High-Strength, Low-Shrinkage Composite With Potential To Self-Bond To Dentine.

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Introduction

Dental composites are considered to be the material of choice for anterior teeth's for many years, and due to recent developments it is widely used in posterior teeth's as well. However these restorative materials require complex adhesive procedures for bonding to dentine, Additionally, polymerization shrinkage can damage the bond.

Aims & Objectives

The aim of this study was to develop alternating dentine adhesion models that could help in the evaluation of a self-bonding, high strength, and low shrinkage dental composite. The later can be used as a restorative material in both load, and non-load bearing areas.

Materials & Methods

UDMA: TEGDMA (3:1) was mixed with 5 wt% adhesive monomer (HEMA or 4-META). This was combined with silane treated glass particles. PLR was 4:1. Mechanical properties of composites 3 commercial (Z250, Gradia Direct, & Vertise Flow), and 2 experimental (C-HEMA, & C-4META) were determined using biaxial flexural test. Samples were made of 1 mm thickness, and 10 mm diameter.

Composite bonding to dentine (ivory & human), with and without use of acid pre-treatment and / or the adhesive ibond, were assessed using a shear bond test. Brass tubes of 3 mm diameter and 6 mm deep were used. Composites were applied in 2 mm increments. All the composites were cured for 40 s. Furthermore, micro gap formation after restoration of 3 mm diameter cavities in dentine was assessed by SEM.

Results

The C-4META composite showed reduced micro-gap formation (0- 2 µm) with dentine. While in other commercial and experimental composites a micro-gap of 5-20 µm were seen using different dentine pre-conditionings (Figure 1).

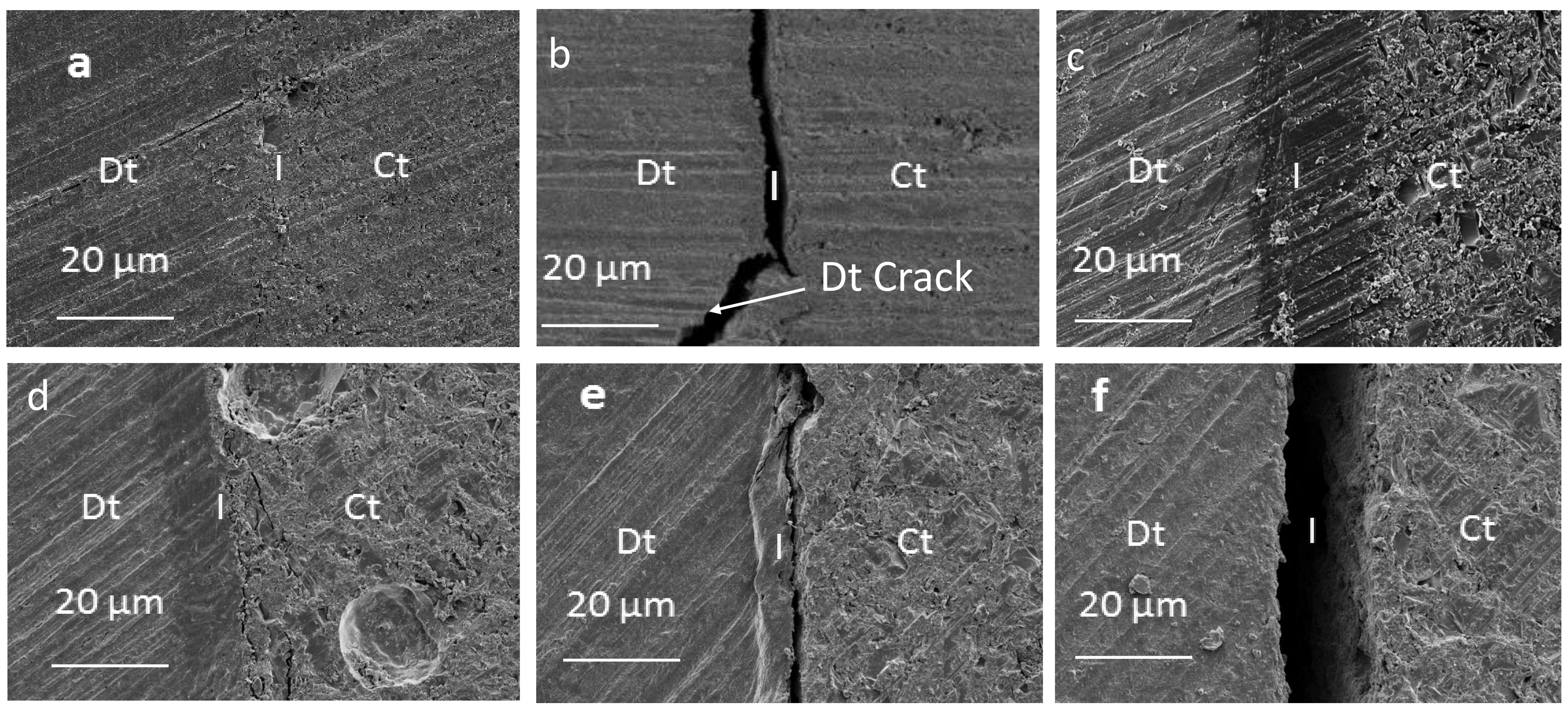

Figure 1: SEM images of interfaces between composites and dentine (a) ibond treated dentine with 4-META composite shows 3 different zones (dentine (Dt), interface (I), & composite (Ct)), (b) with ibond treated dentine and Z250 some interface and dentine cracking is observed, (c) acid and ibond treated dentine with 4-META composite has an ~20 micron thick interface layer. (d) Acid etched dentine with 4-META composite shows only minor cracking within the composite. (e) Un-treated dentine with 4-META composite has gaps of < 2 micron whilst (f) un-treated dentine with HEMA composite has gaps > 10 micron.

