Original Research Paper

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Cephalometric Evaluation of Lip Strain and Nasolabial Angle Changes Following Orthodontic Treatment with First Premolar Extractions: A Retrospective Study

Abstract:

Background: Orthodontics aims to correct malocclusions for improved aesthetics, function, and structural balance. Extraction of teeth, particularly first premolars, is often necessary to gain space for treating crowding, proclination, and sagittal discrepancies. This is especially relevant in cases like bimaxillary protrusion, where extraction enhances facial aesthetics by reducing lip procumbency. Lip strain and nasolabial angle, key considerations in treatment planning, are influenced by incisor retraction. However, the correlation between these factors remains debated across different ethnicities.

Aim: To evaluate and compare changes in the nasolabial angle and lip thickness before and after orthodontic treatment in bimaxillary protrusion cases treated with first premolar extractions.

Materials: A retrospective cephalometric study was conducted on 50 adult patients with bimaxillary protrusion treated with first premolar extractions. Pre- and post-treatment lateral cephalograms were evaluated. The sample included Angles Class I malocclusion and proclined incisors, treated with pre adjusted edgewise appliances. Lip strain and nasolabial angle were measured using standard cephalometric tracing techniques.Statistical analysis was conducted using a paired t-test.

Results: The results showed significant changes in both lip strain and nasolabial angle following orthodontic treatment. Overall, both male and female participants exhibited reductions in lip strain and increases in nasolabial angle, with statistical significance ($p<0.05$). Lip strain changes were more pronounced in females ($p<0.001$) compared to males , while nasolabial angle changes were highly significant for both genders ($p<0.005$)

Conclusion: Significant enhancements in nasolabial angle and lip strain were observed following orthodontic treatment, with more pronounced soft tissue changes in female participants.

Key-words: Cephalometrics, Lip strain, Nasolabial angle, orthodontics.

Introduction:

Orthodontics is a dental specialty focused on the diagnosis and treatment of malocclusions to enhance aesthetics, function, and the structural harmony between hard and soft tissues. A primary objective for many orthodontic patients is to achieve improved aesthetics upon completion of treatment. Effective correction of various malocclusions often necessitates the creation of space for optimal tooth positioning, particularly in cases of crowding, proclination, and derotation of anterior teeth.

Common methods for space gaining include proximal stripping, expansion, and the extraction of permanent or primary teeth, with extraction frequently employed to facilitate orthodontic correction. Indications for tooth extraction during orthodontic treatment may include arch length discrepancies, tooth material discrepancies, and the

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correction of sagittal interarch relationships. Premolars are the most commonly extracted teeth in orthodontic practices, as their removal typically provides adequate space for addressing crowding and proclination. Notably, Charles (1940) reported that post-treatment occlusion was more stable in patients who underwent extraction of all first premolars.

Bimaxillary protrusion is characterized by the protrusion and proclination of both upper and lower incisors, resulting in increased lip procumbency[1]. This dental configuration typically produces a convex facial profile and enhances the forward positioning of the lips[2]. In patients with bimaxillary protrusion, the vermilion height may be significantly elevated due to the inclination of the anterior teeth. Consequently, extraction of the maxillary and mandibular first premolars is often performed to create space, thereby improving facial aesthetics by the conclusion of orthodontic treatment.

Lip strain, a cephalometric concept first introduced by Holdway, is defined as the difference between the actual upper lip thickness and the baseline upper lip thickness. Protrusion of the maxillary or mandibular incisors often compels patients to make efforts for lip closure, resulting in lip strain, which is associated with hyperactivity of the mentalis muscle and elevation of the chin integument[3]. Vertical lip thickness plays a crucial role in determining the attractiveness of a smile; therefore, the relationship between incisor protrusion and upper lip thickness should be carefully considered during orthodontic treatment planning[4].

