CHAPTER V
DISCUSSION

Previous investigators showed the course of normal development of the skeletal and integumental profiles by longitudinal and serial studies which considered the changes by growth, while others were interested in the effects of orthodontic treatment upon the facial profile, exclusive of growth. In this case, orthodontic treatment had a direct effect on the changes that happened. Therefore, it was absolutely necessary to pay due attention to what an orthodontist could do to the patients.

Consequently, in this study, adult samples with the average ages of 17.7 for males and 16.8 for females were used in order to evaluate skeletal and soft tissue changes resulting from orthodontic treatment (exclusive of growth) and to see whether there were any different changes between sexes. Finally, the relationship between skeletal, dental and soft tissue variables were also calculated. All of the samples used were dental class I malocclusion with extraction of four fiirst premolars followed by Edgewise Technique therapy. All of them were treated by the staff of the Department of Orthodontics, Faculty of Dentistry, Chiang Mai University. Using same type of malocclusion in order to decrease the effects of the different malocclusions on the result of the study. All of the samples had no abnormal oral habits. According to Meach (1966), hard skeletal tissue was highly adaptive to environmental influences, and extrinsic habits.

All cephalometric radiographs were taken with relaxed lip position in order to eliminate the variability due to lip strain caused by lip closure. According to Hillesund et al. (1978), cephalograms taken with the lips relaxed and the teeth in occlusion seemed to provide the most accurate image of lip position and morphology. In addition, Oliver (1982) also reported the effect of lip strain on the relationship between incisor changes and vermilion border changes. Each pretreatment and posttreatment cephalogram was taken on the

same X-ray machine to eliminate the need for correcting of radiographic magnification.

Linear measurement was measured relative to two reference lines recommended by the University of Connecticut computerized analysis which are Constructed Frankfort Horizontal plane (CFH) as the X axis and S vertical (SV) as the Y axis.

The X-axis was drawn 7 degrees inferiorly to SN line.

The Y-axis was drawn from S and perpendicular to X-axis. It was clear that both two reference lines had their origins from the S-N line.

The S-N line was selected because both Sella and Nasion points which located in hard, nonyielding tissue in the midsagittal plane were directed and easily visible in a profile X-ray picture, therefore they could be located easily and accurately. As SN line was not a true horizontal line, it was unsuitable for comparison of profile changes in distances. So the CFH line was proposed by drawing a line 7 degrees inferior to the S-N line. This CFH line was accepted that it was parallel to a true horizontal plane. The changes of skeletal and soft tissue landmarks were measured parallel to the CFH line, which was on the X-axis. When we observed a patient's profile, we watched it in the direction parallel to the CFH line, which was accepted that it was parallel to horizontal plane. In other words, CFH line was used as Frankfort Horizontal line which had often been accepted as an indication of the patient's natural head position.

If we used inpropriate reference line, unfavorable prediction could occur. Ricketts et al. (1957) suggested that Frankfort Horizontal line was appreciably better than SN line. However, for the use of Frankfort Horizontal line, some problems were arised because its bilaterally reference structure might confuse clinicians. Cooke and Wei (1991) also found that there were problems with replication of Frankfort Horizontal line. Anderson et al. (1973) suggested that growth at nasion and to a greater extent, pogonion, resulted in an anterior movement of the facial plane from which several measurements originated. This change, though not quantified, must be considered when evaluating results

from this reference line. Other lines, such as Facial plane, palatal plane are not parallel to the horizontal plane, so they are not suitable to be used in evaluating soft tissue profile changes.

Sexes difference of distance changes

From Table 3, all distance changes showed no significant difference between sexes. This indicated that, hard tissue and soft tissue responses following incisor retraction were the same in females and males. In contrast, Lundstrom and Cooke (1991) found that the horizontal measurements of soft tissue profile of males were greater than those of females. Garner (1974) reported that the change in lip posture was not the same in boys and girls, whereas Baum (1961) found that in boys the facial stuctures moved further forward relative to dentition than in girls of similar age, but the samples Garner and Baum studied were growing patients, which were different from the adult patients used in the present study, therefore the result obtained could be different. Lundstrom and Cooke (1991) also studied in growing samples with Caucasian and Chinese, the result was different from this study. This might be attributed to different racial origins which may affect static position, functional movement, facial form and type, facial proportion and contour, respiratory pattern, soft tissue consistency and soft tissue response, etc.

