Effects of Alumina Sand Blasting on the Orthodontic Bracket Surface

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The aim of this study was to observe the characteristics of the adhesion surface for different bracket systems after being sandblasted with alumina particles. The brackets that we used in our study were: ceramic (Fairfield Orthodontics), composite (US Orthodontics), sapphire and metallic (American Orthodontics). Sandblasting was performed, with 50 \( \mu \)m alumina abrasive particles (Al\(_2\)O\(_3\)), for a 3 s period. The sandblaster (Microetcher II, Danville) was 10 mm away from the bracket surface. After the sandblasting process, the adhesion surface was examined using a portable microscope (Dino-Lite AM 4515T8). This type of mechanical treatment creates a very fine roughness on the surface area, and increases mechanical and chemical bonding between the tooth surface and the bracket base.

Keywords: sandblasting, alumina particles, brackets, adhesion

Esthetics and functional biomechanical properties are important for the clinical performance and the quality of direct bonding. Most brackets do not chemically bond to enamel or resin, so efforts have been made to improve mechanical retention by improving the design of the appliances. The increasing demand for a more esthetic metal bonded appliance led to a reduction in the size of the brackets and their bases areas [1]. Smaller brackets require a better bond strength. Achieving a good adhesion between the brackets and the tooth surface is essential. One way to increase adhesion is to use a conditioner on the tooth surface and the bracket base. Sandblasting is one technique for conditioning the bracket base and it uses a high-speed stream of aluminum oxide particles, propelled by compressed air; it can be done at chairside. The results of the studies from the literature reported that the shear bond strength values, before and after sandblasting, are equivocal. [2].

Experimental part
Material and methods
Ceramic brackets (Fairfield Orthodontics), composite brackets (US Orthodontics), sapphire and metallic brackets (American Orthodontics) were used. Sandblasting with 50 \( \mu \)m alumina abrasive particles (Al\(_2\)O\(_3\)) was performed for 3 s, from a distance of 10 mm, with a sandblaster (Microetcher II, Danville).

After being sandblasted, the adhesion surface was examined using a portable microscope (Dino-Lite AM 4515T8).

In this study, the brackets were never used before and have never been sandblasted. One error that could influence the study was the sandblasting pressure that wasn't constant. Another variable that can influence the sandblasting is the time and the size of the alumina particles.

In this study the bracket base was sandblasted for 3 s according to the previous study performed by Arici S et al [3]. Arici used 3 different sizes (25, 50 and 110 \( \mu \)m) of aluminum oxide powder and three sandblasting time periods (3, 6 and 9 s) for testing. The bond strength values were measured using a Weibull analysis, which showed that the most favorable size was 25 \( \mu \)m and the optimal time period was 3 s.

Ibrahim Nergiz et al [4] proved that sandblasting for a longer time leads to material loss, by increasing the roughness, without increasing adhesion. For our bracket base sandblasting, 50 \( \mu \)m alumina abrasive particles were used, because a bigger size (110 \( \mu \)m) of Al\(_2\)O\(_3\) would lead to material loss [4].

In our study, 4 different designs of the bracket base were used: foil mesh base for the metallic bracket, mechanical undercuts for the ceramic bracket, crystalline particles in the base for the composite bracket and irregular base for the sapphire bracket. All of these types of designs should improve adhesion.

Results and discussions
With the use of the digital microscope (fig. 1), photos (20 X magnification) of the bracket base were taken. This treatment creates very fine roughness, increasing surface area and thus enhancing mechanical and chemical bonding (fig. 2-4). However, bond strengths obtained from sandblasting alone might be insufficient.

Different studies were conducted to analyze the variables that influence bond strength [10-12]. Scott A. Soderquist et al [5] showed in their study the compared mean static tensile bond strength and the mean cyclic tensile bond strength of 3 different ceramic bracket types using a Weibull analysis. The results showed that the mean static tensile bond strength of 3 different ceramic brackets were measured using a Weibull analysis, which showed that the most favorable size was 25 \( \mu \)m and the optimal time period was 3 s.

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Sandblasting with alumina particles the 4 bracket systems lead to an increased surface area and enhanced mechanical and chemical bonding, however future studies are necessary to determine the variables that influence bracket adhesion [15-17].

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