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Pre- and post- treatment changes in lip position: A retrospective cephalometric study on bimaxillary protrusion cases

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ABSTRACT

Context: Pre and Post treatment changes in lip position
Aims: To determine the changes in lip position in pre and post treatment lateral Cephalogram in bimaxillary protrusion cases.
Settings and Design: Retrospective Cephalometric study on bimaxillary protrusion cases.
Materials and Methods: The study comprised of 45 subjects (6 Male and 39 Females) aged between 18 to 26 years having Bimaxillary protrusion malocclusion and treated with all four first premolar extraction. The pre-treatment and post treatment lateral cephalograms were traced and landmarks were identified Statistical analysis used: Statistical Package for the Social Sciences (SPSS Version 23; Chicago Inc., IL, USA), Kolmogorov –Smirnov and Shapiro Wilk tests, One-way analysis of variance (ANOVA), Tukey's post hoc analysis.
Results: A positive correlation was found in changes in pre- and post-treatment changes in upper lip curvature, H-Line Angle, Upper sulcus depth, Upper lip strain, changes in the upper lip and the soft tissue from the nose tip, length of upper and lower lip, Nasolabial angle, Upper lip protrusion, Lower lip protrusion. However changes in Facial angle, Steiner's S line, Upper and lower lip thickness were not statistically significant.
Conclusions: Treatment of Bimaxillary protrusion cases with extraction of all four first premolars resulted in a significant improvement in facial profile, esthetics and enhanced the soft tissue harmony.

1. Introduction

The foundation of the soft tissue paradigm was laid with the declaration that "today's truths become tomorrow's myths".[1] Earlier more emphasis was given to dental and skeletal components, however today the focus has shifted towards the soft tissue components in Orthodontics.

Bimaxillary protrusion is a form of malocclusion characterized by protrusion of both upper and lower jaws and proclined incisors. In 1897 Calvin Case coined the term bimaxillary protrusion describing "a condition in which the entire denture of both jaws is protruded in relation to the mandible and other bones of the skull".[2] this deformity is always aggravated by a receding chin.[3]

The most common findings in patients presenting with bimaxillary protrusion are flared maxillary and mandibular anterior teeth which causes protruded lips and a convex profile. In the perioral area the soft tissue features are eminent like gummy smile, short upper and lower lips, varying degree of lip incompetence, decreased nasolabial angle, absence of lip seal, strained lips, mentalis strain and in some cases anterior open bite.[3,4]

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The main objective is to retract the mandibular and maxillary incisors, which will gradually reduce the convexity of the soft tissues. To do this, four premolars are extracted, and then anterior teeth are retracted using maximum anchorage mechanics.[5]

The assessment of the changes in the facial profile during and following orthodontic treatment is focused with the relationship between incisor retraction and lip position.

2. The aim and Objective of this Study

1. To determine the changes in lip position in pre and post treatment lateral Cephalogram in bimaxillary protrusion cases.
2. To assess the upper and lower lip changes on lateral Cephalogram in bimaxillary protrusion cases.

The study comprised of retrospective records of 45 patients (6 Males, 39 Females) having Class I bimaxillary protrusion malocclusion requiring all first premolar extraction. All patients were treated with MBT 0.022 inch bracket slot. The pre-treatment and post-treatment orthodontic records i.e., lateral Cephalogram for all patients were collected from the record room of the Department of Orthodontics, Saraswati Dental College. The lateral cephalometric films were traced by the same investigator, and all the landmarks were identified. All cephalometric measurements were made at least twice. If there was a difference between the two measurements, a third reading was made, and the aberrant one was discarded. All records were standardized & exposed during lateral Cephalogram X-Ray as per ideal standards.

2.1. The inclusion criteria

1. Non- growing patients. (18 to 30 years of age)
2. Patients requiring extraction of all the first premolars
3. Amount of crowding 6mm or less.
4. Skeletal Class I malocclusion.

2.2. The exclusion criteria

1. Any craniofacial disorders including cleft lip and palate.
2. Local/systemic problems or trauma affecting the growth and development of facial structures or body.
3. Medically compromised cases.
4. Growing patients.
5. Non extraction cases.
6. Patients having more than 6 mm crowding.
7. Periodontally compromised patients.

3. Data analysis

The data obtained were subjected to statistical analysis using Statistical Package for the Social Sciences (SPSS Version 23; Chicago Inc., IL, USA). Data comparison was done by applying specific statistical tests to find out the statistical significance of the comparisons.

