

## CHAPTER IV

### RESULTS

The results of this study are presented in two parts as follows:

#### 4.1 SHEAR BOND STRENGTH

#### 4.2 ADHESIVE REMNANT INDEX SCORE

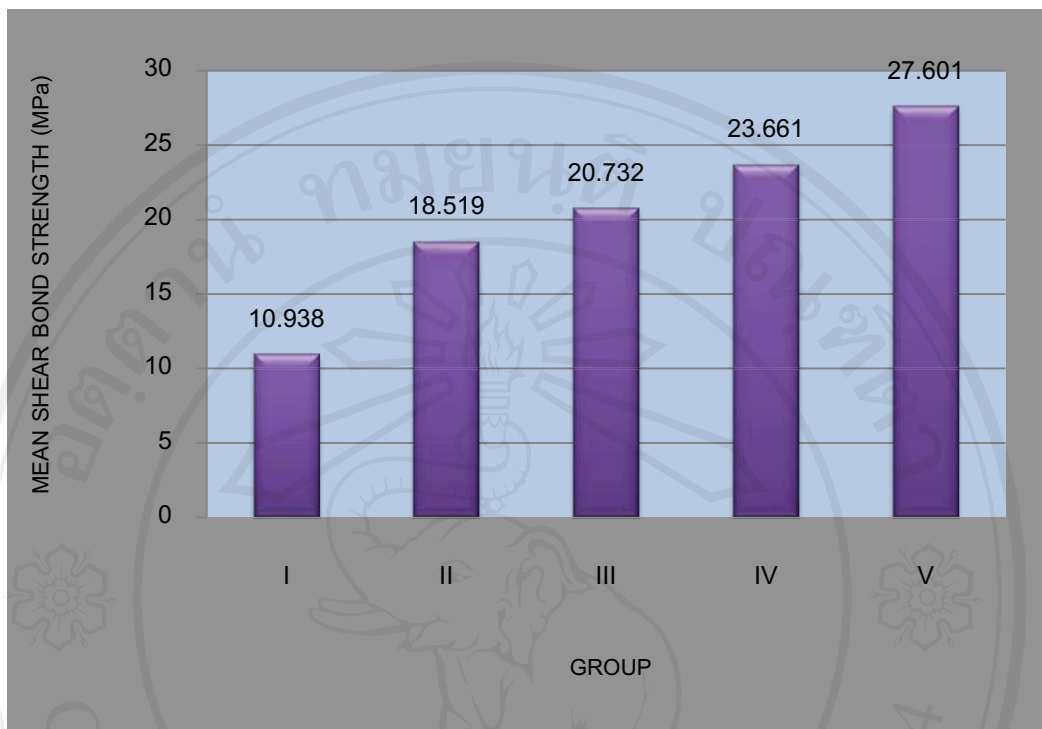
#### 4.1 SHEAR BOND STRENGTH

##### 4.1.1 Determination of the shear bond strength

Shear bond strength values of the five different adhesive systems were described by means, standard deviations, maximum and minimum, which are shown in Table 4.1 and Figure 4.1. The shear bond strength values were recorded in Megapascals (MPa).

**Table 4.1** Means, standard deviations, maximum and minimum values of shear bond strength at the point of bond failure of the five groups of different adhesive systems

Group	System	Shear bond strength (MPa)			
		Mean	SD.	Max	Min
I	9.6% hydrofluoric acid/ System <sup>TM1+</sup>	10.94	4.09	19.93	5.52
II	37% phosphoric acid /Silane/System <sup>TM1+</sup>	18.51	4.86	26.20	9.73
III	9.6% hydrofluoric acid/Silane/ System <sup>TM1+</sup>	20.73	6.66	32.49	5.36
IV	37% phosphoric acid/Silane/Super-Bond C&B	23.66	6.55	33.86	12.13
V	9.6% hydrofluoric acid/Silane/ Super-Bond C&B	27.60	10.53	40.54	11.00



**Figure 4.1** Histogram shows mean shear bond strength values of five groups of adhesive systems

#### 4.1.2 Comparison of the shear bond strength

The first hypothesis of this study was “there is no statistically significant difference in mean shear bond strength values among five adhesive systems in orthodontic bracket placement.”

