

## In vitro Comparative Evaluation of Tensile Bond Strength of 6<sup>th</sup>, 7<sup>th</sup> and 8<sup>th</sup> Generation Dentin Bonding Agents

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### Abstract:

**Background:** Newer dentin bonding agents were developed to improve the quality of composite restoration and to reduce time consumption in its application. The aim of the present study was to evaluate tensile bond strength of 6<sup>th</sup>, 7<sup>th</sup> and 8<sup>th</sup> generation bonding agents by *in vitro* method.

**Materials and Methods:** Selected 60 permanent teeth were assigned into 20 in each group (Group I: 6<sup>th</sup> generation bonding agent-Adper SE plus 3M ESPE, Group II: 7<sup>th</sup> generation bonding agent-G-Bond GC Corp Japan and Group III: 8<sup>th</sup> generation dentin adhesives-FuturaBond, DC, Voco, Germany). With high-speed diamond disc, coronal dentin was exposed, and selected dentin bonding agents were applied, followed by composite restoration. All samples were saved in saline for 24 h and tensile bond strength testing was done using a universal testing machine. The obtained data were tabulated and statistically analyzed using ANOVA test.

**Results:** The tensile bond strength readings for 6<sup>th</sup> generation bonding agent was 32.2465, for 7<sup>th</sup> generation was 31.6734, and for 8<sup>th</sup>-generation dentine bonding agent was 34.74431. The highest tensile bond strength was seen in 8<sup>th</sup> generation bonding agent compared to 6<sup>th</sup> and 7<sup>th</sup> generation bonding agents.

**Conclusion:** From the present study it can be conclude that 8<sup>th</sup> generation dentine adhesive (Futura DC, Voco, Germany) resulted in highest tensile bond strength compared to 6<sup>th</sup> (Adper SE plus, 3M ESPE) and 7<sup>th</sup> generation (G-Bond) dentin bonding agents.

**Key Words:** Bonding agents, tensile bond strength, 8<sup>th</sup> generation, 7<sup>th</sup> generation, 6<sup>th</sup> generation

### Introduction

Prognosis of root canal treated teeth depends on the quality of apical and coronal seal and lack of this seal can results in to failure of root canal treatment. Nowadays, amalgam is not usually used as coronal restoration of root canal treated teeth since it lacks proper seal, adhesion, esthetic properties, and there is an environmental and safety issue. Composite core buildup strengthens the coronal tooth structure and increases the resistance to fracture.<sup>1</sup> Development in bonding agents has moved from multistep bonding process (etching, washing, drying, primer, adhesive) to simplification i.e. self-etch and single bottle system. Ideal bonding agent should be biocompatible, should have adequate bond strength, and should bond to enamel and dentin. Various dentin bonding agents were developed to improve the quality of adhesives and composite restorations.<sup>2,3</sup> The 6<sup>th</sup> generation bonding agents consists of acidic primer and bonding resin separately, while 7<sup>th</sup> generation bonding agents are self-etch adhesives with combination of etchant, primer, and bonding agent in one (all-in-one system) component and applied as single step.<sup>2</sup> Development in nanotech dentistry has lead to development of nanocomposites and nano-adhesives which contains nanosized fillers. Nano-bonding agents are solutions with nanofillers which produce better enamel and dentin bond strength, stress absorption, and longer shelf life.<sup>4</sup> It has been observed that filled bonding agents produced higher *in vitro* bond strength. Recently the manufacturer of nanofilled dentin adhesives (Futurabond DC, Voco, Germany) has claimed it as 8<sup>th</sup> generation bonding agent.<sup>5</sup> The most frequently applied laboratory parameter to evaluate the effectiveness of adhesives is micro shear and tensile bond strengths.<sup>1,3</sup> The aim of this study was to evaluate and compare the tensile bond strength of 6<sup>th</sup>, 7<sup>th</sup> and 8<sup>th</sup>-generation dentin adhesives.

