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Changes in the curvature of upper and lower lips following the first premolar extraction in Class I bimaxillary protrusion - A cephalometric study

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ABSTRACT

Background and Objectives: Bimaxillary dentoalveolar protrusion is a condition characterized by protrusion of the maxillary and mandibular incisors with increased procumbency of the lips. The treatment of choice for these patients is fixed orthodontic treatment after extraction of four first premolars. This treatment would result in the retraction of anterior teeth with a resultant decrease in soft tissue convexity. Objective of the study is to find out how the curvature of upper and lower lip change following fixed appliance therapy in patients with class I Bimaxillary protrusion following extraction of first premolars.
Materials and Methods: A total of 32 subjects, 13 males and 19 females in the age group of 13-21 years diagnosed with BMP were included in the study. Pre-treatment and post-treatment cephalograms were obtained from subjects satisfying the inclusion and exclusion criteria. Cephalometric landmarks, lines used in the study were marked and analysed. The soft tissue parameters were measured and compared using paired t test and Pearson's correlation coefficient.
Results: The overall effect of orthodontic correction of bimaxillary protrusion from subjects were analysed by evaluating the soft tissue changes between pre-treatment and post treatment cephalometric radiographs. There is a statistically significant difference with decrease in ULST, B'-PM line, B'-LiPog', A'-PM line, LLIT, LLVT, Pog-Pog' and no statistically significant difference in A'-NtLs and ULVT. The results showed a reduction in lip procumbency.
Conclusion: Among the soft tissue parameter studied, there is a statistically significant decrease observed for ULST, B'-PM line, B'-LiPog', A'-PM line, LLIT, LLVT and Pog-Pog'.

1. Introduction

The soft tissue and profile changes due to orthodontic treatment have been the subject of controversy for decades. Orthodontic treatment can alter the soft tissue profile, especially when four premolars are removed and anterior teeth are retracted. There is, however, a lack of agreement regarding soft tissue response to changes in the position of teeth and alveolar process. Soft tissue changes could either improve the profile or result in a flatter and "dished-in" shape.

Lips are an integral part of a person's face. They have traditionally been perceived as an important feature contributing to a person's beauty and attractiveness. Profile views are especially useful for evaluating lips because they show the impact of the dentition and alveolar ridges on the appearance of the lip. Due to the statistical effect that

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orthodontic treatment can have on anterior teeth position, the role of the orthodontist in affecting the soft tissue profile becomes captious.[1,2]

McNamara et al. concluded that the vertical thickness of the upper lip is the most important aesthetic factor in a smiling face. It is therefore important to consider the relationship between proclination of incisors and upper lip thickness when planning orthodontic treatment.[3]

Burstone, Merrifield and Holdaway considered the soft tissue effects on facial profile. They believed that the treatment planning relying only on hard tissue parameters would sometimes end with an unpleasant experience. As the additional information taken from the structures of hard tissue was more meaningful, they incorporated soft tissue parameters to Cephalometric analysis. This is what is called "a soft tissue approach on treatment planning".[4–6]

Some investigations found a strong link between upper incisor retraction and lip retraction, implying a close interaction between soft tissues and the underlying hard tissue.[7–9] In most trials, the lower lip responded to orthodontic movement better than the upper lip.[9–11] Sharma's skeletal and soft tissue points A and B retracted proportionately, with the upper lip responding slightly better than the lower. Another key factor in the procedure's facial aesthetic effect is the curvature of the lips before treatment.[12]

A study on South Indian ethnicity and attained a ratio of 1:2.01 for upper lip to upper anterior teeth retraction and 1:1 for lower lip to lower anterior teeth retraction. Moreover, the thickness of the lip is said to be a governing factor affecting the lip morphology post treatment. While some studies have shown a correlation between lip thickness and upper lip response to incisor retraction.[13]

Facial aesthetics are the patient's most important concern when they seek treatment for bimaxillary protrusion. However, careful and complete skeletal, dental, and soft tissue evaluation must be performed. Fixed orthodontic treatment involving the extractions of premolar teeth may at times be appropriate and necessary to deal with crowding, increased overjet, tooth and lip protrusion, molar and anteroposterior skeletal discrepancies, or skeletal asymmetry.[13–15] Profile modifications after the extraction of 4 first premolars and orthodontic treatment of bimaxillary protrusion confirmed a favorable exchange in upper and lower incisor protrusion, and upper and decrease lip protrusion.[16]

Most of the extraction spaces in patients with BMP is used for incisor retraction and correction of lip procumbency, which reduced the arch dimension and affected the tongue position. The present study purpose was to evaluate the changes in the curvature of the upper and lower lips following first premolar extraction in class I bimaxillary protrusion. No such study evaluating the pre- and post-treatment changes in curvature of the upper and lower lips following first premolar extraction in class I bimaxillary protrusion has been done before in Central Kerala population.

