

CHAPTER IV RESULTS

The present investigation was performed on forty one subjects: thirty females and eleven males. The age of the female group ranged from 14 to 22 years with the average age of 16.8 years; whereas the age of the male group ranged from 16 to 26 years with the average age of 17.7 years. All samples were dental class I malocclusion had been treated by extraction of four first premolars with Edgewise Technique. The pretreatment and posttreatment lateral cephalograms of each patient were used. The amount of distance changes of each measurement were measured and analysed. The pretreatment and posttreatment distance changes for both groups were summarized, then sex difference were analysed and the relationships of each variable were also calculated.

The results of the study were presented in tables with descriptions as follow:

- Descriptive statistic data of the changes of each variable in either sex shown in Table 1 and Table 2.
- Comparison between mean changes of male and female sample were shown in Table 3 and the combined data of both sexes were shown in Table 4 and Table 5.
- Data show the relationship of each variable and multiple regression equation were shown in Table 6 to Table 12.

Table 1 Descriptive statistics for distance changes of each measurement (mm.) following orthodontic treatment for female group. (n=30)

VARIABLE	\bar{X}	SD
Δ UI	4.783	2.908
Δ UIa	-0.492	2.672
Δ LI	3.325	2.452
Δ LIa	1.200	2.455
Δ A	0.125	1.441
Δ B	0.742	1.941
Δ A'	0.533	1.813
Δ UL	1.600	2.632
Δ B'	1.658	2.450
Δ LL	2.567	3.254

From Table 1 after orthodontic treatment of female sample, it was found that

Dental changes

UI (the most anterior point on the labial surface of the upper incisor) moved backward for an average of 4.783 ± 2.908 mm. whereas UIa (the upper incisor apex) moved forward for an average of 0.492 ± 2.672 mm..

LI (the most anterior point on the labial surface of the lower incisor) moved backward for an average of 3.325 ± 2.452 mm. whereas LIa (the lower incisor apex) moved backward for an average of 1.200 ± 2.455 mm..

Skeletal changes

Point A moved backward for an average of 0.125 ± 1.441 mm..

Point B moved backward for an average of 0.742 ± 1.941 mm..

Soft tissue changes

A' (the deepest point on the anterior contour of the upper lip) moved backward for an average of 0.533 ± 1.813 mm..

UL (the most anterior point on the convexity of the upper lip) moved backward for an average of 1.600 ± 2.632 mm..

B' (the deepest point on the anterior contour of the lower lip) moved backward for an average of 1.658 ± 2.450 mm..

LL (the most anterior point on the convexity of the lower lip) moved backward for an average of 2.567 ± 3.254 mm..

Table 2 Descriptive statistics for distance changes of each measurement (mm.) following orthodontic treatment for male group. (n=11)

VARIABLE	\bar{X}	SD
ΔUI	4.386	2.771
ΔUIa	0.023	2.760
ΔLI	4.159	2.432
ΔLIa	1.409	2.570
ΔA	0.295	2.027
ΔB	1.000	2.216
$\Delta A'$	0.705	1.952
ΔUL	2.000	2.629
$\Delta B'$	1.432	2.214
ΔLL	3.727	2.919

From Table 2 after orthodontic treatment of male sample, It was found that

Dental changes

UI (the most anterior point on the labial surface of the upper incisor) moved backward for an average of 4.386 ± 2.771 mm. whereas UIa (the upper incisor apex) moved backward for an average of 0.023 ± 2.760 mm..

LI (the most anterior point on the labial surface of the lower incisor) moved backward for an average of 4.159 ± 2.432 mm. whereas LIa (the lower incisor apex) moved backward for an average of 1.409 ± 2.570 mm..

Skeletal changes

Point A moved backward for an average of 0.295 ± 2.027 mm..

Point B moved backward for an average of 1.000 ± 2.216 mm..

Soft tissue changes

A' (the deepest point on the anterior contour of the upper lip) moved backward for an average of 0.705 ± 1.952 mm..

UL (the most anterior point on the convexity of the upper lip) moved backward for an average of 2.000 ± 2.629 mm..

B' (the deepest point on the anterior contour of the lower lip) moved backward for an average of 1.432 ± 2.214 mm..

LL (the most anterior point on the convexity of the lower lip) moved backward for an average of 3.727 ± 2.919 mm..

Table 3 Sexes difference of each measurement.

VARIABLE	FEMALE (n=30)		MALE (n=11)		t value
	\bar{X}	SD	\bar{X}	SD	
ΔUI	4.783	2.908	4.386	2.771	0.392
ΔUIa	-0.492	2.672	0.023	2.760	0.542
ΔLI	3.325	2.452	4.159	2.432	0.967
ΔLIa	1.200	2.455	1.409	2.570	0.239
ΔA	0.125	1.441	0.295	2.027	0.300
ΔB	0.742	1.941	1.000	2.216	0.364
$\Delta A'$	0.533	1.813	0.705	1.952	0.263
ΔUL	1.600	2.632	2.000	2.629	0.431
$\Delta E'$	1.658	2.450	1.432	2.214	0.269
ΔLL	2.567	3.254	3.727	2.919	1.038

From Table 3 it was found that there were no significant mean differences between sexes. Therefore, the female and male data were combined for subsequent analyses as shown in Table 4.

