

CHAPTER IV

RESULTS

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

- I. Shear bond strength values
- II. Failure modes

I. Shear bond strength values

Shear bond strength values of the different adhesive systems are presented as follows:

Determination of the shear bond strength values

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

Table 4.1 Shear bond strength values of the adhesive systems

Group	Tooth	Adhesive	Mean Shear bond Strength (MPa)	SD (MPa)	Min-Max (MPa)
1	Normal	37%phosphoric acid and System TM 1+	10.25	2.00	6.30-13.23
2	Normal	37%phosphoric acid and Unite TM	11.59	2.32	7.30-15.89
3	Normal	65 %phosphoric acid and Superbond C&B	13.86	1.65	10.81-16.99
4	Fluorotic	37%phosphoric acid and System TM 1+	6.51	3.57	0.77-11.37
5	Fluorotic	37%phosphoric acid and Unite TM	7.51	4.79	0.90-14.80
6	Fluorotic	65 %phosphoric acid and Superbond C&B	12.29	2.91	5.43-17.77

Mean shear bond strength (MPa)

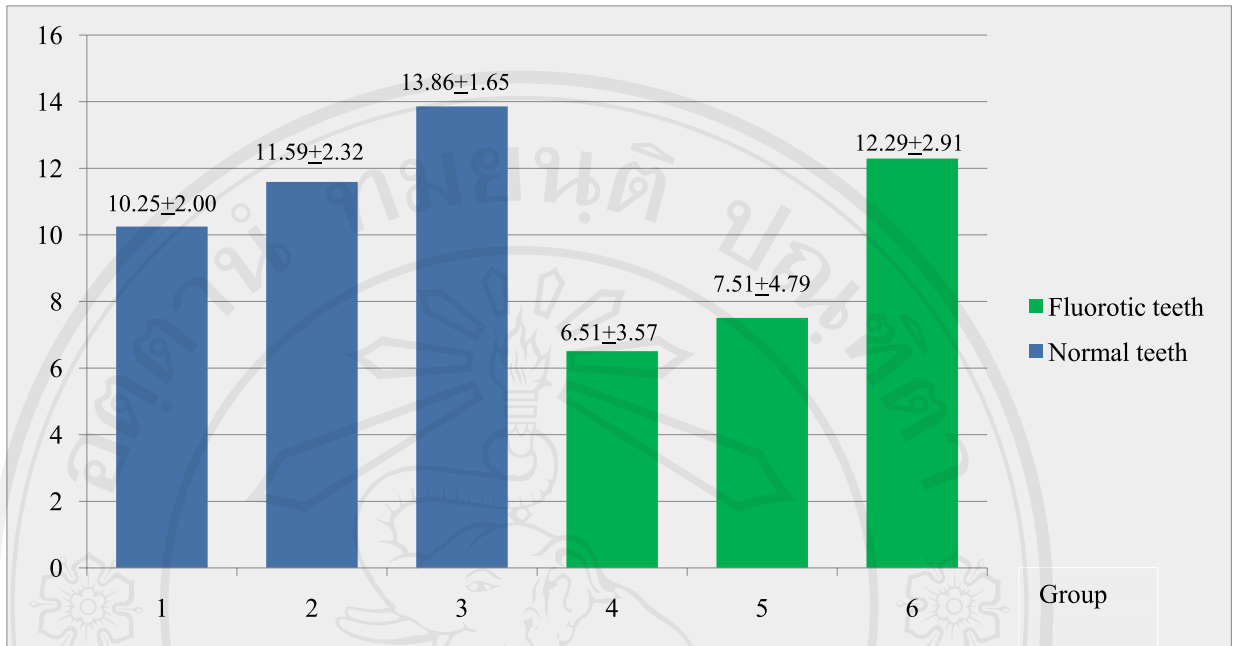


Figure 4.1 Histogram of the means and standard deviations of shear bond strength values of the different adhesive systems.

Comparison of shear bond strength

The first hypothesis of the study was “There is no statistically significant difference in mean shear bond strength between fluorotic and normal teeth.”