In adult sample studies, in order to avoid any difference between sexes, researchers usually used single sex samples, mostly female samples, because females completed their growth at a younger age than males did, which made it easier to collect an enough number of samples. However, in this study both sexes were used in order to compare if there were any differences between sexes. In this study, the number of the male samples are less than the female ones because male patients seek orthodontic treatment less than female patients. This may be because the females are more realized of the malocclusion problems and are more esthetic concerned. Moreover, males ceased growth at an older age than females and most male patients were

younger than the age wanted in this investigation. As a result, the number of male samples were less than that of the female samples. From table 3 when analysed with a t-test there was no difference between sexes, then both sexes were pooled into one group.

The changes of hard tissue point A and point B

From Table 5, there were no significant changes of point A, no change of point B at 0.01 significant level but there was a change at the 0.05 level. However, in this research the significant level desired at 0.05 to be reliable, thus it was accepted that there was a significant change of point B. Whereas Lew (1989) found that the changes in points A and B were not statistically significant. Similar findings were reported by Rains and Nanda (1982), who described no significant changes of point A and B. But Hershey (1972) found no change in point A at 0.01 significant level but there was a change at the 0.05 level. He also found significant change of point B. Assuncao et al. (1994) found that there was no significant change of point A but posterior change of point B.

The authors mentioned earlier studied in adult patients which had the same age range as this investigation.

For growing patients; Holdaway (1956) reported that point A could be changed following retraction of upper incisors. In addition, he found that the changes of point A and B were influenced by the type of treatment.

Linquist (1958) reported that point A could be moved more posteriorly by remodelling associated with lingual movement of maxillary incisors. However, he did not mention a change of point B. King (1960) found that orthodontic treatment could influence on the area around point A. He also found that change in point A decreased with age. He did not study the change of point B. He studied in patients with class II division 1 malocclusion who were treated by extraoral traction in the upper teeth. Normally such malocclusion is corrected by decreasing maxillary teeth protrusion. Thus, this may be the reason why he did not study the change of point B.

Taylor (1956) found backward movement of point A 1.1 mm. and of point B 2.5 mm. after orthodontic treatment of 225 growing patients. Whereas Roos (1977) found that point A and B moved 2.23 mm. and 1.28 mm. posteriorly respectively after orthodontic treatment of adolescents. LaMastra (1981) also found that points A and B moved backward 2.34 mm. and 1.89 mm. respectively in forty growing patients.

Battagel (1990) found no change in point A but forward movement of point B in class II division 1 patients who were treated with Edgewise and extraoral traction.

In each study, there are varying degrees of points A and B changes. The reasons of this may be as follow:

1) The distances of incisor retraction were different depending on the amount of space left in the arch for incisor retraction.

2) Each study used different reference lines which resulted in varying amount of the distances measured. Therefore, direct comparison could not be made. As a result, it was incorrect to consider the distance changes. The statistically significant changes at varying levels were more suitable for consideration.

3) The types of treatment vary according to each researcher, such as Edgewise, Begg, functional appliance, lingual appliance, etc. Holdaway (1956) reported that the nature of the change in relationship of points A and B was influenced by the type of treatment followed.

4) Sample from each study had different malocclusions which might cause different results. For example, in class II division 1 group the result can be either a forward movement of point B or no change of point B. When considering the modes of treatment of such malocclusion, the maxillary teeth protrusion are decreased while the mandibular teeth are not moved or the mandibular teeth are proclined (the mandibular teeth are never retracted in this malocclusion). Therefore, the backward movement of point B was not found.

It was found that the change of point B is inconsistent due to a movable characteristic of the mandible, in contrast to a fixed characteristic of the maxilla. This may result in some errors in the measurement of point B change. For example, if the mandible rotates, point B will change even if its position, in fact, does not change. On the other hand, if point B changes but there is a forward or backward rotation of the mandible, when measured relative to a reference line, point B may remain constant. A rotation of the mandible may result from treatment mechanics such as extrusion or intrusion of molars.

For the change of point A, the position of upper incisor apex after orthodontic treatment may influence on the change of point A. This agreed with Holdaway (1956) who found that all too often, lingually tipped upper incisor will have the root apices in a more forward position than the pretreatment position, and, as they approached the labial plate, the tendency for resorption is greatly aggravated. Under such circumstances, point A is not improved and, therefore, the improvement of facial esthetics is limited. He also stated that patients treated during periods of active growth respond with better apical base changes than do patients treated during nongrowth periods.