Table 4 Descriptive statistics for distance changes of each measurement (mm.) following orthodontic treatment for all sample of both sexes.(n=41)

VARIABLE	\bar{X}	SD
ΔUI	4.677	2.843
ΔUIa	-0.354	2.671
ΔLI	3.549	2.445
ΔLIa	1.256	2.456
ΔA	0.171	1.593
ΔB	0.811	1.994
$\Delta A'$	0.579	1.828
ΔUL	1.707	2.604
$\Delta B'$	1.598	2.364
ΔLL	2.878	3.174

From Table 4 after orthodontic treatment of all sample, it was found that

Dental changes

UI (the most anterior point on the labial surface of the upper incisor) moved backward for an average of 4.677 ± 2.843 mm. whereas UIa (the upper incisor apex) moved forward for an average of 0.354 ± 2.671 mm..

LI (the most anterior point on the labial surface of the lower incisor) moved backward for an average of 3.549 ± 2.445 mm. whereas LIa (the lower incisor apex) moved backward for an average of 1.256 ± 2.456 mm..

Skeletal changes

Point A moved backward for an average of 0.171 ± 1.593 mm..

Point B moved backward for an average of 0.811 ± 1.994 mm..

Soft tissue changes

A' (the deepest point on the anterior contour of the upper lip) moved backward for an average of 0.705 ± 1.952 mm..

UL (the most anterior point on the convexity of the upper lip) moved backward for an average of 2.000 ± 2.629 mm..

B' (the deepest point on the anterior contour of the lower lip) moved backward for an average of 1.432 ± 2.214 mm..

LL (the most anterior point on the convexity of the lower lip) moved backward for an average of 3.727 ± 2.919 mm..

The findings revealed posterior changes of skeletal and soft tissue following incisor retraction.

Table 5 Student t-test for mean changes of each measurement of hard and soft tissue following incisor retraction.

VARIABLE	\bar{X}	SD	t value
ΔA	0.171	1.593	0.687341
ΔB	0.811	1.994	2.6042796*
$\Delta A'$	0.579	1.828	2.028123*
$\Delta B'$	1.598	2.364	4.3283384***
ΔUL	1.707	2.604	4.1974397***
ΔLL	2.878	3.174	5.8059833***

* $p < .05$, ** $p < .01$, *** $p < .001$

From Table 5 it was found that there was no significant change in hard tissue point A. For hard tissue point B, there was a significant change at the 0.05 level.

For soft tissue, the findings revealed significant changes of point A', B', UL, LL at the 0.001 level.

That was: following incisor retraction there were posterior changes of hard tissue point B and all of soft tissue points (A', B', UL, LL).

When the relationships between changes of all variable were evaluated, the degree of correlations were found to vary in each variable, as demonstrated in table 6 for all samples (n=41).

Table 6 Correlation coefficients (r) for distance changes between variables.

	ΔUIa	ΔA	$\Delta A'$	ΔUL	ΔUI	ΔLI	ΔLL	ΔLIa	ΔB	$\Delta B'$
ΔUIa	1.00									
ΔA	0.710	1.00								
$\Delta A'$	0.448	0.592	1.00							
ΔUL	0.357	0.534	0.801	1.00						
ΔUI	0.328	0.525	0.468	0.668	1.00					
ΔLI	0.308	0.325	0.523	0.531	0.663	1.00				
ΔLL	0.301	0.434	0.665	0.832	0.684	0.798	1.00			
ΔLIa	0.376	0.371	0.575	0.630	0.682	0.595	0.666	1.00		
ΔB	0.354	0.560	0.663	0.683	0.592	0.614	0.724	0.730	1.00	
$\Delta B'$	0.344	0.419	0.651	0.725	0.612	0.634	0.813	0.772	0.817	1.00

From Table 6 the findings revealed that

Skeletal changes

The change of point A was related to the changes of UIa, UI, and B with correlation coefficient 0.710, 0.525, and 0.560 respectively at 0.001 level of significance whereas the change of point B was related to the changes of Lla, LI, B', LL, UI, A, A', and UL with correlation coefficient 0.730, 0.614, 0.817, 0.724, 0.592, 0.560, 0.663 and 0.683 respectively at 0.001 level of significance.

Soft tissue changes

The change of A' was related to the changes of UL, LL, B, B', Lla, A and LI with correlation coefficient 0.801, 0.665, 0.663, 0.651, 0.575, 0.592 and 0.523 respectively at 0.001 level of significance.

The change of B' was related to the changes of B, LL, Lla, UL, A', LI and UI with correlation coefficient 0.817, 0.813, 0.772, 0.725, 0.651, 0.634 and 0.612 respectively at 0.001 level of significance.