One way analysis of variance (ANOVA), revealed a statistically significant difference in the mean shear bond strength values among five different adhesive systems.

The results of a multiple comparisons test (Tukey’s test) are shown in Table 4.2

The results indicate that

1. Group I (HF/System™1+) had the lowest mean shear bond strength value at 10.94 MPa and this value was significantly different from the values in the other groups ( $P<0.05$ ).
2. Group II (Phosphoric acid/silane/Super-Bond C&B), Group III (HF acid/silane/System™1+) and Group IV (Phosphoric acid/silane/System™1+) showed mean shear bond strength values that were not significantly different, at 23.66, 20.73 and 18.51 MPa, respectively.
3. Group V (HF/silane/Super-bond C&B) had the highest mean shear bond strength value at 27.60 MPa and this value was significantly different from the values in Group I, II and III ( $P<0.05$ ).

**Table 4.2** Statistical comparison of mean shear bond strength values among five different adhesive systems

GROUP	N	1	2	3
I	20	10.937625		
II	20		18.509677	
III	20		20.731833	
IV	20		23.661379	23.661379
V	20			27.600938
Sig.		1.000	.136	.377

\* Significance level  $p < 0.05$

#### 4.2 ADHESIVE REMNANT INDEX SCORE

Failure sites were divided into five locations according to the Modified Adhesive Remnant Index (ARI)<sup>13,14</sup> as follows:

**Score 0** = No adhesive left on the porcelain

**Score 1** = Less than half of the adhesive left on the porcelain

**Score 2** = More than half of the adhesive left on the porcelain

**Score 3** = All adhesive left on the porcelain, with a distinct impression of the bracket mesh

**Score 4** = Porcelain fractured

The numbers and percentages of the ARI scores of the five different adhesive systems are shown in Table 4.3 and Figure 4.2.

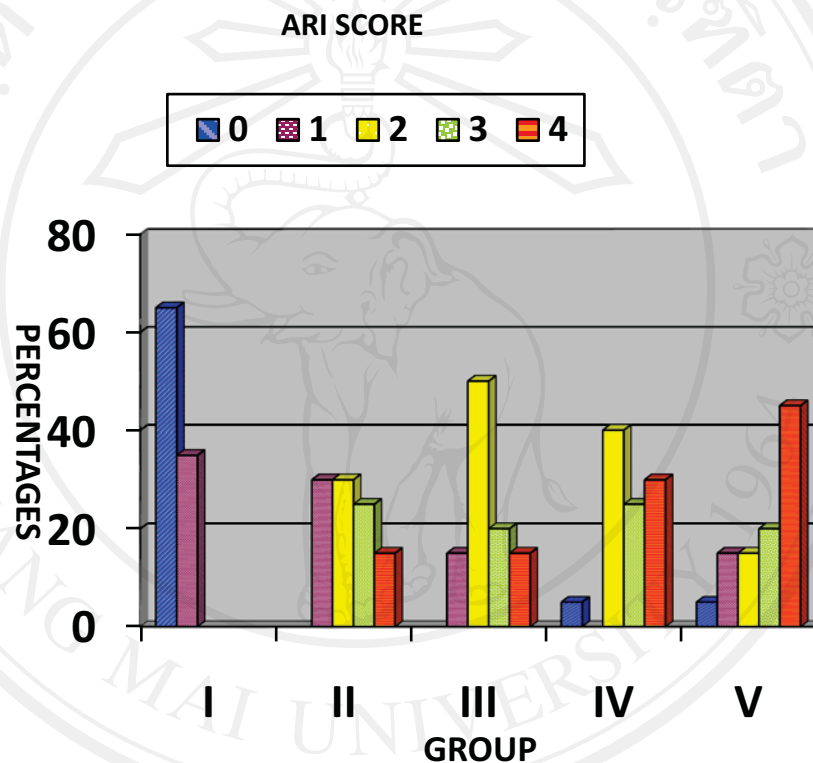
**Table 4.3** The numbers and percentages of ARI scores of the five groups