The nasolabial angle is a critical parameter in orthodontic treatment planning, defined as the angle formed between the lower border of the nose and a line drawn from the intersection of the nose and upper lip to the lip tip. The normal range for this angle is 102° to 110°. It tends to decrease in patients with proclined upper anterior teeth or a prognathic maxilla, while it increases in individuals with a retrognathic maxilla or retroclined maxillary anterior teeth. According to Franklin D. Lo, the nasolabial angle remains relatively stable with growth. Moreover, an increase in the nasolabial angle has been found to correlate significantly with the degree of maxillary incisor retraction during the treatment of various malocclusions[5]. Nils Roos noted that changes in the skeletal profile do not always result in corresponding changes in the soft tissue profile.

Numerous studies in the past have described the relationship of maxillary and mandibular incisor retraction to changes in upper and lower lip. Values of these studies varied according to different ethnicities. However, the nature of correlation between incisor retraction and lip adaption is still controversial. so the present study evaluated the effects of tooth extraction on the nasolabial angle and lip strain in patients treated with all first premolar extraction and orthodontic mechanotherapy.

Materials:

A retrospective cephalometric study was conducted on 100 adult patients treated with all first pre molars extraction. Ethical clearance was obtained from institutional ethical committee. Pre treatment and post treatment Lateral cephalograms of the patients were evaluated before and after orthodontic treatment. Records of these patients were collected from the Department of Orthodontics and Dentofacial Orthopedics, Drs Sudha and Nageswara Rao Siddhartha institute of dental sciences, chinnaoutpalli. Samples were selected based on the following

Inclusion criteria:

- Indian ethnic group with dentoalveolar class I malocclusion.
- Proclined upper and lower incisors and protrusive lips.
- Patients in whom all first pre molars were extracted to treat bimaxillary protrusion & crowding.
- All patients who were treated with pre adjusted edge wise appliance (0.0022" slot with MBT PRESRIPTION)
- Conventional anchorage.
- Both pre and post treatment lateral cephalograms which were taken with patient's lips in rest and teeth in centric occlusion.

Exclusion criteria:

- Patients with class II &III dentoskeletal malocclusion.
- Patients from other ethnic groups were not included.
- Patients who were treated with non extraction and other extraction.
- Patients who were treated with functional appliances or head gear therapy

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Materia lsuse Dare:

1. 100 pre and post treatment lateral cephalograms.
2. Lead Acetate Tracing sheets
3. Lead pencil (0.3mm)
4. Viewing box
5. Adhesive tape
6. Protractor and Ruler.

Methodology:

Tracing Sheet was stabilized to the lateral cephalogram using adhesive tape, orientation marks were drawn on the lateral cephalogram and the same were reciprocated on to the tracing sheet. A 0.3mm lead pencil was used to trace the hard and soft tissue outlines and land marks.

Measurement of the nasolabial angle was done by drawing a tangent from the base of the nose and another tangent was drawn to the upper lip and the angle was measured Using a protractor.

The next measurement was the lipstrain. Lip strainis the difference in upper lip thickness and basic upper lip thickness seen on the later alcephalogram. Upper lip thickness was measured from the most labial point of upper incisor and most prominent point on the upper lip, where as the basic upper lip thickness is measured from A point marked 3mm below the hard tissue point A and most prominent point on the upper lip. Difference between the seme asurements is noted as lip strain.

LIPSTRAIN=BASIC UPPERLIP THICKNESS-UPPER LIP THICKNESS:

All the pre treatment and post treatment later alcephalograms were traced and the changes in nasolabial angle and lip strain were evaluated by single observer in or dertopreventbias. Statistical tests and analys is were doneusing SPSS Version 20.0 (IBM, Armonk).

