ORIGINAL ARTICLE

LIP MORPHOLOGY: A FACTOR LEADING TO BIMAXILLARY DENTOALVEOLAR PROTRUSION

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ABSTRACT

The objective of this study was to see the effect of lip morphology in the study sample presenting with bimaxillary dentoalveolar protrusion on normal skeletal pattern.

This cross sectional study comprised 50 subjects having bimaxillary dentoalveolar protrusion on class I skeletal pattern. Age of the subjects ranged from 18-25 years. The sampling comprised random selection of the subjects. The method involved Cephalometric analysis of skeletal, dental and soft tissues made on lateral cephalograms taken in natural head position of the subjects. A total of twenty variables were used in this study, comprising six skeletal, three dental and eleven soft tissue variables.

Data were analyzed using SPSS version 10.00. Descriptive analysis and Independent t- test were carried out for significance ($P < 0.05$). Variables of the skeletal analysis were found within norms, whereas dental variables showed an increased value of Upper Incisor to Sella-Nasion plane (UI-SN) 115.12^0 (SD 5.50^0), Incisor Mandibular Plane Angle (IMPA) 102.70^0 (SD 3.40^0) and consequent decrease in Frankfort Mandibular Incisor Angle (FMIA) 55.50^0 (SD 5.49^0). Soft tissue analysis determined full profile with greater vermilion of upper and lower lips, deficient lip strain and decreased length of upper and lower lips. Among six variables of skeletal analysis four were found very highly significant, among three variables of dental analysis only one was analyzed as significant and among eleven variables of soft tissue analysis four were found as very highly significant.

This study concluded that the yielding effect of lips, because of relaxed orbicularis oris muscle and greater lip vermilion is the contributing factor in bimaxillary protrusion.

INTRODUCTON

The study of facial beauty and harmony has been pivot to the practice of orthodontics, right from its early infancy to date. Analysis of the soft tissue profile of the face is therefore a concern for the orthodontist.[1] A balanced profile should be one of the key factors in deciding on the methods of treatment for any form of malocclusion, as good occlusion does not necessarily mean good facial balance.[2] In fact the adaptation of soft tissue over underlying skeletal pattern is of prime importance towards the overall appearance of face.[3] Cephalometrics provides information about skeletal, dental and soft tissue structures of the face. A number of cephalometric analyses have been introduced and amongst the pioneers were Tweed[4], Steiner's[5], Ricketts[6], Burstone[7] and Holdaway[8] etc. Witt's analysis[9] also gives valuable information of the apical bases. A harmonious facial profile is the reflection of the ideal proportions among different facial areas. They depend on the position of the teeth, bones and soft tissues.[10] The dentoskeletal cephalometric analysis assesses hard

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tissue problem, discloses the nature of a possible skeletal discrepancy and might indicate the surgical corrective approach to follow. However, soft tissue cephalometric study is required for the clinical diagnosis of a case.[11]

Patients with bimaxillary protrusion demonstrate dentoalveolar flaring of both maxillary and mandibular anterior teeth, with increased procumbency of lips, excessive vermilion show of upper and lower lips and lip strain on closure.[12] The proclination of upper and lower incisors is due to the soft tissue pattern. Usually the lips are full and yielding and the tongue acts to mould the dental arches as the teeth erupt. Occasionally, the tongue itself is very large and is the primary cause of bimaxillary protrusion, although this is unusual.[13]

Lip form is of importance in determining the inclination of upper and lower incisors. Ballard suggested that it is the form of the lips which is of primary importance in determining the labiolingual inclination of the incisor teeth and that the tongue, unless it is abnormally large or small, acts to mould the teeth against the lips.[14] This is an over-simplification and incisor position has, in turn, an effect on lip position. Thus there is a complex interplay between these factors. Clinically it is found that where the lips are full and everted, both the upper and lower labial segments are often more proclined (bimaxillary proclination), whereas in individuals with more vertically positioned or straight lips the upper and lower labial segments are often more retroclined (bimaxillary retroclination).[15-16] Oliver found that patients with thin lips or a high lip strain displayed a significant correlation between incisor retraction and lip retraction, but patients with thick lips or low lip strain displayed no such correlation.[17]

Subtelny[18] found that the upper lip in both sexes usually attained a greater thickness in the vermilion region than the region overlying point A. Lip thickness increased in both male and female subjects until age 14. The increase in thickness seen at the vermilion region was approximately equal to the increase in lip length. Similarly, the lower lip thickness was greater in the vermilion region than at pogonion and point B.

