Mechanical and adhesion properties of dental composites

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Introduction

Dental composites are widely used restorative materials but requires complex adhesive procedures for bonding to dentine, and there is some level of polymerization shrinkage . Additionally current methods of assessing bonding to human teeth are very variable. The aim of this study is to produce high strength composites containing adhesion promoting, and surface active activators, and develop a more reproducible method of assessing their dentine bonding potential.

Objectives:

Assess how replacement of the activator DMPT by the surface active and methacrylate containing amine SAN, and TEGDMA diluent with higher molecular weight PPGDMA, affects mechanical and adhesive properties of dental composites.

Materials and methods

UDMA and TEGDMA (T) or PPGDMA (P) in 3:1 mass ratio were mixed with 5 wt % HEMA, 1wt% CQ and 1wt% DMPT (D) or SAN (N) to provide 4 composites designated as TD, TN, PD and PN. These were combined with silane treated glass particles (PLR 4:1). Results were compared with commercial Z250.

The biaxial flexural strength / modulus of discs (10 mm diameter, 1 mm thick) were determined after 24 hours in distilled water. Composite debonding force was determined using a "push out" test, and ivory dentine blocks from 2 elephant tusks used as received or hydrated and dehydrated for 24 hours prior to use. Cylindrical holes (3mm diameter, 5 mm deep) were drilled, and filled by composite.

Figure 1: Metal ring, and composite disc.

Figure 2: Phosphoric acid 37 % etchant.