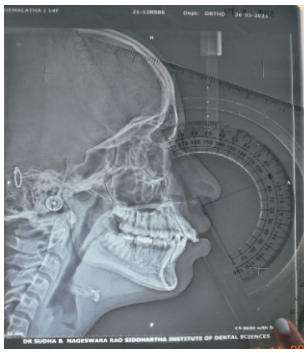


Figure1:-measuringof Nasolabialangle

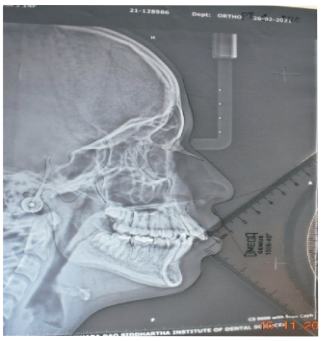


Figure2: Measuring of Upper Lip Thickness

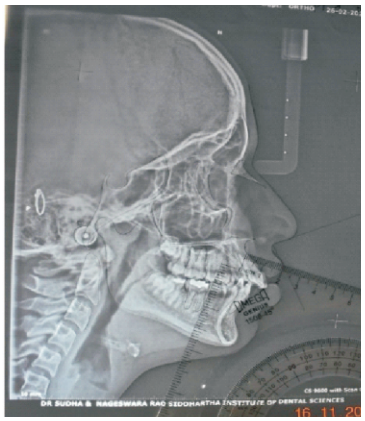


Figure3: Measuring of Basic Upperlip Thickness

Results:

The collected data was statistic allyanalysedusing SPSS Version 20.0 (IBM, Armonk). The data is checked for the normality using Shapiro Wilk test ($p<0.65$) and it showed that the data is of normal distribution. Descriptive statistics were calculated followed by paired t test was conducted for intra group comparison.

Table1:Comparison of pre and post lips train in the participants with paired t test

Lip strain		N	Mean±SD	Std.Error Mean	Sig.
	Pre	25	5.24±2.76	0.554	p<0.001*
	Post	25	2.52±1.22	0.244	

*Statistical significance level set as **p<0.05***

Table 1 shows the result of comparison of pre and post lip strain in the participants with paired t test. It was observed that there is high significance between pre and post measurements pertaining to Nasolabial angle when all the participants were considered, where statistical significance level set as P<0.05*

Table2: Comparison of pre and post lip strain in female participants with paired t test

Lip strain		N	Mean±SD	Std.Error Mean	Sig.
	Pre	13	5.96±3.57	0.991	p<0.001*
	Post	13	2.15±1.12	0.312	

*Statistical significance level set as **p<0.05***

Table 2 shows the result of comparison of pre and post lip strain in female participants with paired t test. It was observed that there is high significance in pre and post nasolabial angle, where statistical significance level set as p<0.005*

Table3: Comparison of pre and post Lip stain in Male participants with paired t test

Lip strain		N	Mean±SD	Std.Error Mean	Sig.
	Pre	12	4.46±1.23	0.356	p<0.019*
	Post	12	2.92±1.24	0.358	

*Statistical significance level set as **p<0.05***

Table 3 shows the result of comparison of pre and post lip strain in male participants with paired t test. It was observed that there is high significance in pre and post naso labialangle, where statistical significance level set as P<0.005*

Table 4: Comparison of pre and post Nasolabial angle in the participants with paired t test

Nasolabi alangle		N	Mean±SD	Std.Error Mean	Sig.
	Pre	25	84.48±11.32	2.26	p<0.001*
	Post	25	92.68±10.81	2.16	

*Statistical significance level set as **p<0.05***

Table 4 shows the result of comparison of pre and post nasolabial angle in the participants with paired t test. It was observed that there is high significance between pre and post measurements pertaining to Nasolabial angle when all the participants were considered, where statistical significance level set as P<0.05*

Table 5: Comparison of pre and post Nasolabial angle in female participants with paired t test.

Nasolabi alangle		N	Mean±SD	Std.Error Mean	Sig.
	Pre	13	82.15±9.127	2.531	p<0.001*
	Post	13	91.08±9.115	2.528	

*Statistical significance levels et as**p<0.05***

Table 5 shows the result of comparison of pre and post nasolabial angle in female participants with paired t test. it was observed that there is high significance in pre and post nasolabial angle in female participants, where statistical significance level set asP<0.005*

Table 6: Comparison of pre and post Nasolabial angle in Male participants with paired t test

Nasolabi alangle		N	Mean±SD	Std.Error Mean	Sig.
	Pre	12	87.00±13.25	3.826	p<0.002*
	Post	12	94.42±12.5	3.632	

*Statistical significance level set as **p<0.05***

Table 6 shows the results of comparison of pre and post Nasolabialangle in male participants with paired t test. It was observed that there is high significance in pre and post lip strain in male participants From the above result, it was observed that there is high significance in pre and post Nasolabialangle and Lip strain in female participants than male participants.