Mamandra[19] also examined lip thickness during growth and found that in the female the maxillary lip reached its maximal thickness by age 14 and remained the same until age 16. In the male, maximal lip thickness was attained around age 16. The horizontal thickness of the lower lip has reached its maximal thickness by age 16 in males and by age 18 in females. Genecov[20] in a study of a different subject population, found that males between ages 7 and 17 had a greater increase in upper lip length than females in the same period. The males experienced a little more than 2mm in vertical height of the upper lip, and the females experienced less than 1mm in vertical height of the upper lip. When lip position is evaluated in the framework of the growing nose and chin, the lips drop slightly backward as the nose and the chin grow forward to a greater extent than the lip regions. This backward evolution of the lips remains within conventional esthetic prescriptions.[21]

The labial area needs thorough evaluation because the appearance of the lips and the smile may be improved by orthodontic treatment. The size of lip vermilion causes exposure of the mucocutaneous lip. Its volume is also responsible for muscular tension of that lip. The more the vermilion, the lesser the muscular tension of that lip and vice versa.[22] This article reports on a cross sectional analytical study that was conducted on subjects presenting with bimaxillary dentoalveolar protrusion. The aim of this study was to see the effect of lip morphology in the development of bimaxillary dentoalveolar protrusion on normal class I skeletal pattern.

METHODOLOGY

The study was conducted in the Orthodontic Department of Dental Section of Children Hospital and Institute of Child Health, Lahore. The sample comprised of 50 subjects of age range 18-25 years, having class I skeletal pattern and permanent dentition.

Subjects with supernumerary teeth, class II or class III skeletal pattern or having any parafunctional habits like thumb sucking, mouth breathing etc were not included.

DATA COLLECTION PROCEDURE

The study sample were collected from the Nursing school and Allied Health Sciences of The Children's' Hospital and The Institute of Child Health, Lahore.

Lateral cephalometric radiographs of these subjects were taken with Orthophos plus machine. The subjects stood in natural head position with relaxed lips and teeth in centric occlusion. Head was positioned in the cephalostat with ear rods and x-ray source placed on the right side of the patient at a distance of 5 feet from the midsagittal plane. The subject-film distance was one foot. Exposure was made at 90 kvp (kilovoltage) and 12 mA (milliamperes). Exposure time adjusted was 1.2 seconds for each radiograph. Tracing sheets were fixed along the whole length of the left side border of the cephalograms with adhesive tape. Lateral Cephalometric radiograph of each subject was traced and measured manually by the same operator on 0.003 inch thick and 8 by 10 inch size acetate paper with 3H lead pencil.

Following lateral landmark points were traced on the lateral cephalograms.

1. **Sella (S):** The midpoint of the pituitary fossa of the sphenoid bone.
2. **Nasion (N):** The point in the midline located at the nasal root.
3. **Porion (Po):** The superior most point on the external auditory meatus.
4. **Orbitale (Or):** The lower most point on the inferior margin of the orbit.
5. **Point A:** The deepest point on the concavity formed by the anterior maxillary contour of the alveolar process.
6. **Point B:** The deepest point on the concavity of the anterior surface of the symphysis.
7. **Menton:** The most inferior point on the inferior border of the chin.
8. **Subnasale (Sn):** The point where the upper lip joins the columella.
9. **Steiner's point (S):** The point at half of the distance between Pn (Pronasale) and Sn (Subnasale).
10. **Pronasale (P):** The most prominent point on the tip of the nose.
11. **Labial superioris (Ls):** The point that indicates the mucocutaneous limit of the upper lip.
12. **Stomion superior (Sts):** The most inferior point of the upper lip.
13. **Stomion inferior (Sti):** The most superior point of the lower lip.
14. **Labial inferioris (Li):** The point that indicates the mucocutaneous limit of the lower lip.
15. **Supramentale (Sm):** The deepest point of the inferior sublabial concavity.
16. **Pogonion (Pog):** The most anterior point of the soft tissue chin.