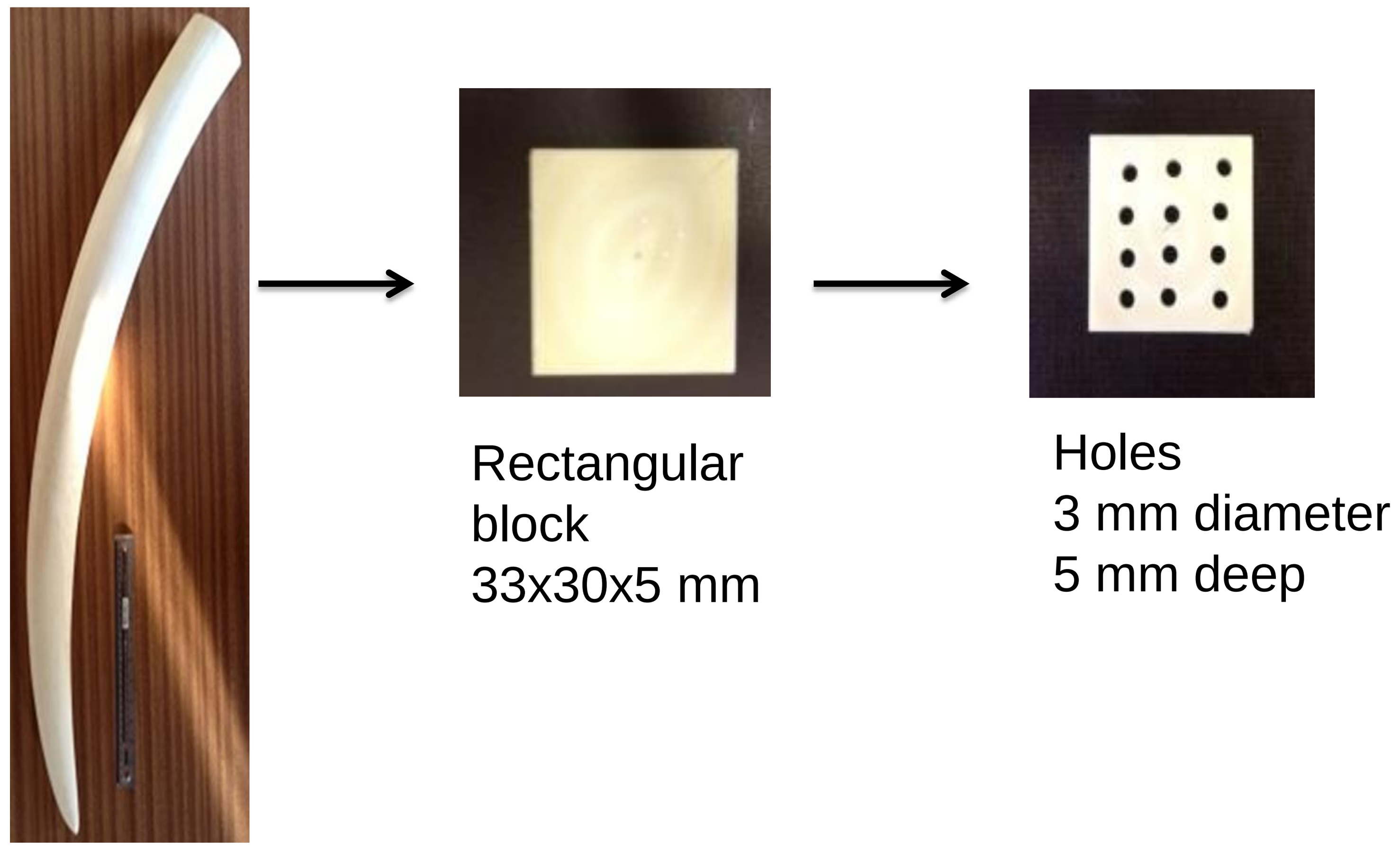

Figure 3: Ivory tusk after cutting into rectangular blocks, and holes of 3mm x 5 mm.

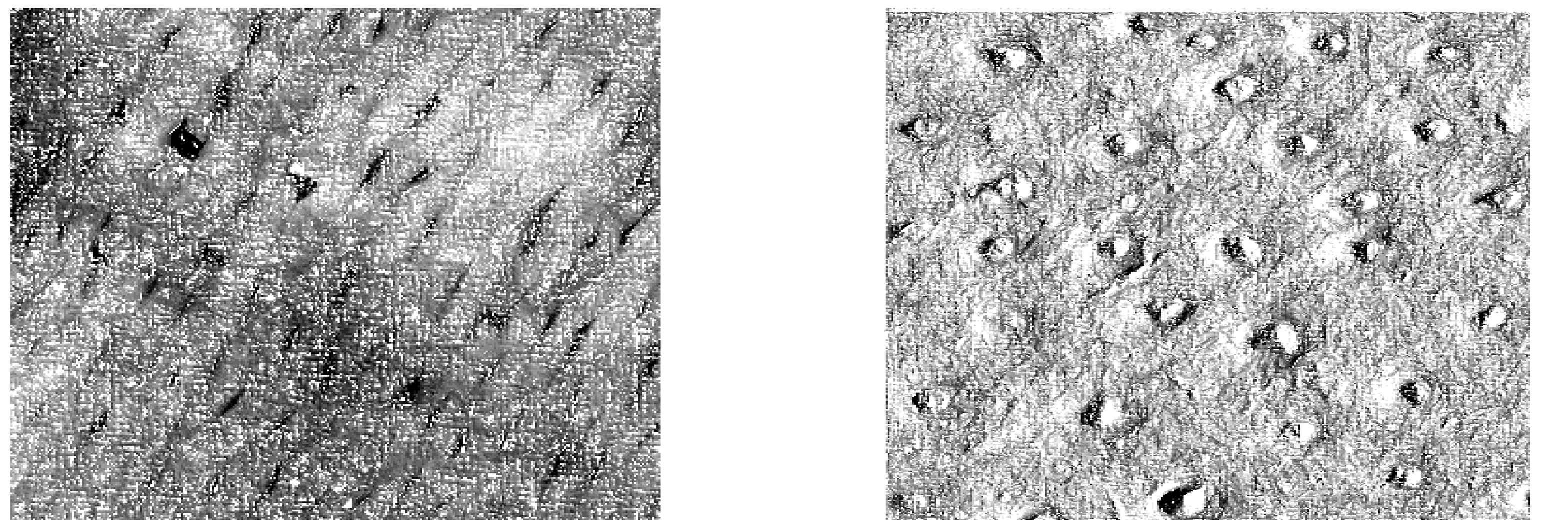

Figure 4: SEM images of ivory (left), and Human (right) dentinal tubules.

