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CHANGES IN SOFT TISSUE PROFILE IN AFRICAN-AMERICAN MALES AND FEMALES WITH CLASS I BIMAXILLARY PROTRUSION FOLLOWING ORTHODONTIC TREATMENT

by

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Department of Orthodontics

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Abstract

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Changes in facial soft tissues as a result of retraction of incisors has been studied extensively in Caucasians. However, such changes have not been well documented in the African-American population showing bimaxillary protrusion. The purpose of this investigation was to determine the changes in soft tissue profile as a result of orthodontic treatment that involves extractions and incisor retraction in African-American males and females with Cl I bimaxillary protrusion. The specific aims of the study were to 1.) Compare the soft tissue response between African-American males and females and 2.) determine the ratio of soft tissue changes to hard tissue changes.

Pre and post treatment lateral cephalometric radiographs of 30 adolescent males and 30 adolescent females of African-American descent were collected from several sources.

The radiographs were traced, superimposed and measured. Hard and soft tissue angular and linear analyses were performed. Superimpositions were projected on a grid with a Cartesian coordinate system to determine changes from pre to post treatment. Data analysis consisted of descriptive statistics, Student-t tests and correlation coefficients.

The following observations were made by analyzing the data:

1.) A significant increase was seen in nasolabial angle in the male and female group.

2.) Retraction of upper and lower lip relative to the SnPg line was significant and similar in the male and female group.

3.) The female group showed more lip retraction when superimposed on cranial base.

4.) The male group showed larger amounts of forward and downward growth of hard and soft tissue of the lower face.

5.) Ratio's for lip to incisor retraction showed to be relevant only in the female and not in the male sample.

DEDICATION

To Jolande, whose love, commitment and sacrifices made it possible to achieve one of my childhood dreams and to my parents, for their continuous encouragement and support. My gratitude is beyond words.

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INTRODUCTION

A significant number of African-American patients show dento-facial characteristics of bimaxillary dento-alveolar protrusion, also called bimaxillary protrusion, or simply bimax. Bimaxillary protrusion is characterized by protrusive teeth in both jaws with a greater degree of lip prominence and lip strain upon closure. To reduce procumbency of the teeth as well as the lips, orthodontic treatment often involves extraction of bicuspid teeth followed by retraction of the incisors. Changes in facial soft tissues as a result of retraction of incisors has been studied extensively in Caucasians. However, such changes have not been well documented in the African-American population.

Often the sole purpose of extracting bicuspid teeth in bimax patients is to make more room to retract the anterior teeth in order to reduce the procumbency of the lips. It is therefore important to find out the extent to which lip procumbency is affected by incisor retraction. In addition , if a reliable ratio between hard and soft tissue was found, it would help the clinician to better predict the changes in a patient's soft tissue profile as a result of incisor retraction. This in turn would help him to decide whether to extract teeth and also to determine the amount of incisor retraction.

Moreover, if the ratio of hard tissue to soft tissue is found to be different in males and females, as has been suggested by a previous study,

then this would be an important consideration in planning treatment based on the sex of the patient.

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LITERATURE REVIEW

CHARACTERISTICS OF THE BLACK PROFILE

Numerous studies in the orthodontic literature describe cephalometric profile standards. However the great majority reflect on standards applicable to the Caucasian race and little is known about the Black race.

The American Black facial pattern is very diversified because of the admixtures with the African, White and Indian races. Despite this diversification, the one common facial type that is frequently treated by orthodontists is bimaxillary protrusion. Bimaxillary protrusion is characterized by dentoalveolar flaring of both the upper and the lower teeth with resultant protrusion of the lips and convexity of the face.

Several early anthropological studies on non-white ethnic groups demonstrated that significant skeletal, dental, and soft-tissue differences exist between the races. One such study by Hrdlicka, in 1928 revealed some interesting differences. He described the anthropometric measurements of twenty normal American Negro males and six females. The face and mouth of the North American Black were larger especially in the females, than those of the American White, whereas the head and ears were smaller. The

nose of the Black was broader, shorter, and flatter. Hrdlicka estimated that between 70 and 80 percent of the black population in America were of mixed descent.

Cotton et al. (1951) used Down's analysis to study the cephalometric features of 10 Black males and females, 11 to 34 years of age. They found a larger angle of convexity and procumbent upper and lower incisors. They also reported a steeper mandibular plane angle and a smaller interincisal angle.

Altemus (1960) studied the cephalometric relationship of 40 Black boys and 40 Black girls with normal occlusion, age 12-16. Downs analysis revealed more protrusiveness and procumbency of the teeth. The Sassouni analysis showed that lower facial height was larger than upper facial height and a greater variability of proportions among the Blacks than was shown among the Caucasians. North American Blacks had a greater overall mean size of the head and face than did the North American Caucasians of the same age.

In another study, Altemus (1963) found that when he compared the integumental profile of 50 North American Negro children, 25 males and 25 females aged 12-16 years, with that of 37 North American Caucasian children, the Blacks exhibited more dentofacial protrusiveness than the Caucasians. Results showed that means were similar to those of Caucasians in the areas of menton, incision-stomion and glabella; yet Negroes had greater values in other areas except subspinale which was smaller.

Fonseca's (1973) cephalometric study of 40 Black females with good occlusion and an average age of 25 years, revealed a protrusive profile that was greater than the control of 20 Caucasian females. The maxilla and the mandible were more protrusive while the upper and lower incisors were more proclined with an acute interincisal angle. He found that the projection of the upper and lower lips related to the facial plane was greater in the Negro sample. Lip thickness was approximately the same in the two groups.

Kowalski et al. (1974) compared the distribution of the variables in the Steiner analysis in large samples of American black and white men. They concluded that the proclination of the lower incisor to the NB line was much higher in Negroes, as was the degree of maxillary prognathism, whereas the interincisal angle was considerably more obtuse in the Caucasian sample. They also described the cant of the occlusal plane relative to the cranial base as more severe in the Negro sample.

Sushner (1977) compared Ricketts, Steiner and Holdaway soft tissue values to the profiles of 50 Black males and 50 Black females. He found that the soft tissue profile was more protrusive than that of Caucasians. With the variation in profile, those standards established for Caucasians would not be applicable in Blacks. Sushner also found that there was a greater degree of protrusiveness in Black males than in Black females.

Drummond (1982) compared cephalometric radiograms of 40 American Negro patients, aged 8-23 years with acceptable occlusion, with the norms of 40 Southern Caucasian children. He described the Negro patient to have a large, strong tongue and very loose, flaccid lips that allow his teeth to be in balance and harmony in a procumbent position. The

position of the teeth and the thickness of the lips make the lower face appear very full. Because of the steepness of the mandibular plane, the mandible has very little chin.

Many authors agreed on the fact that norms of one racial group cannot be applied directly to another and that new standards for Blacks were needed.

EVALUATION OF FACIAL ESTHETICS IN THE NORTH AMERICAN BLACK POPULATION BY THE GENERAL PUBLIC

Surprisingly little research dealing with evaluation of facial esthetics in the North American black population has been reported.

Martin (1964) examined the relationship between racial group membership and judgment of female beauty by males. A panel of judges ranked ten facial photographs of black females from the least Negroid to the most Negro. The least Negroid type was understood to have the most Caucasian appearance. After the judges ranked the photographs, three groups of men, 50 American whites, 50 American blacks and 50 African (Nigerian) blacks were asked to rank the photographs according to attractiveness. The results indicated that American whites and blacks share a common esthetic standard -the Caucasian facial model for judging beauty. In this study it was concluded that Caucasian features were considered more attractive than Negroid features in American society.

Cross and Cross (1971) examined preference judgments of human facial beauty from portrait photographs by 300 persons consisting of both sexes, two races (white and black), and at four age levels. The photographs were of persons of various age levels, both sexes and also the white and black race. The judges rated the perceived beauty of the preferred faces on a seven point scale. In general it was found that when judging the relative beauty of a human face, black judges gave higher ratings than did white judges. In addition, female faces and adolescent faces received higher beauty ratings than other sex and age groups, and the Caucasian faces were judged to be more attractive than the Negroid faces.

Thomas (1979) evaluated the soft tissue facial profile of the American black woman. He surveyed white and black members of the orthodontic specialty by using profile tracings of photographs representing 10 common black soft tissue profiles. The results showed that black and white orthodontists shared the same opinions: the straighter profile with good facial balance and mild convexity.

DeLoach (1978) expanded on the study by Thomas. He used the same 10 black profiles to survey 224 black females. The same profiles that the orthodontic group selected were also preferred by these black women. He also concluded that most of the respondents, regardless of profile type, chose not to alter their profile in any way. He found that socioeconomic level made no significant difference. Respondents were generally unable to recognize their own profiles. Many thought their profiles were more ideal than they actually were and that they had never given any thought to the nature of their own profile. From this, DeLoach concluded that the lay

persons' esthetic preferences may be based primarily on facial features other than the profile. In conclusion the study revealed that blacks do prefer a flatter profile, but they like a bit more fullness in the lips than the typical white profile.

Farrow et al (1993) attempted to discover what black Americans find attractive about their profiles. Lateral photographs of 8 black males and 7 black females, selected at random, were altered by computer to depict 4 levels of bimaxillary protrusion. The profile types were classified as S (straight), BM1 (bimax 1), BM2 (bimax 2), and BM3 (bimax 3) sequentially increasing in protrusion of upper and lower lips. Black and white lay persons, general dentists, and orthodontists surveyed the photographs. The results found the BM1 profile to be the most attractive. This was consistent with all groups surveyed. The BM1 profile would be considered a slightly convex profile and is more protrusive than white orthodontic norms.

SOFT TISSUE ANALYSIS

Burstone (1958) presented a method of direct integumental analysis using angular readings that describe profile components to the skull as a whole (inclination angles) and to each other (contour angles). The readings were made from oriented lateral headplates exposed to show both hard and soft tissue detail. The average morphology and variation of acceptable profiles are described based on the Herron sample (40 acceptable faces). He developed an integumental profile grid to expedite the analysis of malocclusion deformity and the study of soft tissue changes.

Neger (1959) selected a group of 48 young male and female subjects with a mean age of 12.4 years and acceptable profiles. He analyzed the soft tissue profiles using six profile angles constructed by the intersections of Frankfort horizontal, Glabella-Po', Gl-labrale sup. and Gl.-labrale inf.. Standards for these six profile angles were established.

Steiner (1960) constructed a line from the middle of the S-shaped curve between the tip of the nose and the skin subnasale to the soft tissue pogonion. He stated that lips lying behind this reference line are too flat, while those lying anterior to it are too prominent.

Merrifield (1966) introduced the Profile-line to evaluate the soft tissue profile. This line of reference was established by drawing a line tangent to the soft tissue chin and to the most anterior point of either the lower or upper lip, whichever was most protruding, and extending it upward to Frankfort plane. This is a modification of the H-line used by Holdaway. "The profile line is thus a reference to the position of the face over which the orthodontist has influence through tooth movements, namely, the region of the mouth. By using the most anterior point on the upper or lower lip, the line expresses the amount of lip protrusion". Merrifield used the Profile-line to construct an angle with Frankfort. For simplicity this angle was called the Z-angle.

Burstone (1967) emphasized the role and significance of lip posture in orthodontics. He described two postural lip positions: relaxed lip position, in which the lips are relaxed, apart and hanging loosely with no effort made at lip contraction, and closed lip position, in which the lips are lightly touching in order to produce an anterior seal of the oral cavity. In theory, the relaxed lip position represents a state in which there is no contraction of lip

musculature. He stated that relaxed lip posture is a muscle determined position. Therefore it cannot have the reproducibility that is associated with measurements of hard structures. Burstone found a plane connecting subnasale and soft-tissue pogonion to be useful to evaluate relative protrusion or retrusion of the lips. The plane is established by dropping a tangent to the chin area from subnasale. Lip protrusion or retrusion is measured as a perpendicular linear distance from the subnasale-pogonion plane to the most prominent point on the upper and lower lips. The subnasale-pogonion plane has been selected as a plane of minimal variation in the area of the face. If tracings of non growing persons are superimposed before and after treatment, subnasale and pogonion will not show a radical change, provided that the head plate is taken in relaxed-lip position.

Ricketts (1968) proposed his "law of normal lip relations". This law stated essentially that the lips in white adults are contained within a line from the nose to the chin, the lower lip is closer to the line than the upper, the lips are smooth in contour, and the mouth is closed with no strain. His reference plane, a tangent to tip of the nose and soft tissue pogonion is known as the Esthetic plane or line or E-line. Ricketts reports that normally the upper lip is about 4 mm. behind the reference line while the lower lip lies approximately 2 mm. behind this line.

Legan and Burstone (1980) designed a soft tissue analysis for patients who required surgical-orthodontic care. The data were derived from a population of 40 white adults (20 men and 20 women) between the ages of 20 and 30 with class I occlusion and normal facial proportions. Standards

for facial form such as convexity angle, maxillary and mandibular prognathism and vertical height ratio were determined. In addition standards for lip position and form such as nasiolabial angle, upper and lower lip protrusion and lip to chin ratio were assessed.

Holdaway (1983) noticed when using the Steiner analysis that when the convexity increased, the convexity of soft tissue profile also increased. The original H-angle was expressed by the profile vertical line and the NB line. Later it was revised to the angle of Glabella-Pg' and the H (Harmony) -line, which is a line drawn tangent to the soft tissue chin and the upper lip. Holdaway stated that this angle should be 7-8 degrees and that the tip of the nose should be about 9 mm. anterior to this reference line. The lower lip should touch the reference line and the reference line should bisect the S-curve of the nose.

RELIABILITY OF SOFT TISSUE MEASUREMENTS IN CEPHALOMETRICS

Wisth and Böe (1975) studied the reliability of cephalometric soft tissue measurements by analyzing comparable hard and soft tissue measurements on two sets of radiographs in 60 children and 30 adults. Thirty children featured a Cl. I occlusion and competent lip morphology. The others had Angle Cl. II div. 1 occlusion and morphologically incompetent lips. The adults had a Cl. I occlusion with competent lips. A comparison of the soft tissue errors of method on two consecutive cephalograms generally showed increased values, especially for variables related to the oral area.

The lip morphology influenced the reliability of the measurements, as it was more difficult to reproduce the reference points on the upper lip in children with incompetent lips. No systematic differences were found between the soft tissue error of method in children and adults with competent lips.

Hillesund et al. (1978) studied the reliability of soft tissue profiles in two groups of Norwegian children (10-14 years), one group with an average overjet of 10 mm., the other with normal incisor relationship. One of their conclusions was that reproducibility was not definitely dependent upon whether or not the recordings were made with lips relaxed or closed. They also found that for profile analysis purposes, the reproducibility of Steiner's S point was surprisingly good. The S line and Rickett's E-line were about equally reproducible: both were less variable than Holdaway's H-line. A reduction in upper lip thickness was recorded in the group with increased overjet when the lips were changed from the relaxed to the closed position. Flattening of the lips in closed position head films may tend to camouflage lip response to retraction of the incisors, particularly when one is dealing with large overjets.

Hsu (1993) compared the consistency and sensitivity of five soft tissue analytic reference lines: Rickett's E-line, Holdaway's H-line, Steiners S-line, Burstone's B-line and Sushner's S-line. The lateral facial profiles of 110 Taipei students ,12 years of age, were traced and judged by a panel of 4 men and 3 women from different educational backgrounds. Comparisons of the "consistency" (the smaller the coefficient of variation the better the consistency) and the "sensitivity" (the power to differentiate the attractive lateral facial profiles from the unattractive ones) of the five analytic lines

were performed. This study found that those analytic reference lines that do not transverse the nose have poor consistency and sensitivity. The B-line was found to be best in terms of both.

INFLUENCE OF GROWTH ON THE SOFT TISSUE PROFILE

Subtelny (1959) studied the soft tissue profile of thirty subjects on a longitudinal basis. The serial roentgenograms were obtained from the Charles Bingham Bolton Study of the Face of the Growing Child at Western Reserve University. The sample included an equal number of male and female subjects, whose radiographs were periodically taken from 3 months to 18 years of age. The study showed that the bony facial profile tended to become less convex with age. The total soft tissue profile (including the nose) was found to increase in convexity with progression in growth. Excluding the nose, the soft tissue profile showed a tendency to remain stable in its degree of convexity. In this aspect, the soft tissue changes did not follow those manifested by the skeletal profile. The soft tissue nose continued to grow in a downward and forward direction from 1 to 18 years of age. The upper and lower lips lengthened as a function of growth. After eruption of the maxillary incisors, the upper lip was found to maintain a fairly stable vertical relationship to the incisal edge of the central incisors. The lower lip showed the same relative stability. The antero-posterior posture of the lips was found to be closely related to the teeth and alveolar processes.