The cephalometric analysis of each of the study sample was prepared at two different occasions. For diagnostic purpose, 20 variables both angular and linear were used from the following different methods, making use of multiple reference lines, in order to prepare a comprehensive cephalometric analysis.

Angular measurements taken from Steiner's analysis comprised sella-nasion-point A (SNA) $82^0 \pm 2^0$, sella-nasion-point B (SNB) is $80^0 \pm 2^0$, Point A-nasion-point B (ANB) $2^0 \pm 2^0$, Upper incisor to SN plane (UI-SN) $102^0 \pm 2^0$ degrees, Sella-nasion to mandibular plane (SN-MP) $32^0 \pm 4^0$ degrees (Fig 1). Steiner's (S) Line (0 ±2mm) for both upper/lower lips was the linear measurement included from this method.

The angular measurements used from Tweed triangle were incisor mandibular plane angle (IMPA) $90^0 \pm 5^0$, Frankfort mandibular plane angle (FMA) $25^0 \pm 5^0$ and Frankfort mandibular incisor angle (FMIA) $65^0 \pm 5^0$ (Fig 1).

Witt's Method included perpendiculars dropped from point A and point B to the functional occlusal plane used as reference plane (Fig 1). The linear difference between these points was measured. In a well proportioned face BO is 1mm ahead of point A in the male where as in the female, both these projections fall on the same point.

The E plane from Rickett's method connects the most prominent points on the tip of the nose and the chin (Fig 2). It assesses soft tissue balance between the lips and the profile. The mean distance of the lower lip from the E plane is approximately -2±2 mm and of upper lip is -3±2 mm.