Two-way analysis of variance (ANOVA), which is shown in Table 4.2, revealed that the interaction of two factors, adhesive system and type of enamel, was not significant ($p > 0.05$). So, the bond strength was influenced by two factors: adhesive system ($p < 0.05$) and type of enamel ($p < 0.05$). The mean shear bond strength values of all adhesives used on normal teeth were significantly greater than those used on fluorotic teeth ($p < 0.05$).

Table 4.2 Two-way ANOVA

Source	F	Sig.
Corrected Model	17.215*	.000
Intercept	1366.265*	.000
Teeth	31.265*	.000
Adhesive	25.425*	.000
Teeth * adhesive	1.979	.143

* The mean difference is significant at the $p < 0.05$ level

The second hypothesis of the study was “There is no statistically significant difference in mean shear bond strength among three different adhesive systems in orthodontic bracket placement.”

A multiple comparisons test, whose results are shown in Table 4.3, indicated that with both normal and fluorotic teeth, the mean shear bond strength values of the SystemTM 1+ and UniteTM were not significantly different, but both were significantly different from that of Superbond C&B ($p < 0.05$).

Table 4.3 Post Hoc Tests (Multiple Comparisons)

Adhesive	Adhesive	Mean Difference	Std. Error	Sig.
System TM 1+	Unite TM	-1.16985	.685264	.207
	Superbond C&B	-4.69378*	.685264	.000
Unite TM	System TM 1+	1.16985	.685264	.207
	Superbond C&B	-3.52393*	.685264	.000
Superbond C&B	System TM 1+	4.69378*	.685264	.000
	Unite TM	3.52393*	.685264	.000

* The mean difference is significant at the $p < 0.05$ level

II. Failure modes

Failure modes of the different adhesive systems are presented as follows:

Determination of the numbers and percentages of the failure sites

The failure sites were divided into four locations according to the method of Artun and Bergland⁵³ as follows:

The Adhesive Remnant Index scores range from 0 to 3

0 = no adhesive remains on the tooth surface

1 = less than half of the adhesive remains on the tooth surface

2 = more than half of the adhesive remains on the tooth surface

3 = all the adhesive remains on the enamel surface

The numbers and percentages (in parentheses) of failure sites of the different adhesive systems are shown in Table 4.4 and Figure 4.2

Table 4.4 The numbers and percentages of ARI scores of different adhesive systems

Group	Tooth	Adhesive	Adhesive Remnant Index				
			0	1	2	3	n
1	Normal	System 1+		10 (50%)	9 (45%)	1 (5%)	20
2	Normal	Unite		10 (50%)	10 (50%)		20
3	Normal	Superbond C&B			5 (25%)	15 (75%)	20
4	Fluorotic	System 1+	5 (25%)	13 (65%)	2 (10%)		20
5	Fluorotic	Unite	3 (15%)	12 (60%)	5 (25%)		20
6	Fluorotic	Superbond C&B		4 (20%)	6 (30%)	10 (50%)	20