ARI Group	0	1	2	3	4	Total
I	13 65%	7 35%	0 0%	0 0%	0 0%	20
II	0 0%	6 30%	6 30%	5 25%	3 15%	20
III	0 0%	3 15%	10 50%	4 20%	3 15%	20
IV	1 5%	0 0%	8 40%	5 25%	6 30%	20
V	1 5%	3 15%	3 15%	4 20%	9 45%	20
Total	15	19	27	18	21	100

The results of examination of failure sites showed that

1. Group I showed an ARI score of 0 for 65% of its specimens which means that the porcelain/adhesive interface was the commonest site of failure (Figure 4.3A) and

the bond strength at the porcelain surfaces were lower than both the cohesive strength of the adhesive resin and the bond strength of the adhesive resin to the bracket. The rest of the specimens (35%) showed an ARI score of 1. This group was the only group with no visible porcelain surface damage.

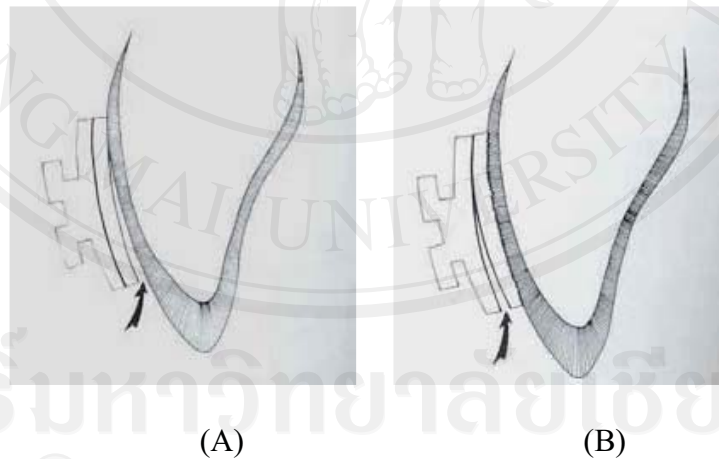


**Figure 4.2** Histogram demonstrates percentages of ARI score of five groups

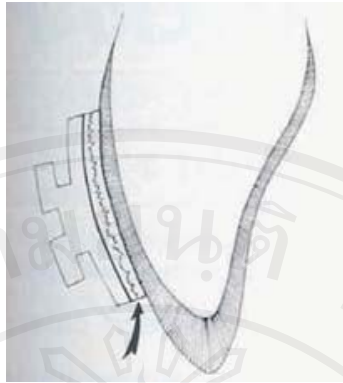
- The failure sites in Group II showed ARI scores of 1 for 30% of the specimens, 2 for 30% and 3 for 25%. The failure sites in Group III showed ARI scores of 1 for 15%, 2 for 50% and 3 for 20%. The failure sites in Groups II and III showed mixed types of bond failure, with all or most of the resin remaining on both the porcelain and the bracket base, indicating the failure of the cohesive bond of the

adhesive resin or the failure of the adhesive bond between the resin and both the bracket base and the porcelain (Figure 4.3 and 4.4). The specimens with damaged porcelain surfaces (Figure 4.5) in Groups II and III constituted 15 % of their specimens.

3. The failure sites in Groups IV and V were generally distributed at each ARI score. Group IV showed ARI scores of 0 for 5% of its specimens, 2 for 40% and 3 for 25%. Group V showed ARI scores of 0 for 5%, 1 for 15%, 2 for 40% and 3 for 25%. Groups IV and V had high percentages of damaged porcelain surfaces at the ARI score of 4 for 30% and 45%, respectively. The result showed that the group with the highest bond strength (Group V) had the greatest number of specimens with cohesive failure in the porcelain surfaces (Figure 4.5).



**Figure 4.3** Adhesive failures. (A) Interface of the adhesive and enamel, (B) Interface of the adhesive and bracket<sup>38</sup>



**Figure 4.4** Cohesive failures within the adhesive<sup>38</sup>



**Figure 4.5** Cohesive failures within porcelain<sup>38</sup>