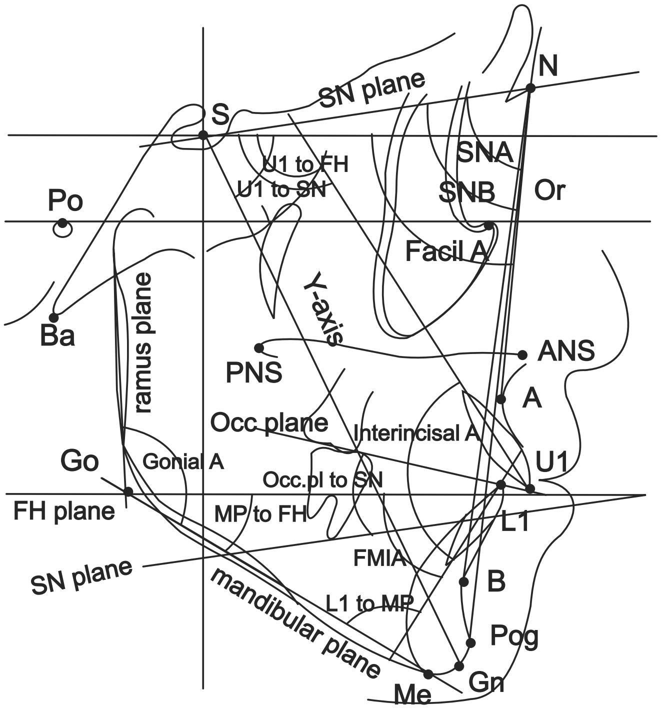

Fig 1: Skeletal and Dental Analysis

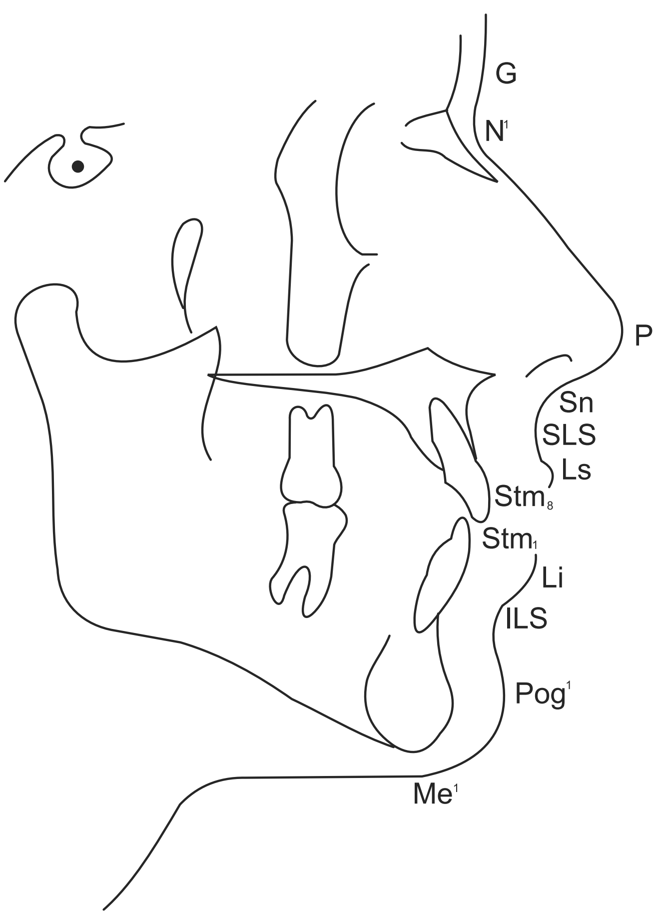

Fig 2: Soft Tissue Landmarks

Variables included from Holdaway analysis were; the upper lip thickness with mean value of 15$\pm$2mm and upper lip strain having a mean of 15mm. The upper lip thickness is measured horizontally from 2mm below point A to the outer border of the upper lip whereas the upper lip strain is measured from the vermillion border of the upper lip to the labial surface of the maxillary central incisor (Fig 2).

The linear parameters included from Burstone's esthetic analysis (Fig 2), were the position of the upper (Ls) and lower (Li) lips regarding the Sn-Pg line, the nasal length (measured perpendicular to the palatal plane), and the interlabial gap (Sts – Sti). The length of the upper lip from subnasale to stomion superior (Sn-Sts) on average is 18$\pm$1.5mm and lower lip length from stomion inferior to menton (Sti-Me) on average is 23$\pm$1.5mm. The lower lip thickness is measured horizontally from 2 mm above point B to the outer border of the lower lip (Fig 2). On average it is 19$\pm$2mm. The upper lip vermillion is measured vertically from Labial superioris (Ls) to Stomion superior (Ls-Sts) (Fig 2). On average it is 8.5$\pm$1.5mm. The lower lip vermillion is measured vertically from the Labial inferior (Li) to Stomion inferior (Sti). On average it measures 10.2$\pm$1.6mm.

DATA ANALYSIS PROCEDURE

Data analysis was done by using the SPSS version 10.0. Descriptive analysis was carried out for norms, mean and standard deviations and then the mean and norms were subjected to independent t test for significant differences between the mean values.

RESULTS

The skeletal analysis included five angular and one linear measurements namely SNA, SNB, ANB, SNM, FMA and Witt's value. Three angular measurements were used for dental analysis namely UI-SN, IMPA, FMIA. The eleven linear measurements for soft tissue analysis comprised Lower lip to E line, Upper lip to E line, Upper lip to S line, Lower lip to S line, Upper lip length / thickness, Upper lip strain, Lower lip length / thickness, Upper lip vermilion, and Lower lip vermilion.

