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Original Research

The influence of extraction treatment on soft-tissue cephalometric measurements – A retrospective study

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ABSTRACT:
Background - A harmonious soft tissue profile, an important treatment goal in orthodontics, is sometimes difficult to achieve, partly because the soft tissue overlying the teeth and bones is highly variable in its thickness. **Aim -** The aim of this study was to determine influence of first premolar extraction on soft tissue profile in orthodontic patients and possible gender differences between pre- and post-treatment values. **Method-** Pre-treatment and post-treatment lateral cephalogram of 80 patients were analyzed with respect to linear parameters. A paired samples t test was carried out to know the difference in pre & post treatment measurements of the nine parameters in males and females and unpaired t test was used to know the differences in the pre-treatment & post-treatment measurements in Males & Females. **Results-** There was statistically significant difference between all the pre-treatment & post treatment parameters. The post-treatment measurements of H angle, soft tissue subnasale to H line, upper-lip strain, E line (Upper & Lower) & Angle of facial convexity decreased significantly ($p = <0.001$). The post-treatment measurements of Nose prominence, upper-lip thickness, Merrifield's Z angle increased. **Conclusion-** The results of this study indicate that there is considerable effect of extraction of first premolars on the soft tissue profile, as suggested by all soft tissue parameters of current study which show significant changes in post-treatment value.
Keywords - First premolar extraction, H Angle, Merrifield's Z angle, upper-lip thickness.

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INTRODUCTION

Facial balance and harmony are the important pillars of orthodontic treatment. Esthetics is based on the architecture and topographic relationships of the facial skeleton. However, it is the overlying soft tissues and their relative proportions that enhance esthetics of face. It is seen that with growth of facial skeleton there is change in soft tissue. Orthodontic mechanotherapy also causes changes in soft tissue.[1] The major change in 20th century was the re-orientation of orthodontics to

the soft tissue paradigm. This soft tissue paradigm states that both the goals and limitations of orthodontic treatment are established more by soft tissue considerations than skeletal/dental relationship.[2] Thus soft tissue relationships and adaptations have become the primary goal of orthodontic treatment. Adaption of Soft tissue to the position of the teeth determine whether or not the orthodontic result will be stable.[2] Clinical observations have shown that balance between dental and perioral muscles are important to obtain stability of the attained orthodontic results, must be achieved.[3]

It has been long recognized that the extraction of premolars often is accompanied by changes in the soft-tissue profile.[4] Orthodontic correction of bimaxillary protrusion results in favorable soft and hard tissue changes, with facial profile straightening and lip posture improvement.[5]

AIM OF THE STUDY

The aim of this study was to determine influence of first premolars extraction on soft tissue profile in orthodontic patients and to identify gender differences between pre-treatment and post-treatment measurement.

MATERIALS AND METHODS

This retrospective study was designed to evaluate the differences in soft-tissue characteristics as determined by the soft-tissue analysis of orthodontic patients treated with extraction of four first premolars. A total of 80 patients (36 males and 44 females) treated in the Department of Orthodontics were included in this study. Lateral cephalometric films were obtained before treatment (T1) and after treatment (T2). The age range of the patients at the beginning of treatment was between 14-24 years. Data were collected from pre- and post-treatment lateral cephalometric radiographs of 80 patients.

Inclusion Criteria

- Subjects in whom all four first premolars were extracted for orthodontic treatment.
- Conventional lateral cephalogram.

Exclusion criteria:

- Subjects undergone functional appliance therapy or surgical procedure.
- Lateral cephalogram in which the subject's lips were not in rest position.
- Congenitally missing teeth (excluding third molars).
- Digital lateral cephalogram.

Cephalometric records

The procedure followed uniformly for entire sample was as described below:

Pre-treatment and post-treatment lateral cephalogram of 80 adult patients was taken in natural head position with rotograph 230 eur Villa sistemimedicali. A single operator performed the tracings in a standardized manner to avoid error due to inter operator variations.