Chart1: Representing pre and postmean values of Lip strain in females and males.

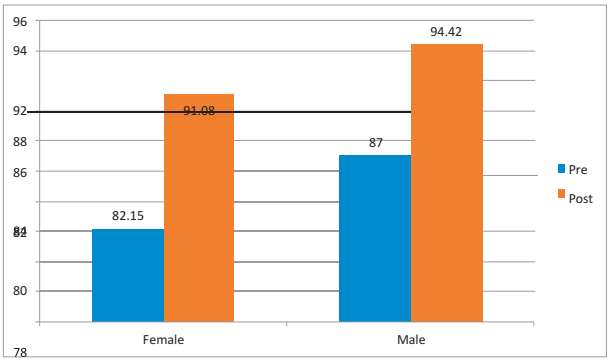
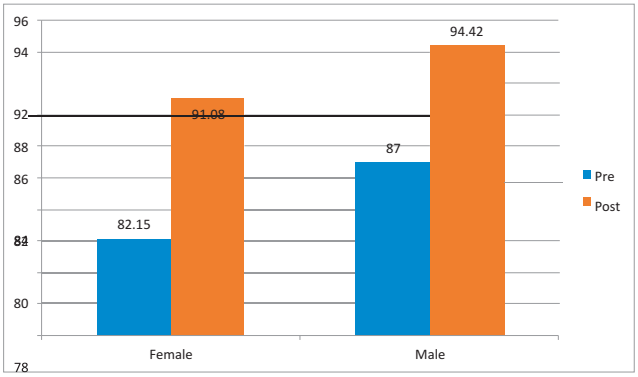


Chart2:-Representing pre and postmean values of Nasolabialanglein females and males.



Discussion:

Orthodontics is the branch of dentistry concerned with prevention interception and correction of malocclusion and other abnormalities of dental facial region. Malocclusions often result in undesirable functional, aesthetic, and muscular imbalances. Additional consequences include an increased risk of dental caries, temporomandibular joint (TMJ) disorders, such as pain and dysfunction, speech alterations, and swallowing difficulties. Patients seeking orthodontic treatment are typically motivated not only by concerns about facial aesthetics but also by a desire to address psychological distress related to facial and dental appearance, ultimately aiming to improve their social well-being.

Historically, treatment strategies in orthodontics were primarily based on hard tissue parameters derived from

lateral cephalograms. However, with evolving practices, a significant shift towards the soft tissue paradigm has emerged. As noted by William R. Proffit, in modern orthodontic and orthognathic treatment, treatment goals and limitations are determined predominantly by the soft tissues of the face rather than by the teeth and bones. Facial soft tissues not only undergo continuous changes with aging, but these changes are also more pronounced than those observed in the hard tissues of the face and jaws.

Cephalometric radiography has allowed orthodontists to quantify changes in tooth and jaw positions resulting from growth and treatment. The primary objective of cephalometric analysis is to assess the skeletal and dental relationships contributing to malocclusion. Its most critical clinical application lies in recognizing and evaluating the effects of orthodontic treatment. With the increasing emphasis on the soft tissue paradigm, there has been a growing focus on incorporating soft tissue cephalometric analysis as an integral component of routine orthodontic diagnosis.

The majority of orthodontic patients require additional space for correction, particularly in cases of malocclusion such as crowding or proclination. Various techniques are employed in orthodontics to create this space, including interproximal reduction (proximal stripping), arch expansion, tooth extraction, and derotation of posterior teeth. Protrusion of the teeth in both jaws, a condition known as bimaxillary dentoalveolar protrusion, often necessitates extraction to achieve significant improvements in the soft tissue profile. A study conducted by Afifty R[6] demonstrated that premolar extractions in such cases lead to a substantial reduction in soft tissue procumbency, a characteristic commonly observed in patients with bimaxillary protrusion.