Kolmogorov –Smirnov and Shapiro Wilk tests were performed to determine the normality of the data .Both the tests showed no significant differences and hence confirmed that the data obtained were normally distributed.

Variables were compared using mean values and standard deviation. The mean for different readings were compared using One-way analysis of variance (ANOVA), and the intercomparison between each group was done using Tukey's post hoc analysis. P value lesser than 0.05 was considered to be statistically significant.

3.1. Soft tissue measurements

3.1.1. Angular measurements

1. Facial Angle
2. H-Line Angle
3. Nasolabial Angle

3.2. Linear measurements

3.2.1. Upper Lip Curvature

1. Upper Sulcus Depth
2. Upper Lip Strain
3. Rickett's E line
4. Steiner's S line
5. Length of Upper lip
6. Length of Lower Lip
7. Thickness of Upper Lip
8. Thickness of Lower Lip
9. Upper Lip Protrusion
10. Lower Lip Protrusion

Picture-1 (Armamentarium)

4. Results

1. Age of studied population: The mean age of the radiographs evaluated were 20.933 + 2.1881 years as seen in Table 1.
2. Gender distribution of study population: Table 2 show the gender distribution of the study population. A greater number of lateral Cephalogram were of females (86.7%) as against 13.3% of males as the value taken in the study does not show any difference in gender.

Table 1: Age of studied population

N	Minimum	Maximum	Mean	Std. Deviation
45	18.00	26.00	20.9333	2.18881

Table 3: Pre- and post- cephalometric changes in lip position

Variable							
Facial Angle	Pre – change	45	83.87778	3.332273	-.211111	-.346	.731 (NS)
	Post - change	45	84.08889	3.219770			
Upper lip Curvature	Pre – change	45	4.71111	1.324974	1.188889	4.240	.000*
	Post - change	45	3.52222	1.356615			
H line angle	Pre – change	45	19.38889	3.903508	1.377778	3.046	.004*
	Post - change	45	18.01111	2.993343			
Upper Sulcus depth	Pre – change	45	7.46667	1.736637	.822222	2.291	.027*
	Post - change	45	6.64444	1.594102			
Upper lip strain	Pre – change	45	1.2444	1.25961	.54444	3.030	.004*
	Post - change	45	.7000	.82158			
Nose tip to soft tissue (upper lip)	Pre – change	45	1.4778	1.89783	.63333	2.046	.047*
	Post - change	45	.8444	1.82103			
Nose tip to soft tissue (lower lip)	Pre – change	45	4.3222	2.45217	1.91111	5.345	.000*
	Post - change	45	2.4111	2.01779			
Steiner's S-Line	Pre – change	45	9.0778	2.34268	-.13333	-.593	.556 (NS)
	Post - change	45	9.2111	2.26758			
Length of upper lip	Pre – change	45	19.1778	2.04260	-.67778	-2.691	.010*
	Post - change	45	19.8556	2.14164			
Length of lower lip	Pre – change	45	34.7222	3.18832	-1.71111	-3.175	.003*
	Post - change	45	36.4333	3.01247			
Thickness of Upper lip	Pre – change	45	11.4889	1.52438	-.45556	-1.879	.067 (NS)
	Post - change	45	11.9444	1.98924			
Thickness of Lower lip	Pre – change	45	14.3889	1.52587	.00000	.000	1.00 (NS)
	Post - change	45	14.3889	1.36885			
Nasolabial Angle	Pre – change	45	86.8556	12.59988	-10.08889	-4.821	0.000*
	Post - change	45	96.9444	13.13359			
Upper lip Protrusion	Pre – change	45	8.2889	3.57149	1.17778	4.552	0.000*
	Post - change	45	7.1111	4.05486			
Lower lip Protrusion	Pre – change	45	7.4333	2.78715	1.20000	3.137	.003*
	Post - change	45	6.2333	3.32620			

Table 2: Gender distribution of study population

Gender	Frequency	Percentage
Males	6	13.3
Females	39	86.7
Total	45	100.0

Figure 1:

5. Discussion

With the soft tissue paradigm now being at the forefront of orthodontic treatment. It is crucial for orthodontists to consider the soft tissue when formulating a comprehensive treatment plan.[1,6]

Orthodontists have long been interested in the changes in lip position, thickness and in establishing a harmonious balance of all the soft tissue components in the dento- facial region.[7]