Results

TD, TN, PD, and Z250 strengths were comparable, while PN strength was slightly reduced.. Moduli were 3.2 ± 0.2 GPa for experimental composites, and 4.2 GPa for Z250.

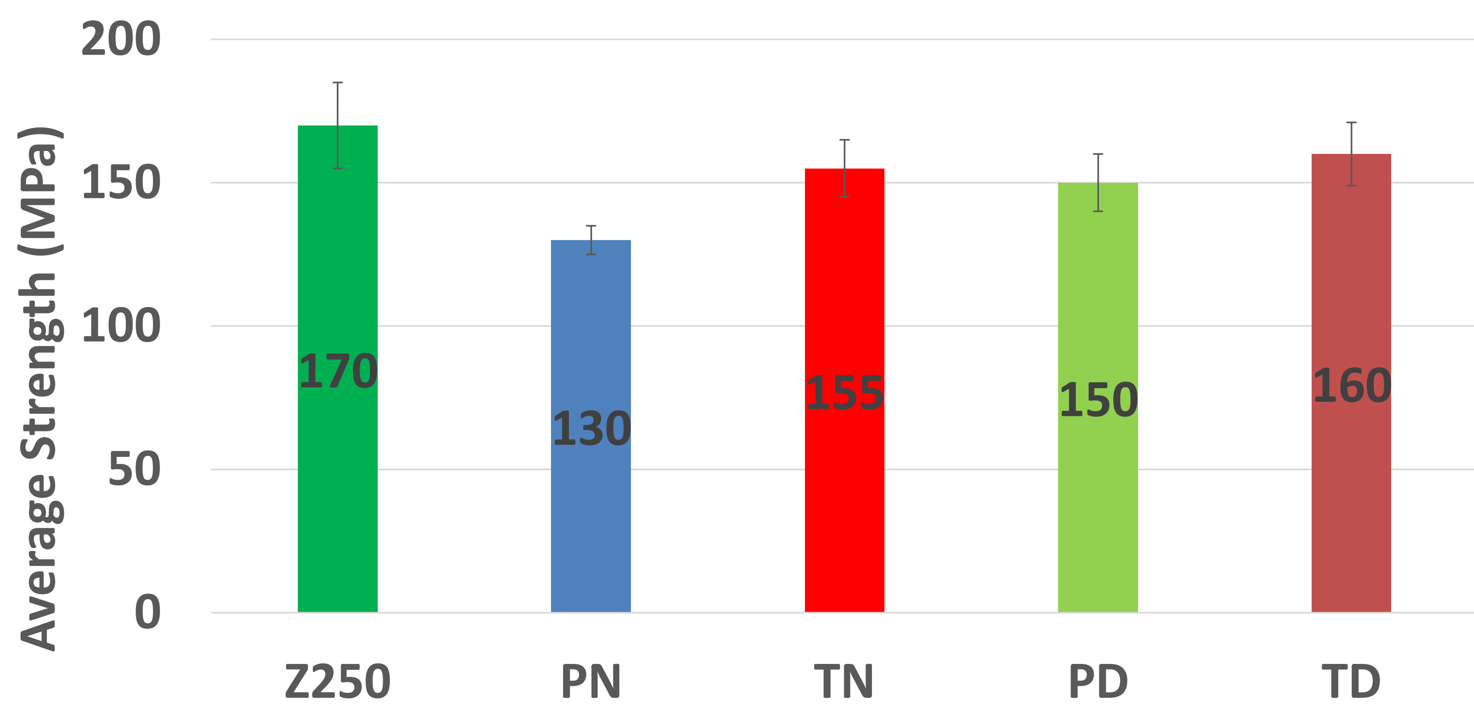

Figure 5: Biaxial flexural strength of composites.