The change of UL was related to the changes of LL, A', B', B, UI, Lla, A and LI with correlation coefficient 0.832, 0.801, 0.725, 0.683, 0.668, 0.630, 0.534 and 0.531 respectively at 0.001 level of significance.

The change of LL was related to the changes of UL, B', LI, B, UI, Lla, A' with correlation coefficient 0.832, 0.813, 0.798, 0.724, 0.684, 0.666 and 0.665 respectively at 0.001 level of significance.

As there were more than one variable that influenced the changes of point A, A', B, B', UL, LL, therefore Stepwise multiple regression were used to predict the above changes as shown in table 7 to table 12. The results were shown by score weight (B), standard error of score weight (SE B), beta weight (Beta), t-test of significance (t), multiple correlation (R), coefficient of determination (R^2) and F-test (F). The prediction equations were also constructed.

Table 7 Result of stepwise multiple regression to predict amount change of point A.

Variable	B	SE B	Beta	t
ΔUIa	0.359320	0.064812	0.602334	5.544***
ΔUI	0.183678	0.060893	0.327714	3.016**
constant	-0.561220	0.034668		-1.677

$$R = 0.77445$$

$$R^2 = 0.59978$$

$$F = 28.47338***$$

* $p < .05$, ** $p < .01$, *** $p < .001$

From Table 7 it was found that there were two variables that could be significantly constructed in the equation which were change of upper incisor apex (ΔUIa) and change of most anterior point on labial surface of upper incisor (ΔUI).

The prediction equation in the form of score was

$$\Delta A = 0.359320 (\Delta UIa) + 0.183678 (\Delta UI) - 0.561220$$

The prediction equation in the form of standard score was

$$Z_{\Delta A} = 0.602334 (Z_{\Delta UIa}) + 0.327714 (Z_{\Delta UI})$$

with multiple correlation 0.77445, coefficient of determination 0.59978 which meant that we could predict change of point A 59.978%, F test = 28.47338 at 0.001 level of significance. This showed that the constructed equation could be used for prediction.

The ratio of ΔA to ΔUIa was approximately 0.5:1 ($\Delta A:\Delta UIa \sim 0.5:1$) and that of ΔA to ΔUI was approximately 0.2:1 ($\Delta A:\Delta UI \sim 0.2:1$). { see appendix for more detail }

The above ratios meant that:

When the root apex of an upper incisor moved 1 mm., there was a change of point A for 0.5 mm. in the same direction (or 50 percent).

When the most anterior point on the labial surface of an upper incisor moved 1 mm., point A moved 0.2 mm. in the same direction (or 20 percent).

To make this clearer, the ratio in the form of a histogram was shown in Figure 15.

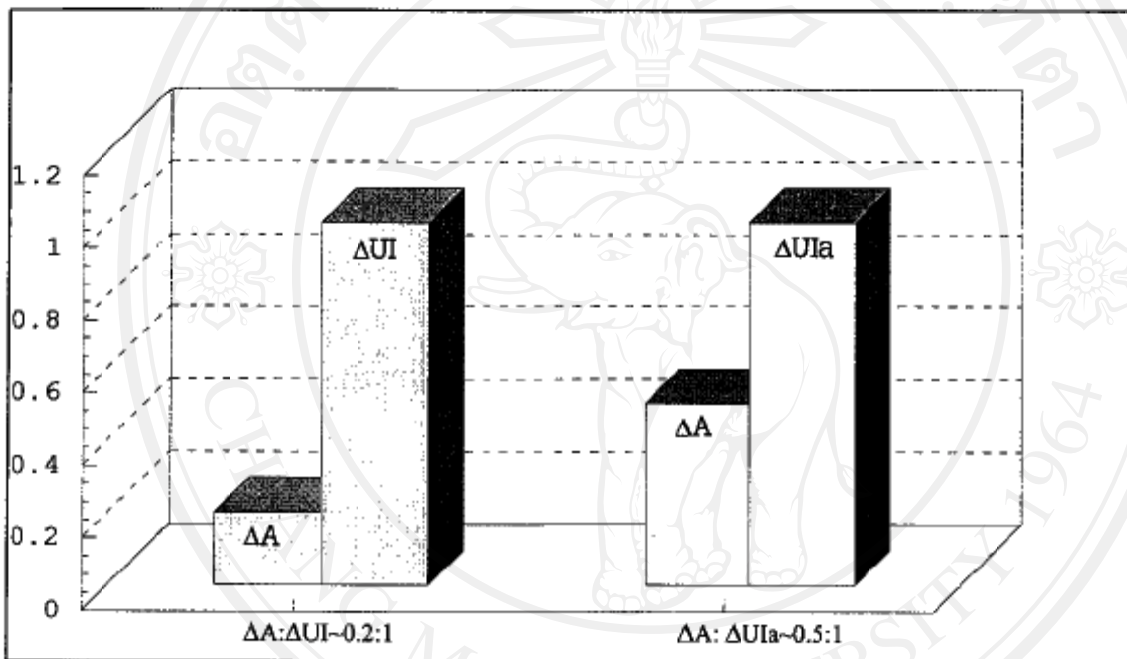


Figure 15 Ratios between change of point A and change of upper incisor, change of point A and change of upper incisor apex.