In males and females the upper lip increased in thickness from 1 to 14 years of age. In males this growth pattern continued to show an increased thickness whereas in females after the age of 15 this was not the case. It was observed that the labial alveolus and central incisor teeth have a tendency to retrude and upright relative to the facial plane with increment in age. The vermilion aspect of the lips, especially of the lower lip, was observed to become more retruded in relation to the facial profile. Subtelny concluded that lip posture is closely related to underlying structures, the teeth and alveolar processes, whereas some other areas were found to diverge in soft tissue contour from underlying skeletal structures.

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SOFT TISSUE CHANGES CONCURRENT WITH ORTHODONTIC THERAPY IN CAUCASIANS

Robinson (1960) studied changes in lip position coincident with the movement of artificial teeth. Ten edentulous patients with a mean age of 28 years were evaluated. Acrylic bite rims with artificial teeth were used to alter lip position. He concluded that as the maxillary incisors move forward, the interlabial gap increases and the upper lip also moves forward. There were considerable variations in the individuals response.

Bloom (1961) studied the relationship between changes in the dentoskeletal framework and the soft tissue profile around the mouth. Thirty American white boys and girls with an average age of 11 years 6 months,

who underwent orthodontic treatment, were selected. The coefficients of correlation of the upper incisor to the superior sulcus, the upper lip and lower lip were all between .82 and .89 indicating a high degree of relationship. The range for the lower incisor to the inferior sulcus and lower lip were in the range .87 to .93. Bloom found that it was possible to predict the perioral soft tissue profile changes in relation to the expected amount of anterior tooth movement.

Rudee (1964) analyzed 85 treated cases (50 females and 35 males, age 6-22). He used facial plane as reference plane. Coefficients of correlation found for upper incisor to upper lip (0.73) and lower incisor to lower lip (0.70) show a tight relationship. The ratio for upper incisor to upper lip was 2.9:1 and for the lower incisor to lower lip 0.59:1. The ratio for the upper incisor to lower lip was 1:1. Large individual variations resulted in extremely large standard deviations. Rudee stated that although tooth and lip movements resulting from orthodontic treatment influence the facial profile, equal concern must be given to the role of concurrent growth as it affects the prominence of nose and chin. In his investigation the average amount of upper lip retraction is approximately equal to the average amount of the forward chin growth and only half the average forward growth of the nose.

Roos (1977) analyzed 10 boys and twenty girls, age 8-16 years, with CL II div. 1 malocclusions. He found high correlations between soft and hard tissue changes except for upper incisor to upper and lower lip. He found a ratio of 2.5:1 for the retraction of upper incisor to upper lip. Also he found

large individual variations in the response of the soft tissues to changes in underlying skeletal structures.

Anderson et al. (1973) found that soft tissue changes of the facial profile were closely related and dependent on the underlying dentoskeletal framework. Thickness of the upper lip increased considerably during treatment and this change was related to maxillary incisor retraction (1 mm. thickening for every 1.5 mm. of maxillary incisor retraction). Males showed significantly more growth than females in soft tissues of the nose, base of the upper lip and chin.

Hershey (1972) included 36 female subjects (mean age 20.3 years) in his study. Twenty exhibited Angle Cl I malocclusion, fifteen Cl II and one Cl III. All except for 4 subjects had extractions of 4 first premolars. Correlation coefficients for superior labial sulcus and labrale superius showed a moderately strong correlation (0.71 and 0.82) whereas the correlation coefficient for the lower lip, 0.58, showed a weaker relationship. Apparently the lower lip is less dependent than the other profile points upon the underlying skeleton for its position in space. Increasing the magnitude of upper incisor retraction decreased the strength of the correlation between tooth movement and lip response. Gross lingual tooth movement may not result in gross lingual soft tissue repositioning. The response of the soft tissue to incisor tooth retraction showed no significant differences between Cl. I and Cl. II subjects.

Jacobs (1975) included 20 patients, 11 male and 9 female, age 11-16 years, in his study. All patients had 4 premolars extracted. He found that the interlabial gap closes vertically at a ratio of approximately 1 mm. for

every 2 mm. of horizontal retraction of maxillary incisors if neither extrusion nor intrusion occurs during such retraction.

Wisth (1974) studied the perioral soft tissue morphology in 60 boys, 30 of whom had an overjet of 3-4 mm. and 30 had an 8-10 mm. overjet. When the treatment effect was studied he concluded that the upper lip response was more closely correlated to the degree of incisor retraction in individuals with a small overjet. In the group with large overjet the lower lip response was almost as great as the upper lip change. The variability of the results was large and indicates that prediction of soft tissue changes in an individual case is impossible, particularly if the overjet is large. Correction of the great overjets did not result in the same lip morphology as in the other group and is no guarantee for favorable soft tissue changes.

Lo (1982) compared fifty orthodontically treated boys and girls with forty three untreated all of whom had Cl. II div 1 malocclusions. The average age was 12 years 2 mo. for boys and 12 yr 7 months for girls. He found the greater the maxillary incisor retraction, the greater was the increase in nasolabial angle.

Oliver (1982) investigated the influence of maxillary lip strain and lip thickness on the relationship between dental and integumental tissue changes in orthodontically treated patients. The sample included 40 Caucasians, 20 males and 20 females with a mean age of 12 years. He found a strong correlation (r=0.92) between osseous changes and soft tissue changes in both males and females with thin lips whereas no significant correlations (r=0.61) were found in subjects with thick lips. Correlations were strong between incisor changes and vermilion border

changes in subjects with high lip strain (r=0.92), but were insignificant in subjects with low lip strain.

Rains (1982) reported a study in which he analyzed the integumental profile of 30 late adolescent female patients that were orthodontically treated. He found the lower lip to be more variable than the upper lip to differences in the upper incisor movement. The upper lip at labrale superius was more variable with increased retraction of the upper incisors. In the prediction equation, the upper lip response was related to both upper and lower incisor movement, mandibular rotation, and the lower lip.

Waldman (1982) evaluated upper lip retraction with retraction of the incisor edge in 41 Cl II. cases. He found an average ratio of 1:3.8 between lip retraction and incisor retraction. Increase in the nasolabial angle was found to be associated with change in incisor angle and with palatal tilt, but there was no consistent relationship with horizontal movement of the incisal edge.

Keating (1986) compared thirty bimaxillary protrusion cases, who had four first premolars extracted with thirty Class I malocclusion cases who, likewise, had similar extractions and treatment. During treatment, the interincisal angle was increased by 20 degrees and relapsed 4 degrees post treatment. The protuberance of the soft tissue profile was significantly reduced by 4 degrees concurrently (Holdaway angle). He concluded that worthwhile treatment objectives can be achieved in these cases.

Talass et al. (1987) analyzed the cephalometric records of 80 treated and 53 untreated white female subjects. They found that in general growth was associated with only minimal changes in the soft tissue profile in a

period not exceeding 36 months. The three significant soft tissue changes were the retraction of the upper lip, the increase in lower lip length and the increase in nasolabial angle. the low predictability associated with the upper lip response may be caused by the complex anatomy and/or dynamics of the upper lip.

SOFT TISSUE CHANGES CONCURRENT WITH ORTHODONTIC THERAPY IN AFRICAN-AMERICANS

Garner (1974) included 10 black girls and 6 black boys in his study. The subjects had various malocclusions including 5 boys and two girls with bimaxillary protrusion. The facial plane was used as reference plane. He found the maxillary incisor to upper lip retraction ratio of 3.6:1 for the total Negro sample and a ratio of 2:1 for the female Negro sample. He concluded that Negro boys and girls who undergo orthodontic treatment do exhibit changes in lip posture as a result of tooth movement, but that the extent of the lip change is not always predictable. He also concluded that the change is not uniform between boys and girls. He stated however that the study was too small to support a positive declaration about clinical cases under consideration for treatment.

Russel and Nelson (1986) studied the soft tissue response of the perioral area of North American Black patients before and after orthodontic treatment with the extractions of four first premolar teeth. The records of twenty-five patients from the clinic at Howard University were selected. A

vertical reference plane through pterygoid point, perpendicular to the Frankfort horizontal plane was established. Linear measurements to specified soft tissue points were made from this plane. The points labrale superior, labrale inferior and sulcus inferior could not be shown to be affected because of the masking effect of growth. Points A and B increased significantly from the reference plane indicating that growth was moving the maxilla and mandible in a forward direction. The nasolabial angle increased 13 degrees and became more obtuse. The tip of the nose increased 6.7 mm.. The study did not mention the mean age of the sample but they concluded that assessments of soft tissue response were hard to make since the treatment effects were counteracted by growth in the opposite direction.

STATEMENT OF THESIS

The purpose of this study is to asses the changes in the soft tissue profile as a result of orthodontic treatment that involves extractions and incisor retraction in African-American males and females with class I bimaxillary protrusion.

The specific aims of the study are:

1) To compare the soft tissue response between males and females .

2) To determine the ratio of soft tissue changes to hard tissue changes.

MATERIALS AND METHODS

SAMPLE

The sample of this study consisted of pre and post treatment lateral cephalometric radiographs of 60 Black adolescent patients, 30 males and 30 females, who presented with a bimaxillary protrusion at the beginning of treatment. The sample was derived from patients treated at Case Western Reserve University department of orthodontics and 3 private orthodontic offices.

The average age of the patients at the time of exposure of the pre treatment cephalometric radiograph was 13 years 2 months for the males (age range 10 years 4 months to 17 years 6 months) and 13 years 7 months for the females (age range 10 years 4 months to 17 years 6 months). The average age at the time of the post treatment cephalometric radiograph was 16 years for the male group and 16 years and 10 months for the female group. Average time between pre treatment and post treatment radiographs was 2 years and 11 months for the male group and 3 years and 3 months for the female group.

The following criteria were used in selection. Cephalometric requirements were a class I molar relation plus or minus 1 mm., an interincisal angle of 120° or less, an overbite of 0 % to 50 % and an overjet no greater than 7 mm. .

The average amount of upper incisor retraction, as determined by maxillary superimposition, was 4.15 mm. for the male group and 5.48 mm. for the female group with a range of 1 mm. to 9 mm.. The amount of lower incisor retraction, as determined by mandibular superimposition ,was 3.17 mm. for the males and 3.98 mm. for the females with a range of 2 mm. to 9 mm..

The lateral cephalometric radiographs were of good quality with soft tissue structures clearly discernible. Radiographs that showed excessive straining of perioral soft tissue or severe lip incompetence were excluded from the study. All the subjects in the study were treated with fixed appliances and in all of them extraction of four bicuspids was part of treatment.

The subjects in the male and female groups were selected to show as much similarity in cephalometric parameters as possible.

CEPHALOMETRIC ANALYSIS

The pre and post treatment lateral cephalograms were traced on one piece of .003" acetate tracing paper (Masel) with 0.5 mm. 6H black and blue mechanical pencil leads (Pentel), respectively. Materials used in the study

were a millimeter ruler (3M Unitek tracing template, Steiner design), a cephalometric protractor (Unitek, design by Dr. A.T. Baum) and a protractor/ruler/template combination instrument (Dome, Ricketts design). Linear measurements were performed by overlaying the acetate paper on millimeter grid paper (National 12-188).

Landmarks that were traced and their definitions are listed in the appendix(page).

The pre and post treatment tracings were superimposed by estimating a best fit of the anatomical structures of the floor of the anterior cranial fossa where primary consideration was given to the region between the anterior glenoid processes and crista galli. Baumrind (1976) found that the rotational errors for the anterior cranial base superimposition were smaller than those for the Sella-Nasion superimposition. He stated that in superimpositions the magnitude of the errors increases as a function of the distance of the landmark from the center of rotation of the tracing.

To assess pre and post treatment differences in upper incisor position, regional superimpositions were performed by estimating a best fit for the anterior maxillary structures with special attention to the anterior surfaces of the hard palate and the region between anterior nasal spine with the superior surfaces of the hard palate aligned.

Differences in position of the lower incisor were evaluated by creating an optimal fit of the two images of the mandible with primary consideration to the inner tables and trabecular anatomy of the symphysis and the lower anterior contour of the body of the mandible.

A Horizontal plane (CFH), constructed by drawing a line through nasion 7 degrees up from sella was used as a horizontal reference line. Also a vertical reference line (VRL) perpendicular to the horizontal reference line and passing through sella was constructed (see figure 1). These two reference lines, drawn on the acetate sheet served as a Cartesian coordinate system, the horizontal reference line being the X-axis, the vertical the Y-axis and the origin at the intersection of both lines.

To determine linear changes in the pre- and post treatment tracings, the acetate was overlaid on a grid with a 1 mm. scale. Measurements were recorded to the 0.5 mm. level.

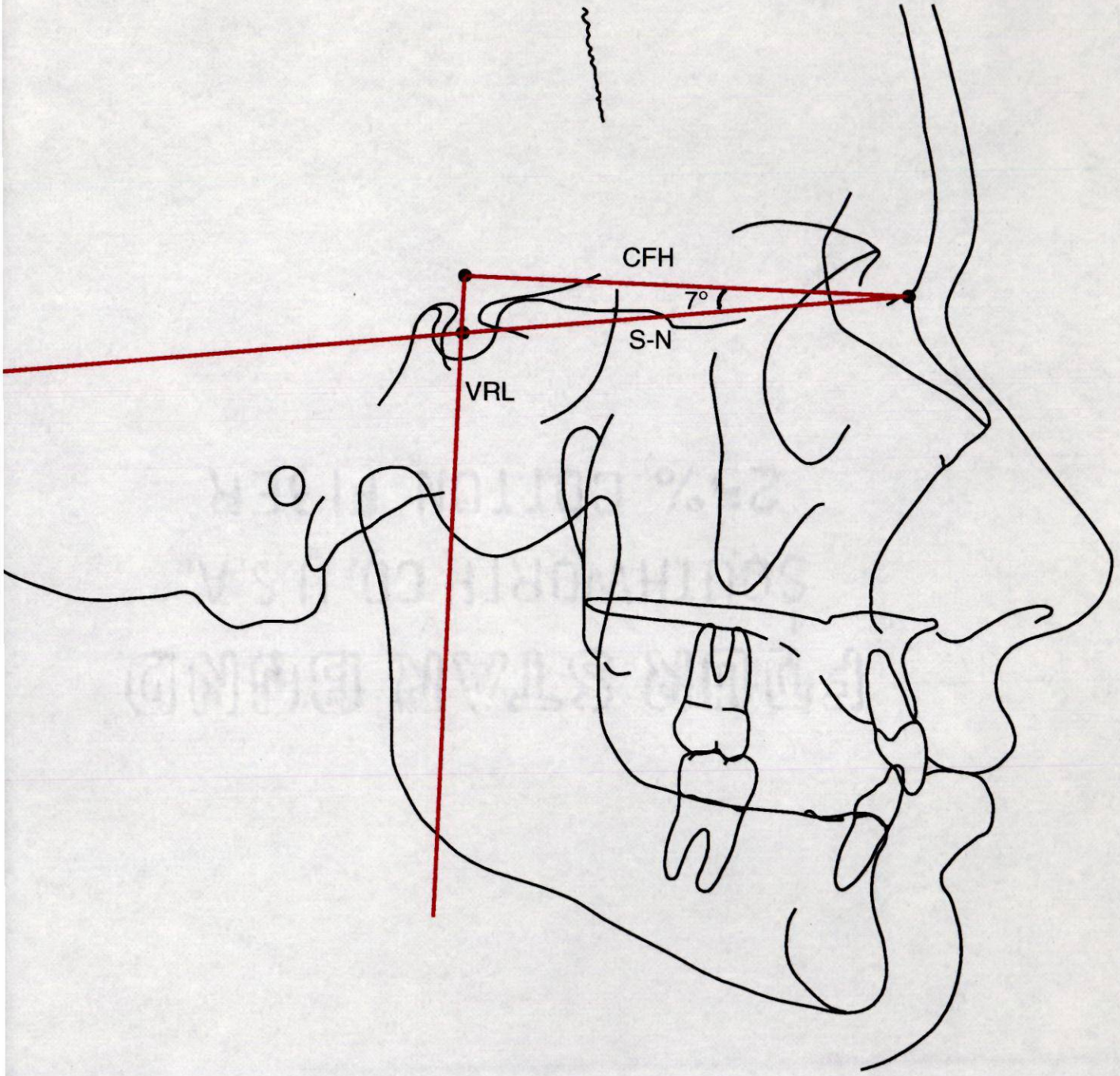


Figure 1. Horizontal and vertical reference lines

The linear measurements could not be corrected for existing enlargement factors of the cephalometers because of the fact that there was no standardization in recording technique. The distance of the midsagittal plane to the film was not standardized nor was the actual individual distance from the midsagittal recorded on all films. It must be kept in mind however that even with a conservative estimate the enlargement factor of a standard Broadbent cephalometer will be at least 4% in all films.

