

CHAPTER IV

RESULTS

The results of this study were sequentially presented as follows:

Part I: The descriptions of the patients

Part II: The clinical scores

Part III: The changes in HA level per unit protein

Part IV: Comparison of the HA level per unit protein during the leveling phase (L- phase), the first eight weeks of canine movement phase (M-phase), and after complete orthodontic canine movement phase (S-phase)

Part V: Comparison of the HA level per unit protein between canines and incisors in any periods of sample collection

Part I: The descriptions of the patients

Each of four patients was given a code (C, D, E, and H) (Table 4.1). The canines and incisor from each patient were labeled by a two numbering system (Table 4.1). The ages of patients ranged from 20 to 21 years at the beginning of this study. All four patients were female (Table 4.1).

Table 4.1 A summary of the patients' profiles in this study: patients' code, tooth number, age, and sex.

Patient's code	Tooth number	Age	Sex
C	11, 13	20	Female
D	11, 13, 23	21	Female
E	11, 13, 23	20	Female
H	13, 23	20	Female

Part II: The clinical scores

All four patients (C, D, E, and H), who participated in this study, received repeated oral hygiene instructions (toothbrush, dental floss, and inter-dental brush). Plaque and gingival indices (PI and GI, respectively) were used to assess the periodontal conditions before, during, and after orthodontic canine movement. The means and standard deviations of PI and GI were shown in Table 4.2. A non-parametric statistical analysis (Friedman Test) was used to compare PI and GI scores between three different periods of treatment, i.e. before, during, and after (Table 4.3 and 4.4).

Table 4.2 The means (standard deviations) of plaque index (PI) and gingival index (GI) before, during, and after complete orthodontic canine movements.

Patients	PI			GI		
	Before	During	After	Before	During	After
C	2.71(0.48)	2.96(1.42)	3.19(1.42)	0.56(0.94)	0.84(0.42)	1.01(0.28)
D	1.74(1.10)	1.76(1.76)	1.80(1.13)	0.97(0.35)	0.82(0.38)	0.99(0.25)
E	1.90(1.54)	1.53(1.53)	1.79(1.00)	0.30(0.49)	0.63(0.49)	0.61(0.49)
H	1.62(0.95)	2.63(2.63)	3.26(4.66)	0.49(0.50)	0.81(0.44)	1.01(0.26)

Table 4.3 The mean rank of plaque index (PI) and gingival index (GI) scores of all four patients before, during, and after complete orthodontic canine movements (n = 4).

Parameter	PI			GI		
	Before	During	After	Before	During	After
Duration						
Mean Rank	1.50	1.75	2.75	1.25	2.00	2.75

Table 4.4 The non-parametric statistical analysis (Friedman Test) of plaque index (PI) and gingival index (GI) scores.

Clinical Parameters	PI	GI
Statistical Test ^a		
N	4	4
Chi-Square	3.500	4.500
df	2	2
Significant Level	.174	.105

a. Friedman Test

The plaque index (PI) and gingival index (GI) scores of all four patients were not significantly different among all three periods, i.e. before, during, and after complete orthodontic canine movements ($P = 0.174$ and 0.105 , respectively).

Part III: The changes in HA level per unit protein

The duration of a longitudinal study (before insertion of orthodontic appliance T0, the leveling phase (L0, L4, L8,...), the movement phase (M0, M1, M2, M3,...), and the complete movement phase (S0, S1, S2,...) in each patient was shown in Figure 4.1. The duration of each phase was different in each patient, ranging from 3 to 10 weeks before appliance insertion, from 4 to 12 weeks in the leveling phase, and from 15 to 39 weeks for the movement phase. In the complete movement phase (S0-S10), the closed coil spring was removed, and the canine and second premolar were tied together with a ligature wire to maintain a canine position and to prevent relapse. The GCF samples were then collected for another 8 weeks or more. Moreover, intraoral photographs were taken for each phase and some examples were illustrated in Figure 4.2.



Figure 4.1 The duration of a longitudinal study.

