CHAPTER I

INTRODUCTION

PRINCIPLES, THEORIES, AND RATIONALES

Bonding orthodontic brackets to the enamel surfaces of teeth has become a routine orthodontic procedure when using fixed appliances. Orthodontic bonding reduces the need for orthodontic banding and has been influenced by advancements in adhesive systems.

Orthodontists commonly use the conventional phosphoric acid etching adhesive system when attaching brackets to the enamel surface. Phosphoric acid etching requires rinsing and drying after application of the etching agent. The etching procedure is sometimes troublesome, and there is a risk of contamination during the etching process (Zachrisson, 1977; Gwinnette, 1988). Moreover, phosphoric acid etching has been blamed for decalcification and the development of white spot lesions around bonded orthodontic appliances (Gorelick et al., 1982; Ogaard et al., 1988). Some reports have described mechanical damage to enamel during de-bonding and removal of the remaining resin after phosphoric acid etching (Brown et al., 1978; Diedrich, 1981; Joseph and Rossouw, 1990). The depth of etched enamel surface created by phosphoric acid might be a contributing factor to the incidence of enamel fracture (Herris et al., 1992; Guess et al., 1988; Chaconas et al., 1989). Maintaining a sound unblemished enamel surface is a primary clinical expectation during de-bonding of orthodontic brackets.

Self-etching adhesive systems are being increasingly used instead of conventional phosphoric acid etching adhesive systems in restorative dentistry. Self-etching adhesive systems consist of a self-etching primer and an adhesive. Self-etching primers function as both an etching agent and a primer. Rinsing is not required after application of a self-etching primer. Thus the self-etching adhesive system reduces the clinical steps and saves operating time. Moreover, the self-etching

adhesive system causes less demineralization because the depth of the etching is identical to that of the primer penetration (Miller, 2001; Buyukyilmaz et al., 2002).

The highest possible bond strength to tooth structure is desirable in restorative dentistry. In contrast, the orthodontic bond strength must be sufficient to retain the brackets but allow easily clean-up of adhesive when a case is completed and the brackets are removed. Reynolds (1975) and Power and Messersmith (2001) suggested that a minimal bond strength of 6 to 8 MPa was adequate for clinical orthodontic needs because those values were considered to be able to withstand masticatory and orthodontic forces.

Therefore, an alternative adhesive system that can maintain clinically useful orthodontic bond strength while decreasing the depth of enamel dissolution may result in a decrease in the incidence of enamel surface damage after debonding.

Three self-etching adhesive systems (Xeno® III, ED PRIMER® and AdheSE®) are new materials that are used extensively in restorative procedures. However, they have not been used in orthodontic bonding and no studies have been reported evaluating their effects in orthodontic use. Therefore, this study is needed to determine if they can be used in orthodontic bracket placement.

PURPOSES OF THE STUDY

1. To determine and compare the shear bond strengths among three self-etching and one conventional phosphoric acid etching adhesive systems in orthodontic bracket placement.

2. To determine and compare the failure modes among three self-etching and one conventional phosphoric acid etching adhesive systems in orthodontic bracket placement.

HYPOTHESES OF THE STUDY

1. There is no statistically significant difference in the shear bond strengths among three self-etching and one conventional phosphoric acid etching adhesive systems in orthodontic bracket placement.

2. There is no statistically significant difference in the failure modes among three self-etching and one conventional phosphoric acid etching adhesive systems in orthodontic bracket placement.

ANTICIPATED BENEFITS

1. To find an alternative adhesive system which can be used instead of the conventional phosphoric acid system in orthodontic bracket placement.

2. To gain knowledge of shear bond strengths and failure modes of adhesive systems for further studies.

SCOPE OF THE STUDY

This *in vitro* study was conducted to determine and compare both the shear bond strengths and the failure modes among three self-etching and one conventional phosphoric acid etching adhesive systems in orthodontic bracket placement. The failure modes were assessed from the failure sites and the amount of residual adhesives on debonded enamel surfaces after debonding.

DEFINITIONS

Adhesive

A material used to produce adhesion.

Adhesive failure

A failure of the interface between the bracket and adhesive or of the interface between enamel and adhesive.

Bond

The linkage between two atoms or radicals of a chemical compound.

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

Bonding

The procedure of using an adhesive to combine, unite, or strengthen.

Bond strength

The force required to break a bonded assembly.

Cohesive failure

A failure within the composite resin, within the enamel or within the bracket.

Conventional phosphoric acid etching adhesive system

A bonding system consists of a phosphoric acid etching agent and an adhesive.

Failure mode

A form of bond failure that consists of adhesive and cohesive failures. This study assessed the failure mode from the failure sites and the amount of residual adhesive on de-bonded enamel surface.

Failure site

The location of failure. Failure can occur at five locations: within the enamel, at the adhesive/enamel interface, within the adhesive, at the adhesive/bracket interface and within the bracket.

Self-etching adhesive system

A bonding system consists of a self-etching primer and an adhesive.

Self-etching primer (Acidic primer)

A single dental product that combines two materials: the conditioning and priming agents.

Shear bond strength

The maximum force per unit area that opposes the sliding of one plane of a material on an adjacent plane in a direction parallel to the force without causing a fracture.

Shear force

The internal, induced force that opposes the sliding of one plane on an adjacent plane.

Stress

An internal force that resists an externally applied load or force.