The following measurements were recorded in the pre- and post treatment cephalometric tracings:

Hard tissue angular measurements (fig 2)

1. Sella-Nasion-A point (SNA)
2. Sella-Nasion-B point (SNB)
3. A point-Nasion-B point (ANB)
4. Mandibular plane-SN (Mp-SN)
5. Upper incisor-constructed Frankfort plane (U1-CF)
6. Lower incisor-Mandibular plane (IMPA)
7. Interincisal angle (I-I)

Hard tissue linear measurements (fig. 3)

1. Lower incisor-line A-Pogonion (L1-APo)
2. Overjet (OJ)
3. Overbite (OB)

Soft tissue angular measurements (fig 4)

1. Glabella-Subnasale-soft tissue Pogonion (G-Sn-Pg)
2. Naso-labial angle (NLA)

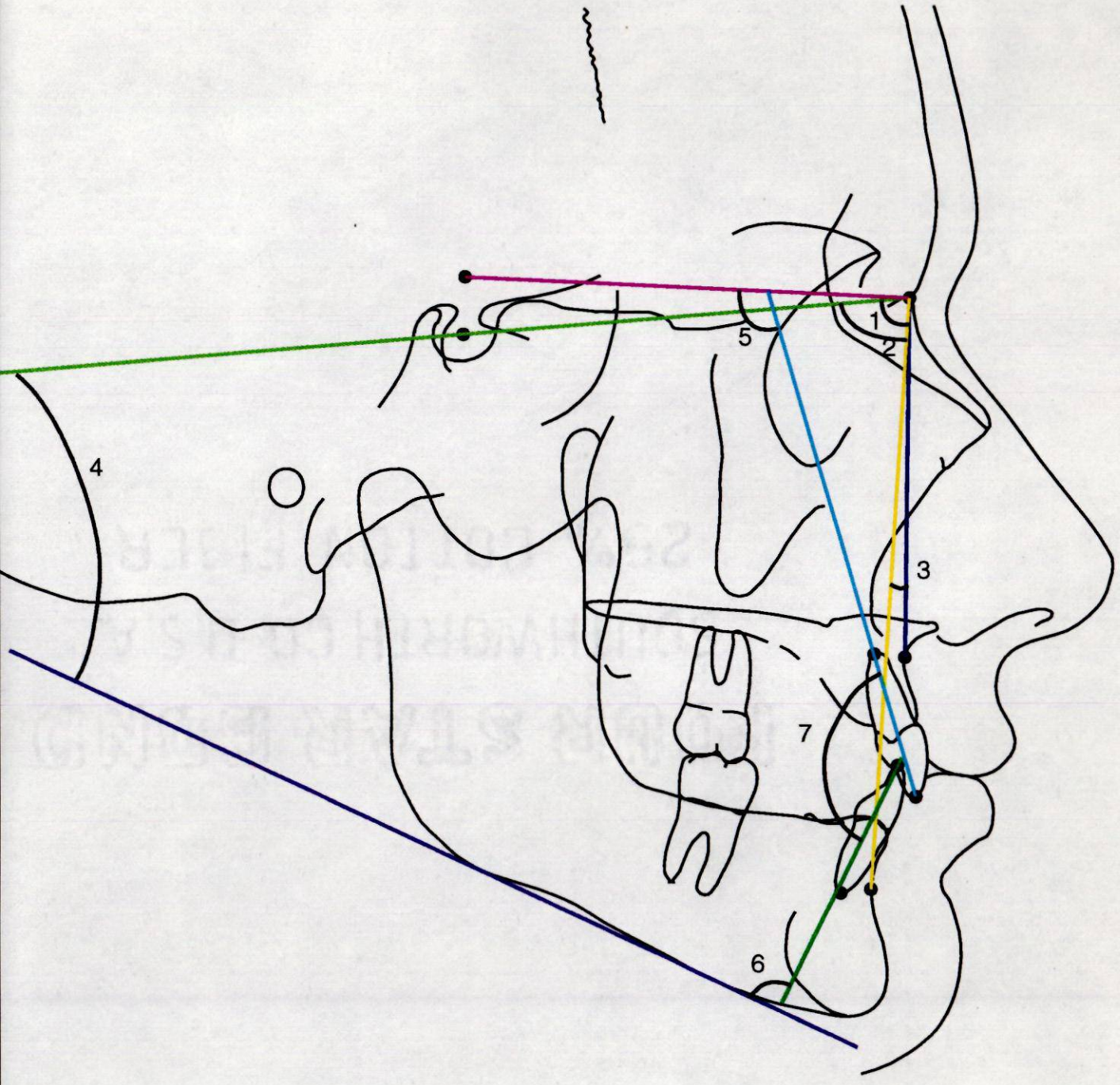


Figure 2. Hard tisue angular measurements

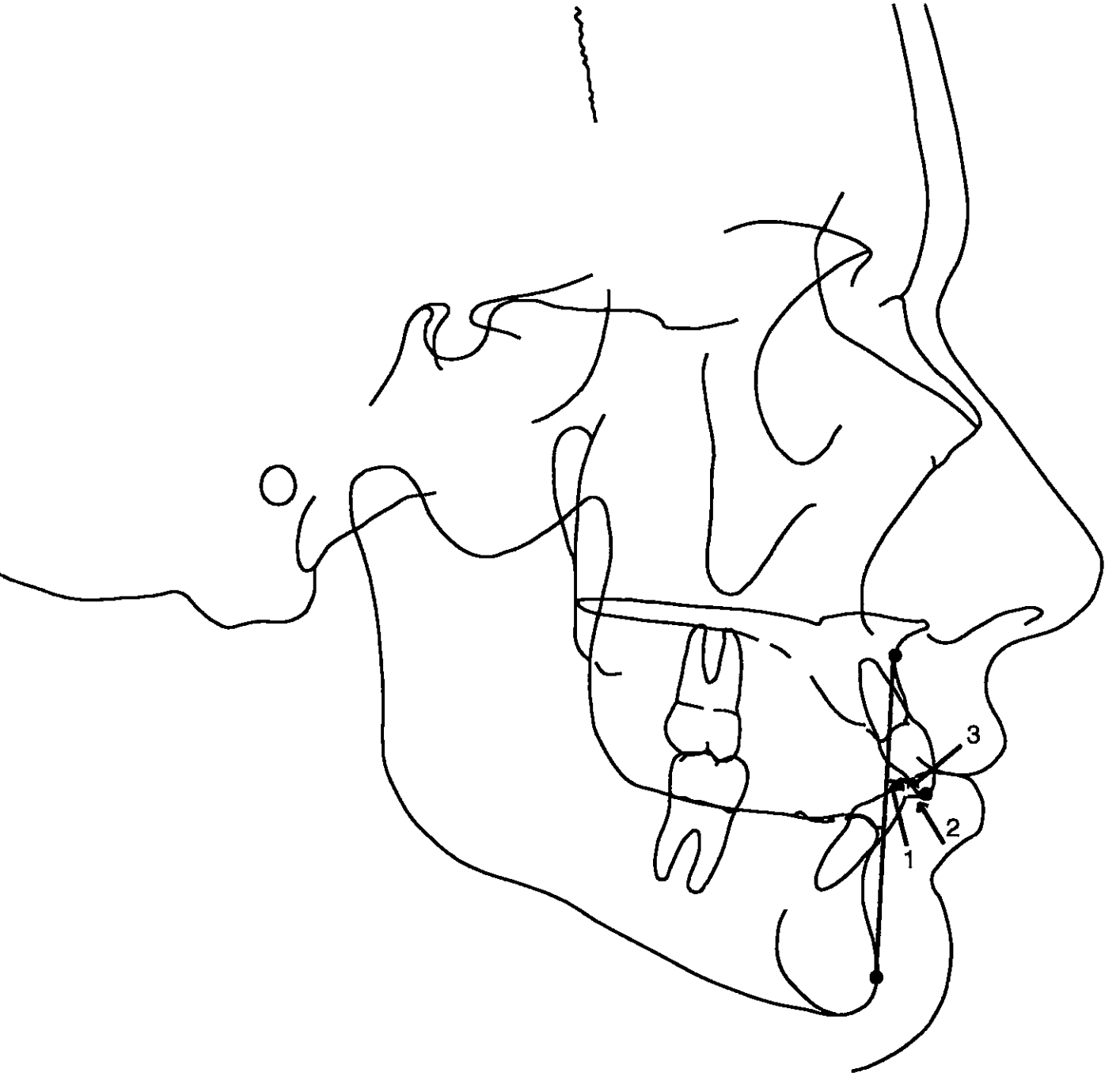


Figure 3. Hard tissue linear measurements

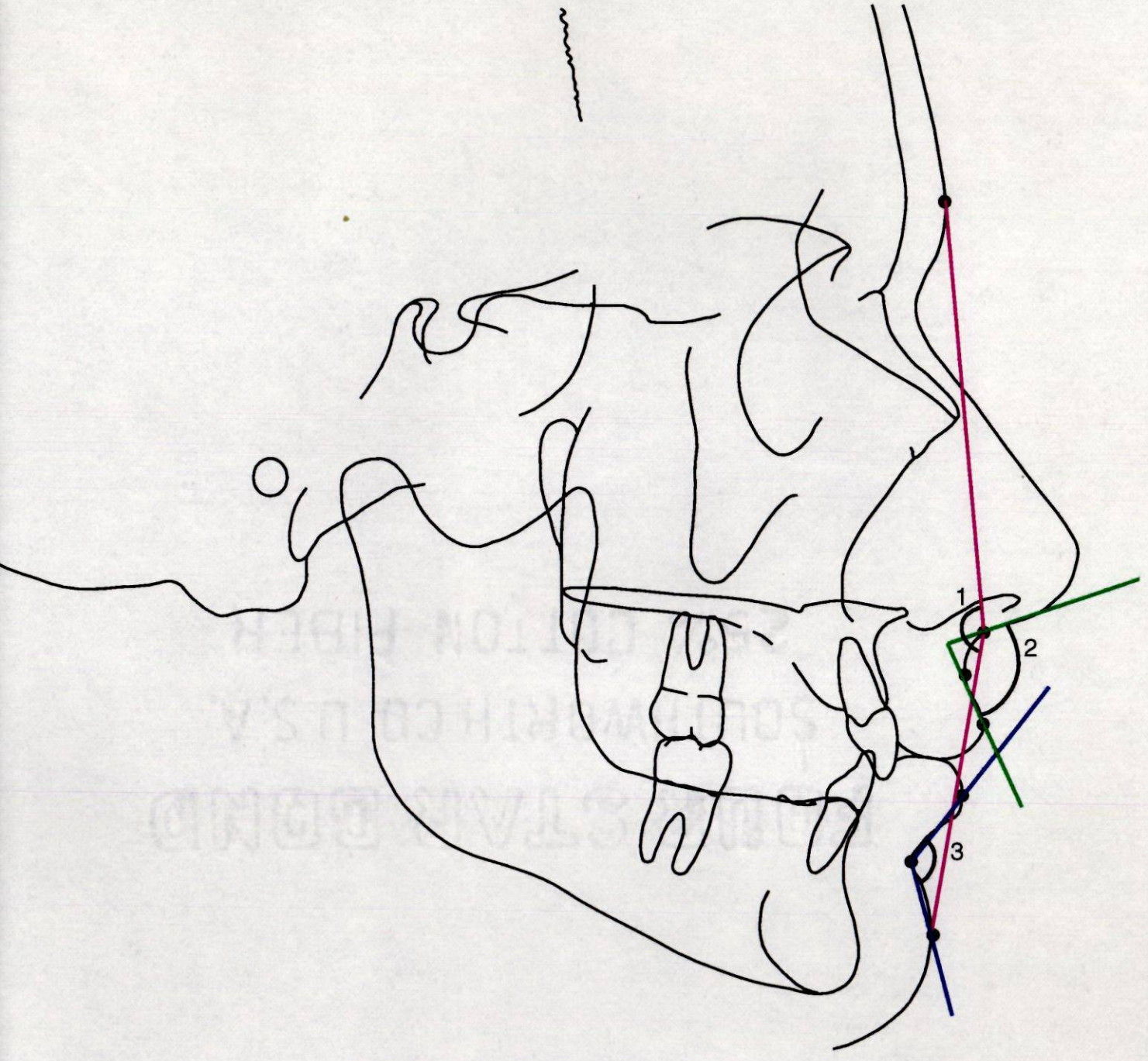


Figure 4. Soft tissue angular measurements

3. Mento-labial-sulcus angle (MLS)

Soft tissue linear measurements (fig. 5)

1. Interlabial gap (ILG)
2. Upper lip length (ULL)
3. Lower lip length (LLL)
4. Subnasale-soft tissue Pogonion-
5. upper lip (SnPg-UL)
6. Subnasale-soft tissue Pogonion-
7. lower lip (SnPg-LL)

Lip thicknes measurements (fig 6)

1. Sulcus superior (SS)
2. Upper lip (UL)
3. Lower lip (LL)
4. Sulcus inferior (SI)

The following linear measurements were recorded by superimposing pre- and post treatment cephalometric tracings on cranial base.

Hard tissue measurements (fig. 7)

1. A-Point x- and y-coordinate
2. Incisor superior x- and y-coordinate
3. Incisor inferior x- and y-coordinate
4. Pogonion x- and y-coordinate