The upper and lower lips are supported by the anterior teeth. Consequently, lip balance and appearance are affected by any changes in the tooth position. In patients with bimaxillary protrusion malocclusion,[8] the anterior teeth are proclined to align the entire dentition in the arch, as a consequence the lips protrude, become strained and incompetent.[9]

The retrospective study was aimed at observing the changes seen in response to orthodontic therapy. Therefore, cases with a minimum age of 18 years were selected to eliminate any significant growth changes that might have an impact on outcomes.[10,11]

According to *Subtelny JD (1959)*[12] the upper lip maintained a reasonably stable vertical relationship to the prosthion and the incisal edge of the central incisor following the eruption of the teeth. He added that the lengthening of the lower and upper lips happened gradually up until the age of 15. In addition, *Chaconas SJ,* Bartroff JD *(1975)*[13] found that there was a minor decline in angular or proportionate convexity from age of 10 to 16 years, contrary to what is frequently claimed, when the lips were measured linearly.

In the present study population's average age was 20.933 years (Table 1) with a greater number of lateral Cephalogram of female patients (86.7%) than males (13.3%). The Pre and Post treatment changes in bimaxillary protrusion cases were assessed by measuring linear and angular parameters were measured and compared on the lateral Cephalogram.

6. Holdaway's Soft Tissue Facial Angle

In the present study mean pre-treatment soft tissue facial angle was 83.877° with the standard deviation of ± 3.33°; post treatment mean value was 84.088° with the standard deviation of ±3.21°. The mean difference was -0.211. The difference in pre-treatment and post-treatment values was found to be statistically insignificant.

6.1. Upper lip curvature holdaway

In the present study the pre-treatment mean value was 4.711 mm with standard deviation of 1.32 mm and post treatment mean value was 3.52 mm with standard deviation of 1.35 mm; mean difference was 1.18 (p=0.00). This is consistent with a systemic review conducted by Leonardi R (2010),[14] which came to similar conclusions in his study that Upper lip curvature measurement is very important in making the decision on where the orientation of the dentition should be so as to provide the best lip support.

6.2. Holdaway H line angle

The variations in H-Line angle were found to be statistically significant in the present study. In the study the mean pre-treatment value was 19.388° with a standard deviation of 3.903°, and the mean post treatment value was 18.011° with a standard deviation of 2.99°. A mean difference of 1.377 was found (p=0.004).

In a 1985 study on the Mexican population, Bishara SE et al. (1985)[15,16] found that greater H Line Angle was found in more convex profiles.[17] In their research, Bishara SE et al. (1998)[18] observed that between the ages of 5 to 25 and 25 to 45, Holdaway angles decreased by 6.9° and 6.2° respectively. His research indicates that the largest H line angle drop occurred in males between the ages of 15 and 25 and in females between the ages of 10-15. In his study of Turkish people, Erbay EF (2002)[19] found that the lower lip was more retrusive when assessed from the Holdaway line.

6.3. Upper sulcus depth

In the present study the change in Upper sulcus depth was found to be statistically significant in our study; pre-treatment mean is 7.46mm with standard deviation of 1.73 mm and post treatment mean is 6.644mm with standard deviation of 1.59 mm. The mean difference is 0.822 (p=0.27). Bravo LA (1994)[20] found that the measurement of the superior sulcus depth was in the range of +3 to +7 mm with +5mm being ideal. He came to the conclusion that the superior sulcus depth decreases following orthodontic treatment.

6.4. Upper lip strain

In the present study, mean pre-treatment value lip strain was 1.244mm with standard deviation of 1.25mm and post treatment mean value was 0.70mm with standard deviation of 0. 821mm. Mean difference was found to be 0.544 (p=0.004). The change in upper lip strain was found to be statistically significant in our study.

Oliver BM (1982)[2] found that high lip strain showed a significantly greater correlation between maxillary incisor retraction and soft tissue vermillion border retraction. His research backs up the finding that individuals with thicker lips will respond differently in their soft tissues to the retraction of their hard tissues than those with thinner lips. In their research on Asian populations, Solem RC et al. (2013)[21] found that the degree of incisor retraction and lip retraction that was seen as a result of intricate parameters, including lip strain, thickness, dentofacial shape, ethnicity, and sex of the individual.

6.5. Rickett's (1960) E- line

In the present study upper lip mean value was 1.477 mm with a standard deviation of 1.89 mm before treatment and 0.844 mm with a standard deviation of 1.82 mm after treatment; the mean difference was 0.633(p=0.047).