Table 8 Result of stepwise multiple regression to predict amount change of Point B.

Variable	B	SE B	Beta	t
ΔLia	0.458056	0.105816	0.564201	4.329***
ΔLI	0.227110	0.106265	0.278556	2.137*
constant	-0.570350	0.377898		-1.509

$$R = 0.76347$$

$$R^2 = 0.58289$$

$$F = 26.55153***$$

* $p < .05$, ** $p < .01$, *** $p < .001$

From Table 8 it was found that there were two variables that could be significantly constructed in the equation which were change of lower incisor apex (ΔLia) and change of most anterior point on labial surface of lower incisor (ΔLI).

The prediction equation in the form of score was

$$\Delta B = 0.458056 (\Delta Lia) + 0.227110 (\Delta LI) - 0.570350$$

The prediction equation in the form of standard score was

$$Z_{\Delta B} = 0.564201 (Z_{\Delta Lia}) + 0.278556 (Z_{\Delta LI})$$

with multiple correlation 0.76347, coefficient of determination 0.58289 which meant that we could predict change of point B 58.289%, F test= 26.55153 at 0.001 level of significance. This showed that the constructed equation could be used for prediction.

The ratio of ΔB to ΔLia was approximately 0.6:1 ($\Delta B:\Delta Lia \sim 0.6:1$) and that of ΔB to ΔLI was approximately 0.5:1 ($\Delta B:\Delta LI \sim 0.5:1$). { see appendix for more detail }

The above ratios meant that:

When the root apex of an lower incisor moved 1 mm., there was a change of point B for 0.6 mm. in the same direction (or 60 percent).

When the most anterior point on the labial surface of an lower incisor moved 1 mm., point B moved 0.5 mm. in the same direction (or 50 percent).

To make this clearer, the ratio in the form of a histogram was shown in Figure 16.

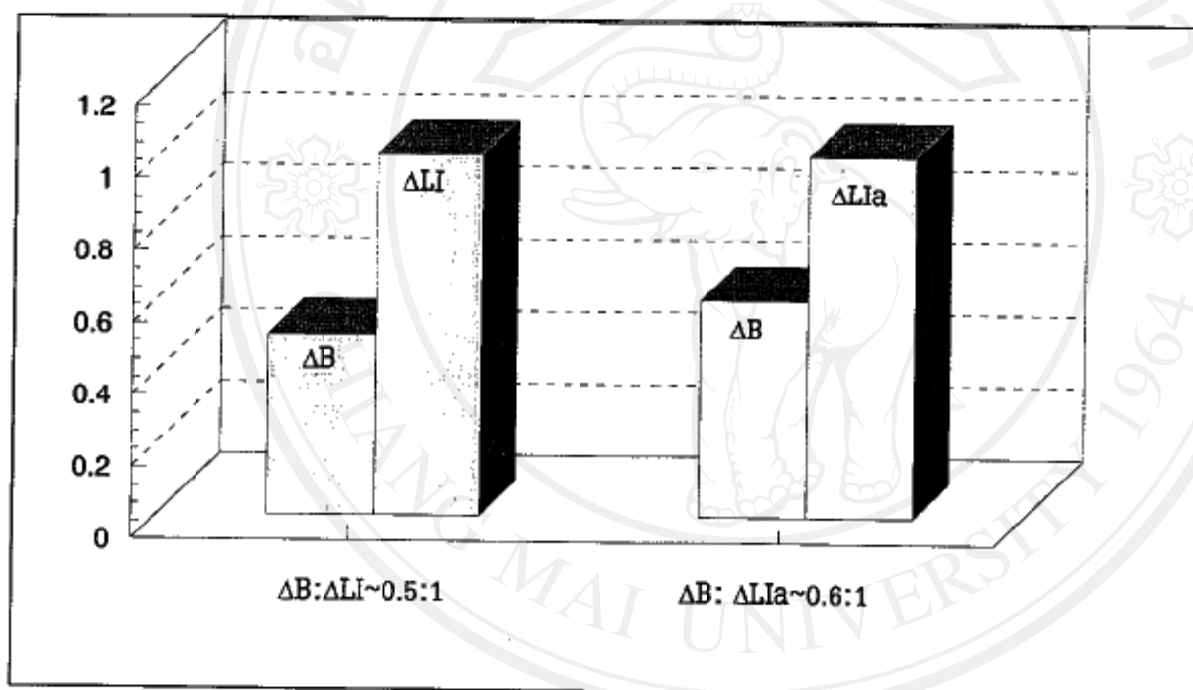


Figure 16 Ratios between changes of point B and change of lower incisor, change of point B and change of lower incisor apex.

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Table 9 Result of stepwise multiple regression to predict amount change of soft tissue point A'.