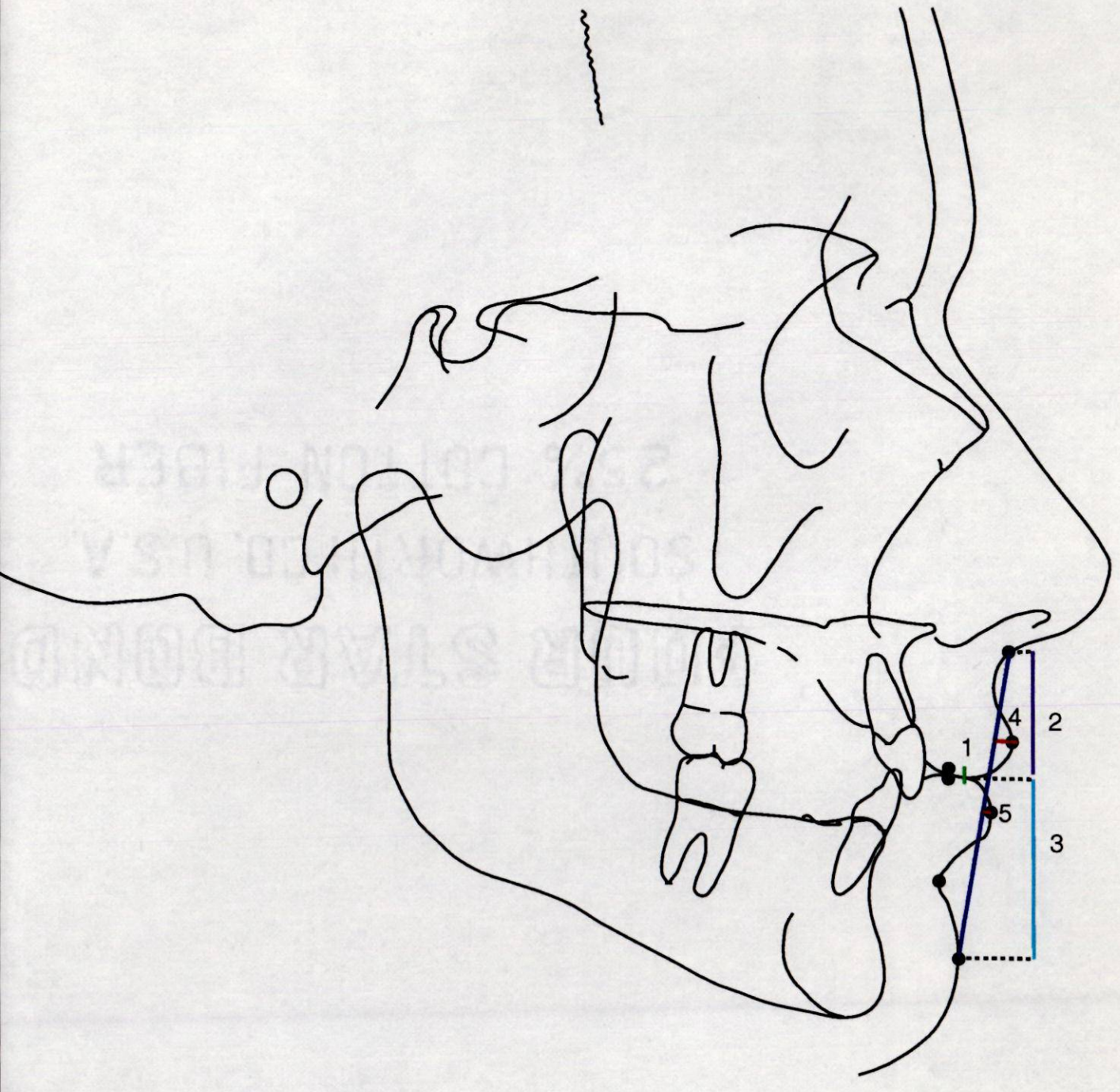


Figure 5. Soft tissue linear measurements

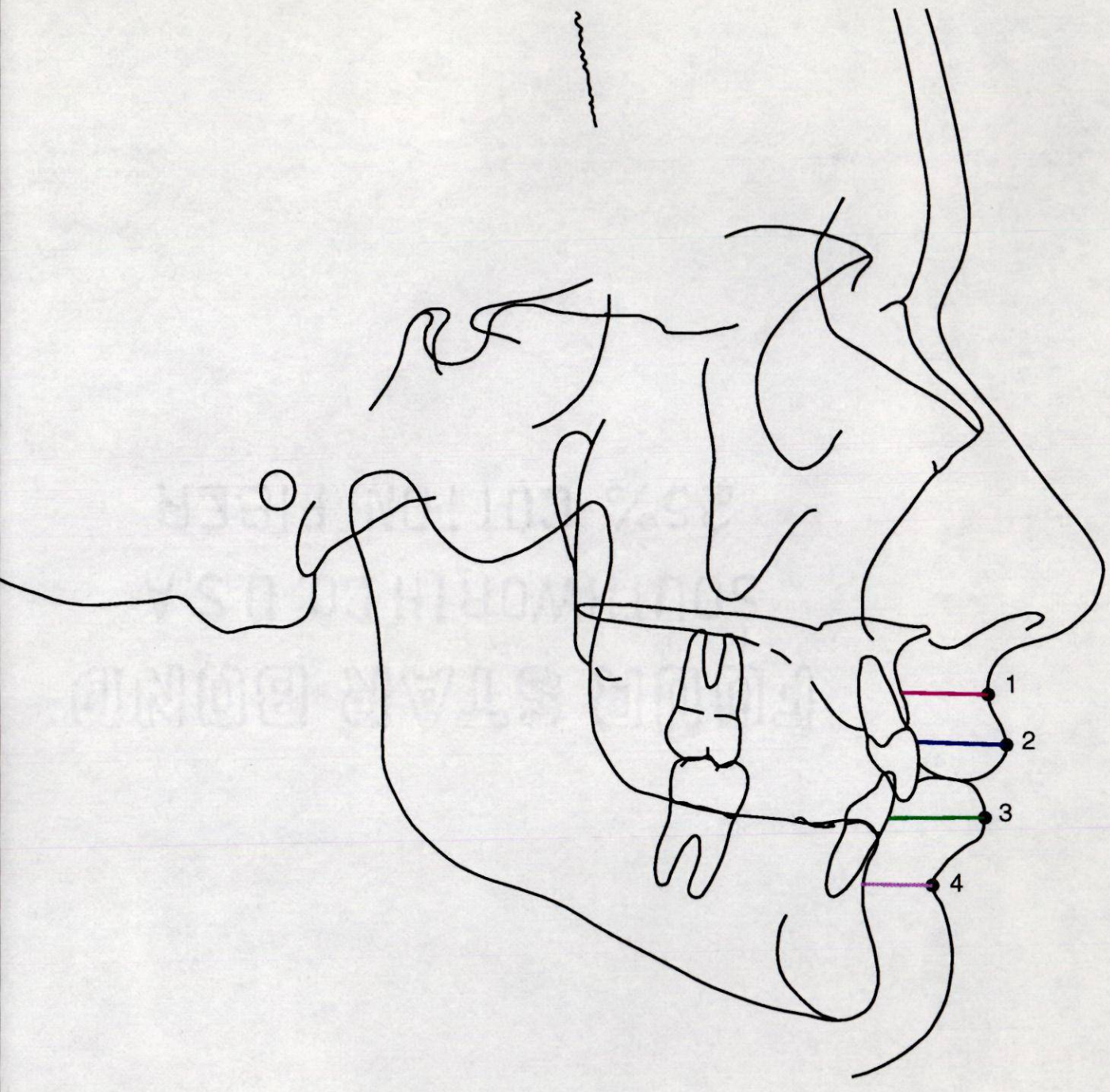


Figure 6. Lip thickness measurements

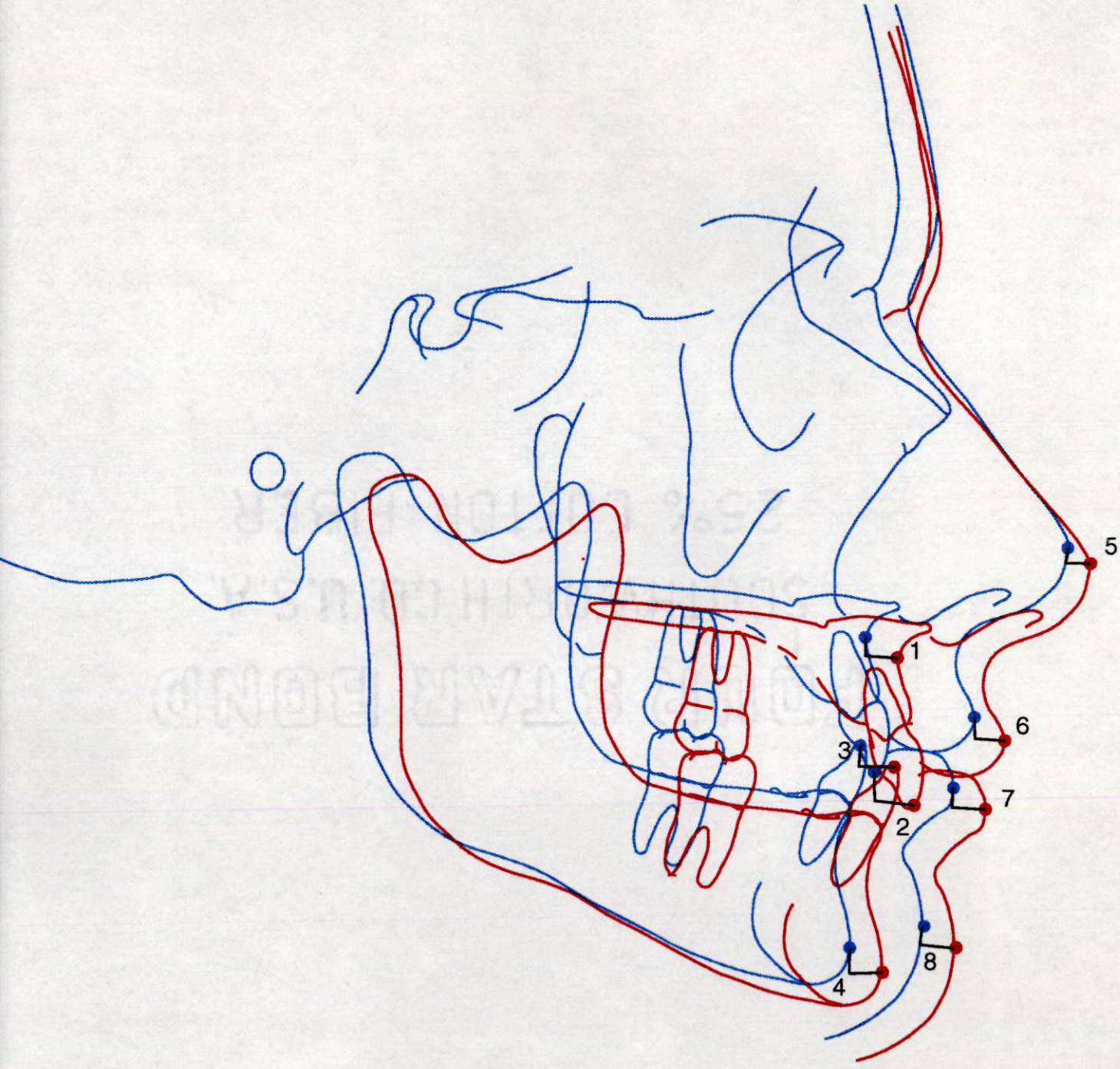


Fig 7. Measurements of various landmarks based on cranial base superimposition of pre- and post treatment cephalometric tracings.

Soft tissue measurements (fig. 7)

5. Apex nasalis x and y-coordinate
6. Labrale superior x- and y-coordinate
7. Labrale inferior x- and y-coordinate
8. Soft tissue Pogonion x- and y-coordinate

The following linear measurements were recorded by regional superimposition of pre- and post treatment cephalmetric tracings on the maxilla and mandible. (fig. 8)

1. Incisor superior x- and y-coordinate
2. Incisor inferior x-and y-coordinate

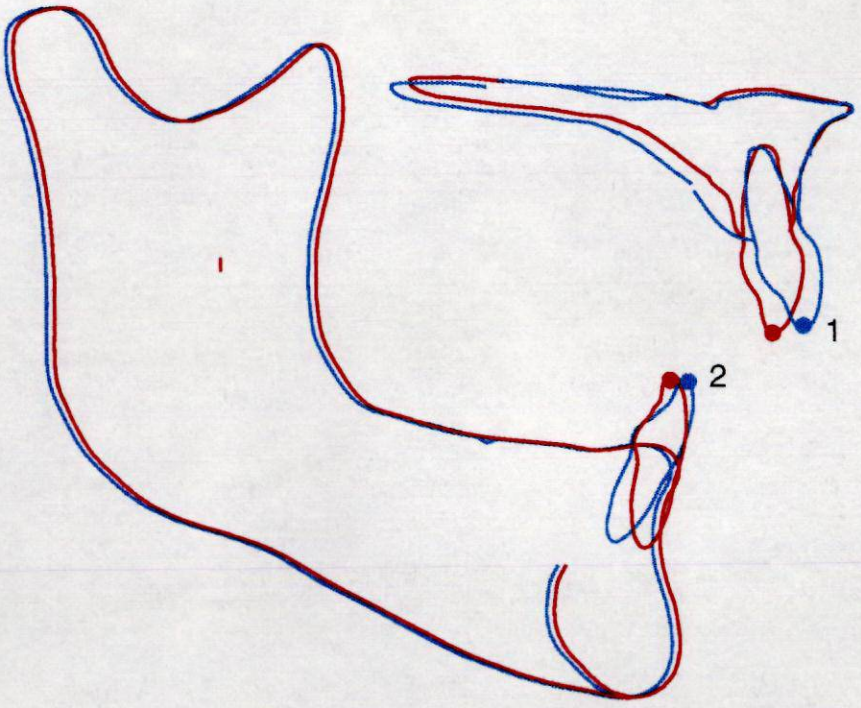


Figure 8. Measurement of incisor superior and incisor inferior based on regional superimposition of pre- and post treatment cephalometric tracings on the maxilla and the mandible.

STATISTICAL METHOD

Means and standard deviations for each cephalometric variable were determined for the male and female group. Also means and standard deviations for the differences between the values of the post treatment (T2) and pre treatment (T1) measurements were determined in the male and female group. Two tailed t-tests were used to determine the statistical significance of the changes in both the male and the female groups. Significance was assessed at $p \leq 0.05$.

The amount of change that occurred in each cephalometric variable of the male group was compared to the amount of change for the same variable in the female group. Two tailed t-tests were used to determine the statistical significance of these differences. Significance was assessed at $p \leq 0.05$.

To determine the strength of the relationship between the cephalometric parameters, correlation coefficients for all possible variable combinations within each group were determined.

ERROR ASSESSMENT

The combined error of tracing and measurement was determined by retracing ten randomly selected cephalometric radiographs and by repetition of the measurements. The initial mean value and repeat mean value were compared for each cephalometric variable. Paired two tailed t-tests were used to determine the statistical significance of the differences in mean value at the $p < 0.05$ level. Also correlation coefficients were calculated to determine the strength of relationship between the repeated tracings.

RESULTS

MAXILLA

The values for SNA remained fairly constant in the male and female group from pre- to post treatment (Table 1 and 2). The forward and downward translation of A-point was larger in the male group, but not statistically significant (Table 3).

UPPER LIP

In both groups there was a significant increase in the nasolabial angle. In the male group there was 9.13 ° increase ($p = 0.008$), compared to 7.05° in the females ($p = 0.032$). The difference of 2.03 ° between the 2 groups was not significant (Table 3 and figure 9).

The increase in upper lip length was similar however not significant in both groups.

In the male group, there was a significant increase of 2.67 mm. of upper lip thickness ($p = 0.000$), whereas in the females the 0.53 mm. increase was not significant (figure 10)

Both groups showed a significant amount of upper lip retraction when measured from the Subnasale-soft tissue Pogonion line, 1.5 mm. and 1.74

mm. respectively (p =0.004 and p= 0.007). The difference between the 2 groups was not significant (figure 10).

The changes in sulcus superior were not significant in the males nor in the females. However there was an 0.8 mm. increase in thickness in the male group whereas the females showed a 0.48 mm. decrease (figure 11). When compared, this difference was significant (p= 0.003).

When the translation of the upper lip was determined by cranial base superimposition, the mean translation for Labrale Superior in the male group was 1.37 mm. forward compared to a 1.5 mm. backward movement in the female group (figure 12). This difference between the 2 groups was highly significant (p=0.000). In both groups there was a downward movement of the upper lip. The 4.55 mm. change in the males was significantly more than the 2.08 mm. in the females (p = 0.000).

Department of Orthodontics

TABLE 1.-- Mean changes in Maxilla and upper lip from pre treatment (t1) to post treatment (t2) in the Male group.

Males (n=30)						
	mean t1	SD	mean t2	SD	mean difference	p value
MAXILLA						
SNA (°)	85.72	3.9	85.3	4.39	-0.39	0.757
UPPER LIP						
NLA (°)	92.27	15.43	101	12.57	9.13	0.008*
ULL (mm.)	25.4	2.53	26.5	2.41	1.13	0.08
SnPg-UL (mm.)	11.33	1.96	9.83	1.91	-1.5	0.004*
SS (mm.)	14.07	1.65	14.9	2.3	0.8	0.127
UL (mm.)	15.38	2.86	18.1	2.57	2.67	0.000*

*significant $p \leq 0.05$

TABLE 2.-- Mean changes in Maxilla and upper lip from pre treatment (t1) to post treatment (t2) in the Female group.

females (n=30)						
	mean t1	SD	mean t2	SD	mean difference	p value
MAXILLA						
SNA (°)	85.62	3.79	85.28	4.06	-0.34	0.731
UPPER LIP						
NLA (°)	90	12.98	97.05	11.92	7.05	0.032*
ULL (mm.)	23.9	2.2	24.87	2.19	0.97	0.094
SnPg-UL (mm.)	9.82	2.37	8.08	2.49	-1.74	0.007*
SS (mm.)	13.3	1.78	12.82	1.51	-0.48	0.261
UL (mm.)	14.12	2.34	14.65	2.68	0.53	0.415

*significant $p \leq 0.05$

TABLE 3. -- Comparison of mean changes in Maxilla and upper lip from pre treatment (t1) to post treatment (t2) between the Male and Female group.