The mean SNA was 82.87^0 (SD 3.61^0), mean SNB was 79.67^0 (SD 3.58^0), mean ANB was 3.20^0 (SD 1.04^0)

mean AO-BO distance was 2.60mm (SD 1.95mm), mean SNM was 31.64^0 (SD 6.17^0), mean FMA was 25.66^0 (SD 7.0^0) shown in (Table 1).

For dental analysis, the mean UI to SN was 115.12^0 (SD 5.50^0), mean IMPA was 102.70^0 (SD 3.40^0), mean FMIA was 55.50^0 (SD 5.49^0) shown in (Table 2).

Similarly, from the soft tissue linear analysis, the mean lower lip to E line was 0.93mm (SD 3.06mm), mean upper lip to E line was -1.62mm (SD 2.59mm), mean upper lip to S line was 1.35mm (SD 2.34mm), mean lower lip to S line was 2.60mm (SD 2.96mm), mean upper lip length was 21.26mm (SD 2.23mm), mean upper lip thickness was 15.32mm (SD 2.08mm), mean upper lip strain was 11.12mm (SD 2.22mm), mean lower lip length was 16.18mm (SD 2.87mm), mean lower lip thickness was 12.38mm (SD 1.52mm), mean upper lip vermilion was 10.52mm (SD 1.69mm), and mean lower lip vermilion was 11.78mm (SD 1.79mm) as shown in Table 3.

TABLE 1: STATISTICS OF SKELETAL ANALYSIS

Parameters	Normal values	Subjects with Class I pattern Minimum	Maximum	Mean	Standard deviation	t-Value	P-Value
SNA	$82^0 \pm 2^0$	70	92	82.870	3.612	-1.538	0.000
SNB	$80^0 \pm 2^0$	67	88	79.670	3.582	3.941	0.000
ANB	$2^0 \pm 2^0$	0	4	3.200	1.049	-9.484	0.000
WITTS	M=(1mm) F=(0mm)	0	4	2.600	1.956	-5.906	0.000
SNM	$32^0 \pm 4^0$	19	49	31.640	6.170	-2.050	0.003
FMA	$25^0 \pm 5^0$	13	40	25.660	7.000	-1.311	0.002

TABLE 2: STATISTICS OF DENTAL ANALYSIS

Parameters	Normal values	Subjects with Class I pattern Minimum	Maximum	Mean	Standard deviation	t-Value	P-Value
UI-SN	$102^0 \pm 2^0$	108	129	115.120	5.501	0.333	0.620
IMPA	$90^0 \pm 5^0$	98	112	102.700	3.400	-2.091	0.377
FMIA	$65^0 \pm 5^0$	45	64	55.500	5.493	3.081	0.003

TABLE 3: STATISTICS OF SOFT TISSUE ANALYSIS

Parameters	Normal values	Subjects with Class I pattern Minimum	Maximum	Mean	Standard deviation	t-Value	P-Value
L-lip to E	-2±2mm	-7	+8.5	0.930	3.067	-2.848	0.002
U-lip to E	-3±2mm	-7	+4	-1.620	2.594	-4.666	0.000
U-lip to S	0±2mm	-3	+6.5	1.350	2.343	-3.081	0.000
L-lip to S	0±2mm	-5	+9	2.600	2.969	-2.425	0.001
U-lip LENGTH	18±1.5mm	16	25	21.260	2.238	-0.374	0.001
U-lip THICKNESS	15±2mm	12	19	15.320	2.084	1.666	0.002
U-lip STRAIN	15mm	7	17	11.120	2.228	0.467	0.004
L-lip LENGTH	23±1.5mm	11	22	16.180	2.876	1.111	0.003
L-lip THICKNESS	19±2mm	9	15	12.380	1.523	-1.112	0.002
U-lip VERM	8.5±1.5mm	6	14	10.520	1.693	-1.533	0.000
L-lip VERM	10.2±1.6mm	8	14	11.780	1.798	- 0.487	0.000

