Euro Dental Congress 2017- Bond Strengths of Metal, Ceramic and Polymer Brackets in Combination with Different Enamel Preconditioning Methods- Lorenz M. Brauchli- University of Basel

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Abstract

Introduction:

Adhesive technology is widely spread throughout the different specialities of dentistry. In orthodontics the bonding of brackets accounts for a significant percentage of time in practice routine. Bond strength is dependent on several factors such as enamel conditioning, adhesive technology and the material and construction of the bracket base. It was the intention of the present study to investigate the bond strength in relation to the above mentioned parameters.

Method:

Four different brackets (metal, ceramic, polymer, fiber reinforced polymer) were evaluated for their bond strength during tensile testing witha universal testing machineusing a conventional composite (Transbond MIP,XT) and in the case of the fiber reinforced bracket additionally a specially designed adhesive (Quick-Bond). Enamel conditioning was achieved with conventional etching, air-abrasion or a combination of both techniques. ARI (adhesive remnant index) scores were evaluated.

Results:

There were significant differences between the types of enamel conditioning. All brackets showed significantly lower bonding forces when the enamel was prepared with air-abrasion alone. Metal brackets had the highest bonding strength and the fiber reinforced composite brackets with the conventional adhesive the lowest. The ARI scores showed good correlation to the bonding forces, with low bonding forces presenting as a detachment at the enamel-adhesive interface.

Conclusion:

Air-abrasion alone showed significantly lower bonding forces than enamel conditioning with etching for all bracket types. This finding was independent of the bracket material, base design or adhesive system.

Keywords:
Air-abrasion; Etching; Bonding; Tensile testing.

Introduction:

The introduction of adhesive systems for orthodontic bonding has dramatically decreased a time consuming step in fixed appliance therapy. Since the introduction of the adhesive technology by Buonocore in 1955 and the first report of its use in bracket placement by Newman in 1964, there have been considerable developments in all areas. Enamel etching was first performed with 80% phosphoric acid but soon changed to a 37% solution, which was routinely accepted by the end of the last millennium. Subsequently the introduction of self-etching primers has again brought a dramatic change in etching technology. Not only were new etching agents such as polyacrylic acid and maleic acid introduced , but the etchant was combined with the low viscosity composite matrix which potentially enhanced the penetration of the etching relief. Alongside the etchants, adhesives have also evolved. Whereas initially Newman advocated the use of an epoxy resin, polyacrylic resins filled with different anorganic fillers are more commonly used today [6]. Finally the use of new materials in bracket manufacturing, such as different ceramics and polycarbonates also emphasizes the ongoing development and research in adhesive technology.

Material and Methods:

225 bovine mandibular incisors were extracted and stored in a Ringer solution at 37°C. After separating the crown from its root, it was embedded in a cold hardening polymer (SR3/60 Quick, IvoclarVivadent, Ellwangen, Germany) with the buccal surface freely exposed from the polymer. The teeth were then grouped according to the four bracket types and three conditioning methods. Metal brackets (Mini Mono™, Forestadent, Pforzheim, Germany), ceramic brackets (Clarity™, 3MUnitek, Monrovia, USA) conventional polymer brackets and fiber reinforced polymer brackets(Brilliant™, In addition the bases of the polymer brackets were activated with a plastic primer (Grundierer 163-500-00, Dentaurum, Ispringen, Germany). All teeth were pumiced, rinsed with water and dried with a blast of air.In the conventional etching group, a 37% phosphoric acid (Unitek etching gel 712-039, 3M Unitek, Monrovia, USA) was applied to the enamel for 15 seconds before it was rinsed and dried again. The airabrasion group was prepared, using a KAVO handpiece(Rondoflex 2013, KAVO, Biberach, Switzerland) with 50µ Al2 O3 particles for 2 seconds at a distance of 5 mm, followed by thorough rinsing and drying with air. For the combined group of etching and air-abrasion, the techniques were used as described above with etching following air-abrasion. SEM images (ESEM, Philips 30, Royal Philips Electronics, Netherlands) of the enamel surface of one single tooth were taken after preparation with the three enamel conditioning methods.

Results:

Tensile bond strength, ARI scores and statistical significance amongst the three pre-conditioning methods shows the significances between the bracket types evaluated according to the three pre-conditioning methods.

Conventional etching:

Bond strength of the MiniMono bracket was 4.9 MPa and significantly higher than the values for Clarity (3.2 MPa), Elegance

(3.7 MPa) or Brilliant (3.45 MPa), which showed no significant intergroup difference. Although the values for Brilliant+ (4.3 MPa) were significantly lower than for MiniMonothey were also significantly higher than for the other remaining groups .

Air-abrasion:

Within the Air-abrasion group, all brackets reacted only low levels of bond strength. The lowest bond strengths were found for Brilliant (1 MPa), which were significantly lower than for MiniMono (1.7 MPa), Clarity (2.1) or Elegance (1.9 MPa). The difference between Clarity and Elegance was significant as well. The Brilliant+ group (2.3 MPa) showed bond strengths comparable to MiniMono and Clarity and significantly higher than Elegance.

Air-abrasion and etching:

MiniMono brackets (5.2 MPa) showed significantly higher values than all other groups.

Bond strength according to bracket type:

significantly higher with etching (4.9 MPa) and air-abrasion+etching (5.2 MPa) than for air-abrasion alone (1.7 MPa). The same was true for the Clarity bracket with 3.2 MPa, 3.5 MPa and 2.1 MPa, the Elegance bracket with 3.7 MPa, 4.2 MPa and 1.9 MPa, the Brilliant bracket with 3.5 MPa, 3.8 MPa, 1 MPa, as well as the Brilliant+ bracket with 4.3 MPa, 4.3 MPa, 2.3 MPa respectively.

Discussion:

Adhesive technology has been one of the major developments in dentistry in the last century and has become a cornerstone for modern dentistry in all specialities. Since its introduction by Buonocore in 1955, constant research and development has led to the current adhesives and their recommended handling. The reliability of the bonding of adhesive and bracket to enamel is thereby influenced by many parameters such as enamel conditioning, the adhesive itself as well as the material and surface treatment of the bracket base. Clinically a conventional preconditioning of enamel with 37% phosphoric acid can still be recommended.

Conclusion:

The study clearly shows disadvantages for air-abrasion when compared to conventional etching and a combination of air-abrasion and etching. The inadequacy of air-abrasion can not only be observed in respect to bonding forces, but also in the occurrence of the fractureline, which was evaluated by an ARI score. The combination of diverse bracket types with a conventional composite showed that not all systems are compatible. The use of a special adhesive (Quick- Bond) eliminated this disadvantage.Tensile testing for bracket bond strength is less common than shear testing and leads to lower mean forces than comparable shear force investigations. However tensile stresses are relevant as they might occur at the adhesive interface and explain unexpected failures

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