The following measurements were used

Reference plane

1. Frankfort- horizontal plane – line joining porion to orbitale (lower most point of orbit)

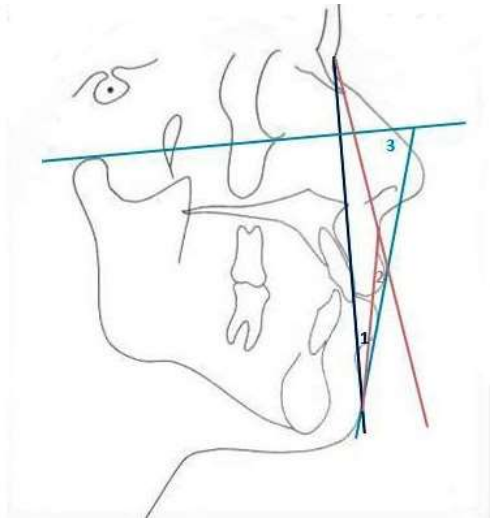

FIG 1: 1-H angle, 2- angle of facial convexity, 3-Merrifield's Z angle

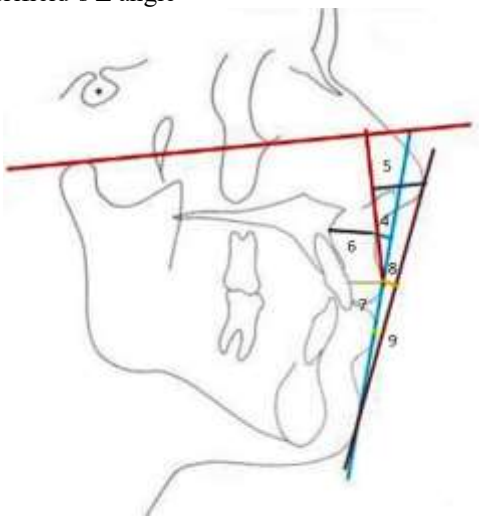

FIG 2: 4- Soft tissue subnasale to H line, **5**-Nose Prominence, **6**-Basic upper lip thickness, **7**- Upper lip thickness, **8**- E line (Upper), **9**- E line (Lower)

Angular measurements (Fig 1)

1. **H angle**[6] -The angle formed between the soft-tissue facial plane line and the H line.
2. **Angle of facial convexity**[7] **–** The dimension between soft tissue glabella to subnasale and the line Sn to soft-tissue pogonion.

3. **Merrifield's Z angle[8] –** It is a angle formed by a tangent drawn to the soft-tissue chin (Pog‟) and to the anterior most point on most protrusive lip.

Linear measurements (Fig 2)

4. **Soft tissue subnasale to H line[6] –** Its horizontal measurement from soft tissue subnasale to the H line.
5. **Nose prominence[6] -** The measurement between the tip of the nose and line drawn perpendicular to the Frankfort horizontal plane from the vermillion.
6. **Upper lip thickness**[6] -The measurement between the labial surface of the upper incisor and the vermillion point
7. **Upper lip-strain [6]-**The difference between the basic upper-lip thickness and the upper-lip thickness.
8. **E line[9] –** The E-line is drawn from the tip of the nose to the soft tissue pogonion.

Method error test

16 radiographs (20%) were randomly selected to determine errors in the radiographic measurements (pre-treatment& post-treatment) , their tracings and measurements were repeated three weeks after the first measurement. A paired samples *t*-test was applied to the first and second measurements.

RESULTS

A paired samples t test was carried out to know the difference in pre & post treatment measurements of the nine parameters (Table I). The post-treatment measurements of H angle, upper-lip strain ,soft tissue subnasale to H line, E line (Upper & Lower) & Angle of facial convexity decreased significantly (p = <0.001). The post-treatment measurements of Nose prominence, upper-lip thickness, Merrifield‟s Z angle increased. These differences were statistically significant (*P* =<0.001).

Table I- Comparison of pre & post treatment parameters in the study subjects (Paired t test)

N=80	Pre-treatment		Post-treatment		Statistical analysis			
Parameters	Mean	SD	Mean	SD	Mean Difference	SD	t value	p value
H angle (°)	24.0	3.7	20.6	4.2	3.5	2.8	11.3	<0.001*
Soft tissue subnasale to H line (mm)	10.5	2.2	7.8	2.3	2.7	2.1	11.5	<0.001*
Nose prominence (mm)	8.4	3.1	11.8	3.4	-3.4	2.4	-12.8	<0.001*
Upper lip thickness (mm)	11.2	2.0	13.0	2.3	-1.8	1.6	-9.8	<0.001*
Upper lip-strain (mm)	3.7	1.9	1.9	1.4	1.8	1.5	10.5	<0.001*
E line upper (mm)	1.4	1.9	-1.4	2.3	2.9	1.6	16.2	<0.001*
E Line Lower (mm)	4.5	2.6	1.9	2.3	2.6	1.9	12.2	<0.001*
Angle of facial convexity (°)	23.3	5.2	20.9	4.9	2.4	2.5	8.7	<0.001*
Merrifield's Z angle	55.3	8.3	61.1	7.9	-5.8	4.9	-10.5	<0.001*