DISCUSSION

The study was based on cephalometric analysis and it involved 50 subjects presenting with bimaxillary dentoalveolar protrusion on skeletal class I pattern. The material for this study consisted of 50 lateral cephalograms. The study sample comprised subjects having bimaxillary dentoalveolar protrusion on skeletal class I pattern. The age of the whole sample ranged from 18-25 years. The skeletal analysis comprised of sagittal and vertical measurements. Variables of the skeletal analysis were found within normal values. A total of four variables were used for the sagittal analysis and all four elements were found statistically very highly significant (P-Value 0.000) with (P< 0.001). The findings of Israr J[1] and McNamra[10] match the result of our study. These findings were unlike the description of Bergman[2], Fujita[23] and Ferario.[3]

Among the vertical analysis, highly significant difference (P< 0.01) was found in the values of Frankfort mandibular plane angle (FMA) (P-Value 0.002) and sella nasion mandibular plane angle (SNM) (P-value 0.003). These results support the findings of Kerouso.[15] Among the dental analysis, for two out of three elements no significant difference (P< 0.05) was found among UI-SN (P-Value 0.37) and IMPA (P-Value 0.62). The inclinations of upper and lower incisors were enhanced in selected subjects presenting with bimaxillary proclination. These results coincide with those of McNamara[10], Mingchu[24] and Houston.[7] One variable of the dental analysis (FMIA), however, showed a decreased value of statistically high significance (P-Value 0.003). This finding of our study is supported by Tweed triangle[4] which describes that an increase in IMPA in bimaxillary proclination leads to mathematical reduction of FMIA considering three angles of a triangle. From the soft tissue analysis out of eleven variables, very highly significant difference (P< 0.001) was found among four variables (P-Value 0.000) such as, upper lip to E line, upper lip to Steiner's line, upper and lower lip vermilion. These results coincide with the results of Riveiro[22], Rudee[21], Ming[25] and Holdaway.[8] The remaining seven variables of the soft tissue analysis were statistically found to have a highly significant value (P< 0.01) namely lower lip to E line (P-Value 0.002), lower lip to S line (P-Value 0.001), upper lip length (P-value0.001), upper lip thickness (P-Value 0.002), upper lip strain (P-value 0.004), lower lip length (P-value 0.003) and lower lip thickness (P-value 0.002). These results of our findings coincide with those of Burstone[7], Riveiro[22], Subtelny[18] and Oliver.[17]

The findings of our four soft tissue variables, namely, Upper lip length, lower lip length, upper lip vermilion and lower lip vermilion matched with the study of Israr J.[1] However, five out of ten angular variables (SNA, SNB, ANB, SNM, FMA) of that study showed partial similarity with our study (21%), being based on an inclusion criteria of normal distribution i.e., more Class II, less Class I, and least Class III individuals. Another study conducted by the authors[26], on linear photogrammetric analysis of the adult soft tissue profile concluded sexual dimorphism in most of the horizontal measurements. The said study supports findings for four soft tissue variables from the present study.

Hameed A[27] conducted a study on soft tissue profile analysis on patients with Class I and Class II skeletal pattern in the same setting. Results for most of the variables used in common for skeletal I subjects of that study (SNA, SNB, ANB, Upper and Lower lip length, Upper and Lower lip vermilion, Upper and Lower lip to E and S line respectively) are in agreement with the findings of present study.

These findings in all of the three analyses support the hypothesis that both upper and lower lips are full and flaccid and the lower lip is everted with greater vermilion in subjects having bimaxillary dentoalveolar protrusion on normal skeletal pattern.

The authors conducted a comparative study[28] between skeletal I and skeletal II subjects in the same center and concluded that no significant difference was seen in the lip morphology of the study sample presenting with bimaxillary dentoalveolar protrusion on skeletal I and skeletal II pattern.

CONCLUSIONS

On the basis of the above mentioned findings in this study, the conclusion may be drawn that yielding effect of lips, because of relaxed orbicularis oris muscle and greater lip vermilion is the contributing factor in the development of bimaxillary dento alveolar protrusion.

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