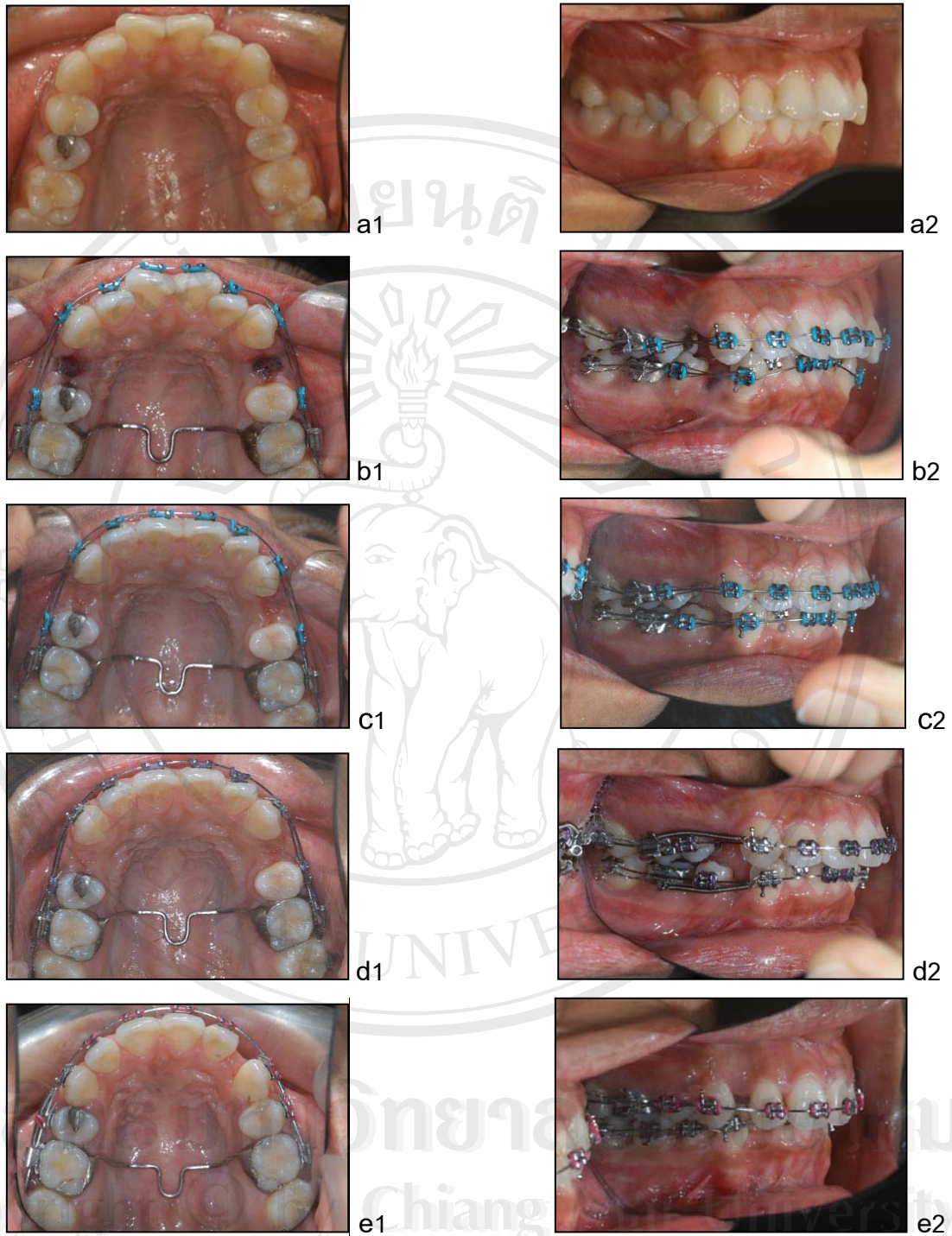


Figure 4.2 Intraoral photographs; a1, a2) T0: before appliance insertion, b1, b2) L0: the first visit of leveling phase, c1, c2) L4: the second visit of leveling phase, d1, d2) M0: began to retract the canine, e1, e2) S0: complete movement, a canine contacted to a second premolar. An occlusal view (a1, b1, c1, d1, and e1) and a lateral view (a2, b2, c2, d2, and e2).

The HA level per unit protein of each tooth had a cyclical pattern with several highest levels of HA, regardless of the timing of the applied orthodontic force. The results demonstrated increases and decreases in HA level per unit protein from T0 to S phase. The cyclical changes in HA level per unit protein occurred throughout the period of GCF collection in both canines and incisors with a wide range interval from 2 to 10 weeks between two neighboring highest values.

A linear graph in Figure 4.3 demonstrated cyclical changes in HA level per unit protein in GCF collected from subject C. Several peaks of changes in HA level per unit protein were observed throughout the study from T0 to S phase in both experimental (C13) and control (C11) teeth (Figure 4.3). It was interesting to note that the highest levels of HA released into GCF from the tooth C13 were more than those of the tooth C11. However, it appeared that the highest levels of HA in any periods of time did not correlate with the timing when an orthodontic force was applied to the canine.