Factorial analysis gave average debonding forces (DF) for hydrated / dehydrated ivory source 1 and 2 & those without water treatment figure 6. The average DF for 37 % acid treated and un-treated samples are also shown in figure 6. The average DF for TD, TN, PD, PN and Z250 are given in figure 7.

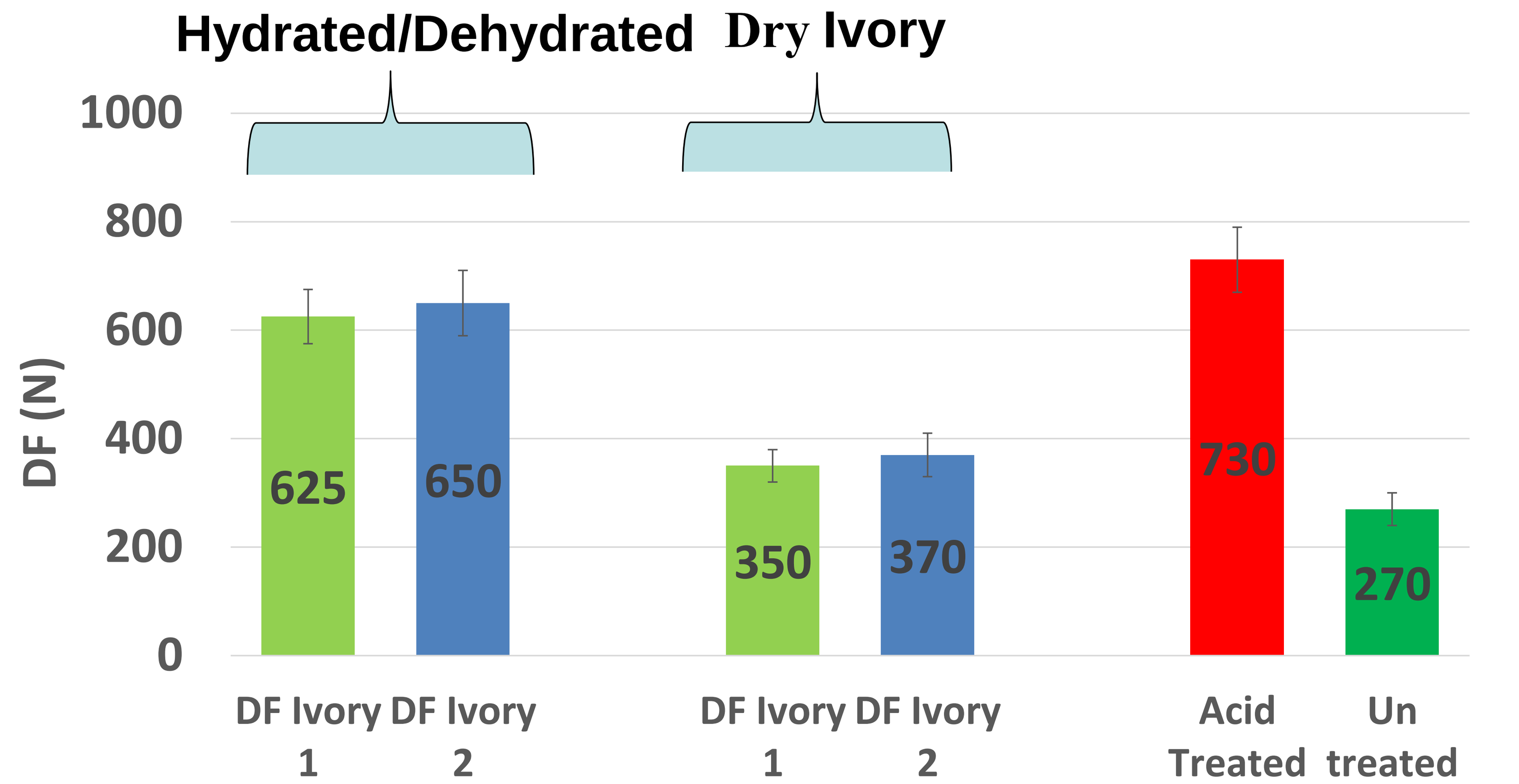

Figure 6: Debonding forces of hydrated / dehydrated, and dry ivory source 1 & 2, along with average DF for 37 % acid treated and un-treated samples .