The aim is to study the changes in the curvature of upper and lower lips following first premolar extraction in patients with Class I Bimaxillary protrusion.

2. Materials and Methods

The study was conducted in the Department of Orthodontics & Dentofacial Orthopedics, Government Dental College, Kottayam. The study was approved by Institutional Ethics Committee and number obtained was IEC/M/17/2019/DCK.

2.1. Inclusion criteria

1. Pre-treatment and post-treatment lateral cephalograms of patients diagnosed with bimaxillary protrusion with Angle Class I molar and Class I canine relationship.
2. Fixed orthodontic treatment consisting of extraction of premolars
3. Well-aligned dental arches with minimal or no crowding
4. Cephalometric radiographs of good soft tissue outlines, with occlusion and the lips resting in a natural position.

2.2. Exclusion criteria

1. Patients who have undergone any prior orthodontic treatment.
2. Patients who do not provide written informed consent.
3. Medically compromised patients.

2.3. Sample size

32 patients diagnosed with Class I Bimaxillary protrusion in the Department of Orthodontics at Government Dental College, Kottayam was included in the study.

2.4. Methods

Pre-treatment lateral cephalograms (T1) and post-treatment lateral cephalograms (T2) were obtained from patients satisfying the inclusion and exclusion criteria. All lateral cephalograms were taken in the same cephalostat. Similar conditions of light box and general illumination was maintained during viewing and tracing all head films. Cephalometric Tracing was done on acetate matte tracing paper of .003 thickness and 8x10 inches dimension. Tracings were done by a single operator.

Cephalometric landmarks and measured both hard and soft tissue landmarks with reference to the pterygomaxillary (PM) line were marked. The depth of curvature for upper and lower lip was calculated as the difference in x coordinates between the respective vermilion point and the

deepest point along the curvature of that lip (point A' or point B'). The upper lip depth was measured as the perpendicular distance to point A' from a line joining the nasal tip to the upper vermilion point. The lower lip depth was measured as the perpendicular distance to point B' from a line joining the lower vermilion point to soft tissue pogonion.

Three weeks after the first measurement, the tracings and measurements were repeated by the same investigator on the lateral cephalograms of 5 randomly selected subjects to assess the intra-observer error. To check inter-observer errors, tracings and measurements were done by 5 separate investigators on lateral cephalogram of 5 randomly selected subjects. There was an excellent agreement between the observations and between the observers, *p value < 0.05.

2.5. Parameters for upper and lower lip curvature (Figure 1 A,B,C)

Upper lip-superior thickness (ULST) - Distance between hard tissue point A and point of intersection with the outline of the upper lip, drawn perpendicular to PM line.

Upper lip-vermilion thickness (ULVT) - Distance between the vermilion point of the upper lip and inner aspect of lip, drawn perpendicular to PM line.

Lower lip-vermilion thickness (LLVT) - Distance between the vermilion point of the lower lip and inner aspect of the lip, draw perpendicular to the PM line.

Lower lip-inferior thickness (LLIT) -Distance between hard tissue point B and point of intersection with the outline of the lower lip, drawn perpendicular to PM line.

Pogonion soft tissue thickness (Pog-Pog‘) - Distance between hard tissue pogonion and point of intersection with the outline of the soft tissue chin, drawn perpendicular to PM line.

Depth to point A‘- (A‘-PM line) (relative to PM line)- Difference between distance from PM line to upper vermilion point and distance from PM line to soft tissue point A‘.

Depth to point B‘ (B‘-PM line) (relative to PM line)- Distance from PM line to lower vermilion point and distance from PM line to soft tissue point B‘.

Depth to point A‘ (A‘-NtLs line) (relative to constructed anterior soft tissue reference lines Nt-Ls)

Depth to point B‘ (B‘-LiPog‘ line) (relative to constructed anterior soft tissue reference lines Li-Pog‘)

2.6. Statistical analysis

The data collected was entered into spread sheets using Microsoft Excel and analysed using SPSS for windows version 16. Quantitative variables were summarized using mean and standard deviation. Gender was summarized using frequencies. Paired t test was done to compare the pre-treatment and post-treatment measurements separately for males, females and total population. The correlation between quantitative variables was tested using Pearson correlation coefficient.