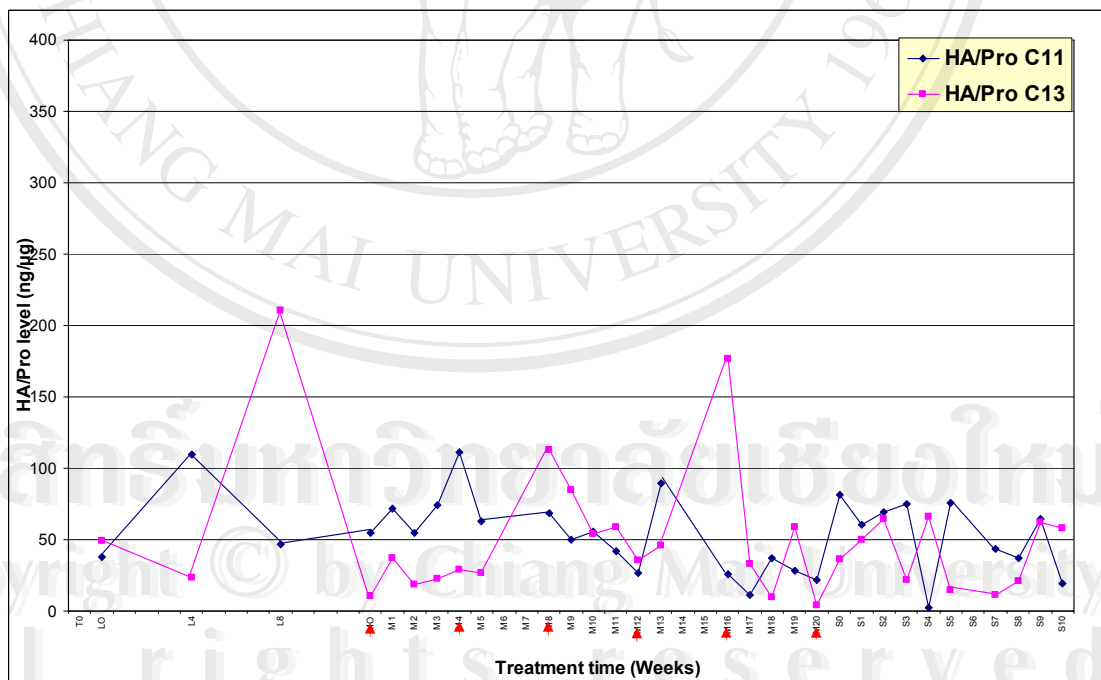


Figure 4.3 A linear graph demonstrated HA level per unit protein (ng/μg) of tooth C11 (Blue) and C13 (Pink). The red arrows indicated the time when a new closed coil spring was changed and the force was therefore applied to the experimental tooth, C13.

Similar to the cyclical changes of HA level per unit protein in subject C, a linear graph in Figure 4.4 demonstrated cyclical changes in HA level per unit protein in GCF collected from subject D. In contrast to subject C, the highest levels of HA in GCF from both experimental (D13 and D23) and control (D11) teeth were not different (Figure 4.4). Moreover, similar to subject C, it appeared that the highest levels of HA level per unit protein in both experimental and control teeth in any periods of time did not correlate with the timing when an orthodontic force was applied to the canine. Therefore, consistent with the unpredictable pattern of HA level per unit protein changes in subject C, the pattern of HA level per unit protein changes in subject D was not predictable and did not depend on hard and soft tissue remodeling, resulting from applied orthodontic force. In addition, the pattern of cyclical changes found in the other two subjects (E and H) was similarly unpredictable as well.