	Males (n=30)		Females (n=30)			
	Mean	SD	Mean	SD	Mean difference	p value
MAXILLA						
SNA (°)	-0.39	2.42	-0.35	1.3	0.04	0.947
Ax (mm.)	1.37	3.27	0.4	1.25	0.97	0.07
Ay (mm.)	-2.88	3.13	-1.68	2.34	1.2	0.098
UPPER LIP						
NLA (°)	9.08	12.82	7.05	7.76	2.03	0.46
ULL (mm.)	1.13	1.89	0.967	1.48	0.163	0.71
SnPg-UL (mm.)	-1.5	1.37	-1.74	1.45	0.24	0.51
SS (mm.)	0.8	1.85	-0.48	1.36	1.28	0.003*
UL (mm.)	2.67	2.54	0.53	2.038	2.14	0.000*
LSX (mm.)	1.37	3.6	-1.5	2.37	2.87	0.000*
LSy (mm.)	-4.55	2.95	-2.08	2.41	2.47	0.000*

*significant $p \leq 0.05$

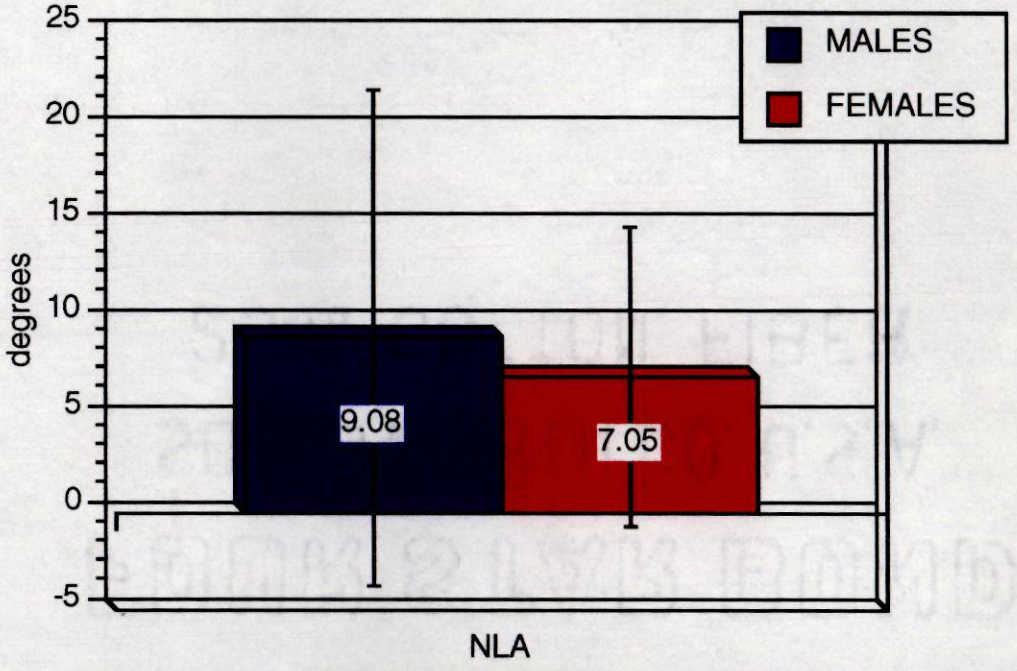


Figure 9. Comparison of change in naso-labial angle (NLA) from pre treatment to post treatment between the Male and Female group.

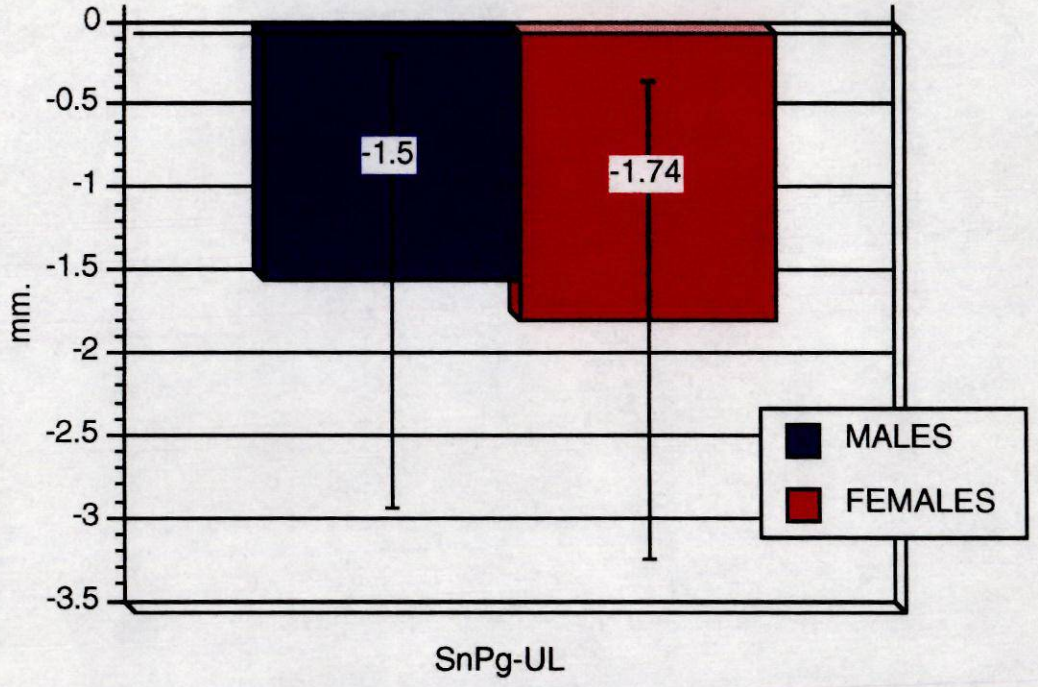


Figure 10. Comparison of change in Subnasale -soft tissue Pogonion to upper lip (SnPg-UL) from pre treatment to post treatment between the Male and Female group.

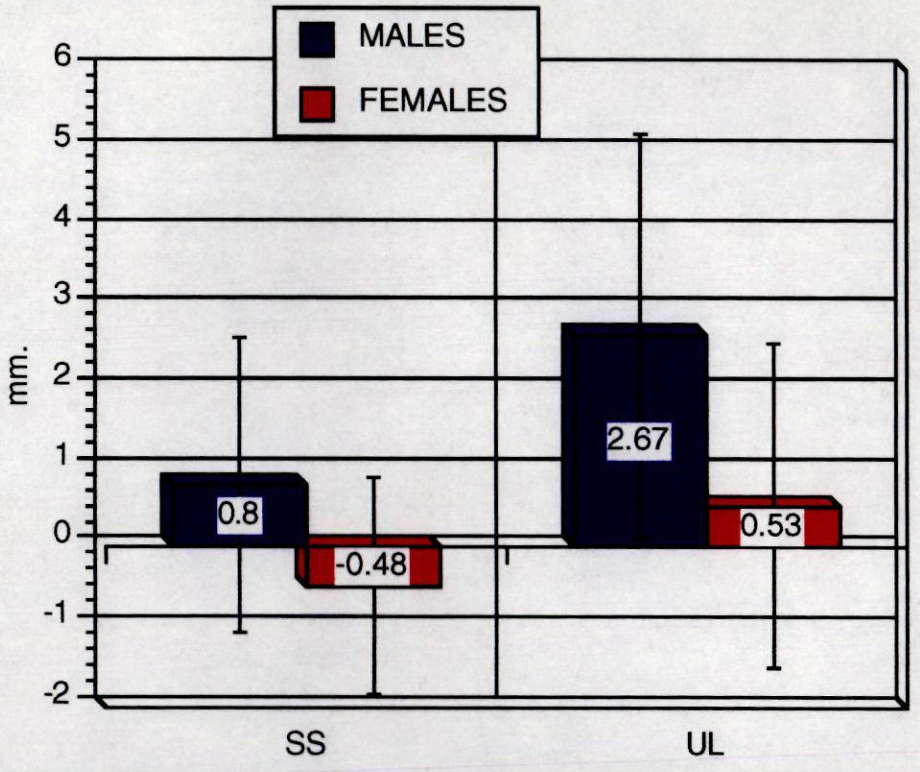


Figure 11. Comparison of change in upper sulcus thickness (SS) and upper lip thickness (UL) from pre treatment to post treatment between the Male and Female group.

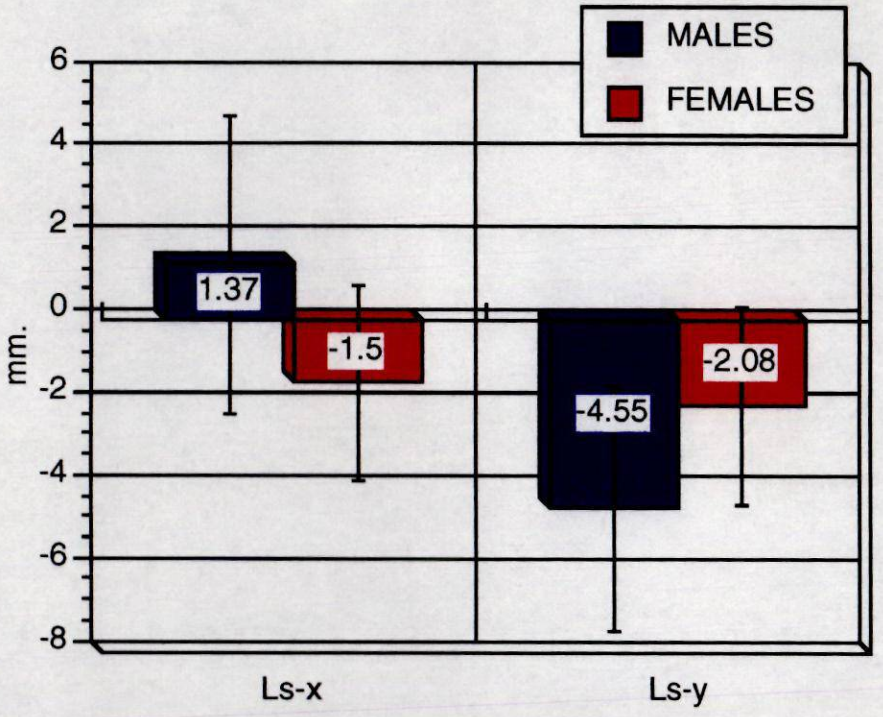


Figure 12. Comparison of change in horizontal (Ls-x) and vertical (Ls-y) translation, as determined by cranial base superimposition, of Labrale superior from pre treatment to post treatment, between the Male and Female group.

MANDIBLE

The changes from pre- to post treatment for SNB and MP-SN were small and not significant (Table 4 and 5).

There was a significant mean change in the translation of Pogonion which moved 2.65 mm. for males and 0.65 mm. for females (Table 6) in a forward direction ($p = 0.002$). The difference in vertical change of Pogonion was even more significant; 7.17 mm. for males and 2.98 mm. for females ($p = 0.000$).

LOWER LIP

In both groups the mento-labial-sulcus angle decreased (became more acute) by 7.71° for males and 5.52° for females, this was however not statistically significant. The intergroup difference of 2.19° was also not significant.

The thickness of the lower sulcus integumentum decreased in both groups by approximately 0.6 mm. .

The increase in lower lip thickness by 0.6 mm. in the male group vs. the decrease by 0.38 mm. was not significant. Lower lip length increased approximately the same amount.

The change in position of lower lip to Subnasale-soft tissue Pogonion was significant (p = 0.005 and p= 0.004 resp.) in both groups (figure 13). The mean change was -2.7 mm. for the males and -2.53 for the females. The difference was not significant.

The difference in horizontal translation of Labrale inferior, -0.27 mm. for males, -2.22 mm. for females, was significant (p = 0.024). The difference of 3.2 mm. for vertical change was even larger(p = 0.000) (figure 14).

Horizontal translation of soft tissue-Pogonion was approximately ten times the amount of the translation in the female group (figure 15). The change in down ward position was 3.71 mm. more in the male group. Both differences were highly significant (p = 0.000).

TABLE 4. -- Mean changes in Mandible and lower lip from pre treatment (t1) to post treatment (t2) in the Male group.

Males (n=30)						
	mean t1	SD	mean t2	SD	mean difference	p value
MANDIBLE						
SNB (°)	79.48	3.35	79.8	4.2	0.34	0.735
MPSN (°)	34.13	5.38	34	5.82	-0.1	0.945
LOWER LIP						
MLS (°)	137.9	21.36	130.2	18.46	-7.72	0.139
LLL (mm.)	32.08	3.85	33.5	4.63	1.45	0.192
SnPg-LL (mm.)	12.98	3.01	10.3	4	-2.7	0.005*
LL (mm.)	18.8	2.16	19.4	2.33	0.6	0.305
SI (mm.)	18.8	2.16	19.4	2.33	0.6	0.083

*significant $p \leq 0.05$

TABLE 5. -- Mean changes in Mandible and lower lip from pre treatment (t1) to post treatment (t2) in the Female group.

females (n=30)						
	mean t1	SD	mean t2	SD	mean difference	p value
MANDIBLE						
SNB (°)	78.93	4.19	78.91	4.41	-0.02	0.988
MPSN (°)	35.83	5.19	36.36	5.7	0.53	0.733
LOWER LIP						
MLS (°)	129.05	26.09	123.53	28.63	-5.52	0.439
LLL (mm.)	27.73	3.97	29.47	4.8	1.74	0.133
SnPg-LL (mm.)	10.65	3.11	8.12	3.37	-2.53	0.004*
LL (mm.)	17.63	2.67	17.25	2.87	-0.38	0.594
SI (mm.)	12.97	1.91	12.33	1.56	-0.64	0.164

*significant $p \leq 0.05$

TABLE 6. -- Comparison of mean changes in Mandible and lower lip from pre treatment (t1) to post treatment (t2) between the Male and Female group.

	Males (n=30)		Females (n=30)			
	Mean	SD	Mean	SD	Mean difference	p value
MANDIBLE						
SNB (°)	0.34	2.01	-0.01	1.24	0.35	0.421
MPSN (°)	-0.1	2.73	0.48	1.6	0.58	0.318
Pox (mm.)	2.65	4.02	0.65	2.2	2	0.02*
Poy (mm.)	-7.17	2.67	-2.98	2.78	4.19	0.000*
LOWER LIP						
MLS (°)	-7.71	13.36	-5.52	12.32	2.19	0.51
LLL (mm.)	1.45	3.98	1.73	3.11	0.28	0.76
SnPg-LL (mm.)	-2.7	2.54	-2.53	2.09	0.17	0.782
LL (mm.)	0.6	2.27	-0.38	2.34	0.98	0.104
SI (mm.)	-0.68	1.21	-0.63	1.13	0.05	0.87
LIx (mm.)	-0.27	3.49	-2.22	3.03	1.95	0.024*
LIy (mm.)	-5.25	3.07	-2.05	3.37	3.2	0.000*
Pgx (mm.)	3.52	4.45	0.32	2.24	3.2	0.000*
Pgy (mm.)	-6.58	3.86	-2.87	3.6	3.71	0.000*

*significant p≤ 0.05

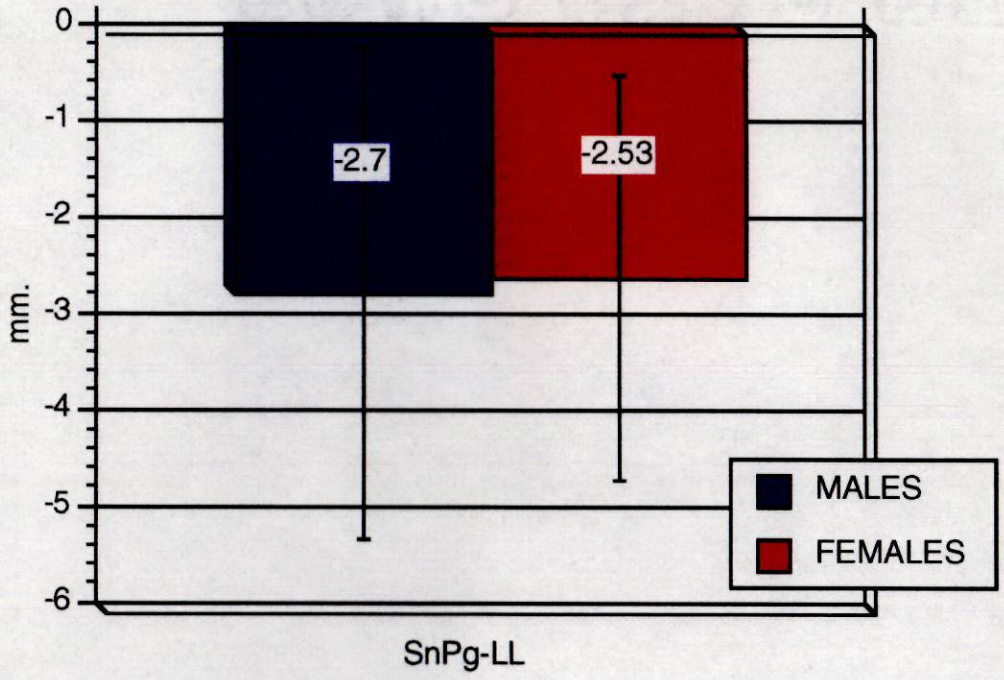


Figure 13. Comparison of change in Subnasale -soft tissue Pogonion to lower lip (SnPg-LL) from pre treatment to post treatment between the Male and Female group.