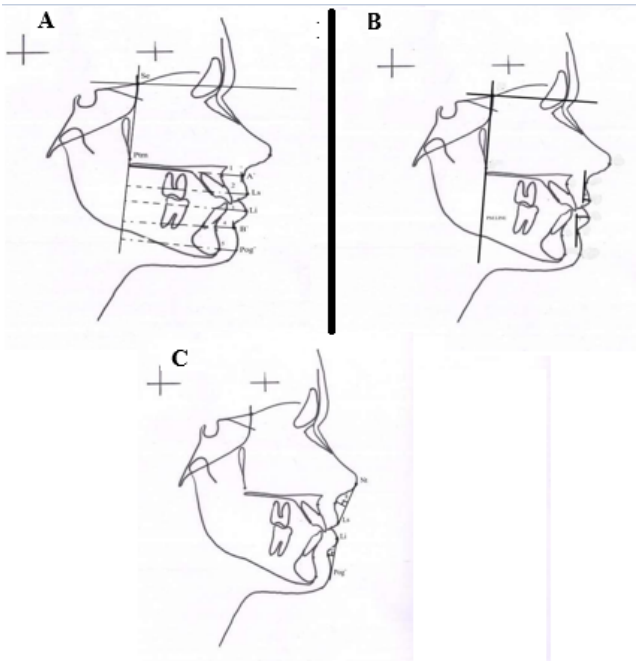

Figure 1: A: Parameters used in the study using PM as the reference line (1. ULST, 2. ULVT, 3. LLVT, 4. LLIT, 5. Pog-Pog‘); **B:** Parameters used in the study using PM as the relative line (6. A‘-PM line, 7. B‘-PM line); **C:** Parameters used in the study using anterior soft tissue as the reference line (8. A‘-NtLs, 9. B‘-LiPog‘)

3. Results

The total study population included 32 subjects. Out of the 32 subjects, 13 were males and 19 were females. The age of the study population ranged from 13-21 years, Mean age of males in the study group is 16.15±1.04 years and that of females is 16.53 ± 1.6 years.

Out of 13 males, 4 were “≤16” years of age group and 9 were “>16” years of age group. In the females, 11 were “≤18” years of age group and 8 were “>18” years of age group. The age groups were divided into “≤16” and “>16” in males; and “≤18” “>18” years in females in present study. The study had 2 groups the pre-treatment group (T1) and post-treatment group (T2).

Mean ± SD values for T1 and T2 groups and the Mean ± SD difference between the T1 and T2 group values were calculated. Paired t test was performed for parameters ULST, ULVT, LLVT, LLIT, Pog-Pog‘, A‘-PM line, B‘-PM line, A‘-NtLs line, B‘-LiPog‘ line.

The results of the study showed that, a statistically significant difference in the Mean±SD value of ULST between males and females of the T1 group. The Mean±SD value for ULST is 10.96±1.69 in males and 9.68±1.18 in

Table 1: Comparison of difference between pre-treatment & post treatment values for various cephalometric parameters in males and females.

S.No.	Parameter	Sex	T1 Mean±SD	p value	T2 Mean±SD	p value	T1-T2 Mean±SD	p Value
1	ULST	M	10.96±1.69	0.017*	10.08±1.55	0.005*	0.88±1.56	0.063
		F	9.68 ±1.18		8.47 ±1.42		1.21±1.19	0.000*
2	ULVT	M	10.15±1.81	0.311	10.08±1.62	0.081	0.08±1.41	0.848
		F	9.53±1.61		9.10±1.41		0.42±0.92	0.061
3	LLVT	M	11.81±2.50	0.099	11.00±1.10	0.007*	0.81± 2.09	0.188
		F	10.45±2.01		9.89±1.03		0.55±1.91	0.223
4	LLIT	M	9.23±1.35	0.074	8.65±0.96	0.074	0.58±0.93	0.045*
		F	8.39±1.18		7.95±1.12		0.45±1.16	0.112
5	Pog–Pog‘	M	8.35±1.20	0.158	7.69±1.33	0.342	0.65±1.01	0.037*
		F	7.66±1.39		7.24± 1.29		0.42 ±0.98	0.076
6	A‘-PM line	M	4.88±1.23	0.967	3.96 ± 1.31	0.637	0.92±0.49	0.000*
		F	4.87± 0.97		4.16 ± 1.01		0.71 ±0.89	0.003*
7	B‘-PM line	M	7.54 ± 1.05	0.125	6.50 ± 0.96	0.044*	1.04 ±0.66	0.000*
		F	6.76± 1.54		5.53 ±1.47		1.24 ±1.15	0.000*
8	A‘-NtLs line	M	6.61 ±1.60	0.97	6.04 ±1.59	0.592	0.58 ±0.84	0.029*
		F	6.63 ±1.01		6.26 ± 0.73		0.37±0.94	0.105
9	B‘-LiPog‘	M	4.46 ±1.07	0.322	3.96 ±1.23	0.804	0.50± 0.93	0.078
		F	4.08 ±1.04		3.87±0.88		0.21 ±1.06	0.397

