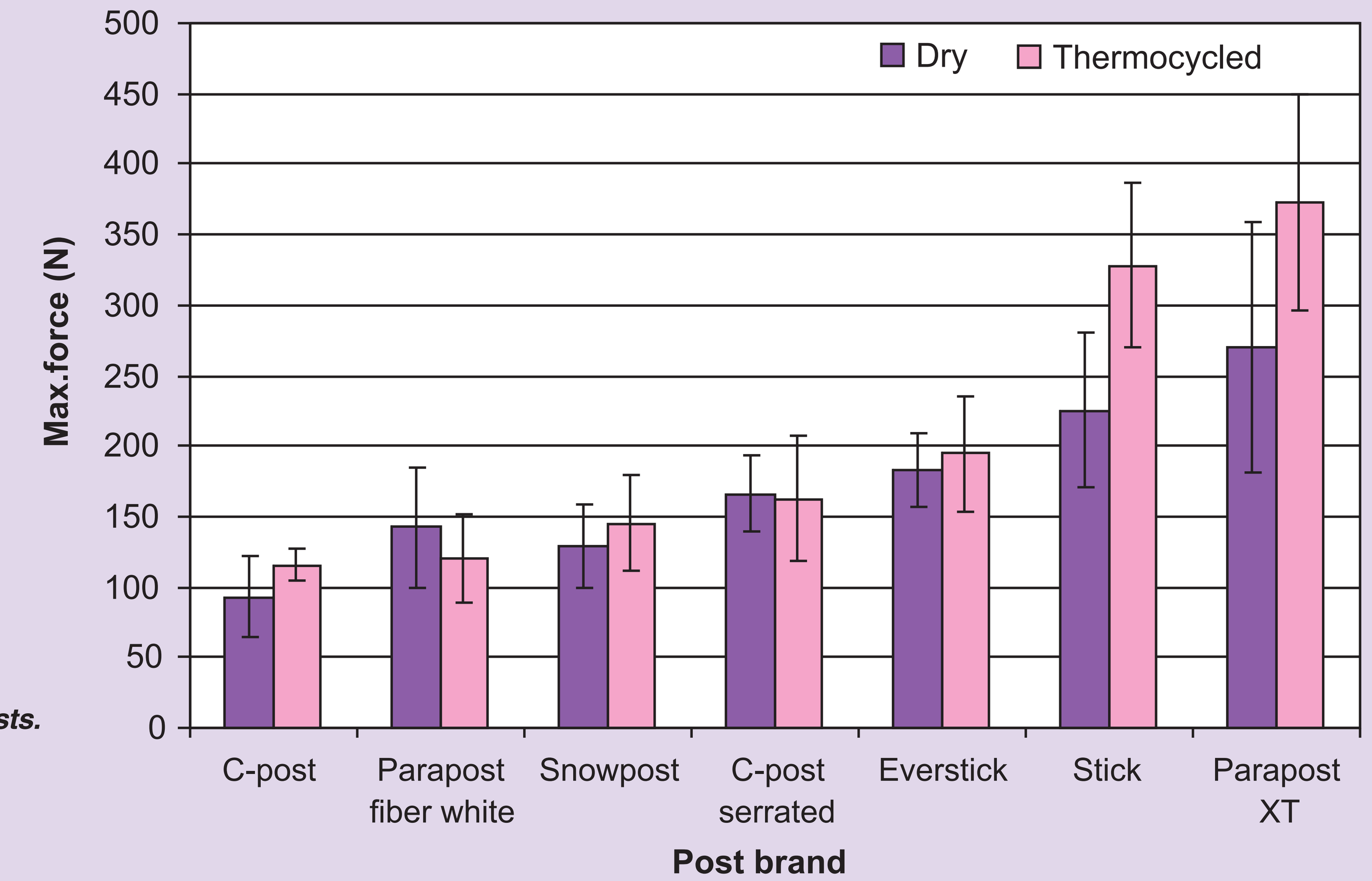

Figure 6. Mean Pull-out forces and standard deviations for studied posts.

Discussion

The higher values observed for the titanium posts can be explained by the good mechanical retention provided by surface serrations. However, serrated FRC posts did not show similar behaviour. This may be due to the anisotropic properties of Fibre Reinforced composites.

Of the FRC posts with a smooth surface, posts with IPN-polymer matrix had a tendency to offer more reliable bonding than those with a cross-linked matrix. The difference between the two types of FRC posts with an IPN matrix could be due to the larger amount of linear polymer in the matrix of the individually made Stick™ post, resulting in IPN structure with improved adhesional behaviour. It is of importance to notice that no intermediate resin on the FRC posts was used. It has been shown that resins can considerably enhance bonding of resin composites to FRC with IPN polymer matrix[2]. It may be assumed that bonding of FRC posts with an IPN polymer matrix can be improved by using intermediate resin before cementation.

Conclusions

This *in vitro* study showed that the FRC posts with an IPN polymer matrix can offer some benefit over prefabricated FRC posts with cross-linked polymer matrix. Further studies are however needed.

Correspondance:
Dr Anna-Maria Le Bell
Institute of Dentistry
University of Turku
Lemminkäisenkatu 2
FIN-20520 Turku, Finland
Phone: +358-2-3338376
Fax: +358-2-3338390
e-mail: ami.lebell@utu.fi

1) Kallio TT, Lastumäki TM, Vallittu PK. Bonding of restorative and veneering composite resin to some polymeric composites. Dent Mater 2001;17:80-86
2) Lastumäki TM, Kallio TT and Vallittu PK. The bond strength of light curing-composite resin to finally polymerized and aged glass fiber-reinforced composite substrate. Biomat 2002;23:4533-4539