### Materials and Methods

For the study, 60 human mandibular permanent molars extracted for periodontal region, free from decay, restorations, and cracks were selected and the teeth were cleaned with scalars and saved in saline. Teeth were divided into 20 in each group (Group I: 6<sup>th</sup> generation bonding agent-Adper SE plus 3M ESPE, Group II: 7<sup>th</sup> generation bonding agent-G-Bond GC Corp Japan and Group III: 8<sup>th</sup> generation dentine adhesive-Futura Bond DC, Voco Germany). With high-speed diamond disc, coronal dentin was exposed. The selected bonding agents were applied on exposed dentine surfaces according to manufacturer's instructions, followed by composite

restoration. Acrylic resin blocks were prepared on each study teeth. All teeth were saved in sterile saline for 24 h and using universal testing machine (KIC-3-050-C, Kalpak Instruments and controls) tensile bond strength was tested. Applied force (N) was divided by the stick cross-sectional area (mm<sup>2</sup>). The tensile force required to debond the specimen was calculated in MPa. The obtained data were recorded and ANOVA test was used to statistically analyze the data.

**Results**

For each group the mean tensile bond strength and slandered deviation were calculated. The mean tensile bond strength value for 6<sup>th</sup> generation bonding agent was 32.2465, for 7<sup>th</sup> generation was 31.6734, and for 8<sup>th</sup> generation bonding agent was 34.74431. The highest tensile bond strength was seen in 8<sup>th</sup> generation bonding agent, followed by 6<sup>th</sup> generation bonding agent while 7<sup>th</sup> generation bonding agent showed lowest bond strength (Table 1 and Graph 1).

**Discussion**

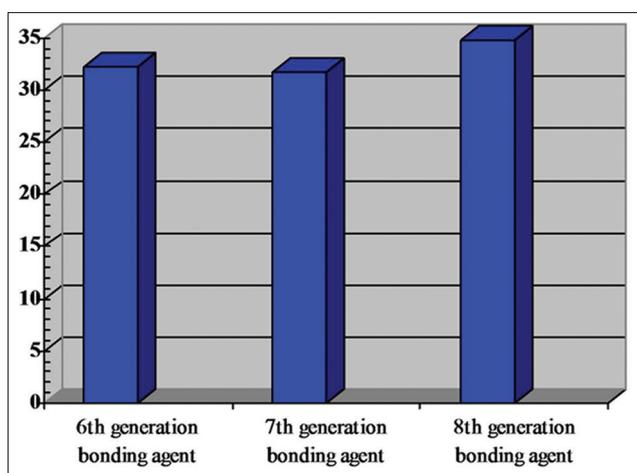
The main purpose of measuring the bond strength is to assess the bonding strength of a bonding agent to the dental hard structures. Development of newer dentin bonding agents aims to improve the bonding quality and to reduce the time consumption in application. However, polymerization shrinkage is still a major problem in bonding composite to tooth structure. Polymerization contraction occurs during the conversion of monomer molecules into a polymer network. Polymerization shrinkage leads to failure of composite tooth interface and micro-leakage, which ultimately results in postoperative sensitivity, secondary caries, micro-cracking

and failure of restoration. 17-21 MPa bond strength has been estimated to withstand this stress of polymerization shrinkage of the composite restoration. Several factors can influence the *in vitro* bond strength to dentin surface such as; type of tooth, dentine surface, type of bond strength to be tested (shear or tensile), type of bonding agent used, storage media, composite restorative material, and testing procedure.<sup>4</sup>

All the three tested dentine bonding agents (6<sup>th</sup> generation-AdperSE plus 3MESPE, 7<sup>th</sup> generation- G-Bond GC-Corp Japan and 8<sup>th</sup> generation - Futura Bond DC, Voco, Germany) used in the present *in vitro* study were self-etching adhesives. Self-etch adhesives need one step (7<sup>th</sup> generation) or two-step application (6<sup>th</sup> generation). They are mild and less aggressive compared to non-self-etch adhesive system. 8<sup>th</sup> generation an adhesive (Futurabond DC, Voco, Germany) contains nano-sized cross-linking silica particles and can be dual-cured.<sup>4</sup>