females (p≤ 0.05) (Table 1).

A statistically significant difference was observed in the Mean±SD values between males and females of T2 group in ULST, LLVT and B‘-PM line. The Mean±SD for ULST in males is 10.08±1.55 and that in females is 8.47±1.42 (p≤ 0.005). The Mean±SD for LLVT in males is 11.00±1.10 and that in females is 9.89±1.03 (p≤ 0.005). The Mean±SD for B‘-PM line in males is 6.50 ± 0.96 and in females is 5.53 ±1.47 (p≤ 0.05) (Table 1).

Comparison of the differences in Mean±SD pre-treatment and post-treatment values in males and females showed a statistically significant difference in females between pre- treatment and post-treatment group for ULST 1.21±1.19 (p=0.000), A‘-PM line 0.71±0.89 (p≤ 0.005) and B‘-PM line 1.24±1.15 (p=0.000). Among males a statistically significant difference was observed in LLIT 0.58±0.93 (p≤ 0.05), Pog-Pog‘ 0.65±1.01 (p≤ 0.05), A‘-PM line is 0.92±0.49 (P=0.000), B‘-PM line is 1.04±0.06 (p=0.000), A‘-NtLs line 0.58±0.84 (p≤ 0.05). (Table 1)

Comparison of differences between T1 and T2 values in males showed a statistically significant decrease in parameters LLIT (0.58±0.93) (p≤0.05), Pog-Pog‘ (0.65±1.01) (p≤ 0.05), A‘-PM line (0.92±0.49) (p=0.000), B‘-PM line (1.04±0.66) (p=0.000) and A‘-NtLs line (0.58±0.84) (p≤ 0.05). The Mean±SD values of the difference between T1 and T2 values in females showed a statistically significant decrease for ULST (1.21±1.19) (p=0.000), B‘-PM line (1.24±1.15) (p=0.000) and A‘-PM line (0.71 ± 0.89) (p≤ 0.005). (Table 1)

In the total population difference between T1 and T2 values showed a statistically significant decrease in ULST (1.08 ± 1.34) (p=0.000), A‘-PM line is (0.80 ± 0.75) (p=0.000), B‘-PM line (1.16 ±0.97) (p=0.000) and LLVT (0.66±1.95) (p≤ 0.05), LLIT (0.50 ± 1.06) (p≤ 0.005), Pog-Pog‘ (0.52± 0.98) (p≤ 0.005), A‘NtLs line (0.45 ± 0.89) (p≤ 0.005) and B‘-Li pog‘ line (0.33±1.00) (p≤ 0.05).(Table 2)

There is a statistically significant difference in the pre-treatment value of ULST in different age groups in females. The Mean±SD of the pre-treatment values for ULST “≤18” age group is 10± 1.06 mm and that for “>18” age group is 8.80 ± 1.15 mm (p≤0.05). There is statistically no significant difference observed in the post-treatment values in females of different age groups.(Table 3)

When we consider females in the age group “≤18” there is statistically significant difference observed between the pre-treatment and post-treatment values only in the case of parameters ULST, Pog-Pog‘, A‘-PM line and B‘-PM line. ULST decreased by 1.46± 0.86 mm (p=0.000), Pog-Pog‘ decreased by 0.57± 0.85 mm (p≤ 0.05). A‘-PM line and B‘-PM line also decreased by 0.75±0.70 (p≤0.001) and 1.57±1.00 (p=0.000) respectively.(Table 3)

There is not a statistically significant difference between the pre-treatment and post treatment values of the parameters for females in the age group “>18” (Table 3).