The changes of soft tissue

From Table 5 it was found significant change of soft tissue point A' at 0.05 level and also significant change of soft tissue point B', upper lip and lower lip at 0.001 level. Hence, following incisor retraction there were posterior movements of soft tissue profiles. We could state that following orhodontic treatment, the facial appearance of the subjects had improved.

Correlation between skeletal, dental, and soft tissue changes

The last concern in this study was to determine whether there was a correlation between skeletal, dental and integumental covering changes.

From the former part of this study, the findings showed no significant different changes between the female and the male groups. Consequently, variable values used in this part were combinations of females and males. The findings demonstrated these correlations into three ways; those were correlation coefficients, ratios, and prediction equations.

Correlation between change of had tissue point A (dependent variable) and other related variables (independent variable)

Table 13 Correlation coefficients between ΔA and other related variables

ΔA - ΔUIa	ΔA - ΔUI
0.710***	0.525***

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

Table 14 Ratios between ΔA and other related variables

ΔA : ΔUIa	ΔA : ΔUI
~ 0.5 : 1	~ 0.2 : 1

Table 15 Prediction equation to predict the change of hard tissue point A

equation	R	R^2	F
ΔA= 0.359320(ΔUIa) + 0.183678 (ΔUI) - 0.561220	0.77445	0.59978	97.5355***

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

Table 13 and Table 14 showed that there was a high correlation between change of hard tissue point A and upper incisor apex movement, giving a ratio of ΔA to ΔUIa approximately 0.5:1 with correlation coefficient 0.710 at 0.001 the significant level. This indicated that, for every 10 millimeters of change of upper incisor apex, point A moved by 5 millimeters in the same direction.

In addition, it was also found high correlation between change of hard tissue point A and upper incisor movement, giving a ratio of ΔA to ΔUI approximately 0.2:1 with correlation coefficient 0.525 at 0.001 the significant level. This indicated that, for every 10 millimeters of change of upper incisor, point A moved by 2 millimeters in the same direction.

From Table 15, when considered the changes of both independent variables one at a time on the change of point A from the prediction equation ΔA = 0.359320 (ΔUIa) + 0.183678(ΔUI) - 0.561220, with the high multiple correlation coefficient and correlation determination, this meant that prediction of the change of point A was in a high degree of predictability. In confirmation, regression analysis indicated the relationship between both variable changes and point A change with the high value of F-test.

From prediction equation, it was shown that the score weight of ΔUIa was greater than of ΔUI. This meant that the change of hard tissue point A was found to be more directly related to the change of upper incisor apex [0.359320(ΔUIa)] than to the change of upper incisor [0.183678(ΔUI)]. This was consistent with the correlation coefficients and ratios that were calculated.

Correlation between change of hard tissue point B (dependent variable) and other related variables (independent variable)

Table 16 Correlation coefficients between ΔB and other related variables

ΔB - ΔLIa	ΔB - ΔLI
0.730***	0.614***

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

Table 17 Ratios between ΔB and other related variables

ΔB : ΔLIa	ΔB : ΔLI
~ 0.6 : 1	~ 0.5 : 1

Table 18 Prediction equation to predict the change of hard tissue point B

equation	R	R^2	F
ΔB=0.458056 (ΔLIa) +0.227110 (ΔLI) -0.570350	0.76347	0.58289	26.55153***

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

Table 16 and Table 17 showed that there was a high correlation between change of hard tissue point B and lower incisor apex movement, giving a ratio of ΔB to ΔLIa approximately 0.6:1 with correlation coefficient 0.730 at 0.001 the significant level. This indicated that, for every 10 millimeters of change of upper incisor apex, point B moved by 6 millimeters in the same direction.

In addition, it was also found high correlation between change of hard tissue point B and lower incisor movement, giving a ratio of ΔB to ΔLI approximately 0.5:1 with correlation coefficient 0.614 at 0.001 the significant

level. This indicated that, for every 10 millimeters of change of lower incisor, point B moved by 5 millimeters in the same direction.

From Table 18, when considered the changes of both independent variables one at a time on the change of point B from the prediction equation $\Delta B = 0.458056\ (\Delta LIa) + 0.227110(\Delta LI) - 0.570350$, with the high multiple correlation coefficient and correlation determination, this meant that prediction of change of point B was in a high degree of predictability. In confirmation, regression analysis indicated the relationship between both variable changes and point B change with the high value of F-test.