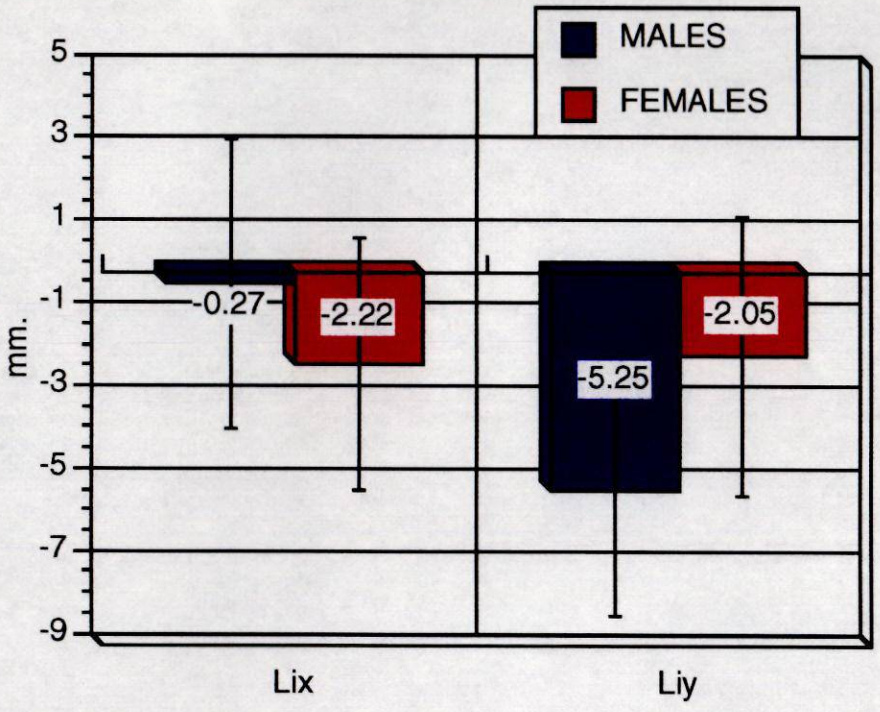


Figure 14. Comparison of change in horizontal (Li-x) and vertical (Li-y) translation of Labrale inferior, as determined by cranial base superimposition, from pre treatment to post treatment, between the Male and Female group.

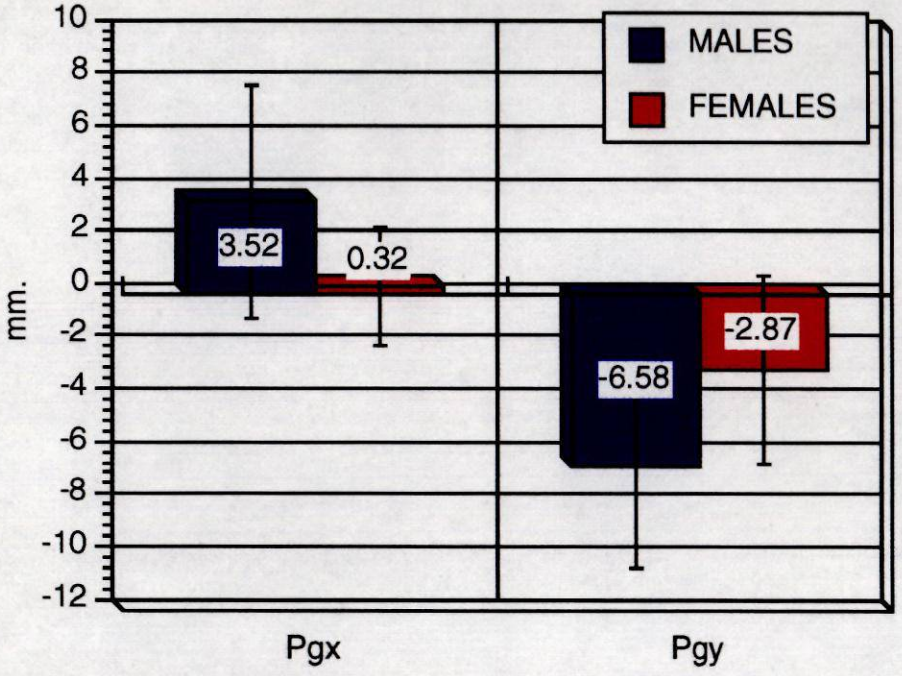


Figure 15. Comparison of change in horizontal (Pg-x) and vertical (Pg-y) translation of soft tissue Pogonion as determined by cranial base superimposition, from pre treatment to post treatment, between the Male and Female group.

FACE

The changes in ANB angle were small with no significant intergroup difference (Table 7, 8 and 9)

FACIAL SOFT TISSUE

The changes in G-Sn-Pg were small and not significant.

The female group showed a slight but significant decrease in interlabial gap ($p = 0.029$).

The males showed more than three times the amount of horizontal change of the tip of the nose than the females and more than twice the amount of vertical change (figure 16). These differences were significant ($p = 0.000$ and $p = 0.009$ resp.).

TABLE 7. -- Mean changes in face and facial soft tissue from pre treatment (t1) to post treatment (t2) in the Male group.

Males (n=30)						
	mean t1	SD	mean t2	SD	mean difference	p value
FACE						
ANB (°)	6.17	1.99	5.45	2.25	-0.72	0.196
FACIAL SOFT TISSUE						
GSnPg (°)	13.72	6.44	13.1	5.86	-0.64	0.691
ILG (mm.)	0.13	0.73	0.1	0.55	-0.03	0.842

*significant p≤ 0.05

TABLE 8. -- Mean changes in facial hard and soft tissue from pre treatment (t1) to post treatment (t2)in the Female group.

females (n=30)						
	mean t1	SD	mean t2	SD	mean difference	p value
FACE						
ANB (°)	6.72	2.57	6.21	2.24	-0.51	0.196
FACIAL SOFT TISSUE						
GSnPg (°)	12.98	5.53	12.58	4.43	-0.4	0.758
ILG (mm.)	0.95	1.85	0.17	0.48	-0.78	0.029*

*significant p≤ 0.05

TABLE 9. --Comparison of mean changes in facial hard and soft tissue from pre treatment (t1) to post treatment (t2) between the Male and Female group.

	Males (n=30)		Females (n=30)			
	Mean	SD	Mean	SD	Mean difference	p value
FACE						
ANB (°)	-0.72	1.28	-0.52	1.71	0.2	0.53
FACIAL SOFT TISSUE						
GSnPg (°)	-0.63	2.27	-0.4	2.05	0.23	0.678
ILG (mm.)	-0.03	0.93	-0.78	1.78	0.75	0.045*
Nose-x (mm.)	5.17	3.22	1.57	1.7	3.6	0.000*
Nose-y (mm.)	-3.02	2.39	-1.4	2.16	1.62	0.009*

*significant $p \leq 0.05$

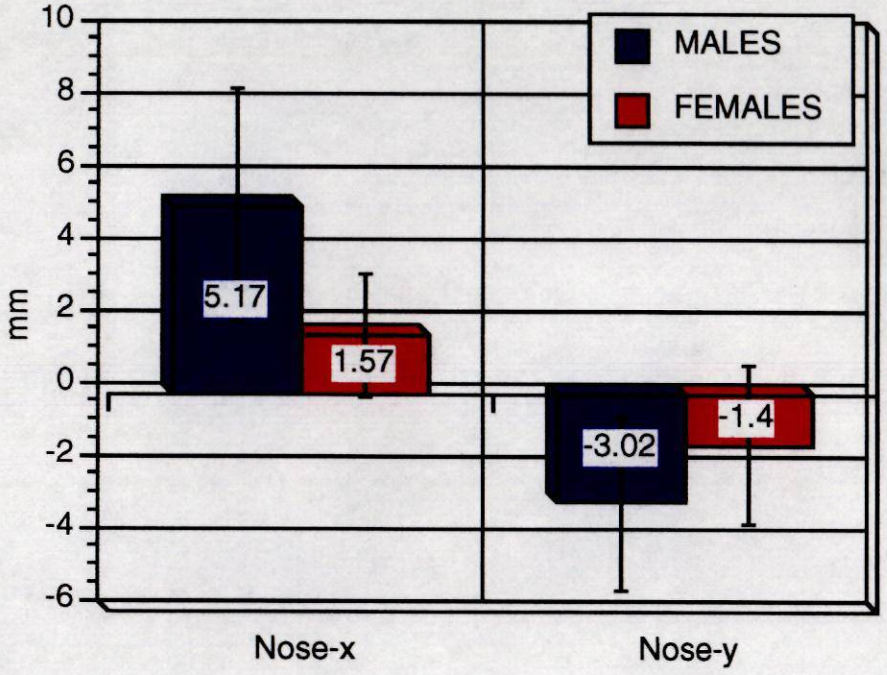


Figure 16. Comparison of change in horizontal (Nose-x) and vertical (Nose-y) translation of the tip of the nose, as determined by cranial base superimposition, from pre treatment to post treatment, between the Male and Female group.

DENTAL

The mean change in the uprighting of the upper incisor to the constructed Frankfort was with 12.5 ° in the female group significantly more than the 8.6° in the male group (p = 0.038) (Table 10, 11 and 12 and figure 17).

The decrease in IMPA was significant and comparable in both groups, where the lower incisors uprighted approx. 8° (p = 0.000) (fig. 17).

A similar picture was seen when the lower incisor was measured to the A-Pogonion line.

Interincisal angle increased approximately the same amount in both groups, 18.23° in the males, 19.77° in the females.

Overjet and overbite changed significantly (p =0.000 for OJ, p=0.065 and 0.034 for OB resp.) in both groups but did not show any intergroup differences.

Horizontal change of upper incisor translation from pre- to post treatment determined by cranial base superimposition showed significant (p = 0.018) more mean change in the female group (-5.28 mm.) than the male group (-3.57 mm) (Table 12 and figure 18). The reverse was seen for the vertical component were the mean change in the males exceeded the change in the females (p = 0.000) (figure 18).

Similar changes were seen in the position of the lower incisor where the females showed 1.5 mm. more backward translation and the males more 2.3 mm. downward translation (figure 19).

TABLE 10.-- Mean dental changes from pre treatment (t1) to post treatment (t2) in the Male group.

Males (n=30)						
	mean t1	SD	mean t2	SD	mean difference	p value
DENTAL						
U1CF (°)	121.3	7	113	8.08	-8.3	0.000*
IMPA (°)	104.7	7.14	96.7	9.36	-8	0.000*
II (°)	103.6	9.09	122	13.63	18.4	0.000*
L1APO	8	2.28	4.35	2.79	-3.65	0.000*
OJ (mm.)	3.57	1.79	1.43	1.08	-2.14	0.000*
OB (mm.)	2.82	1.69	2.08	1.31	-0.74	0.065

*significant p≤ 0.05

TABLE 11.-- Mean dental changes from pre treatment (t1) to post treatment (t2) in the Female group.

females (n=30)						
	mean t1	SD	mean t2	SD	mean difference	p value
DENTAL						
U1CF (°)	121.3	6.83	108.9	8.72	-12.4	0.000*
IMPA (°)	106.2	7.59	97.41	6.61	-8.79	0.000*
II (°)	101.5	8.48	121.8	10.38	20.3	0.000*
L1APO	7.93	2.94	4.05	2.77	-3.88	0.000*
OJ (mm.)	3.18	1.8	1.31	1.23	-1.87	0.000*
OB (mm.)	3.17	1.45	2.38	1.35	-0.79	0.034*

*significant p≤ 0.05

TABLE 12.--Comparison of mean dental changes from pre treatment (t1) to post treatment (t2) between the Male and Female group.

	Males (n=30)		Females (n=30)			
	Mean	SD	Mean	SD	Mean difference	p value
DENTAL						
U1CF (°)	-8.6	6.55	-12.5	7.45	3.9	0.038*
IMPA (°)	-8.03	8.48	-8.32	5.14	0.29	0.876
II (°)	18.23	11.69	19.77	9.53	1.54	0.58
L1APO	-3.65	2.17	-3.88	1.91	0.23	0.66
OJ (mm.)	-2.13	2.82	-1.87	1.76	0.26	0.555
OB (mm.)	-0.73	2	-0.78	1.59	0.05	0.915
MX1x (mm.)	-3.57	3.27	-5.28	2.09	1.71	0.018*
MX1Y (mm.)	-4.15	2.59	-1.58	2.16	2.57	0.0001*
MD1x (mm.)	-2.18	3.31	-3.68	2.46	1.5	0.051
MD1y (mm.)	-4.43	3.43	-2.13	2.36	2.3	0.004*

*significant $p \leq 0.05$

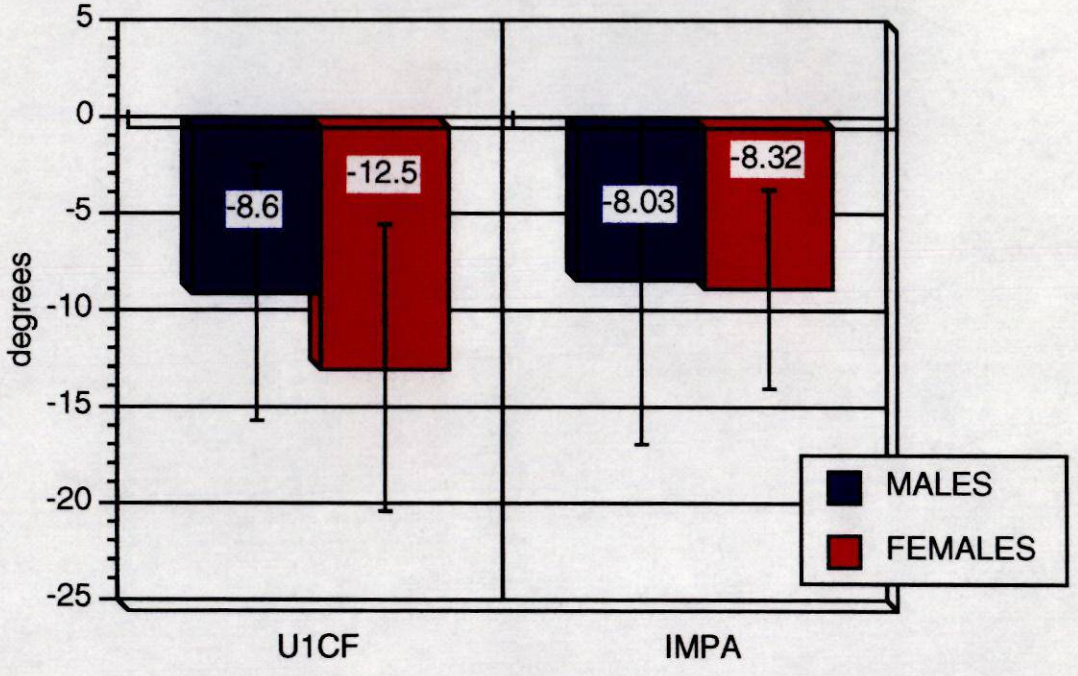


Figure 17. Comparison of change in angulation of upper incisor to constructed Frankfort (U1CF) and lower incisor to mandibular plane (IMPA) from pre treatment to posttreatmen between the Male and Female group.