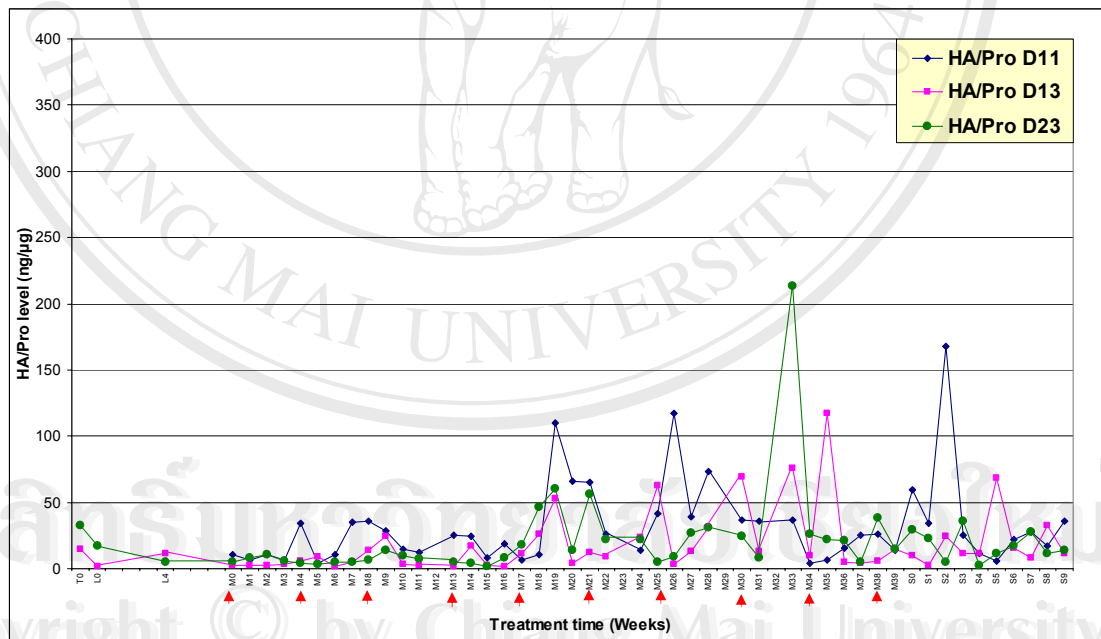


Figure 4.4 A linear graph demonstrated HA level per unit protein (ng/μg) of teeth D11 (Blue), D13 (Pink), and D23 (Green). The red arrows indicated the time when a new closed coil spring was changed and the force was therefore applied to the experimental teeth, D13 and D23.

Part IV: Comparisons of the HA level per unit protein during the leveling phase (L-phase), the first eight weeks of canine movement phase (M-phase), and after complete orthodontic canine movement phase (S-phase)

The following part focused on the changes of HA level per unit protein from the leveling phase, the first eight weeks of canine movement phase (M0, M1, M2, ..., and M8), and after complete orthodontic canine movement phase (S0, S1, S2, S3, S4, S5, S6, S7, and S8). The medians were shown in Table 4.5 and a linear graph of the medians was shown in Figure 4.5.

Table 4.5 The medians of HA level per unit protein (ng/ μ g) of canines (n=7) and incisors (n=3) during the leveling phase, the first eight weeks of canine movement phase (M0, M1, M2, M3, ..., and M8), and after complete orthodontic canine movement phase (S1, S2, S3, ..., and S8).

Treatment phase	Median	
	Canine	Incisor
L0	17.02	38.07
L4	5.01	11.89
M0	10.71	54.68
M1	18.73	56.63
M2	29.31	28.21
M3	22.94	7.74
M4	29.01	34.42
M5	18.92	27.20
M6	28.44	10.88
M7	31.41	18.16
M8	13.79	37.47
S0	31.33	59.27
S1	33.89	40.95
S2	34.79	69.74
S3	12.38	25.23
S4	2.60	2.53
S5	14.72	5.90
S6	16.33	22.15
S7	22.10	27.65
S8	32.44	16.92

The linear graph demonstrated the medians of HA level per unit protein of canines and incisors (Figure 4.5). L0 was the first time when force was applied by the arch wire in the leveling phase. It was interesting to note that the median of HA level per unit protein in both experimental canines and control incisors was decreased in L4 (Figure 4.5). Subsequently, the median of HA level/total protein in both experimental and control teeth varied inconsistently with the timing when a new closed coil spring was changed at M0, M4, and M8. S0 was the first visit when a closed coil spring was removed, and the varying medians of HA level per unit protein changes without any consistent pattern in both experimental and control teeth were observed thereafter.

