CHAPTER V

DISCUSSION

In this experiment, the maxillary premolar teeth from orthodontic patients (10-20 years old) were selected as the samples because: 1) they were easy to collect, 2) the different of tooth surface effect on the bracket base adaptation (Alexandre et al., 1981), and 3) the age of patient had influenced on acid etching on enamel surface (Nordenvall et al., 1980; Sheen et al., 1993).

System 1+, Transbond, Sequence and Enlight were chosen to use in this study because they were available in the market in Chiang Mai. Although the gold standard for comparison is Concise because of long history as the standard in orthodontic bonding (Smith and Shivapuja, 1993), System 1+ is regularly used in dental clinics without the problem in mixing the resin, thus reducing the bond strength effect.

The light curing time in this study was 40 seconds which was recommended by Wang and Meng (1992). They studied the effect of curing time for Transbond on bond strength and suggested that 40 seconds was the optimal time for curing and was greater bond strength than 20 seconds which was indicated by the manufacturer instruction. But 40 seconds curing time might not be optimal for Sequence and Enlight which that the manufacturer instruction suggested 30 seconds for curing.

It is difficult to compare these findings with other studies on shear bond strength due to the differences in the brackets, adhesives and/or experimental methods used. However, System 1+, Transbond and Sequence were investigated by several studies and were summarized in Table 5.

Table 5 Comparison of the bond strength values of System 1+, Transbond and Sequence in several studies

Adhesives	Bond strength value (N)						
	this study	Wang and Meng (1992)	Alexander (1993)	Smith and Shivapuja (1993)	Sargison et al. (1995)	Chamda and Stein (1996)	Willems et al. (1997)
System 1+	99.85						46.2
Transbond	112.85	72.49	144.06	102.9	51.1	92.3	66.3
Sequence	96.19				52.4		51.5

From Table 5, the mean bond strengths of System 1+, Transbond and Sequence were higher than those reported by Wang and Meng (1992), Smith and Shivapuja (1993), Sargison et al. (1995), Chamda and Stein (1996), and Willems et al. (1997) but lower than the study of Alexander (1993). The mean bond strength of Transbond was greater than the bond strength of Sequence and System 1+. This result was in agreement with the study of Willems et al. (1997). In this study, the four composite resins showed a statistically significant difference in shear bond strength values with Transbond (light cured composite resin) displaying a significantly greater bond strength than the other. This may be due to the differing composition (liquid sealant, filler size, type and volume of filler) and sufficient light penetration through the thin layer of resin itself in order to activate polymerization (Sargison et al., 1995) which recognized from completely polymerization of the resins at tooth surface and bracket base of Transbond after debonding.

Reynolds (1975) suggested that a successful clinical bonding would be achieved by means of an adhesive that produced a bond strength of 60-80 Kg/cm^2 or 6-8 MN/m^2. From Table 1, the lowest shear bond strength value was 54.11 N (6.4 MN/m^2). All composite resins exhibited shear bond strength values that were above the accepted bond strengths necessary for intraoral retention.

From Table 4, the sites of bond failure revealed that fracture modes for these resins may vary among types of adhesives.

Eversoll and Moore (1988) stated that the mechanical retention of enamel surface was improved by acid etching and/or the liquid portion of the bonding adhesive and adding inorganic filler acted to increase the cohesive strength.

The combination failures occurred in chemically cured composite resin, System 1+. It was possible that System 1+ was a lightly filled adhesive which could increase cohesive failure and the liquid sealant was unfilled which could reduce the strength of resin tags.

Visible light cured composite resin, Transbond, was a highly filled resin. The failure mode was adhesive failure because of the increased filler in adhesive paste.

Dual cured composite resins, Sequence and Enlight, predominantly underwent bond failure at bracket-composite interface. These resins had high cohesive strength because of highly filled component and the weak linked of enamel-composite interface was due to lightly VLC sealant and unfilled XM sealant.

Furthermore, the direction of force during debonding also influenced the fracture site.

While a strong and durable bond is required, the problem of removing the bracket without damaging the enamel must not be overlooked (Williems et al., 1997). For the debonding process, the bracket-composite interface must have a relatively higher bond strength than the cohesive strength of adhesive or bond strength created by the mechanical retention of the etched enamel surface (Eversoll and Moore, 1988; Williems et al., 1997). In this study, a mixed failure mode was observed for all materials. The dual (Sequence and Enlight) cured composite resins tended to show a reduced percentage of material remaining on the enamel following debonding. This is considered a clinical advantage. However, higher bond strengths could reduce the surface area needed for a strong bond, which ultimately result in the use of smaller brackets.

The data of treatment group derived after shear bond strength testing were found to have wide standard deviations and ranges. This might be a reflection of the variation of the material tested, but in the specific condition in this experiment, the following factors should also be considered.

1. Nature of the enamel surface

The chemical and histological characteristics of a tooth during development and the environmental factor; such as topical fluoride, toothpaste or plaque; may influence enamel solubility.

2. Thickness of the material tested

The increased thickness of the adhesive layer gave a poor bond strength (Bounocore, 1963) but the minimum thickness of the adhesive layer gave the maximum adhesion (Alexandre et al., 1981). In this investigation, the quantity of materials and the magnitude of the bracket seating pressure were not controlled, therefore, the adhesive thickness were varied.

3. Continuity of the material under the bracket

Be careful for adhesive application on the bracket base to ensure that all bracket were not underloaded with adhesive.

4. Difficulties in aligning the testing apparatus

The difficulties caused by this factor were minimized by having one operator carrying out all the shear force testing (Fox et al., 1991).

5. Bracket position on the tooth surface

The enamel prisms in the middle third of the tooth were orientated at right angles to the tooth surface and produced a better surface for bond strength after etching (Sheykholeslam and Brandt, 1977; Scott and Symon, 1982). The bracket position in this study might not be the middle third of the tooth.

6. Experience of the operator

However, the ease of manipulation must also be considered, bracket placement and excess removal were found to be much easier with light and dual cured composite resins than with chemically cured composite resin.

In addition, these dual cured composite resins, Sequence and Enlight, have the advantage of preventing decalcification due to fluoride releasing and of easier debonding. However, Enlight can perform in a moist field better than Sequence due to its hydrofilic-like FluoroBond XM sealant which displaces moisture and does not bead (Ormco Corporation, 1998).

Smith and Shivapuja (1993) suggested that in clinical study, the curing time required by a dual cured composite resin was about half the time required to cure with visible light cured composite resin. Clinical disadvantages which appeared with the use of the dual cured composite resins were that in void of light, these resins had an initial setting time of 8 to 10 minutes. Therefore there was not an unlimited working time with the dual cured composite resins (Smith and Shivapuja, 1993).

In conclusion, successful bonding of orthodontic attachments depends on several factors:

1. conditioning of the teeth,
2. bonding material,
3. size, shape, and quality of the attachment,
4. type of the teeth to be bonded,
5. bonding procedure, and
6. experience of the operator.

If some factors were reduced, the successful of bonding would be decreased.

Limitations

1. Fox et al. (1994) suggested that premolar tooth should be used after 1 month, but before 6 months after extraction. In this study, the teeth were used within 1 year after extraction because in order to reduce the variation of shear bond strength and generate meaningful data. Thirty specimens should be used per test and collecting thirty specimens took as long as 1 year.

2. The places for bonding procedure, immersing specimens and shear test should be the same place.

Suggestions

The findings lead to the following suggestions:

1. If the method of activation is considered, materials which is used to test the bond strength will consist of the same basic components.

2. Further research projects are recommended to investigate the bond failure of these resins in clinical study.