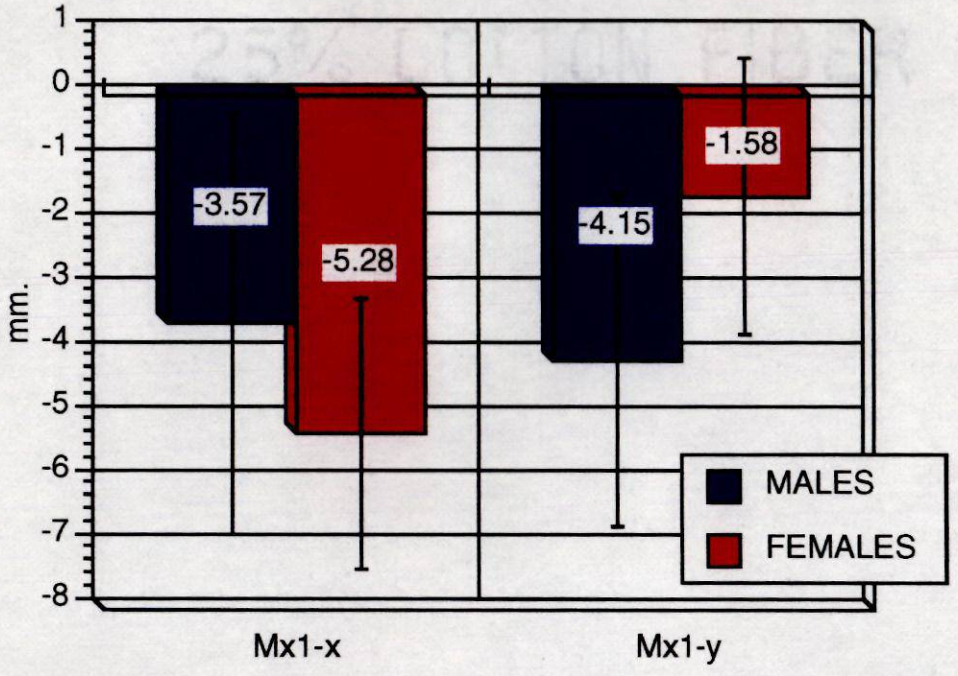


Figure 18. Comparison of change in horizontal (Mx1-x) and vertical (Mx1-y) translation of upper incisor, as determined by cranial base superimposition, from pre treatment to post treatment, between the Male and Female group.

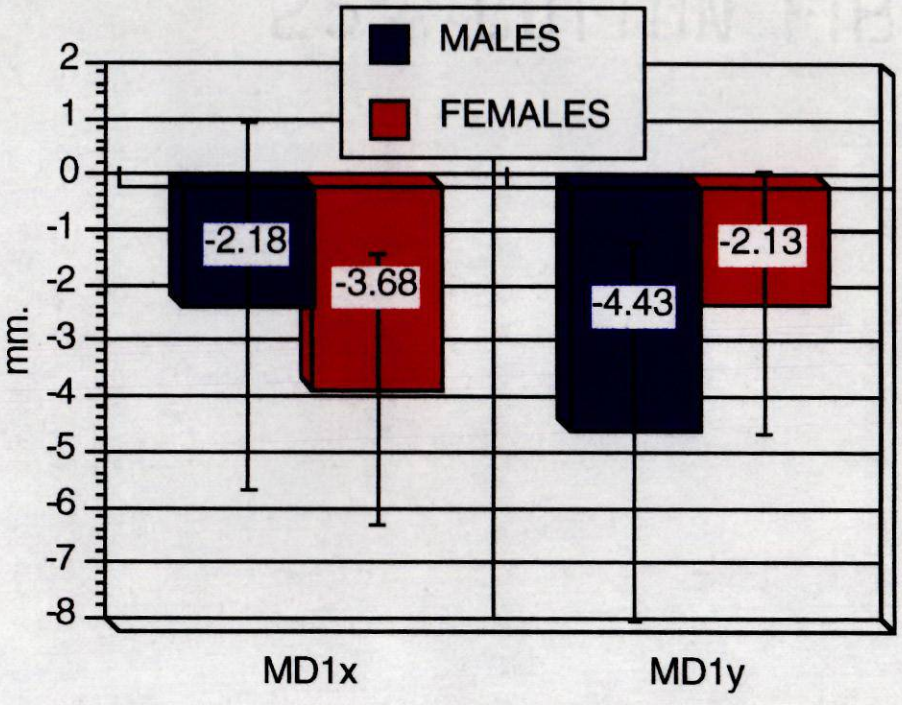


Figure 19. Comparison of change in horizontal (Md1-x) and vertical (Md1-y) translation of lower incisor, as determined by cranial base superimposition, from pre treatment to post treatment, between the Male and Female group.

Regional superimposition exhibited significant greater values for horizontal retraction of the upper incisors in the female group than the male group (p = 0.048) and more extrusion for upper and lower incisors in the males (p = 0.000 and p= 0.031 respectively) (Table 13).

TABLE 13.-- Comparison of mean dental changes (regional superimposition on Maxilla and Mandible) from pre treatment (t1) to post treatment (t2) between the Male and Female group.

	Males (n=30)		Females (n=30)			
	Mean	SD	Mean	SD	Mean difference	p value
MX1x (mm.)	-4.15	3.23	-5.48	1.63	1.33	0.048*
MX1y (mm.)	-2.1	1.46	-0.57	1.29	1.53	0.000*
MD1x (mm.)	-3.17	1.88	-3.98	1.58	0.81	0.074
MD1y (mm.)	2.55	2.66	1.22	1.95	1.33	0.031*

*significant p≤ 0.05

By comparing the mean horizontal changes in translation of the incisors and the lips, as determined by cranial base superimposition (Table 13), ratio's of lip to tooth retraction were determined (Table 14). In addition correlation coefficients between lip and tooth translation were determined (Table 14).

Table 14. -- Comparison of horizontal change in upper incisor (Mx1x) and lower incisor (Md1x) and upper lip (Lsx) and lower lip (Lix) between the male and female group.

	Males (n=30)		Females (n=30)		Mean difference	p value
	mean	SD	mean	SD		
Mx1x (mm.)	-3.57	3.27	-5.28	2.09	1.71	0.018*
Lsx (mm.)	1.37	3.6	-1.5	2.37	2.86	0.000*
Md1x (mm.)	-2.18	3.31	-3.68	2.46	1.5	0.051
Lix (mm.)	-0.27	3.49	-2.22	3.03	1.95	0.024*

*significant $p \leq 0.05$

Table 15. -- Comparison of ratio's and correlation coefficients for upper lip to upper incisor changes (Lsx: Mx1x), lower lip to lower incisor changes (Lix: Md1x) and lower lip to upper incisor changes (Lix: Mx1x) in the male and female group.

	Males		Females	
	ratio	r	ratio	r
Lsx:Mx1x	NA	0.74	1:3.25	0.68
Lix:Md1x	1:15.3	0.72	1:0.7	0.75
Lix:Mx1x	1:13.2	0.73	1:2.4	0.74

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ERROR ASSESSMENT

The combined tracing- and measurement error was not significant ($p \geq 0.05$) for all measurements except for interincisal angle and mento-labial sulcus. Correlation coefficients for the latter however were high (0.96 and 0.97 resp.) (Table 15 and 16 appendix).



Figure 20. Pretreatment cephalometric radiograph of one of the male patients.



Figure 21. Post treatment cephalometric radiograph of one of the male patients.

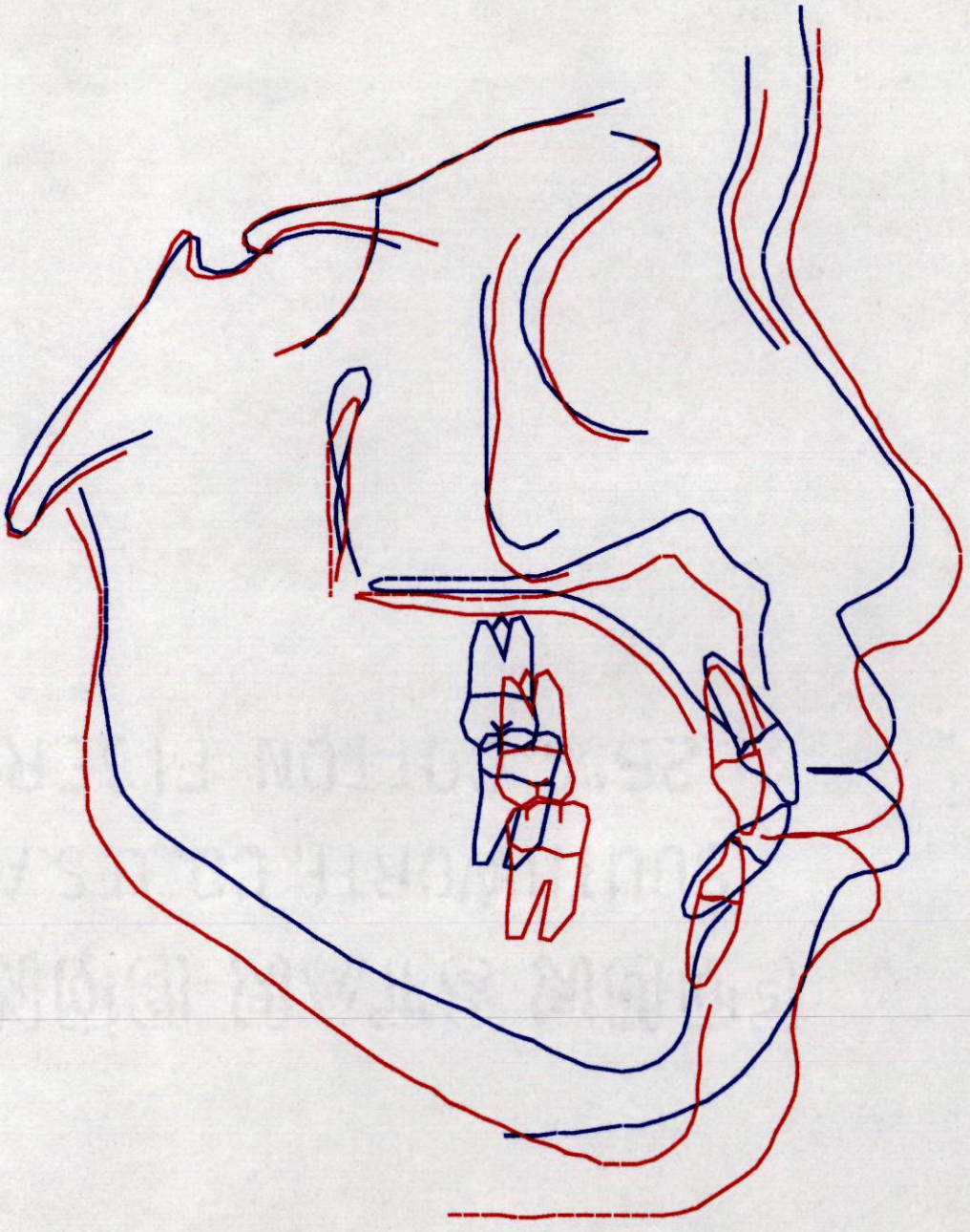


Figure 22. Cephalometric tracing of soft tissue profile of one of the male patients between pre treatment and post treatment when superimposed on cranial base.



Figure 23. Pretreatment cephalometric radiograph of one of the female patients.



Figure 24. Post treatment cephalometric radiograph of one of the female patients.

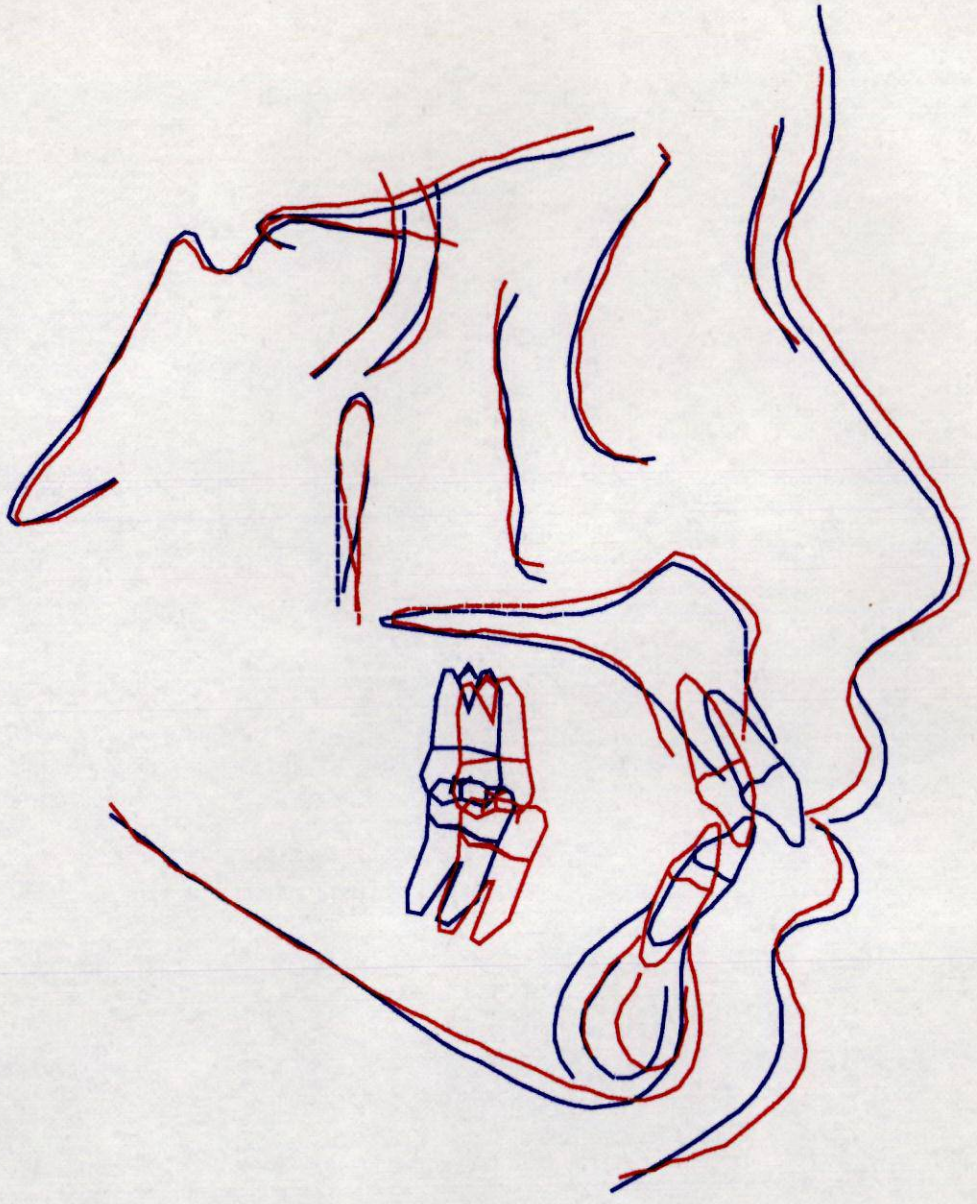


Figure 25. Cephalometric tracing of soft tissue profile of one of the female patients between pre treatment and post treatment when superimposed on cranial base.

DISCUSSION

The goal of this study was to asses the change in reduction of soft tissue protrusion that occurs through orthodontic treatment in the African-American bimax patient. Probably the most interesting finding was that the translation of the upper lip, when determined by cranial base superimposition, was 1.4 mm. in a forward direction in the males compared to 1.5 mm. in a backward direction in the females in spite of retraction of the incisors in both groups. The 0.3 mm. retraction of the lower lip in the male group vs. the 2.2 mm. for the female group also showed a large difference. Although the retraction of upper and lower incisor, when determined by regional superimposition, was slightly larger in the female group, the significant changes in lip translation can only be explained by a difference in the amount of growth during time of treatment.

Considering the average group ages at the start of treatment, 13 years 2 months for the male group and 13 years 7 months for the females, the majority of growth potential in the females had already been expressed whereas the males were still in an active growth phase (Subtelny 1961). Therefore, during treatment, which lasted an average 2 years and 11 months in the male group and 3 years and 3 months in the female group, the

contributon of growth to changes from pre- to post treatment was larger in the male group.

Although a number of earlier studies have described soft tissue changes concurrent with orthodontic treatment, there are few studies with which the results of the present study can be directly compared.

The findings correlate with Garner's (1974), who conducted a study in which he examined the soft-tissue changes in 10 Black girls and 6 Black boys in the age range of 11 years 3 months to 16 years and 2 months at the start of treatment.

In the present study the 3.6 mm. upper incisor retraction in the male group was larger than the 2 mm. upper incisor retraction in Garner's study. In his study, the male group exhibited a forward translation of 1.5 mm. of the upper lip compared to 1.4 mm. in the present study.