There is a statistically significant difference in the pre-treatment value of B‘LiPog‘ line in the different age groups in males. The Mean±SD of the pre-treatment values for parameter B‘-Li-Pog‘ line for the “≤16” age group is 3.50 ± 1.29 mm and that for the “>16” age group 4.89 ± 0.15 mm (p≤0.05).(Table 4)

The post-treatment values showed a statically significant difference in different age groups in males. The Mean±SD of the post-treatment values for parameter LLIT for the age

Table 2: Mean±SD of difference between pre-treatment & post treatment values for various cephalometric parameters in the total population

S.No	Parameter	T1 Mean ± SD	T2 Mean ± SD	T1-T2 Mean ± SD	p Value
1	ULST	10.20 ± 1.52	9.12 ± 1.66	1.08 ± 1.34	0.000*
2	ULVT	9.78± 1.69	9.50± 1.55	0.28 ± 1.14	0.085
3	LLVT	11.00 ± 2.29	10.34 ± 1.18	0.66 ± 1.95	0.033*
4	LLIT	8.73 ± 1.30	8.23 ± 1.10	0.50 ± 1.06	0.006*
5	Pog–Pog‘	7.94 ± 1.34	7.42± 1.31	0.52± 0.98	0.003*
6	A‘-PM line	4.88± 1.06	4.08± 1.13	0.80 ± 0.75	0.000*
7	B‘-PM line	7.08± 1.40	5.92 ± 1.36	1.16 ± 0.97	0.000*
8	A‘-NtLs line	6.62 ± 1.26	6.18 ± 1.14	0.45 ± 0.89	0.003*
9	B‘-LiPog‘	4.23 ± 1.05	3.91 ± 1.02	0.33 ± 1.00	0.037*

Table 3: Comparison of different between pre and post treatment values between the ≤18 and >18 age group in females

S.No	Parameter	Age Groups	T1 Mean±SD	p Value	T2Mean ±SD	p Value	T1-T2Mean± SD	p Value
1	ULST	≤18	10.00±1.06	0.048*	8.54± 1.47	0.760	1.46 ± 0.86	0.000*
		>18	8.80 ± 1.15		8.30 ± 1.40		0.50 ± 1.77	0.561
2	ULVT	≤18	9.54 ± 1.77	0.968	9.21 ± 1.58	0.587	0.32 ± 0.82	0.168
		>18	9.50 ± 1.22		8.80 ± 0.84		0.70 ± 1.20	0.263
3	LLVT	≤18	10.43±2.04	0.948	9.89 ± 1.09	0.990	0.54 ± 1.99	0.333
		>18	10.50±2.18		9.90 ± 0.96		0.60 ± 1.85	0.509
4	LLIT	≤18	8.36± 1.13	0.825	7.86 ±1.10	0.571	0.50 ± 0.92	0.063
		>18	8.50 ± 1.46		8.20 ± 1.25		0.30 ± 1.82	0.732
5	Pog–Pog‘	≤18	7.71 ± 1.59	0.777	7.14 ± 1.23	0.611	0.57 ± 0.85	0.026*
		>18	7.50 ± 0.71		7.50 ± 1.58		0.00 ± 1.27	1.00
6	A‘-PM line	≤18	5.00 ± 1.04	0.336	4.25± 1.09	0.523	0.75 ± 0.70	0.001*
		>18	4.50± 0.71		3.90 ± 0.82		0.60± 1.39	0.388
7	B‘-PM line	≤18	6.93 ± 1.63	0.449	5.36 ± 1.55	0.416	1.57± 1.00	0.000*
		>18	6.30 ± 1.30		6.00 ± 1.22		0.30 ± 1.09	0.573
8	A‘-NtLs line	≤18	6.57± 1.03	0.677	6.21± 0.70	0.641	0.36 ± 0.89	0.156
		>18	6.80 ± 1.04		6.40 ± 0.89		0.40 ± 1.19	0.495
9	B‘-LiPog‘	≤18	4.11 ± 1.15	0.850	3.75± 0.89	0.340	0.36 ± 1.20	0.286
		>18	4.00 ± 0.79		4.20± 0.84		0.20 ± 0.27	0.178

Table 4: Comparison of difference between pre and post treatment values for ≤16 and ≥16 age group in males