In the present study, the mean tensile bond strength value for 6<sup>th</sup> generation bonding agent was 32.2465, for 7<sup>th</sup> generation was 31.6734, and for 8<sup>th</sup> generation bonding agent was 34.74431. The highest tensile bond strength was seen in 8<sup>th</sup> generation bonding agent, followed by 6<sup>th</sup> generation bonding agent and lowest seen with 7<sup>th</sup>-generation adhesives (Table 1 and Graph 1). Tensile bond strength of 8<sup>th</sup> generation was more compared to 7<sup>th</sup> which is statistically significant ( $P > 0.005$ ). This is similar to study by Joseph *et al.* 2013.<sup>4</sup> Similarly, lower bond strength was observed by several researchers with 7<sup>th</sup> generation bonding agents compared to 5<sup>th</sup> or 6<sup>th</sup> generation<sup>1,6</sup> whereas Burrow *et al.* observed good results with G-Bond.<sup>7</sup> Possible reason for lower bond strength observed in 7<sup>th</sup> generation is due to less cross-linking monomers<sup>4</sup> and are more hydrophilic (attract water) than 6<sup>th</sup> generation bonding agents. This results in to lower mechanical strength of 7<sup>th</sup>-generation adhesives because the evaporated water from bonded dentin rapidly diffuses back into adhesive.<sup>1</sup>

Nikhil *et al.* in 2011 compared three self-etching adhesives for tensile bond strength and found that Adper Easy one was superior to G-Bond and Xeno V system. They concluded that this difference in tensile bond strength was due to hydrophilic nature of Adper Easy one, which enhances adhesion.<sup>2</sup> Yaseen and Subba Reddy observed lowest shear bond strength on primary teeth with 6<sup>th</sup> generation (Contax) bonding agent and highest with 7<sup>th</sup> generation (Clearfil S3) on permanent teeth<sup>3</sup>. Similarly, Nair *et al.* observed higher shear bond strength with 7<sup>th</sup> generation (Adper Easy one) compared to 6<sup>th</sup> generation (Adper SE plus) bonding agents.<sup>8</sup> Shekhar *et al* observed highest shear bond strength with Prime and Bond NT (5<sup>th</sup> generation) compared to Adper SE plus (6<sup>th</sup> generation) and G-Bond (7<sup>th</sup> generation) bonding agents.<sup>9</sup> Souza-Zaroni *et al.* observed better tensile bond strength with Clearfil Liner



**Graph 1:** Comparative evaluation of tensile bond strength of 6<sup>th</sup>, 7<sup>th</sup> and 8<sup>th</sup> generation bonding agents.

Group	N	Mean	SD
6 <sup>th</sup> generation bonding agent	20	32.2465	1.52632
7 <sup>th</sup> generation bonding agent	20	31.6734	2.12206
8 <sup>th</sup> generation bonding agent	20	34.74431	2.45634

N: Sample size, SD: Standard deviation

Bond 2V self-etching primer adhesive system compared to Prime and Bond NT.<sup>10</sup> Poptani *et al.* after thermocycling didn't find any difference between 5<sup>th</sup> and 7<sup>th</sup> generation bonding agent.<sup>11</sup> Dhawan *et al.* found higher tensile bond strength with single bond (5<sup>th</sup> generation) conditioner as compared to scotch bond multipurpose (4<sup>th</sup> generation) and Prompt-L-Pop (6<sup>th</sup> generation).<sup>12</sup> Chopra *et al.* observed that multi-bottle bonding agents performed better than single bottle dentin adhesives.<sup>13</sup> Elkassas *et al.* found that disinfecting the dentine surface prior to application of binding agents decreases the bond quality.<sup>14</sup> Borsatto *et al.* concluded from their study that, application of the two-step self-etch bonding agent (Adper SE Plus) beneath the resin pit- and -fissure sealant placement resulted in a significantly higher bond strength for the Er: YAG laser-irradiated enamel.<sup>15</sup>

In this study, highest mean tensile bond strength of 34.74431 MPa was observed in 8<sup>th</sup> generation dentine adhesives (Futurabond DC, Voco, Germany) compared to 6<sup>th</sup> and 7<sup>th</sup> generation adhesives, this may be due to its nano-sized cross-linking fillers.

### Conclusion

From the present study, it can be concluded that 8<sup>th</sup> generation dentin adhesives (Futura DC, Voco, Germany) showed better tensile bond strength compared to 6<sup>th</sup> (Adper SE plus, 3M ESPE) and 7<sup>th</sup> generation (G-Bond) dentin bonding agents and appears to be more advantageous.

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