The 3.2 mm. retraction of the lower incisors in the males in the present study was larger than the 0.3 mm. retraction in Garner's study. The lower lip moved 0.3 mm. backward compared to a 0.5 mm. forward movement in his study.

`The amount of lip retraction in the female group, 1.5 mm. for the upper lip was smaller than the 2.8 mm. in Garner's study. In addition the 2.2 mm. for the lower lip was less than the 2.7 mm. in his study, in spite of similar or greater values for incisor retraction. The most obvious reasons for these differences might be differences in sample size and sample characteristics such as the combination of Cl I, Cll and Clll malocclusions in Garner's study and a difference in mean age.

The changes, -1.5 mm. for the male group and -1.7 mm. for the female group, from upper lip to the Sn-Pg reference plane were both significant ($p \leq 0.01$ and $p \leq 0.01$). Cranial base superimposition however showed that in the males Labrale superior was actually translated forward by 1.4 mm. The retraction of the upper lip relative to Sn-Pg can be explained by a forward translation of the Sn-Pg-line since soft tissue Pogonion in itself moved 3.5 mm. forward, which at least partially explains the discrepancy between the 1.5 mm. relative retraction of Labrale superior and the 1.4 mm. forward translation when assessed by cranial base superimposition.

There was no significant difference between the 2.7 mm. backward translation of the lower lip relative to the SnPg reference line in the male and the 2.5 mm. in the female group. Cranial base superimposition however shows only 0.3 mm. backward translation of the lower lip in the males compared to 2.2 mm. and females.The cause of this difference must also be attributed to the forward translation of the SnPg reference line.

When ratio's for lip to incisor retraction are considered, the differences between the male and female groups are obvious. In the females the ratio proved to be 1 mm. of lip retraction for every 3.3 mm. of upper incisor retraction. In the male group, where the upper incisors and the upper lip moved in opposite directions (-3.6 mm. vs. 1.4 mm.), it is impossible to establish a ratio that has any clinical relevance. Garner (1974) found a ratio of 1: 2 for the retraction of the upper lip to the upper incisor in the female group. Because of the opposite direction of movement of the upper incisor and upper lip in the male group Garner (1974) was also unable to establish a ratio. He determined the combined male and female ratio change for

upper incisor to upper lip, being 1: 3.6. When there is such a significant difference in male and female response, the question occurs if an average ratio actually is a contribution to our diagnostic aids.

The ratio for the response of the lower lip to the lower incisor was 1:15.3 for the male group and 1: 0.7 for the females, suggesting a very direct response in the females versus almost none in the males. Rudee (1964) found a 1: 3 ratio for the upper lip and a 0.59 : 1 ratio for the lower lip in a Class II Caucasian sample which consisted of growers and non growers.The values in the female group in the present study correlate very well with these findings. Hershey (1972) , Waldman (1982) and Rains (1982) found ratio's varying from 1 : 1.6 to 1: 3.8 for upper lip to upper incisor and 1: 0.8 to 1 : 1.2 for lower lip to lower incisor. The sample in Hershey's and Rains' studies consisted of adult females and the majority of Waldman's sample consisted of adolescent females indicating that the females in the present study showed changes very similar to the changes occurring in an adult sample.

The increase in nasolabial angle in both groups, 9° for males and 7° for females, could be due to retraction of the upper lip or remodeling of the inferior contour of the nose. Since the superimposition showed that in the males as well in the females the nose was translated forward and downward, the assumption can be made that the change was most likely the result of upper lip retraction. Talass et al. (1987) found that the change in nasolabial was minimal with growth. Although in the male sample the translation of the upper lip, assessed by cranial base superimposition, was in a forward direction, the nasolabial angle increased, indicating that the

upper lip underwent retraction while being translated forward by growth. Upper sulcus and upper lip thickness at the start of treatment showed very low correlations (r=0.1-0.3) with the change in nasolabial angle. The increase in nasolabial angle was less than the findings of Russel et al. (1986), who found a 13.2 degree increase in their study. Average age, type of malocclusion and distribution of males and females however was not mentioned.

The decrease in Mentolabial sulcus angle in both the male (7.7°) and the female (5.5°) group was not significant. We have to keep in mind that in the typical African-American patient with bimaxillary protrusion a lower lip sulcus is often very shallow or almost nonexistent. This feature is very different from the soft tissue appearance of a patient having a class II malocclusion with a large overjet, where upright or retroclined lower incisors allow lower lip entrapment allowing the lower lip to roll out and create a deep lower sulcus.

The proclination of upper and lower incisors and the attempt of the bimax patient to create a lip seal might lead to an adapted increased tonicity in the habitual posture of the perioral musculature without generating pressure against the teeth (Burstone 1958). Retraction of the incisors and increase in lip length with growth might lead to a post treatment redundancy of the lips. The slight decrease in Mentolabial angle corroborates with the findings of Russel et al. (1986), who found an increase in lower sulcus depth.

It was interesting to see that the change in upper lip thickness and upper sulcus thickness was significantly ($p \leq 0.001$ and $p \leq 0.01$) different

between the male and the female sample. In the males the upper sulcus thickness increased by 0.8 mm., whereas in the females the upper sulcus became thinner by 0.5 mm. The upper lip thickness at the level of the vermilion border increased significantly ($p \leq 0.001$) more in the males (2.67 mm.) than in the females (0.53 mm.). Anderson et al. (1973) found that the thickness of the upper lip increased during treatment that involved upper incisor retraction. They concluded that this was related to maxillary incisor retraction (1 mm. of thickening for every 1.5 mm. of maxillary incisor retraction). Russel et al. (1986) found a 0.04 mm. of increase in upper sulcus and a 4.8 mm. of increase in upper lip thickness. It was not mentioned if these values were for males, females or combined groups. Since in the present study the amount of upper incisor retraction and posterior translation of the upper lip were greater in the female group, there must be a reason for the greater increase in upper lip thickness in the males. One of the factors of the increase in thickness of the upper lip in the males might be natural growth. Subtelny (1959) found that thickness of the upper lip after the age of 14 years still increased in the males whereas in the females it remained stable.

The significant difference in forward (2.7 mm. males, 0.7 mm. females) and downward (7.2 mm. males, 3 mm. females) translation of Pogonion and soft tissue Pogonion (3.5 mm. forward and 6.6 mm. downward males, 0.3 mm. forward and 2.9 mm. downward females) can be explained by the occurrence of more growth during treatment in the male group. Russel et al. (1986) found similar values for the movement of hard and soft tissue Pogonion. Also highly significant ($p \leq 0.001$) was the difference in forward

and downward translation of the tip of the nose between the males (5.2 mm. forward, 3 mm. downward) and females (1.6 mm. forward, 1.4 mm. downward). The mean age at start of treatment was 13 years 2 months for the males and 13 years 7 months for the females. It is obvious that the skeletal maturity of the female group was more advanced than the male group and that considerable differences existed in remaining growth potential in both groups.

In the literature it has been stated that confusion can occur if one does not differentiate between relaxed lip and closed lip positions in the evaluation of dental and facial abnormalities (Burstone 1967). It is generally accepted that a relaxed lip position should be used when assessments of the soft tissue are made. The patient however normally does not assume this pose in his daily activity. Rather he maintains an effective lip seal which facilitates swallowing, protects his teeth and the gingiva, and adds certain retaining forces to maintain the position of the anterior teeth (Burstone 1967). In attempts to assess lip retraction following orthodontic tooth retraction, some authors (Anderson et al. 1973 and Wisth 1974) have made cephalometric radiographs with the lips in contact both before and after treatment, others (Bloom 1958, Rudee 1964 and Hershey 1972) have taken radiographs with lips relaxed , and still others (Garner 1974, Huggins and McBride 1975 and Roos 1977) did not specify if they used a standardized lip position. Hillesund et al. (1978) found no differences in reproducebility of lip position in the horizontal plane when he compared closed and relaxed lips.

The muscles of the mouth can be divided into two groups: the various parts of the orbicularis oris muscle, that close the lips, and the group that opens the lips and consists of radially aranged muscles (figure 26). The radial muscles of the upper lip consist of the zygomaticus major and minor muscle, the levator labii superioris and levator labii superioris aleque nasi. The muscles of the lower lip are the depressor anguli oris, the depressor labii inferioris and the mental muscle.

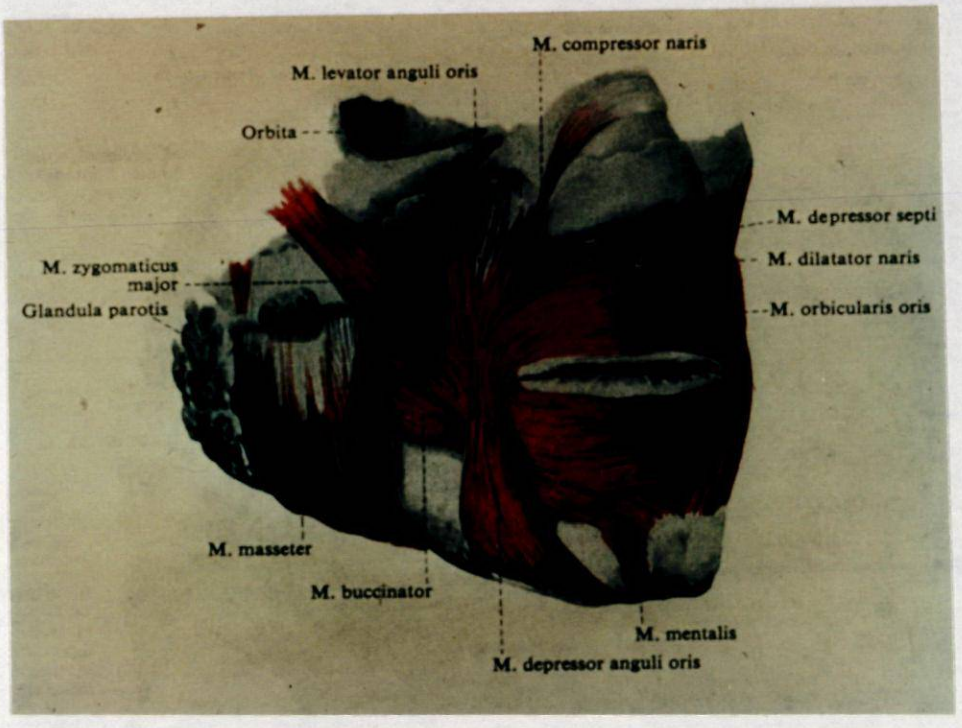


Figure 26. Oral muscalature.

The orbicularis oris muscle, or oral sphincter is able to narrow the lips and press them against the teeth, protrude the lips or to purse them. The various functions of the muscle are made possible, in part, by the independence of its several portions and, in part, by the combinations of its actions with that of the other muscles of the lips.

The interlabial gap in a relaxed lip position varies with excess or deficiency of lip length. The mean interlabial gap in the male group was 0.1 mm., in the female group 0.9 mm. In a retrospective study, like this one, judgment of relaxed perioral musculature in radiographs is a subjective factor. Therefore, it is possible that the patients in this study might have had a higher lip tonicity at the time of exposure of the radiographs than would generally be regarded as ideal in a Caucasian population and that the changes in soft tissue are due to a combination of treatment effects, growth and an alteration in lip tonicity. This alteration of perioral muscle tonicity on the other hand might be a treatment effect induced by incisor retraction. Unfortunately no references in the literature relate to the habitual or rest position of perioral structures in the African-American patient with bimaxillary protrusion.

A limitation of the study was that treatment effects could not be isolated from growth. Therefore a recommendation for future studies would be to involve a control group of patients, featuring longitudinal growth data, that could be matched for age, malocclusion and soft tissue parameters. This would not only reveal information on treatment changes, but also provide a baseline database of chronological soft tissue changes with growth in the African-American patient. In this way, the longitudinal growth data for hard

tissue parameters as recently published by Richardson (1991), would be supplemented with data on growth for soft tissue.

We must realise however that the majority of patients in orthodontics are adolescents in an active growth phase. Therefore it is important to know what the effects of treatment in combination with growth are. The application of ratio's of soft to hard tissue changes, based on data derived from adult samples, are of limited clinical value in growing patients.

On the basis of this study, the conclusion can be made that there are significant changes in the soft tissue profile of the adolescent African-American patient with bimaxillary protrusion during orthodontic treatment involving extraction of bicuspids and retraction of incisors. The most significant changes were seen in nasolabial angle, distance from upper and lower lip to the SnPg line and retraction of the lips by cranial base superimposition.

The female group showed more lip retraction when superimposed on cranial base, whereas the retraction of lips evaluated by the SnPg line, was similar in both groups. The male group showed larger amounts of forward and downward growth of the hard and soft tissue of the lower face.

Application of ratio's for lip to incisor retraction showed to be relevant only in the female sample, where the values correlated with those found in previous studies of Caucasian patients (Rudee 1964 and Waldman 1982) and African-American patients (Garner 1974). The presence of growth combined with treatment effects in the opposite direction generated ratio's for lip to incisor retraction in the male group of very limited clinical significance.

SUMMARY AND CONCLUSION

The purpose of this investigation was to determine the changes in soft tissue profile as a result of orthodontic treatment that involves extractions and incisor retraction in African-American patients with Cl I bimaxillary protrusion. The specific aims were to 1.) Compare the soft tissue response between African-American males and females and 2.) determine the ratio of soft tissue changes to hard tissue changes.

Pre and post treatment lateral cephalometric radiographs of 30 males and 30 females of African-American descent were collected from several sources. Records were selected for good radiographic quality, patient age between 10 and 18 years, CL I molar occlusion and an interincisal angle of 120 degrees or less. Incisor retraction had to be established.

The radiographs were traced, superimposed and measured. Hard and soft tissue angular and linear analyses were performed. Superimpositions were projected on a grid with a Cartesian coordinate system to determine changes from pre to post treatment. Data analysis consisted of descriptive statistics, Student-t tests and correlation calculations.

The following observations were made by analyzing the data:

1.) A significant increase was seen in nasolabial angle in the male and female group.

2.) Retraction of upper and lower lip relative to the SnPg line was significant and similar in the male and female group.

3.) The female group showed more lip retraction when superimposed on cranial base.

4.) The male group showed larger amounts of forward and downward growth of hard and soft tissue of the lower face.

5.) Ratio's for lip to incisor retraction showed to be relevant only in the female and not in the male sample.

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APPENDIX

The hard tissue landmarks that were traced are listed as follows:

Sella (S):	The midpoint of sella turcica.
Nasion (Na):	The anterior point of the intersection between the nasal and frontal bones.
A-point (A):	The innermost point on the contour of the premaxilla between anterior nasal spine and the incisor tooth.
Upper incisor apex (Isa)	The apical midpoint of the most prominent upper incisor
Incisor superior (Is):	The cutting edge of the most prominent upper incisor
Incisor inferior (Ii):	The cutting edge of the most prominent lower incisor.

Lower Incisor apex (lia)	The apical midpoint of the most prominent lower incisor
B-point (B):	The innermost point on the contour of the mandible between the incisor tooth and the bony chin.
Pogonion (Po):	The most anterior point on the mental protuberance.

The soft tissue landmarks that were traced are listed as follows:

Glabella (G):	The most prominent point in the midsagittal plane of the forehead.
Apex nasalis:	The most anterior point on the tip of the nose.
Subnasale (Sn):	The point at which the nasal septum merges with the upper cutaneous lip in midsaggital plane.

Sulcus superior(Ss):	The deepest point on the anterior contour of the upper lip.
Labrale superior(Ls):	The most anterior point of the upper lip.
Stomion superius (Sts):	The lowermost point on the vermillion of the upper lip.
Stomion inferius (Sti):	The uppermost point on the vermillion of the lower lip.
Labrale inferior (Li):	The most anterior point of the lower lip.
Sulcus inferior (Si):	The deepest point on the anterior contour of the lower lip.
Soft tissue pogonion (Pg):	The most anterior point on soft tissue chin.

17. -- Combined tracing and measurement error (cont.).

	REPEATED	SD	INITIAL	SD	p value	R
SnPg-UL	11	3.38	11.05	2.57	0.897	0.96
SnPg-LL	13.65	5.79	13.1	5.92	0.392	0.94
SS	13.35	2.6	13.2	2.44	0.496	0.97
UL	16.5	4.28	16.3	4.5	0.399	0.99
LL	18.4	2.47	18.65	3.28	0.551	0.94
SI	12.4	1.58	12.7	1.42	0.313	0.83