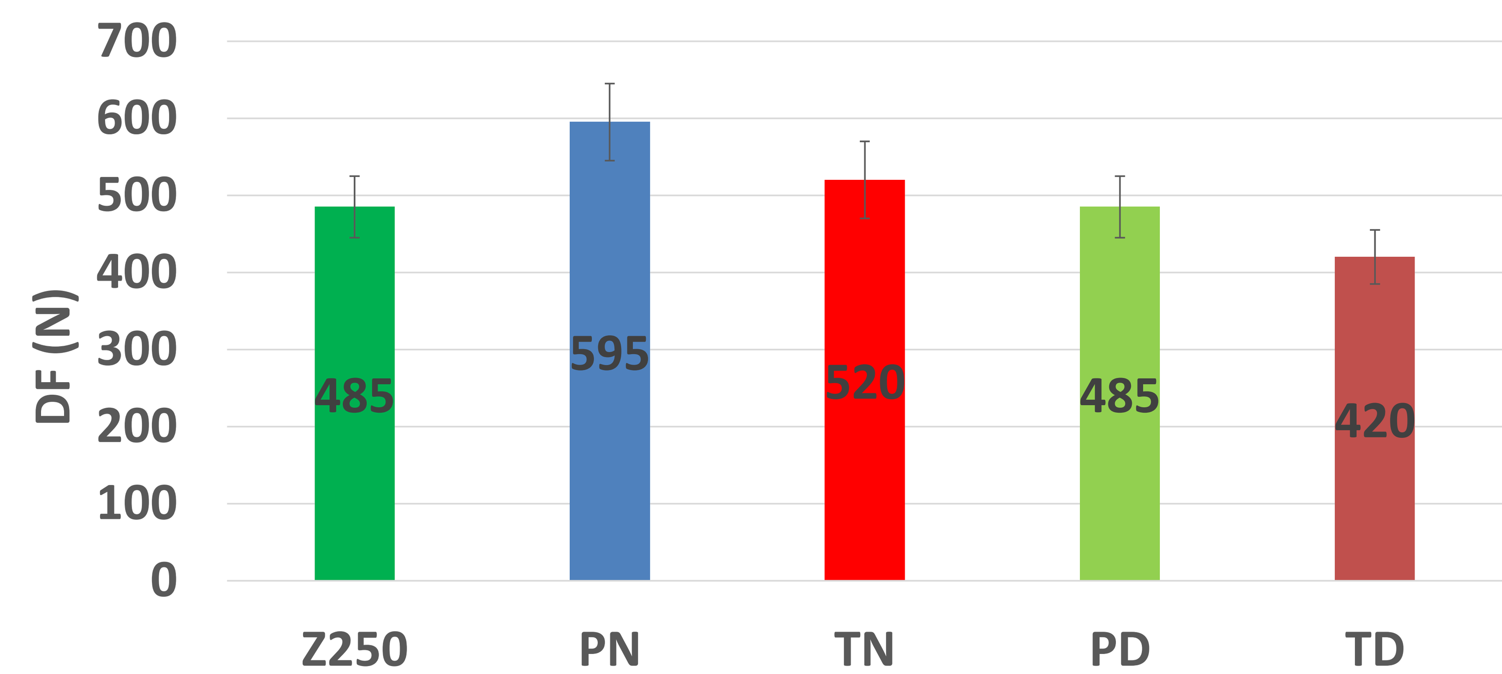

Figure 7: DF for commercial and experimental composites.

Conclusion

DMPT and TEGDMA replacement by SAN and PPGDMA causes minor reduction in composite strength but improves dentine bonding.

Acknowledgments

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