Variable	B	SE B	Beta	t
ΔUL	0.476347	0.076243	0.678525	6.248***
ΔA	0.263583	0.124601	0.229739	2.115*
constant	-0.279009	0.204735		-1.363

$$R = 0.82447$$

$$R^2 = 0.67975$$

$$F = 40.32804***$$

* $p < .05$, ** $p < .01$, *** $p < .001$

From Table 9 it was found that there were two variables that could be significantly constructed in the equation which were change of upper lip (ΔUL) and change of point A (ΔA).

The prediction equation in the form of score was

$$\Delta A' = 0.476347 (\Delta UL) + 0.263583 (\Delta A) - 0.279009$$

The prediction equation in the form of standard score was

$$Z_{\Delta A'} = 0.678525 (Z_{\Delta UL}) + 0.229739 (Z_{\Delta A})$$

with multiple correlation 0.82447, coefficient of determination 0.67975 which meant that we could predict change of point A' 67.975%, F test = 40.32804 at 0.001 level of significance. This showed that the constructed equation could be used for prediction.

The ratio of $\Delta A'$ to ΔUL was approximately 0.5:1 ($\Delta A':\Delta UL \sim 0.5:1$) and that of $\Delta A'$ to ΔA was approximately 0.6:1 ($\Delta A':\Delta A \sim 0.6:1$). { see appendix for more detail }

The above ratios meant that:

When upper lip moved 1 mm. there was a change of point A' for 0.5 mm. in the same direction (or 50 percent).

when point A moved 1 mm., point A' moved 0.6 mm. in the same direction (or 60 percent).

To make this more easily understandable, the ratio in the form of a histogram was shown in Figure 17.

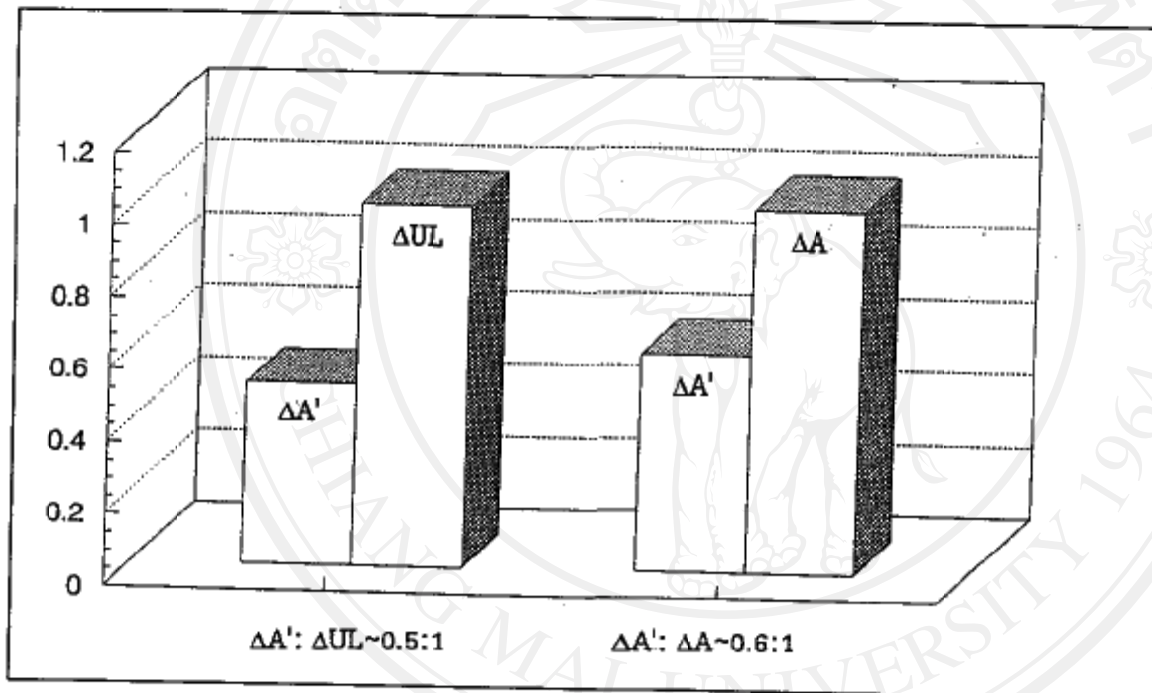


Figure 17 Ratios between change of soft tissue point A' and change of upper lip, change of soft tissue point A' and change of point A.

Table 10 Result of stepwise multiple regression to predict amount change of soft tissue point B'.

Variable	B	SE B	Beta	t
ΔLL	0.289678	0.083185	0.389002	3.482**
ΔB	0.406963	0.144530	0.343235	2.816**
ΔLia	0.252796	0.108441	0.262617	2.331*
constant	0.116281	0.242062		0.480

$$R = 0.89399$$

$$R^2 = 0.79922$$

$$F = 49.09491^{***}$$

* $p < .05$, ** $p < .01$, *** $p < .001$

From Table 10 it was found that there were three variables that could be significantly constructed in the equation which were change of lower lip (ΔLL), change of point B (ΔB) and change of lower incisor apex (ΔLia).

