CHAPTER I

INTRODUCTION

Principles, theory, and rationale

Bonding in orthodontic brackets to the enamel surfaces of teeth has become a routine orthodontic procedure in fixed appliance therapy. This technique that has reduced the need for orthodontic banding has been influenced significantly by advancement in adhesive systems.

The bonding systems generally used in orthodontics is composite materials based on acrylic or diacrylic resins bonded largely by mechanical interlock with enamel, which has been etched with acid. These materials are available with bond strengths providing a near optimal compromise between clinical demand and ease of debonding, thus minimizing damage to the enamel. The commonly used composite resin is a diacrylate. Polymerization of a diacrylate can be accomplished by 1) chemical activation, 2) energy derived ultraviolet light, or 3) a catalyst system that depends on visible light for activation.

In the chemically cured composite resin system, the working time for bracket placement and initial clean up was limited and unpredictable. The operator was anxious to place the brackets as rapidly and accurately as possible, so as to allow time to remove any excess un-cured composite from around the bracket periphery. This must be carried out without disturbing the adhesive matrix or the bracket position (Ash and Hay, 1996).

The introduction of the ultraviolet light cured composite resin had gained interests from orthodontists for many years. Radiation curing offered the advantage of command setting that allowed adequate time for accurate position of orthodontic attachments on tooth surfaces. However, this technique was found to be too slow as exposure and was not suitable for bonding because of the poor transillumination through tooth substance and harmful effects of prolonged exposure to ultraviolet radiation. Then the investigation adversed the development and refinement of bonding systems that were activated by visible light.

After the introduction of visible light cured composite resins, numerous advantages have been reported. A rapid polymerization occurs when visible light (usually 450-470 nanometer wavelength, Pollack and Blitzer, 1982) is applied and produces a 'command set'. An unlimited working time is possible with the visible light cured resin, more accuracy and an unlimited number bracket placements with each mix (Greenlaw et al., 1989).

However, there are potential disadvantages to the use of light cured composite resins, primarily related to the ability to achieve an acceptable degree of cure for the resin. It is well documented that light cured composite resins have a limited depth of cure (Watts et al., 1984). The depth of cure depends on the nature of the material; for example, the composition (percentage of fillers and particle sizes), thickness of the mix, and the opacity. It also depends on the light source; intensity, position, and the duration of cure (Cook, 1980; McCabe and Carrick, 1989).

Polymerization of light cured composite resins may be incomplete below metal brackets following recommended exposure times and inadequate polymerization may result in reduced bond strengths and microleakage (Sargison et al., 1995).

Dual cured composite resins have been developed to overcome problems with inadequate depth of cure below composite or porcelain inlays and onlays. They contain both chemical and visible light activated systems. Complete polymerization of the resin is enhanced by the autopolymerizing component.

The use of dual cured composite resin for orthodontic bonding would confer the advantage of extended working time coupled with continuation of polymerization when the light source had been removed.

The resin materials are available for direct bonding and are being continually improved. When improvements are announced the values of the strength of the bond are often central to the claimed advantages of the newest material and, thus, the determination of bond strength is of great importance and interest (Fox et al., 1994).

The bond strengths of chemically, light and dual cured composite resins have been investigated in previous studies (Alexander, 1993; Smith and Shivapuja, 1993; Sargison et al., 1995; Willems et al., 1997). However, these results has always been a matter of controversy.

The purposes of this study were to compare the shear bond strengths and to determine the failure modes of chemically, light and dual cured composite resins using in orthodontics. Special attention was paid to the question: "Which composite resin has the appropriate properties both bond strength and bond failure?"

The purposes of the study and hypothesis

1. To evaluate the shear bond strengths of chemically, visible light, and dual cured composite resins in orthodontic bonding.

2. To compare the shear bond strengths of chemically, visible light, and dual cured composite resins in orthodontic bonding. Therefore, null hypothesis for this part of study is:

There are no significant differences among chemically, visible light, and dual cured composite resins.

The hypothesis will be rejected if there are significant differences and then, multiple comparison will be analysed at the same significant level.

3. To examine the sites of bond failure between the bracket and tooth surface.

4. To determine the percentage of failure mode in terms of cohesive and adhesive failure.

Anticipated benefits

1. To select proper composite resin materials using in clinics.
2. To be the basic knowledge for further studies.

Scope of the research

1. Sound maxillary premolar teeth which were extracted for orthodontic treatment purposes from patients with the age of 10 to 20 years.

2. Brackets used in the research were 0.018" x 0.022" slot metal mesh-backed premolar standard Edgewise brackets, Minidiamond type (Ormco, Ormco Corporation, USA).

3. Adhesives in this research were as follows:

- Chemically cured composite resin, System 1+ (Ormco, Ormco Corporation, USA);
- Visible light cured composite resin, Transbond (3M, 3M Unitek, USA);
- Dual cured composite resins, Sequence (Ormco, Ormco Corporation, USA) and Enlight (Ormco, Ormco Corporation, USA).

Definition

Bond The force that holds two or more units of matter together

Bonding Adhesion of orthodontic attachments to the tooth without use of an interposed band

Stress A force induced by or resisting an external force

Strength The maximum stress that it can endure before fracturing

Shear force The internal induced force that opposes the sliding of one plane of the material on the adjacent plane in a direction parellel to stress

Shear strength Resistance to a tangential force

Adhesives A material used to produce adhesion

Bonding agent Adhesives

Composite resin A kind of adhesives

Adhesive failure Failure between bracket and composite interface or between enamel and composite interface

Cohesive failure Failure within composite resin