A paired samples t test was carried out to know the difference in pre & post treatment measurements of the nine parameters in males and females (Table II & III). There was statistically significant difference between all the pre-treatment & post treatment parameters in Males and Females (P = <0.001)

Table II - Comparison of pre & post treatment parameters in males (Paired t test)

MALES (n=36)	Pre-treatment		Post-treatment		Statistical analysis			
Parameters	Mean	SD	Mean	SD	Mean Difference	SD	t value	p value
H angle (°)	25.2	4.3	21.7	4.8	3.6	3.2	6.8	<0.001*
Soft tissue subnasale to H line (mm)	11.1	1.9	8.6	2.7	2.5	2.3	6.6	<0.001*
Nose prominence (mm)	8.8	3.6	11.7	3.8	-2.9	2.7	-6.6	<0.001*
Upper lip thickness (mm)	12.2	1.9	13.8	2.3	-1.6	1.5	-6.3	<0.001*
Upper lip-strain (mm)	3.5	1.6	1.7	1.1	1.8	1.4	7.8	<0.001*
E line upper (mm)	2.0	1.7	-0.9	2.5	2.9	1.8	9.7	<0.001*
E Line Lower (mm)	5.0	2.4	2.2	2.2	2.8	2.3	7.3	<0.001*
Angle of facial convexity (°)	25	5.6	22.5	5.5	2.4	2.4	6.1	<0.001*
Merrifield's Z angle	52.5	6.8	58.8	7.7	-6.3	5.2	-7.2	<0.001*

Table III - Comparison of pre & post treatment parameters in females (Paired t test)

Females (n=44)	Pre-treatment		Post-treatment		Statistical analysis			
Parameters	Mean	SD	Mean	SD	Mean Difference	SD	t value	p value
H angle (^{0})	23.1	2.9	19.7	3.4	3.4	2.4	9.3	<0.001*
Soft tissue subnasale to H line(mm)	10.1	2.4	7.1	1.8	2.9	2.0	9.7	<0.001*
Nose prominence (mm)	8.0	2.7	11.9	3.2	-3.8	2.1	-12.0	<0.001*
Upper lip thickness (mm)	10.4	1.7	12.3	2.0	-1.9	1.7	-7.4	<0.001*
Upper lip-strain (mm)	3.8	2.1	2.0	1.6	1.8	1.6	7.3	<0.001*
E line upper (mm)	1.0	1.9	-1.9	2.0	2.8	1.4	13.2	<0.001*
E Line Lower (mm)	4.1	2.7	1.6	2.3	2.5	1.6	10.4	<0.001*
Angle of facial convexity (^{0})	22	4.3	19.6	3.9	2.4	2.6	6.2	<0.001*
Merrifield's Z angle	57.5	8.9	63	7.5	-5.4	4.7	-7.6	<0.001*

Unpaired t test was used to know the differences in the pre-treatment & post treatment measurements in Males & Females (Table IV & V). There was statistically significant difference between males and females in pre-treatment measurements of H angle (p= 0.01), Soft tissue subnasale to H line (p= 0.048), Upper lip thickness (p= <0.001), E line upper (p= 0.019), Angle of facial convexity (p= 0.008), Merrifield's Z angle (p= 0.006). All the measurements were significantly more in Males except Merrifield's Z angle which was more in females. There was no significant difference between males & females in pre treatment measurements of nose prominence, Upper lip strain, E line lower.