From prediction equation, it was shown that the score weight of ΔLIa was greater than of ΔLI. This meant that the change of hard tissue point B depended more on the change of lower incisor apex [0.458056(ΔLIa)] than on the change of lower incisor [0.227110(ΔLI)]. This was consistent with the correlation coefficients and ratios that were calculated.

Previous researchers studied the changes of points A, B in terms of whether there were any changes or how much distance of change in millimeter. They did not analyse the relationship of points A, B and other points. They also did not analyse the ratio of points A, B to other points. Therefore, the previous researches could not be compared with this study in terms of relationship. The only aspect that could be compared was whether there were any changes of points A and B. [Each study had a different result as had been previously discussed in the heading: The changes of hard tissue points A, B]

Correlation between change of soft tissue point A' (dependent variable) and other related variables (independent variable)

Table 19 Correlation coefficients between ΔA' and other related variables

ΔA' - ΔA	ΔA' - ΔUL
0.592***	0.801***

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

Table 20 Ratios between ΔA' and other related variables

ΔA' : ΔA	ΔA' : ΔUL
~ 0.6 : 1	~ 0.5 : 1

Table 21 Prediction equation to predict the change of soft tissue point A'

equation	R	R^2	F
ΔA'= 0.263583 (ΔA) + 0.476347 (ΔUL) - 0.279009	0.82447	0.67975	40.32804***

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

From Table 19 and Table 20, it was found that there was a high correlation between change of point A' and change of point A, giving a ratio of ΔA' to ΔA approximately 0.6:1 with correlation coefficient 0.592 at 0.001 the significant level. This indicated that, for every 10 millimeters of change of point A, soft tissue A' moved by 6 millimeters in the same direction. This quite similar to LaMastra findings (1981) that the ratio of mean change of the superior labial sulcus to subspinale was 0.7:1 with correlation coefficient 0.812. Roos (1977) also found good correlation of subspinale to corresponding soft tissue

point which is soft tissue point A'. This agreeed with Anderson and associates (1973) who found that there were closely related between soft tissue profile and underlying dentoskeletal framework.

In addition, it was also found that the change of upper lip influenced on the change of soft tissue point A', giving the ratio of $\Delta A'$ to ΔUL approximately 0.5:1 with high correlation coefficient 0.801 at 0.001 the significant level. This indicated that for every 10 millimeters of upper lip change, soft tissue point A' moved by 5 millimeters in the same direction.

In contrast, Battagel (1990) reported that there was no statistically significant correlation between soft tissue point A' change and the underlying dentoskeletal tissue. Looís and Mills (1986) also reported that there was great variation in individual responses of the soft tissue to change in the underlying hard tissue and that it was not possible predictability. Neger (1959) stated that proportional change of the soft tissue profile did not necessarily accompany extensive dentition change, and that one could no longer rely entirely on dentoskeletal analysis for accurate information about the soft tissue facial profile change which occur during orthodontic treatment.

From Table 21, when considered the changes of both independent variables one at a time on the change of soft tissue point A' from the prediction equation $\Delta A' = 0.263583(\Delta A) + 0.476347(\Delta UL) - 0.279009$ with the high multiple correlation coefficient and correlation determination, this meant that prediction of soft tissue point A' response was in a high degree of predictability. In confirmation, regression analysis indicated the relationship between both variable changes and soft tissue point A' change with the high value of F-test.

From prediction equation, it was shown that the score weight of ΔUL was greater than of ΔA. This meant that the change of soft tissue point A' depended more on upper lip change [$0.476347(\Delta UL)$] than on change of hard tissue point A [$0.263583(\Delta A)$]. This was consistent with the correlation coefficients that were calculated.

Correlation between change of soft tissue point B' (dependent variable) and other related variables (independent variable)

Table 22 Correlation coefficients between ΔB' and other related variables

ΔB' - ΔB	ΔB' - ΔLIa	ΔB' - ΔLL
0.817***	0.772***	0.813***

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

Table 23 Ratios between ΔB' and other related variables

ΔB' : ΔB	ΔB' : ΔLIa	ΔB' : ΔLL
~ 0.9 : 1	~ 0.7 : 1	~ 0.6 : 1

Table 24 Prediction equation to predict the changes of soft tissue point B'

equation	R	R^2	F
ΔB'= 0.406963 (ΔB) +0.252796(ΔLIa) +0.289678(ΔLL) +0.116281	0.89399	0.79922	49.09491***

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

From Table 22 and Table 23, it was found that there was a high correlation between the change of soft tissue point B' and the change of hard tissue point B, giving a ratio of ΔB' to ΔB approximately 0.9:1 with correlation coefficient 0.817 at 0.001 the significant level. This indicated that change of soft tissue point B' was about 90 percent of change of hard tissue point B.