In the present study the lower lip mean value was 4.32mm with 2.45 mm standard deviation before orthodontic treatment and 2.411 mm with 2.01 mm standard deviation after treatment, with a mean difference of 1.9 (p=0.000).

The shift in the upper and lower lip's relationship to the Ricketts E line was determined to be statistically significant in the current investigation.

6.6. Steiner's S line

In our study when relating the change in position of Nose in extraction and non- extraction cases, it was found that the change in position of Nose to Steiner's S-line was statistically insignificant. Mean pre-treatment value was

9.07 mm with the standard deviation of 2.34 mm and mean post treatment value was 9.211 mm with a standard deviation of 2.26 mm; mean difference was -0.133. (P=-0.593).

6.7. Length of upper and lower lip

In the study the mean pre-treatment value of the upper lip's length was 19.17 mm with a standard deviation of 2.04 mm; the mean post-treatment value of the upper lip's length was 19.85 mm with standard deviation of 2.14 mm. The mean difference of -0.677 was found (p=0.010)

In the present study the mean pre-treatment value of the lower lip's length was 34.72 mm with a mean deviation of 3.18 mm; the mean post-treatment value of the lower lip's length was 36.43 mm with a standard deviation of 3.01 mm. The mean difference was -1.711 (p=0.003).

6.8. Thickness of upper and lower lip

In the study the mean upper lip thickness before treatment was 11.48 mm with a standard variation of 1.52 mm, and the mean upper thickness after treatment was 11.94 mm with a standard deviation of 1.98 mm; the mean difference was -0.455. (p=0.067)

In current study the mean lower lip thickness before treatment was 14.388 mm with standard deviation of 1.52 mm and the mean lower lip thickness after treatment was 14.38 mm with standard deviation of 1.3688 mm. Mean difference between values was 0.00.(P=0.00).Therefore no statistical significance was seen.

According to Ramos AL et al. (2005).[22] in individuals with competent lips, ratio of retraction of anterior teeth to lips was 1:0.75 while in patients with incompetent lips, ratio of retraction of anterior teeth to lips was 1:0.70.

In their 2013 study on Asian populations, Solem RC et al (2013)[21] observed that the degree of lip and incisor retraction was influenced by a number of intricate parameters. Retraction of the lower lip was significantly related to the mandibular incisors; the retraction of the upper lip was significantly correlated to the maxillary incisors. The average ratio of mandibular incisor retraction to average lower lip retraction was 0.83:1, compared to 1.73:1 for maxillary incisor retraction.

The fact that the position of the lips depends on the relative movement and position of the underlying hard tissues is in favor of our claim that in cases of Class I bimaxillary protrusion malocclusion treated with first premolar extraction, there were only minor changes in the positioning of the upper and lower lips.

6.9. Upper and lower lip protrusion

In the study the mean upper lip protrusion before treatment was 8.28 mm, with a standard deviation of 3.57 mm; after treatment, it was 7.11 mm, with a standard deviation of 4.054 mm.1.17 was the mean difference (P=0.00).

The mean lower lip protrusion before treatment was 7.433 mm, with a standard deviation of 2.78 mm; after treatment, it was 6.23 mm, with a standard deviation of 3.32 mm; 1.20 was the mean difference (P 0.003).It was found that the protrusion of the upper and lower lips was statistically significant.

6.10. Nasolabial angle

In the study the mean pre-treatment Nasolabial angle was 86.85º with standard deviation of SD=12.59º and the mean post-treatment Nasolabial angle was 96.94º with the standard deviation of 13.13º with a mean difference of -10.08º. (P=0.00). The change in values was statistically significant in our study population.

7. Conclusion

The present study was undertaken with the aim of assessing the relation of Soft tissue changes in bimaxillary protrusion malocclusion cases treated with extraction of first premolars. The following conclusions were drawn.

Pre- and post-treatment changes in upper lip curvature, H-Line Angle, Upper sulcus depth, Upper lip strain, changes in the upper lip and the soft tissue from the nose tip, length of upper and lower lip, Nasolabial angle, Upper lip protrusion, Lower lip protrusion were found to be statistically significant.

Pre- and post-treatment changes in Facial angle, Steiner's S line, Upper and lower lip thickness were not statistically significant.

7.1. Limitations

1. Anatomic variations
2. Gender difference
3. Small sample size
4. Ethnic makeup etc.

These shortcomings in our study motivate us for future research.

8. Source of Funding

None.

9. Conflict of Interest

None.

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