Table IV -Comparison of pre - treatment parameters between Males & Females (unpaired t test)

	Pre treatment (Males n=36)		Pre-treatment (Females n=44)		Statistical analysis			
Parameters	Mean	SD	Mean	SD	Mean Difference	SE of Diff.	t value	p value
H angle (^{0})	25.2	4.3	23.1	2.9	2.2	0.8	2.7	0.010*
Soft tissue subnasale to H line (mm)	11.1	1.9	10.1	2.4	1.0	0.5	2.0	0.048*
Nose prominence (mm)	8.8	3.6	8.1	2.7	0.7	0.7	1.0	0.310
Upper lip thickness (mm)	12.2	1.9	10.4	1.7	1.7	0.4	4.3	<0.001*
Upper lip-strain (mm)	3.5	1.6	3.8	2.1	-0.3	0.4	-0.7	0.459
E line upper (mm)	2.0	1.7	1.0	1.9	1.0	0.4	2.4	0.019*
E Line Lower (mm)	5.0	2.4	4.1	2.7	0.9	0.6	1.6	0.124
Angle of facial convexity (^{0})	25.0	5.6	22	4.3	3.0	1.1	2.7	0.008*
Merrifield's Z angle	52.5	6.8	57.5	8.9	-5.0	1.8	-2.8	0.006*

Table V - Comparison of post - treatment parameters between Males & Females (unpaired t test)

	Post-treatment (Males n=36}		Post-treatment (Females n=44)		Statistical analysis			
Parameters	Mean	SD	Mean	SD	Mean Difference	SE of Diff.	t value	p value
H angle (^{0})	21.7	4.8	19.7	3.4	2.0	0.9	2.2	0.034*
Soft tissue subnasale to H line (mm)	8.6	2.7	7.1	1.8	1.4	0.5	2.9	0.005*
Nose prominence (mm)	11.7	3.7	11.9	3.2	-0.2	0.8	-0.2	0.819
Upper lip thickness (mm)	13.8	2.3	12.3	2.0	1.5	0.5	3.1	0.003*
Upper lip-strain (mm)	1.7	1.1	2.0	1.6	-0.3	0.3	-0.9	0.356
E line upper (mm)	-0.9	2.5	-1.9	2.0	0.9	0.5	1.9	0.064
E Line Lower (mm)	2.2	2.2	1.6	2.3	0.7	0.5	1.3	0.187
Angle of facial convexity (^{0})	22.5	5.5	19.6	3.9	3.0	1.1	2.8	0.006*
Merrifield's Z angle (^{0})	58.8	7.7	63.0	7.5	-4.2	1.7	-2.5	0.016*

There was statistically significant difference between males and females in post-treatment measurements of H angle (p= 0.034), Soft tissue subnasale to H line (p= 0.005), Upper lip thickness (p= 0.003), Angle of facial convexity (p= 0.006), Merrifield's Z angle (p= 0.016). All the measurements were significantly more in Males except Merrifield's Z angle which was more in females. There was no significant difference between males & females in post treatment measurements of nose prominence, Upper lip strain, E line (lower & upper).

16 radiographs (20%) were randomly selected to determine errors in the radiographic measurements (pre-treatment& post-treatment), their tracings and measurements were repeated three weeks after the first measurement. A paired samples *t*-test was applied to the first and second measurements. A Pearson product-moment correlation was performed to determine the relationship between initial & repeat measurements for all the nine parameters. There was a strong, positive correlation between initial & repeat (pre-treatment) measurements, which were statistically significant for all parameters. Correlation analysis showed the highest *r* value of 0.996for Merrifield's Z angle and the lowest *r* value of 0.796 for H angle.

DISCUSSION

Harmonious soft tissue profile is a vital treatment goal in orthodontic patient, which is sometimes difficult to attain because of the variability in thickness of overlying soft tissue of the teeth and bones. These variations are due to imbalance of the skeletal and dental structures as well as a result of variations in the size and tone of the soft tissues of individual. Orthodontist can use cephalograms to determine the changes that are associated with growth and/or Orthodontic treatment. These cephalograms can be used to identify the severity of existing dentofacial discrepancies.

Holdaway[10], Ricketts[11] and Burstone[12] have published fundamental literature on the soft tissue relationship with dentoskeletal structures. Subtelny[13] indicated that change in soft tissue profile does not directly relate to the underlying skeletal profile. According to Burstone[12] change in soft tissue thickness covering the skeletal profile is independent. Downs[14] indicated that extraction of teeth in many cases required to maintain and restore harmony and balance of the facial component of the face.