The next statistically significant correlated variable was the change of lower incisor apex, giving a ratio of ΔB' to ΔLIa approximately 0.7:1 with

correlation coefficient 0.772 at 0.001 the significant level. This indicated that change of soft tissue point B' was about 70 percent of change of lower incisor apex. Furthermore, it was also found high correlation between the change of soft tissue point B' and the change of lower lip, giving a ratio of ΔB' to ΔLL approximately 0.6:1 with correlation coefficient 0.813 at 0.001 the significant level. This indicated that change of soft tissue point B' was about 60 percent of lower lip change.

In agreement, Roos (1977) reported good correlation of supramentale to the corresponding soft tissue. LaMastra (1951) found that the ratio of mean change of inferior labial sulcus to the supramental was approximately 0.9:1. Hershey (1972) found high correlation between inferior labial sulcus and the underlying hard tissue with correlation coefficient 0.78. Assuncao et al. (1994) also reported high correlation between the depth of the lower lip sulcus and the position of the lower incisor and point B.

Conversely, Garner (1974) found that the extent of lip change was not always predictable. This may be according to racial difference. As sample used by Garner were Negroes, thus soft tissue response might be different from this study. Neger (1959) stated that one could no longer rely entirely on dentoskeletal analysis for accurate information about the soft tissue facial profile change which occur during orthodontic treatment.

From Table 24, when consisdered the changes of all related dependent variables one at a time on the change of soft tissue point B' from prediction equation $\Delta B' = 0.406963(\Delta B) + 0.289678(\Delta LL) + 0.252796(\Delta LIa) + 0.116281$ with the high multiple correlation coefficient and correlation determination, this meant that prediction of change of soft tissue point B' was in a high degree of predictability. In confirmation, regression analysis indicated the relationship between all variable changes and change of soft tissue point B' with the high value of F-test.

From prediction equation, it was shown that the score weight of ΔB was the greatest when compare with the other two variables (ΔLL, ΔLIa). This

meant that the change of soft tissue point B' depended more on change of hard tissue point B than on the change of lower lip or the change of lower incisor apex. This was consistent with the correlation coefficients and ratios that were calculated.

Correlation between change of soft tissue upper lip (dependent variable) and other related variables (independent variable)

Table 25 Correlation coefficients between ΔUL and other related variables

ΔUL - ΔUI	ΔUL - ΔLI	ΔUL - ΔLL	ΔUL - ΔA'
0.668***	0.531***	0.832***	0.801***

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

Table 26 Ratios between ΔUL and other related variables

ΔUL : ΔUI	ΔUL : ΔLI	ΔUL : ΔLL	ΔUL : ΔA'
~ 0.6 : 1	~0.5 : 1	~ 0.6 : 1	~ 0.1 : 1

Table 27 Prediction equation to predict the change of upper lip

equation	R	R^2	F
ΔUL=0.614314 (ΔA') +0.583937 (ΔLL) -0.47166 (ΔLI) +0.250051 (ΔUI) +0.175263	.94073	.88496	69.23676***

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

From Table 25 and Table 26, it was found that there was a high correlation between the change of upper lip and the change of upper incisor, giving a ratio of ΔUL to ΔUI approximately 0.6:1 with correlation coefficient 0.668 at 0.001 the significant level. This indicated that the change of upper lip was about 60 percent of the change of upper incisor.

Upper lip response was also correlated with lower incisor change, giving a ratio of ΔUL to ΔLI approximately 0.5:1 with moderate correlation coefficient 0.531 at 0.001 the significant level. This showed that the change of upper lip was about 50 percent of the change of lower incisor.

In addition, we also found high correlation between upper lip response and lower lip response, giving a ratio of ΔUL to ΔLL approximately 0.6:1 with correlation coefficient 0.832 at 0.001 the significant level. This indicated that the change of upper lip was about 60 percent of the change of lower lip.