The prediction equation in the form of score was

$$\Delta B' = 0.406963 (\Delta B) + 0.289678 (\Delta LL) + 0.252796 (\Delta Lia) + 0.116281$$

The prediction equation in the form of standard score was

$$\Delta B' = 0.389002 (\Delta LL) + 0.343235 (\Delta B) + 0.262617 (\Delta Lia)$$

with multiple correlation 0.89399, coefficient of determination 0.79922 which meant that we could predict change of point B' 79.922%, F test= 49.09491 at 0.001 level of significance. This showed that the constructed equation could be used for prediction.

The ratio of $\Delta B'$ to ΔLL was approximately 0.6:1 ($\Delta B':\Delta LL \sim 0.6:1$), the ratio of $\Delta B'$ to ΔB was approximately 0.9:1 ($\Delta B':\Delta B \sim 0.9:1$) and that of $\Delta B'$ to ΔLia was approximately 0.7:1 ($\Delta B':\Delta Lia \sim 0.7:1$). { see appendix for more detail }

The above ratios meant that:

When lower lip moved 1 mm., there was a change of point B' for 0.6 mm. in the same direction (or 60 percent).

when point B moved 1 mm., there was a change of point B' for 0.9 mm. in the same direction (or 90 percent).

When the lower incisor apex moved 1 mm., point B' moved 0.7 mm. in the same direction (or 70 percent).

To make this clearer, the ratio in the form of a histogram was shown in Figure 18.

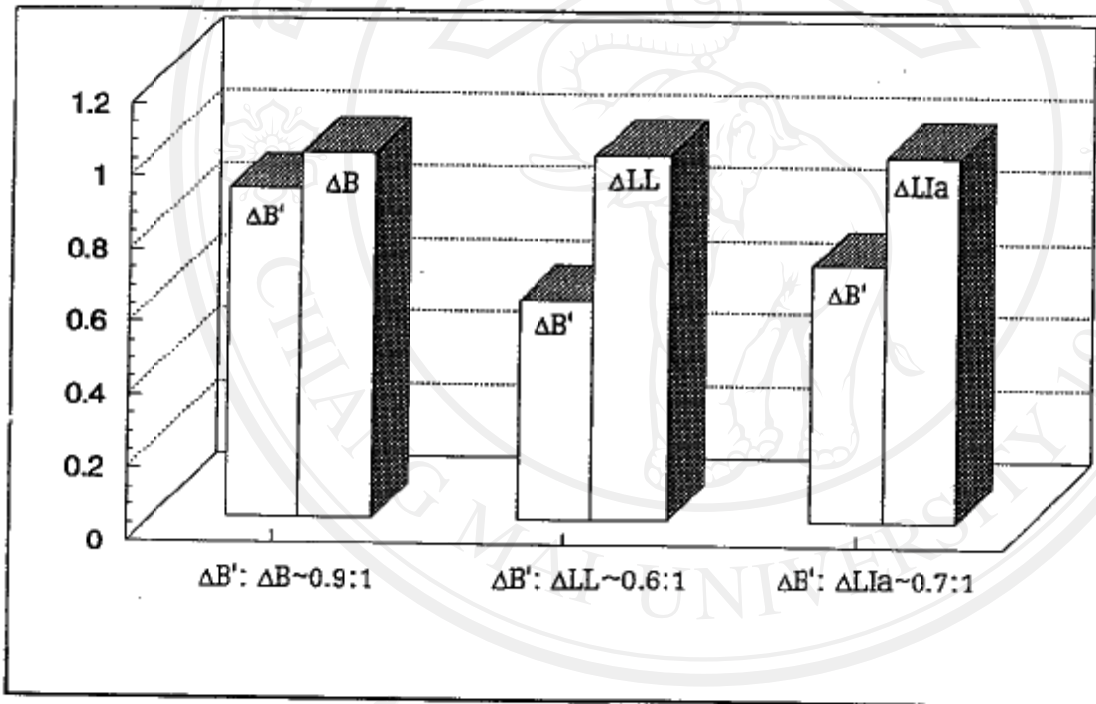


Figure 18 Ratios between change of soft tissue point B' and change of point B, change of soft tissue point B' and change of lower lip, change of soft tissue point B' and change of lower incisor apex.

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Table 11 Result of stepwise multiple regression to predict amount change of UL.

Variable	B	SE B	Beta	t
ΔLL	0.583937	0.091823	0.711789	6.359***
$\Delta A'$	0.614314	0.107939	0.431269	5.691***
ΔUI	0.250051	0.073703	0.272987	3.393**
ΔLI	-0.471666	0.103622	-0.442891	-4.5552***
constant	0.175263	0.318188		0.551
R = 0.94073				
$R^2 = 0.88496$				
F = 69.23676***				

* $p < .05$, ** $p < .01$, *** $p < .001$

From Table 11 it was found that there were four variables that could be significantly constructed in the equation which were change of lower lip (ΔLL), point A' ($\Delta A'$), most anterior point on labial surface of upper incisor (ΔUI) and change of most anterior point on labial surface of lower incisor (ΔLI).