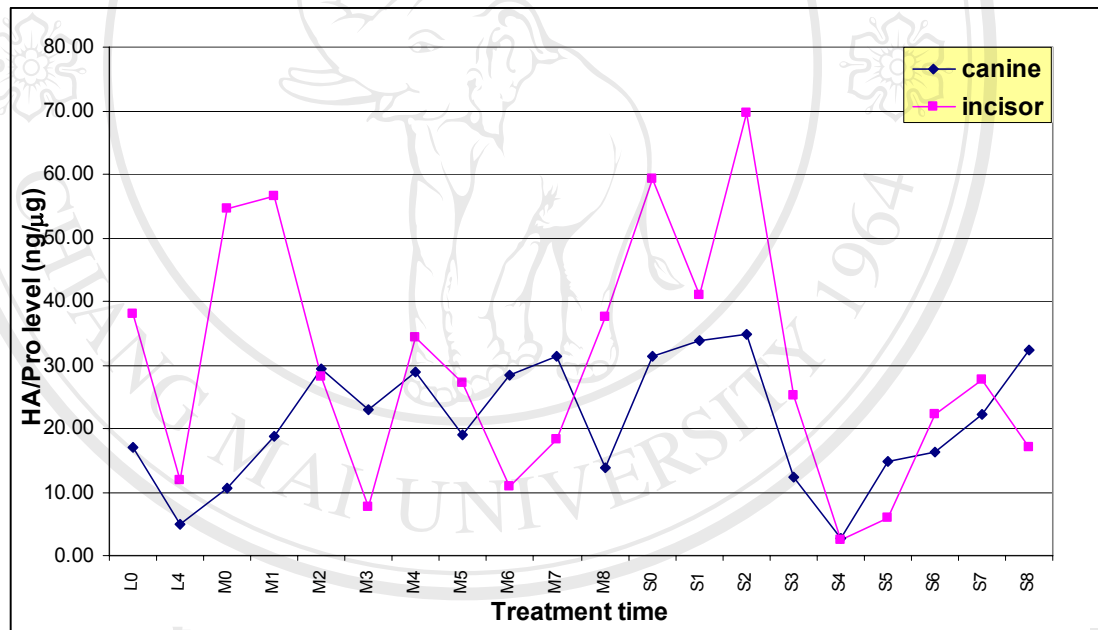


Figure 4.5 A Linear graph demonstrated the medians of HA level per unit protein (ng/μg) of canines (n=7, Blue) and incisors (n=3, Pink) in L-phase, the first eight weeks of canine movement phase (M0, M1, M2, M3, ..., and M8), and after complete orthodontic canine movement phase (S1, S2, S3, ..., and S8)

The medians of HA level per unit protein were calculated from both experimental and control teeth. A non-parametric statistical analysis, the Friedman Test, was used to compare the medians of HA level/total protein in each treatment time (L0, L4, M0, M1, ..., M8, S0, S1, S2, ..., and S8) of seven experimental canines and three control incisors (Table 4.6).

Table 4.6 The non-parametric statistical analysis (Friedman Test) of HA level per unit protein of canines and incisors.

Statistical Test ^a	Canines	Incisors
N	7	3
Chi-Square	14.483	14.091
df	19	19
Significant Level	.755	.778

a. Friedman Test

The non-parametric statistical analysis showed no statistically significant difference in the medians of HA level per unit protein among each treatment time (L0, L4, M0, M1, ..., M8, S0, S1, S2, ..., and S8) of seven experimental canines ($P = 0.755$) and three control incisors ($P = 0.778$) (Table 4.6).

Part V: Comparisons of the HA level per unit protein between canines and incisors in every treatment phase

In all treatment phases, i.e. L-phase, M-phase, and S-phase, the Mann-Whitney U statistical test was used to compare the medians of the HA level per unit protein between canines and incisors (Table 4.7).

Table 4.7 The non-parametric statistical analysis (Mann-Whitney U Test) of the medians of HA level per unit protein between canines (n = 7) and incisors (n = 3) in every treatment phase.

Treatment phase	Mann-Whitney U	Z	Significant Level (2-tailed)
L0	10.00	-.11	.90
L4	5.00	-1.25	.20
M0	5.00	-1.25	.21
M1	8.00	-.57	.56
M2	9.00	-.34	.73
M3	10.00	-.11	.90
M4	9.00	-.34	.73
M5	9.00	-.34	.73
M6	8.50	-.45	.64
M7	7.50	-.68	.49
M8	8.00	-.57	.56
S0	7.00	-.79	.42
S1	5.00	-1.25	.21
S2	7.00	-.79	.42
S3	10.00	-.11	.90
S4	8.00	-.57	.56
S5	6.00	-1.02	.30
S6	10.00	-.11	.90
S7	10.00	-.11	.90
S8	9.00	-.34	.73

To compare the medians of the HA level per unit protein between canines and incisors in every treatment phase, the Mann-Whitney U statistical test was used and the test revealed that no statistically significant difference between canines and incisors in any period of treatment.