% of ARI scores

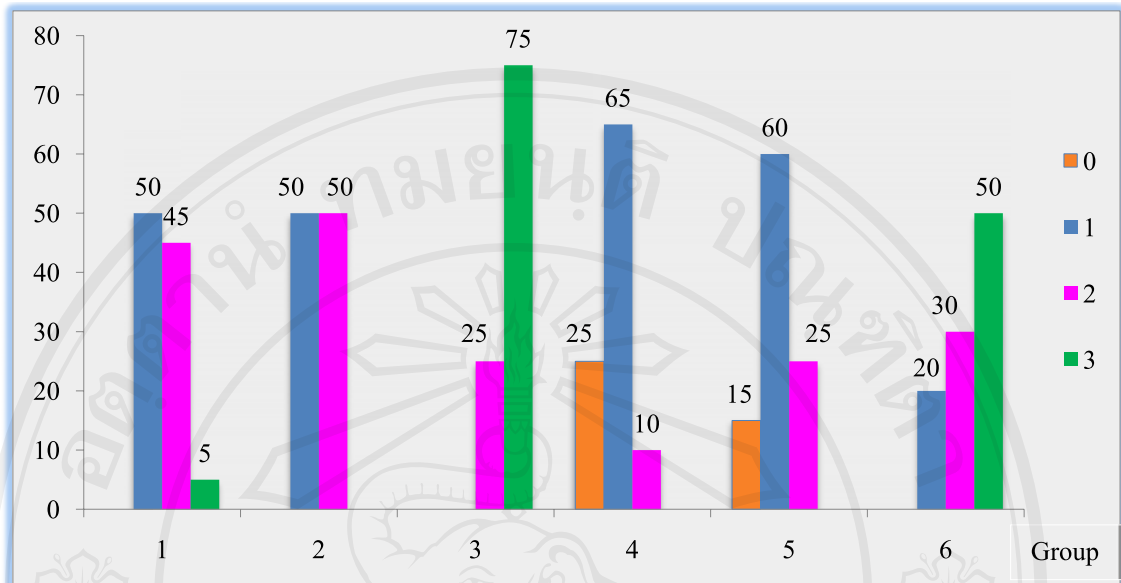


Figure 4.2 Histogram of adhesive remnant index scores of the different adhesive systems.

The sites of bond failure (percentages for each group) are presented in Table 4.4.

Failure sites of six groups showed that

1. Group 1 showed failure sites with adhesive and cohesive failures at the enamel/adhesive interface (50%) (score 1)(Figure4.3 and 4.4), with adhesive and cohesive failures at the adhesive/bracket interface (45%) (score 2) (Figure4.4 and 4.5). and failure sites at adhesive/bracket interface (5%) (score 3) (Figure 4.5).
2. Group 2 showed failure sites with adhesive and cohesive failures at the enamel/adhesive interface (50%) (score 1) (Figure4.3 and 4.4), and with adhesive and cohesive failures at the adhesive/bracket interface (50%) (score 2) (Figure4.4 and 4.5).

3. Group 3 showed failure sites with adhesive and cohesive failures at the adhesive/bracket interface (25%) (score 2) (Figure 4.4 and 4.5) and failure sites at the adhesive/ bracket interface (75%) (score 3) (Figure 4.5).
4. Group 4 showed failure sites at the enamel/adhesive interface (25%) (score 0) (Figure 4.3), with adhesive and cohesive failures at the enamel/adhesive interface (65%) (score 1) (Figure 4.3 and 4.4) and with adhesive and cohesive failures at the adhesive/bracket interface (10%) (score 2) (Figure 4.4 and 4.5).
5. Group 5 showed failure sites at the enamel/adhesive interface (15%) (score 0) (Figure 4.3), with adhesive and cohesive failures at the enamel/adhesive interface (60%) (score 1) (Figure 4.3 and 4.4) and with adhesive and cohesive failures at the adhesive/bracket interface (25%) (score 2) (Figure 4.4 and 4.5).
6. Group 6 showed failure sites with adhesive and cohesive failures at the enamel/adhesive interface (20%) (score 1) (Figure 4.3 and 4.4), with adhesive and cohesive failures at the adhesive/bracket interface (30%) (score 2) (Figure 4.4 and 4.5) and failure sites at the adhesive/ bracket interface (50%) (score 3). (Figure 4.5).



Figure 4.3 Adhesive failures at the enamel/adhesive interface.⁵⁴



Figure 4.4 Cohesive failures within the adhesive.⁵⁴

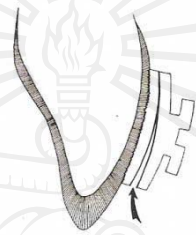


Figure 4.5 Adhesive failures at the adhesive/bracket interface.⁵⁴

In normal teeth, the commonest site of failure for SystemTM 1+ was with adhesive and cohesive failures at the enamel/adhesive interface. For UniteTM, the sites of failure were found with adhesive and cohesive failures at the enamel/adhesive interface as well as with adhesive and cohesive failures at the adhesive/bracket interface. The commonest site of failure for Superbond C&B was found at the adhesive/bracket interface. In fluorotic teeth, the commonest site of failure for SystemTM 1+ and UniteTM were found with adhesive and cohesive failures at the enamel/adhesive interface. The commonest site of failure for Superbond C&B was found at the adhesive/bracket interface.