Finally, there was a high correlation between the upper lip response and the change of soft tissue point A' giving a ratio of ΔUL to ΔA' approximately 0.1:1 with correlation coefficient 0.801 at 0.001 the significant level. This indicated that the change of upper lip was about 10 percent of the change of soft tissue point A'.

In agreement, Subtelny (1961) stated that lip posture was found to be correlated closely with the posture of underlying dental and alveolar structure. Bloom (1961) reported that perioral soft tissue profile changes could be significantly predicted. He also found statistically significant relationship between upper or lower incisor changes and soft tissue changes.

Rudee (1964) found that the ratio of upper incisor to upper lip changes was 2.93:1.0. In other words, ratio of upper lip to upper incisor changes was 0.3:1. This indicated that upper lip change studied by Rudee was a half less than the finding in this study. Battagel (1990) also found statistically significant correlation between the labrale superious and incisor tip position. Rains and Nanda (1982) reported that upper lip response was related to both upper and lower incisor movement. Assuncao et al. (1994) reported a high correlation

between absolute change in the upper lip and upper incisor. Lew (1989) also reported high correlation between upper lip and upper incisor, giving a ratio of upper lip to upper incisor retraction of 1:2.2. Yokosawa (1989) reported that upper lip retraction was about 40 percent of upper incisor retraction. In contrast, Roos (1977) found poor correlation of the incision superior to the labrale superior.

From Table 27, when considered the changes of all related dependent variables one at a time on the change of the upper lip from prediction equation $\Delta UL = 0.614314(\Delta A') + 0.583937(\Delta LL) - 0.471666(\Delta LI) + 0.250051(\Delta UI) + 0.175263$ with the high multiple correlation coefficient and correlation determination, this meant that prediction of upper lip response was in a high degree of predictability. In confirmation, regression analysis indicated the relationship between the four variable changes and upper lip response with the high value of F-test.

From prediction equation, it was shown that the score weight of $\Delta A'$ was the greatest when compare with the other three variables (ΔLL, ΔLI, ΔUI). This meant that the change of upper lip depended more on change of soft tissue point A' than on the other three variables.

Corelation between change of soft tissue lower lip (dependent variable) and other related variables (independent variable)

Table 28 Correlation coefficients between ΔLL and other related variables

ΔLL - ΔLI	ΔLL - ΔUL	ΔLL - $\Delta B'$
0.798***	0.832***	0.813***

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

Table 29 Ratios between ΔLL and other related variables

ΔLL : ΔLI	ΔLL : ΔUL	ΔLL : $\Delta B'$
~ 1 : 1	~ 1 : 1	~ 1 : 1

Table 30 Prediction equation to predict the change of lower lip

equation	R	R^2	F
ΔLL=0.547531 (ΔUL)	0.94220	0.88774	97.53555***
+0.542925 (ΔLI)			
+0.298023 (ΔB')			
-0.459592			

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

From Table 28 and Table 29, it was found high correlation between the change of lower lip and lower incisor retraction, giving a ratio of ΔLL to ΔLI approximately 1:1 with correlation coefficient 0.798 at 0.001 the significant level. This indicated that the change of lower incisor was accompanied by approximate an equally change of lower lip.

The next statistically significant correlated variable was change of upper lip, giving a ratio of ΔLL to ΔUL approximately 1:1 with correlation coefficient 0.832 at 0.001 the significant level. This indicated that lower lip response was about 100 percent of upper lip change.

In addition, lower lip response was also correlated with change of soft tissue point B', giving a ratio of ΔLL to ΔB' approximately 1:1 with correlation coefficient 0.813 at 0.001 the significant level. This showed that change of soft tissue point B' resulted in approximately an equally change of lower lip.

In agreement, Anderson and associates (1973) stated that soft tissue profile was closely related and depended on underlying dentoskeletal framework. Roos (1977) found good correlation of incision inferior to the corresponding soft tissue point. Hershey (1972) found that labrale inferius was related with underlying hard tissue with correlation coefficient 0.58. But he stated that lower lip was apparently less dependent than the other profile points upon the underlying skeleton for its position in space. He concluded that one could not predict soft tissue response to incisor movement. Lew (1989) reported high

correlation between incisor change and lip change with an average ratio of lower lip to lower incisor retraction of 1:1.4 with correlation coefficient 0.80. Assuncao et al. (1994) reported a high correlation between absolute change in the lower lip and lower incisor. Yokosawa (1989) reported that lower lip retraction was about 70 percent of lower incisor retraction, but he found that upper incisor retraction had a stronger influence on the retraction of lower lip than the lower incisor retraction had on the lower lip.