S.No.	Parameter	Age Groups	T1 Mean±SD	p Value	T2 Mean± SD	p Value	T1-T2 Mean±SD	p Value
1	ULST	≤16	12.25 ± 1.50	0.063	10.50± 1.91	0.536	1.75± 1.26	0.034*
		>16	10.39± 1.49		9.89 ± 1.45		0.50±1.58	0.371
2	ULVT	≤16	9.75 ± 2.06	0.613	9.62 ± 1.89	0.526	0.12± 0.25	0.39
		>16	10.33 ± 1.78		10.28± 1.56		0.06± 1.72	0.925
3	LLVT	≤16	11.00 ± 0.82	0.461	11.00± 1.41	1.00	0.00± 0.82	1.00
		>16	12.17± 2.94		11.00± 1.03		1.17± 2.41	0.185
4	LLIT	≤16	10.12 ± 1.31	0.113	9.50 ± 0.71	0.028*	0.62± 0.75	0.194
		>16	8.33 ± 1.22		8.28 ± 0.83		0.56± 1.04	0.149
5	Pog–Pog‘	≤16	7.50 ± 0.58	0.089	6.62 ± 0.48	0.048*	0.88± 0.85	0.133
		>16	8.72 ± 1.23		8.17 ± 1.32		0.56± 1.10	0.169
6	A‘-PM line	≤16	4.00 ± 1.15	0.082	3.00 ± 1.15	0.077	1.00± 0.01	0.135
		>16	5.28 ± 1.09		4.39 ± 1.19		0.89± 0.60	0.001*
7	B‘-PM line	≤16	6.75 ± 0.50	0.068	6.12 ± 0.85	0.369	0.62± 0.95	0.278
		>16	7.89 ± 1.05		6.67 ± 1.00		1.22± 0.44	0.000*
8	A‘-NtLs line	≤16	5.75± 1.44	0.205	5.12± 0.85	0.176	0.62± 1.55	0.478
		>16	7.00 ± 1.58		6.44 ± 1.70		0.56± 0.39	0.001*
9	B‘-LiPog‘	≤16	3.50 ± 1.29	0.023*	3.25± 1.50	0.175	0.25± 0.50	0.391
		>16	4.89 ± 0.15		4.28± 1.03		0.61±1.08	0.129

group "≤16" in males is 9.50 ± 0.71 mm and the Mean±SD of the post-treatment values for parameter LLIT for the age group "≥16" in males is 8.28 ± 0.83 mm (p≤0.05). The Mean±SD of the post-treatment values for parameter Pog-Pog' for the age group "≤16" in males is 6.62±0.48 mm, and the Mean±SD of the post-treatment values of Pog-Pog' for the age group ">16" in males is 8.17 ± 1.32 mm (p≤0.05). (Table 3)

A comparison of difference between pre-treatment and post-treatment values in the age group "≤16" in males showed a statistically significant difference in ULST. ULST decreased by 1.75±1.26 mm (p≤0.05) in males of "≤16" age group.(Table 4)

There is a statically significant difference observed on comparison of difference between the pre-treatment and post–treatment values in the age group "≥16" in males for A'-PM line, B'-PM line and A'-NtLs. A'-PM line & B'-PM line decreased by 0.89± 0.60 (p≤.001) and 1.22± 0.44 (p= 0.000) respectively in males of ">16" age group and A'-NtLs decreased by 0.56±0.39 (p≤ 0.001).(Table 4)

4. Discussion

Bimaxillary proclination can be defined as a condition where the upper and lower incisor are proclined, which result in increased lip procumbency.[17] The negative perception of protruding lips and protrusive dentitions often leads such patients to seek orthodontic care to decrease protrusion and improve profile.[18] According to Bills et al, the goals of orthodontic treatment in BMP cases are retraction and retroclination of incisors with a resultant decrease in soft tissue procumbency and convexity, achieved by extraction of four first premolars followed by orthodontic treatment for retraction of anteriors with maximum anchorage mechanics.[7] The results of the present study showed a reduction in lip procumbency.

The reference lines from where the changes are measured plays an important role in the correct interpretation of the results given by various authors.[19] Various reference lines, like the NA-line, Apo-line, NPo-line, PM line, VRP - a vertical reference line[20,21] (a constructed FH plane - constructed by subtracting 7° from the sella nasion plane serving as the X axis and a perpendicular line to this X axis through the sella serving as the Y axis), SY line,[22] SR line,[23] D' line[16] and Y line[8] were used by authors in the literature. These reference lines are all affected by growth and/or treatment in different ways and this may lead to erroneous interpretation which may make the results inconsistent.[19]

Soft tissue reference lines used were those including nasal tip and those without including the nasal tip, to prevent the influence of nasal growth. In male patients, the nose and the chin continue to grow much more than in females, this may decrease the lip procumbency relative to the SnPg' line and to a line drawn from the tip of the nose to the chin. This has been reported by Diels et al.[20] 19 where soft tissue profile changes following extraction in African Americans using the SnPg' line, the tip of the nose moving forward more in males (5.2mm) than in females (1.6mm); the soft tissue pogonion also moving forward more in males (3.5mm) than in females (0.3mm). In the same study the upper lip continued to move forward (by growth) despite the retraction of anterior teeth.