		Gradia	Z250	C-HEMA	Vertise Flow	C-4META
Biaxial Flexural Strength (MPa)	Mean	77	158	167	125	168
	95 % CI	5	5	6	4	9
Flexural Modulus (GPa)	Mean	2.3	3.7	4.1	3.0	5.5
	95 % CI	0.2	1.0	0.4	0.6	1.1

Figure 2: BFS & Modulus for commercial and experimental composites.

Experimental composite strengths (168 MPa) were higher than commercial (77 – 158 MPa) (Figure 2). With ibond use, average shear bond strengths were 30 and 26 MPa with and without acid etching (Figure 3a). This was irrespective of whether the dentine was ivory or human. With no ibond, average bond strength was 6 MPa for conventional composites. This, however, increased to 14 MPa with a commercial flowable composite or upon addition of low levels of an acidic monomer 4-META to the experimental composite (Figure 3b).

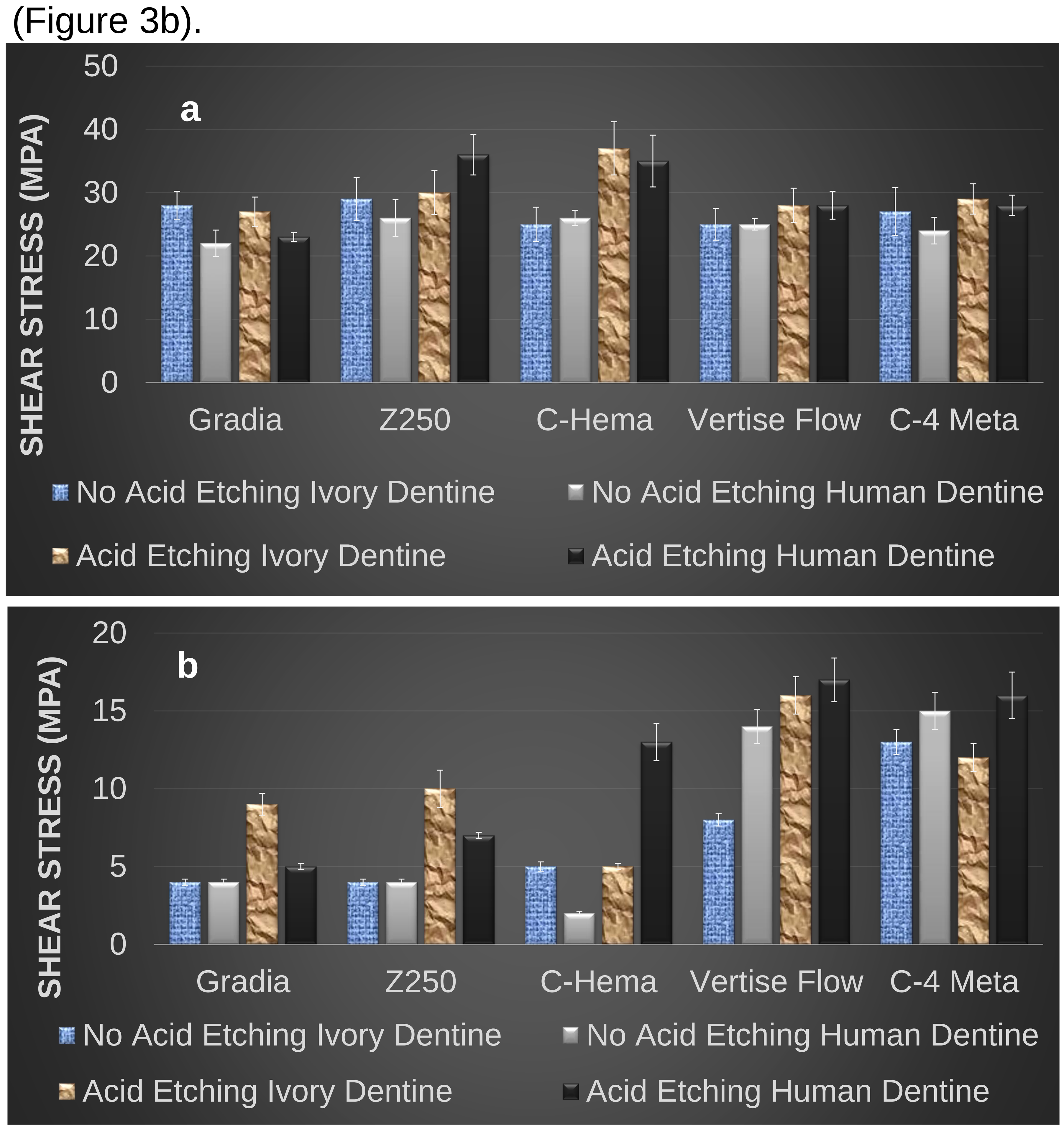

Figure 3: Shear bond strength of experimental and commercial composites, using dentine. (a) Shows the effect of Ibond along with or without acid etching (20 s), (b) shows the effect of No Ibond with or without acid etching (20 s). (n=5).

Conclusions

Improved bonding and mechanical properties were seen with C-4META composite. The high PLR would reduce polymerization shrinkage. This would additionally help to reduce composite failures due to recurrent caries or fracture respectively.

Acknowledgments

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