The prediction equation in the form of score was

$$\Delta UL = 0.583937 (\Delta LL) + 0.614314 (\Delta A') + 0.250051 (\Delta UI) - 0.471666 (\Delta LI) + 0.175263$$

The prediction equation in the form of standard score was

$$Z_{\Delta UL} = 0.711789 (Z_{\Delta LL}) + 0.431269 (Z_{\Delta A'}) + 0.272987 (Z_{\Delta UI}) - 0.442891 (Z_{\Delta LI})$$

with multiple correlation 0.94073, coefficient of determination 0.88496 which meant that we could predict change of point UL 88.496%, F test= 69.23676 at 0.001 level of significance. This showed that the constructed equation could be used for prediction.

The ratio of ΔUL to ΔLL was approximately 0.6:1 ($\Delta UL:\Delta LL \sim 0.6:1$), the ratio of ΔUL to $\Delta A'$ was approximately 0.1:1 ($\Delta UL:\Delta A' \sim 0.1:1$), the ratio of ΔUL to ΔUI was approximately 0.6:1 ($\Delta UL:\Delta UI \sim 0.6:1$) and that of ΔUL to ΔLI was approximately 0.5:1 ($\Delta UL:\Delta LI \sim 0.5:1$). { see appendix for more detail }

The above ratios meant that:

When lower lip moved 1 mm., there was a change of upper lip for 0.6 mm. in the same direction (or 60 percent).

when soft tissue A' moved 1 mm., there was a change of upper lip for 0.1 mm. in the same direction (or 10 percent).

when the most anterior point on labial surface of upper incisor moved 1 mm., there was a change of upper lip for 0.6 mm. in the same direction (or 60 percent).

When the most anterior point on labial surface of the lower incisor moved 1 mm., upper lip moved 0.5 mm. in the same direction (or 50 percent).

To make this clearer, the ratio in the form of a histogram was shown in Figure 19.

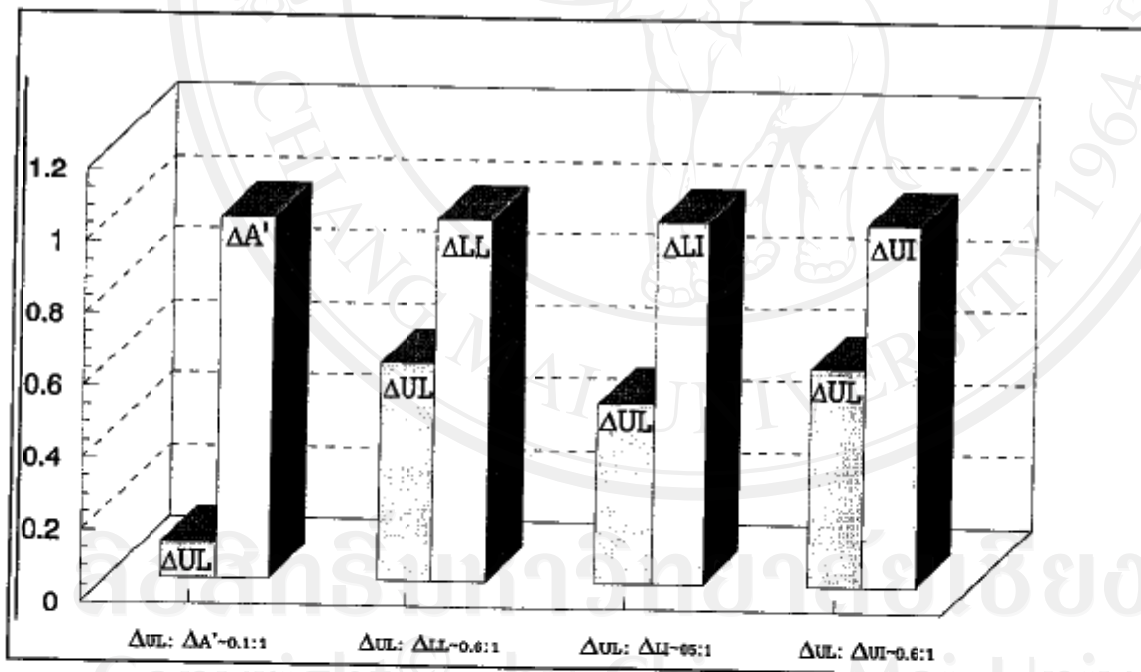


Figure 19 Ratios between change of soft tissue upper lip and change of soft tissue point A', change of soft tissue upper lip and change of lower lip, change of soft tissue upper lip and change of lower incisor, change of soft tissue upper lip and change of upper incisor.

Table 12 Result of stepwise multiple regression to predict amount change of LL.

