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Comparing orthodontic bond failures of light-cured composite resin with chemical-cured composite resin: A 12-month clinical trial

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Introduction: In this clinical trial, we evaluated and compared bond failure rates of light-cured composite resin vs chemical-cured composite resin for 12 months. **Methods:** Twenty-two subjects (356 stainless steel brackets) were included in this study, and a split-mouth design was used to randomly allocate diagonally opposite quadrants to either chemical-cured (178 brackets) or light-cured (178 brackets) composite resin; the brackets came from the same manufacturer. The survival and failure rates of the brackets were evaluated by the mode of polymerization. The overall bracket survival rates were estimated using the Kaplan-Meier product limit estimate. **Results:** There were no significant differences in the bond failure rates between the chemical-cured and the light-cured composites (P = 0.52). Bond failures were greater in posterior teeth (6.7%) than in anterior teeth (1.2%). The highest failure rate was observed in the second premolars (7.7%). **Conclusions:** The overall failure rate of brackets with the 2 bonding systems was 2.8%, which is acceptable for clinical use. The polymerization mode did not influence the bracket survival rate significantly. (Am J Orthod Dentofacial Orthop 2016;150:290-4)

Bonding of brackets to the tooth enamel has been an important issue since the introduction of direct bonding in orthodontics.[1] Many new bonding agents have been developed, including composite resins, conventional glass ionomer cements, resin-modified glass-ionomer cements, and polyacid modified composites (compomers). Each bonding agent uses a different polymerization mechanism: chemical, light, or dual curing.[2]

The success of fixed appliance therapy depends on the capability of the adhesive system to resist failure caused by many factors directed to the bracket-adhesive-enamel junction. These factors include stresses of mastication and stresses exerted by archwires as well as other factors particular to the oral cavity, including humidity, rapid changes in temperature, and pH. A good orthodontic adhesive material should enable the bracket to stay bonded to the enamel for the duration of treatment and permit easy removal of brackets when needed without damage to the enamel surface and with the least discomfort for the patient.[3] In addition, orthodontic adhesives should be nonirritating to the oral mucosa, allow adequate working time for positioning brackets while setting quickly enough for patient comfort, provide a simple way of application and a convenient way of curing, and preferably have fluoride release potential.[4]

Composite resins with different polymerization mechanisms such as chemical, light, or dual curing are the most frequently used adhesives in orthodontic bonding.[5] Although composite resins provide sufficient bonding strength and are easy to handle, they adhere to the tooth enamel only by microretention, requiring a dry field.[6] Traditionally, orthodontic adhesives were chemically cured. The use of light-cured adhesives has grown rapidly in popularity over the last years.[7] The advantages of light-cured adhesive are the extended time for bracket positioning and the ease of cleanup around the bracket base before bonding.[7]

Many factors can influence the bonding strength of orthodontic brackets. Etching the enamel surface is a

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critical variable that affects bond strength and bond failure location.[8] Factors that influence acid etching of enamel include type of acid etch,[9,10] concentration of acid etch,[11,12] and etching time.[13,14] Other factors affecting bond strength include the bonding agent,[1,15] the filler level of orthodontic adhesives,[16,17] the characteristics of the bracket base,[18-20] and the status of the teeth if recently bleached.[21-23] Operator and patient factors are likely to influence the failure rate of any bonding system. Care in the clinical technique, moisture control, choice of bonding material, and instructions given to the patient are all controlled by the operator, whereas the patient's sex, age, malocclusion, and care of the appliance are patient-dependent variables.[24]

Treating enamel with fluoridated prophylactic pastes of varying fluoride concentrations[25] and use of pumice with or without fluoride before acid etching and bonding do not affect bond strength.[26] Also, bond strength is not affected if chlorhexidine is applied after bonding or as a prophylactic paste on enamel before etching.[27] Bond strength is reduced to an unacceptable level, however, if the chlorhexidine is applied as a layer on etched enamel or on the sealant before the adhesive is applied.[27,28]

O'Brien et al[29] investigated bracket failures in a clinical setting using light-cured vs chemical-cured orthodontic resin. In that study, bracket failure rates were recorded as cumulative percentages of failures that occurred by the end of the total observation period. Using this method of reporting bracket failure rates is problematic, especially if not all subjects were observed for the same period of time. Another potential problem with calculating the percentage of bracket failure at the end of the study is that it does not provide information about when the brackets actually failed.[30] A more accurate approach is to use survival analysis to calculate the cumulative probability of bracket failures at various times during the study for each adhesive group.[31]

Bond failure is one of the most frustrating occurrences in an orthodontic practice for both the practitioner and the patient. Consequences of bond failure can include increased treatment time, additional costs in materials and personnel, and unexpected additional visits by the patient. Thus, it is of great importance to determine the mode of polymerization of the bonding material with the lowest failure rate in orthodontic patients.

MATERIAL AND METHODS

This was a clinical prospective study that included patients with complete permanent dentition treated with fixed orthodontic appliances using preadjusted edgewise appliance (22-in slot, MBT system; 3M Unitek, Monrovia, Calif). A list of patients seeking orthodontic treatment was obtained from the orthodontic clinics at the University of Khartoum, Faculty of Dentistry, in Khartoum, Sudan. Subjects were considered for the study according to the following inclusion criteria: treatment without extractions or with symmetrical extractions, no occlusal interferences, no facial restorations at the bonding area, and no gingival hyperplasia or congenital defects. All brackets had to be placed in both arches at the same appointment. All study protocols were approved, and permission was obtained from the ethical committee of the Faculty of Dentistry, University of Khartoum.

Patients satisfying the inclusion criteria were told about the study, and written informed consent forms were obtained from the 22 patients who agreed to participate. For these patients, all permanent teeth except molars were bonded, allowing up to 20 teeth per patient to be included. This provided a total of 356 teeth for the study. One hundred seventy-eight teeth were bonded with a light-cured composite resin, and 178 teeth were bonded with the chemical-cured composite resin from the same manufacturer (American Orthodontics, Sheboygan, Wis). We used the Fédération Dentaire Internationale numbering system to divide the teeth into 4 sets and a split-mouth design to allocate the type of adhesive. Accordingly, diagonally opposite quadrants were allocated randomly to either the light-cured composite resin system group or the chemical-cured composite resin group. This randomly alternated split-mouth design was used to eliminate any bias that could have been introduced because the clinician (R.E.M.) was right-handed. The light-cured and chemical-cured sides were switched from patient to patient to ensure randomization. All brackets were placed at the same appointment according to the manufacturer's instructions. All bonding procedures were carried out by the same operator (R.E.M.) using the direct bonding technique. Enamel surfaces were cleaned with pumice and a rubber cup to remove the enamel pellicle, rinsed with water, and dried with an air syringe. The tooth surfaces were etched for 30 seconds using 37% phosphoric acid (acid etching gel; American Orthodontics). The etched enamel was rinsed with water for 15 seconds and dried with a 3-way oil-free air syringe to show the frosty, chalky white etched enamel surface. In the light-cured group, the composite's primer was applied to the tooth surface and light cured for 10 seconds. Composite was placed on the bracket base, and the bracket was positioned firmly on the tooth. Excess composite material was removed from around the bracket with a sharp probe before curing the material