In the literature, most studies have shown the predictive relationship between lip position and incisor retraction is due to profile change during orthodontic tooth movement.[15-18] The inferoposterior angle formed by the intersection of Frankfort horizontal plane and H line was called the ''Z angle". It gives indication of the anteroposterior position of the lips and chin.[19]

In current study nine parameters were analyzed. There was statistically significant difference between all the pre-treatment & post treatment parameters. The post-treatment measurements of H angle, upper-lip strain, soft tissue subnasale to H line, E line (Upper & Lower) & Angle of facial convexity decreased significantly (p = <0.001). The post-treatment measurements of Nose prominence, upper-lip thickness, Merrifield's Z angle increased. These differences were statistically significant (*P* =<0.001).

A retraction of the upper lip may or may not be caused by the retraction of the maxillary incisors. Factors other than the maxillary incisor retraction may have a greater influence on the upper-lip response like anatomical variation of the upper lip and difficulty in assessing the tension in the lips while taking cephalometric radiographs.[20] In the current study, statistically significant change occurred between the pre- and post-treatment records of basic upper-lip thickness and statistically significant sex differences were found.

The H angle can be used as a guide in planning the anteroposterior position of the denture to give proper lip support and a natural unstrained drape of the soft tissues covering the denture area of the face.[10] It measures the prominence of the upper lip in relation to the overall soft-tissue profile.[10] This measurement shows a significant decrease during the orthodontic treatment (*P* <.0001). Basciftci FA et al[21] indicated significant differences in Holdaway's H angle and Merrifield's Z angle in both extraction and non extraction group. EC Zierhut et al[22] reported that the H angle decreased similarly throughout the study period in both groups. A study done by Shobha Sundareswaran, Ravisankar Vijayan shows significant change in H angle And Merrifield Z angle.[5]

Anderson et al[23] found that soft-tissue thickness of the upper lip increased after lip was being retracted during treatment. According to Ricketts, for every 3 mm of incisor retraction the lips would increase in thickness 1 mm. According to Talass et al[20] and Ricketts[24] retraction of the maxillary incisor would leads to increases in upper lip thickness. Subtelny[14] and Nanda et al[25] reported mild increases in upper lip thickness after retraction of the maxillary incisor. A study by ND Alqahtani et al[26] shows no significant difference in terms of change in upper lip thickness in response to upper incisor retroclination.

Rickets introduced the esthetic plane that is a line tangent to tip of nose & soft tissue pogonion.[9] According to him in adult females lower lip is located 2 mm posterior to the line while upper lip is 4 mm posterior to the line. According to Caplan et al[27], a significant retraction is seen of upper & lower lip post treatment. Tan et al[28] conducted a study in which lip protrusion was reduced in relation to E line. A study conducted by Bills et al[29] concluded that premolar

extraction can reduce soft tissue procumbency in patients with bimaxillary protrusion. Their study showed the retraction of lower lip was by 2.4 mm while that of upper lip was 3 mm. In the current study upper lip retracted by 2.9 mm on average and lower lip by 2.6 mm on average. Young et al[30] conducted a study in which they recorded that there is an average decrease of 0.5-2 mm in lip protrusion post treatment.

Many studies report change in H angle is more in males than in females[31][32] with a exception of a study done by Hasund et al[33] which showed similar H angle measurements in males & females. Basciftci et al[6] have stated that there was no statistical difference existed in soft tissue position between boys and girls after orthodontic treatment. A study done by Baum[34] concluded that there were differences in the soft tissue tendencies in males & females. Therefore, all soft-tissue changes in current study were statistically examined selectively for each sex.

LIMITATIONS OF THE STUDY

Predictability of soft tissue changes concomitant with first premolar extraction varies with sample size. The larger the sample, the smaller the variation. This study was small to support a positive declaration about clinical cases under consideration for treatment.

SCOPE OF THE STUDY

- Larger sample sizes can be used investigate difference before and after orthodontic treatment perspectively.
- 3D evaluation of soft tissue changes before and after orthodontic treatment can be studied perspectively

CONCLUSION

- The results of this study indicate that there is considerable effect of extraction of first premolars on the soft tissue profile, as suggested by all soft tissue parameters of current study which show significant changes in post-treatment value.
- When the pre- and post-treatment measurements after orthodontic treatment were compared, statistically significant differences were found in all parameters.
- The changes in soft-tissue measurements in male and female samples during the extraction treatment showed similarities in some parameters, in other parameters statistically significant differences were found between the two sexes.

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