In the present study, the age groups were divided into, before completion of growth group and after completion of growth group, both in males and in females. The third growth spurt of males and females were reported to be 14 to 15 years in boys and 11-12 in girls.[24] A statistically significant difference was observed in the Mean±SD values of parameters, between males and females of the T1 group, T2 group and also on comparison of differences between pre-treatment & post treatment values for various cephalometric parameters in males and females.

4.1. Upper lip superior thickness (ULST)

In the present study, among males ULST decreased by 1.75±1.26mm (p≤0.05) in the ≤16 group and by 0.50±1.58mm in the >16 year age group (p≥0.05), with reference to the PM line (Table 4). In females, ULST decreased by 1.46±0.86mm in the ≤18 year age group (p=0.000) and by 0.50±1.77 in the >18 group (p≥0.05), with reference to the PM line. (Table 3) This is in contrast to Diels et al.[20] where the upper lip sulcus thickness increased by 0.8mm in males and to decrease by 0.5mm in females. This is due to the difference in age groups of the study population. The males continued to grow rapidly whereas the facial growth slowed down in females.

4.2. Upper lip -vermilion thickness (ULVT)

In the present study, in females, ULVT decreased by 0.32±0.82mm in the ≤18 group and by 0.70±1.20 in the >18 group, with reference to the PM line, this was not a statistically significant difference. This is correlation with Hodges et al.[21] where retraction of upper lip by 1.4±1.9 mm to have occurred in adolescent females (10-14 years) and by 1.5±1.9 in adult females (15 years or older). Diels et al.[20] found the upper lip vermillion thickness to increase by 2.7mm (p≤0.001) in males and by 0.5mm in females. The present study result is in contrast to Jamilian et al.[23] study where upper lip-ULVT in females decreased by 2.7±2.9mm with reference to SR line (p=0.001) (12-38years). Caplan et al.[8] also reported retraction of upper lip of 3.23±1.75 mm following four first premolar extraction in females. This difference may be attributed to have combined the growing and non-growing samples together, while the present study included females in two different age groups, the ≤18 group and >18 group.

4.3. Lower lip – vermilion thickness (LLVT)

In the present study, in males, LLVT decreased by 0.00±0.82mm in the ≤16 group and by 1.17±2.41 in the >16 group (Table 4), with reference to the PM line. In the present study, in females LLVT decreased by 0.54 ± 1.99mm in the ≤18 year age group and by 0.60±1.85 in the >18year age group (Table 3), with reference to the PM line. This is in correlation to Diels et al.,[20] Hodges et al.[21] also reported retraction of lower lip by 0.3±0.1 mm to have occurred in adolescent females (age 10-14 years) and by 0.4±0.3 in adult females (age 15 years or older). Lip retraction was more in adult females compared to that of the adolescent female group in their study. This in contrast to Jamilian et. al[23] and Caplan et. Al,[8] Mattos et al[22] and Lew et al[16] studies.

4.4. Lower lip inferior thickness (LLIT)

In the present study, among males, LLIT decreased by 0.62±0.75mm in the ≤16 group and 0.56±1.04 in the >16group (Table 4), with reference to the PM line (p>0.05). In females, LLIT decreased by 0.50±0.92mm in the ≤18 group (Table 3) and by 0.30±1.82 in the >18 group (Table 3), with reference to the PM line (p>0.05) which is in correlation to Diels et al.[20] study.

4.5. Pogonion soft tissue thickness (Pog–Pog‘)

Present study showed no statistical difference in pogonion soft tissue thickness following treatment which is in correlation with Mattos et al[22] and Sundareswaran et al[13] where Pog-Pog’ to increase by 1.9±4.93mm (p>0.05) in Class I and a decrease of soft tissue chin thickness by 0.48mm respectively. This is attributed to the fact that Mandibular and nasal growth is responsible for aesthetic changes in orthodontically treated cases.[25] Additional growth of nose and chin during maturation of individuals also contribute to a greater flattening of profile after orthodontic treatment.[26] As the movement of the tip of the nose in anterior inferior direction during growth is greater than the displacement of point A and of upper lip, the nose is made more prominent.[27] Both in extraction and in non-extraction cases, a significant growth of nose was observed by Erdinc.[28]

4.6. Depth A‘ (A‘-PM line)

Wholley and woods[29] found the upper lip depth reduced by 0.48±0.93 mm with reference to the PM line. In present study, in males, depth A‘ relative to the constructed PM line (A‘-PM line) decreased by 1.00±0.01 in the ‘≤16’ group and by 0.89±0.60 in ‘>16’ group. In females depth A‘ relative to the constructed PM line (A‘-PM line) decreased by 0.75±0.70 in the ‘≤18’ groups and by 0.60±1.39 in the ‘>18’ groups.