Tooth extractions are commonly indicated for patients with both normal and abnormal jaw relationships, particularly in cases of Class I crowding or protrusion. The permanent first premolars are the teeth most frequently extracted in cases of crowding and bimaxillary protrusion. According to the study done by Alqahtant ND [7] on post orthodontic cephalometric variations in bimaxillary protrusion managed by premolar extraction have shown that there is marked increase innasolabial angle and upper lip length in relation to incisor retraction and retroclination in the patients treated with both maxillary and mandibular first premolars extraction. Results of the current study also showed increase in nasolabial angle following extraction of all four firstpremolars.

Contrast results are seen in a study conducted by Sandry S[8] et al, where conclusion was similar results were observed between 2 pre molar and all 4 pre molar extraction cases, the reason could be alteration in cases included in the study, ethnicity and variation in orthodontic mechano therapy.

Allgayer S[9] have conducted a study on influence of premolar extractions on the facial profile evaluated by the Holdaway analysis in patients treated with fixed edgewise appliances and different extraction protocol and concluded that patients who were treated with four pre molars extraction have significantly higher difference in soft tissue profile than patients who were treated with first two upper premolars and these results are similar to current study.

Bimaxillary dentoalveolar protrusion is seen in the facial appearance as, excessive separation of the lips at rest. The general guideline which holds for all racial groups is that lipseparation at rest should be not more than 0-1mm.

In patients with excessive incisor protrusion, retracting the incisors improves facial aesthetics. A study conducted by Iared W[10] et al on aesthetic perception of changes in facial profile resulting from orthodontic treatment with extraction of premolars have shown that in patients who initially had greater lip protrusion and more convex facial morphologies, extraction of premolar stented to be beneficial to the soft tissue profile. The size of the nose and chin has a profound effect on relative lip prominence.

Hold ways studies have shown that retraction of maxillary lip does not follow tooth retraction until the factor of lip strain has been eliminated. Similar results were seen in study conducetd by Kapoor S et al[2] in north indian population as the mean soft-tissuechanges was more in the unstrained lips compared to the strained lips and these results are similar in current study (Table 1).

In the present study nasolabialangle shows high significance after the orthodontic treatment in the patients who were treated with first premolars extraction. Where as in a study conducted by Franklin D et al[5] on changes in nasolabial angle related to maxillary incisor retraction in patients who were treated without extraction have shown that there is no significant change incor relation with amount of maxillary incisors retraction. So, a brief conclusion can be drawn that extraction significantly improves the Nasolabial angle which in turn beneficial to the soft tissue profile.

Similarly in some previous studies[11,12] on soft tissue profile changes in patients who were treated with premolars extraction have shown that there is significant increase in nasolabial angle regrading retraction of incisors.

In the present study, evaluation of changes in nasolabial angle and lip strain before and after orthodontic treatment was compared in male and females samples and results have shown that there is high significant change in females than males. When similar study was conducted by Roger M Diels et al[13] in African -Americans, results were in contrast and have shown that there is high significancein soft tissue profile changes in males than females. The reason might be the initial soft tissue thickness variation between these 2 ethnic groups(i.e.) South Indian and African-American

Nasolabial angle and lips train are two of important factors when evaluating soft tissue profiles. Other important soft tissue factors like soft tissue facial angle, lip and nosepromineces to H(line) (Holdaway analysis) etc also should be considered when planning anorthodontic case.

Following conclusions can be drawn from current study:

1. High significance between pre and post treatment measurements pertaining to Nasolabialangle when all the participants were considered
2. When the comparison is made based on gender, high statistical significance is observed in Nasolabial angle for females than the males.
3. There is high significance between pre and post treatment measurements pertaining to Lip strain when all the participants were considered
4. When the comparison is made based on gender, high statistical significance is observed in Lip strain for emales than the males.
5. Over all soft tissue changes are more in females when compared to males.

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