Variable	B	SE B	Beta	t
ΔUL	0.547531	0.098336	0.449183	5.568***
ΔLI	0.542925	0.093309	0.418231	5.819***
$\Delta B'$	0.298023	0.118664	0.221928	2.511*
constant	-0.459592	0.312054		-1.473

$$R = 0.94220$$

$$R^2 = 0.88774$$

$$F = 97.53555***$$

* $p < .05$, ** $p < .01$, *** $p < .001$

From Table 12 it was found that there were three variables that could be significantly constructed in the equation which were change of upper lip (ΔUL), point B' ($\Delta B'$) and change of most anterior point on labial surface of lower incisor (ΔLI).

The prediction equation in the form of score was

$$\Delta LL = 0.547531 (\Delta UL) + 0.542925 (\Delta LI) + 0.298023 (\Delta B') - 0.459592$$

The prediction equation in the form of standard score was

$$Z_{\Delta LL} = 0.449183 (Z_{\Delta UL}) + 0.418231 (Z_{\Delta LI}) + 0.221928 (Z_{\Delta B'})$$

with multiple correlation 0.94220, coefficient of determination 0.88774

which meant that we could predict change of point LL 88.774%, F test= 97.53555 at 0.001 level of significance. This showed that the constructed equation could be used for prediction.

The ratio of ΔLL to ΔUL was approximately 1:1 ($\Delta LL:\Delta UL \sim 1:1$), the ratio of ΔLL to ΔLI was approximately 1:1 ($\Delta LL:\Delta LI \sim 1:1$) and that of ΔLL to $\Delta B'$ was approximately 1:1 ($\Delta LL:\Delta B' \sim 1:1$). { see appendix for more detail }

The above ratios meant that:

When upper lip moved 1 mm., there was a change of lower lip for 1 mm. in the same direction (or 100 percent).

when most anterior point on labial surface of lower incisor moved 1 mm., there was a change of lower lip for 1 mm. in the same direction (or 100 percent).

When soft tissue point B' moved 1 mm., lower lip moved 1 mm. in the same direction (or 100 percent).

To make this clearer, the ratio in the form of a histogram was shown in Figure 20.

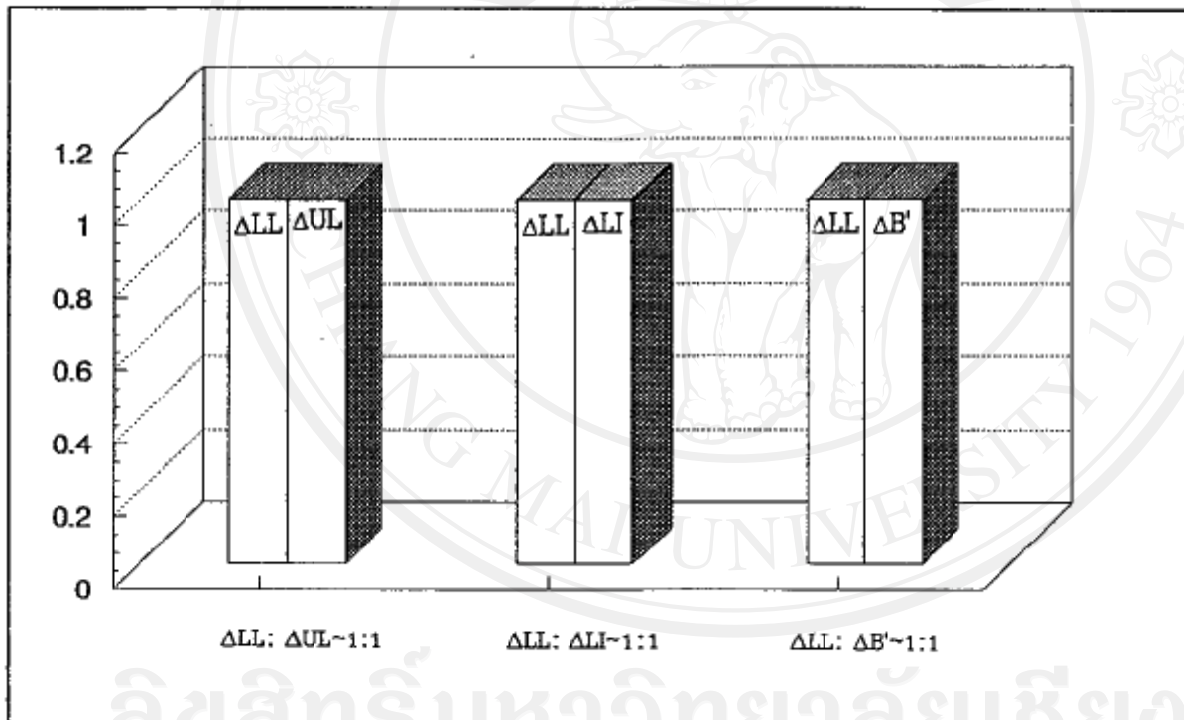


Figure 20 Ratios between change of soft tissue lower lip and change of upper lip, change of soft tissue lower lip and change of lower incisor, change of soft tissue lower lip and change of soft tissue point B'.