Conversely, Garner (1974) found that the extent of lip change was not always predictable. Rains and Nanda (1982) found that upper lip response was related to both upper and lower incisor movement but no significant correlation between lower incisor movement and the response of the lower lip.

Loois and Mills (1986) found that there was a great variation in individual response of the soft tissue to change in the underlying hard tissue and that it was not possible to predict the effect on the lips of a given movement of the teeth. Battagel (1990) also found no statistically significant correlation between the lower lip change and the underlying dentoskeletal tissue.

From Table 30, when considered the changes of all related dependent variables one at a time on the change of the lower lip from prediction equation $\Delta LL = 0.547531(\Delta UL) + 0.542925(\Delta LI) + 0.298023(\Delta B) - 0.459592$ with the high multiple correlation coefficient and correlation determination, this meant that prediction of lower lip response was in a high degree of predictability. In confirmation, regression analysis indicated the relationship between all variable changes and upper lip response with the high value of F-test.

From prediction equation, it was shown that the score weight of ΔUL was the greatest when compare with the other two variables (ΔLI, $\Delta B'$). This meant that the change of lower lip depended more on change of upper lip than on the lower incisor retraction or the change of soft tissue point B'.

When analysing the change of upper lip, it was found that the change of lower lip caused upper lip to change. And when analysing the change of lower lip, the change of upper lip also caused lower lip to change. This meant that

both variables had a mutual effect on each other. In other words, one can cause the other to change.

Soft tissue responses are many varied according to each investigator. Several factors are involved in this matter, for example:

1) Samples used in each study were not the same group which might cause different result.

2) Different races might cause different results.

3) The appropriate reference lines used by each inveatigators were different. This precludes direct comparison of the result of each study.

4) The ratios obtained from calculation of several previous studies were the ratios of mean variable change. But in this study the ratio used was the result calculated from simple linear regression equation (the graph slope was used because it should more precisely show a ratio between two variables than using a ratio of mean change). Thus, the ratios from previous studies may be different from this study.

5) The types of malocclusion may have some influence on results of the study. Although Hershey (1972) did not find any different between class I and class II malocclusion.

Although each study found different soft tissue results, many studies found that when orthodontic treatment was carried out by extraction therapy, the soft tissue profile would change. Therefore, we should realize of this change when planning treatment for each patient.

The prediction equations in this study should be used in patients who come to the Department of Orthodontics, Faculty of Dentistry, Chiang Mai University with dental class I malocclusion treated by extraction of four first premolars and Edgewise Technique.

Limitation

1. Being a retrospective study, no account could be taken on the tonicity of the lips as applicable to individual cases.

2. The reason for a small size of the male samples is careful selection of the samples. Most patients coming to the faculty were younger than the research criteria.

3. Lateral cephalogram gives two dimensional information whereas facial stuctures change in three dimensional directions.

4. Sample used in the study selected with chronological ages, whereas the use of skeletal age are more accurately.

5. Although careful measurements, some errors might be occur.

Suggestions

These findings lead us to suggest the following:

1. The maxillary incisor root must be torqued lingually in order to prevent irregularity of point A and to avoid root resorption during orthodontic treatment.

2. It is better to use electromyographic equipment and lip strain gauges to accurately record lip posture at rest while investigated lip morphology and soft tissue tonicity of patients.

3. By means of skeletal age analysis using a hand-wrist radiograph, it is clear whether the patient has reached his or her adulthood. This means is more reliable than considering the chronological age. Therefore the hand-wrist radiographs should be used to assist in sample selection.

4. Further research projects are recommended to investigate the following:

4.1 Further study should be done on non-orthodontic treatment adult patient to consider whether there are any changes of the soft tissue.

4.2 To evaluate soft tissue changes after postretention phase.

4.3. Analyse skeletal and soft tissue changes in adult patients with various kinds of malocclusions other than the class I malocclusion treated by four first premolar extraction to consider whether there are any differences of the treatment outcome from this study.

4.4. Compare with the adult patients having class I malocclusion treated by four first premolar extraction but with other orthodontic techniques and to compare with Edgewise Technique.