4.7. Depth B‘ (B‘-PM line)

Wholley and woods[29] reported the depth of lower lip curvature were reduced by 0.31±2.31 mm with reference to the PM line. In present study, in males, depth B‘ relative to the constructed PM line (B‘-PM line) decreased by 0.62±0.95 in the ‘≤16’ year age group and by 0.56±0.39 in the ‘>16’ year age groups. In females depth B‘ relative to the constructed PM line (B‘-PM line) decreased by 1.57±1.00 in the ‘≤18’ age groups and 0.30±1.09 in ‘>18’ year age groups.

4.8. Depth point A‘ (A‘-NtLs)

In the present study, in males, depth point A‘ relative to constructed anterior soft tissue reference line A‘-NtLs line decreased in both the age groups (Table 4). In Diels et al.,[20] study despite the retraction of incisors, the upper lip continued to move forwards as determined by cranial base superimposition (Sn-Pg‘) in adolescent males; the upper lip retracted by 1.5mm in males.

In the present study, in females, depth point A‘ relative to constructed anterior soft tissue reference line A‘-NtLs line decreased by 0.36±0.89 in the ≤18 group and by 0.40±1.19 in the >18 group. (Table 3). There was a relative retraction of lower lips in relation to the SnPg‘ line by 1.74mm (p<0.01) in females, observed by Diels et al.[20] it is explained to be due to the continued forward movement of subnasale and soft tissue pogonion with growth, which is more than that of the lips.

A decrease in the superior sulcus depth in relation to H line (1.516) was reported by Sundareswaran et al.[13] Wholley and Woods[29] reported a difference of 0.15±1.8 in upper lip depth with reference to a line drawn from the nasal tip to upper vermillion point in their randomly selected first premolar extraction cases. Bravo[9] reported a decrease in superior sulcus-E line by 1.6±1.0 mm, superior sulcus - H line by 2.4±1.8, and also a decrease in superior sulcus depth by 0.9±1.0mm. This decrease in superior sulcus depth, superior sulcus-E line and superior sulcus-H line measurements has occurred because their sample included Class II Division 1 malocclusions. In the present study also depth point A‘ decreased relative to constructed anterior soft tissue reference line (A‘-NtLs) in females in age group below 18. (Table 3)

4.9. Depth point B‘ (B‘- LiPog‘)

In the present study, in males, depth B‘ relative to the constructed anterior soft tissue reference line B‘-LiPog‘ decreased by 0.25±0.50 in the ≤16 group and by 0.61±1.08 in the >16 group (Table 4). In females, Depth B‘ relative constructed anterior soft tissue reference line B‘-LiPog‘ decreased in the ≤18 group by 0.36±1.20 and increased by 0.20±0.27 in the >18 group (Table 3). Wholly and Woods[29] reported similar results in their study wherein lower lip

depth increased by 0.66±1.02. Also, an increase in the lower sulcus depth in relation to H line (0.56) ($p<0.001$) was reported by Sundareswaran et al.[13] But in the present study, the increase of 0.20±0.27 in the >18 year age group (adult group) was statistically not significant. Moseling and Woods[30] found the lower lip depth to increase by 0.74±1.19 with reference to lower vermillion point to soft tissue pogonion.

The changes observed following first premolar extraction correction in BMP cases in present study revealed the difference in depth point B‘ relative to the constructed anterior soft tissue reference line (B‘LiPog‘).

5. Conclusion

Among the soft tissue parameter studied, there is a statistically significant decrease observed for ULST, B‘-PM line, B‘-LiPog‘, A‘-PM line, LLIT, LLVT and Pog-Pog‘. These changes contribute to enhanced facial harmony and aesthetics. It is necessary to study the combined effect of growth and treatment in orthodontic patients, because most of the patients treated by orthodontist are growing patients.

6. Source of Funding

None.

7. Conflict of Interest

None.

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