THE EFFECT OF ANTERIOR TEETH RETRACTION ON LIP POSITION WITH CHANGE IN LIP STRAIN IN ORTHODONTICALLY TREATED ADULT INDIAN POPULATION - A CEPHALOMETRIC STUDY

Authors:

Dr. Seema Gupta, MDS
Assistant Professor, Department of Orthodontics, Manipal College of Dental Sciences, Manipal, Karnataka, India

Dr. Surendra Shetty, MDS
Professor & Dean, Department of Orthodontics, Manipal College of Dental Sciences, Manipal, Karnataka, India

Dr. Subraya Mogra, MDS
Professor, Department of Orthodontics, Manipal College of Dental Sciences, Manipal, Karnataka, India

Dr. Sandeep Kumar, MDS
Assistant Professor, Department of Prosthodontics and Maxillofacial Prosthetics, Manipal College of Dental Sciences, Manipal, Karnataka, India

For Correspondence:
Dr. Seema Gupta
Assistant Professor
Department of Orthodontics & Dentofacial Orthopedics, Manipal College of Dental Sciences
Manipal-576104
Karnataka.
e-mail: mdsseema31@yahoo.com
Phone: 9964026747, 9844863754

Abstract: Background: There has been a controversy for past so many years regarding effect of anterior teeth retraction on the lip position of orthodontically treated individuals. Many factors influence the effect of upper teeth retraction on upper lip fall & one of such factor is the presence of lip strain. The present study was undertaken to see the effect of lip strain on the upper lip retraction with upper incisor retraction.

Material & Methods: The retrospective study was carried out in the department of orthodontics, Manipal College of Dental Sciences, Mangalore. Total 35 adults with Class I bimaxillary protrusion treated with all first premolar extraction were chosen for the study. Pre & post treatment cephalograms were traced manually & subjected to cephalometric analysis. The differences between the means were calculated using the Student’s paired T test & correlation among various variables was calculated by using Carl Pearson Correlation Coefficient (r).

Results: The positive correlation was found between amount of relief in lip strain with treatment & ratio of upper lip fall with upper incisor retraction i.e as the amount of lip strain will be relieved, the upper lip will follow the upper incisor retraction more closely. A negative correlation was found between pretreatment lip strain present in the patients & the ratio of upper lip fall with upper incisor retraction.

Clinical implications: In the patients with excessive amount of pretreatment lip strain, there will be less amount of profile improvement than the patients with minimal strain.

Key words: Lip strain, upper lip retraction, upper incisor retraction, lip protrusion.
**Introduction:**

Nearly every popular discussion of facial esthetics seems to begin & end with hoary aphorism that “Beauty is in the eyes of beholder”. Harmonious soft tissue profile is an important treatment goal in orthodontics & is sometimes difficult to attain because of soft tissue overlying teeth & bones is highly variable in thickness. Contemporary orthodontics includes treatment of dental & skeletal disharmonies with careful considerations of integumental features of the face. Disharmonies & disproportions of face, as well as, imbalances of lips & their surrounding musculature have been classified in various ways by Peck & Peck, Burstone, Ricketts & others. Whenever, there is protrusion of maxillary or mandibular incisors, attempts by patients to gain lip closure results in lip strain, which is accompanied by hyperactive mentalis muscle function & elevation of the integument of the chin. In most instances orthodontic treatment can correct this problem & produce a smooth contour of the soft tissues. Numerous studies in past adults have described the relationship of maxillary & mandibular incisor retraction to changes in upper & lower lips. Various retrospective clinical reports have tried to establish incisor-lip retraction ratios. However, the nature of correlation b/w incisor retraction & lip adaptation is still controversial.

The aim of the present study was to study the effect of retraction of maxillary & mandibular incisors on the position of upper & lower lips in the orthodontically treated individuals with four premolar extractions & to relate it to the amount of lip strain present in these patients.

**Materials and methods:**

A retrospective study was planned based on the cephalometric analysis performed on lateral head films obtained from a sample of 35 adults. Records of 100 patients were collected who were treated by different postgraduate students in the department of orthodontics, Manipal College of Dental Sciences, Mangalore. Out of which 35 cases were selected after going through their case history forms & lateral cephalograms, based on following selection criteria:

1. Indian ethnic group with dentoskeletal class I malocclusion.
2. Minimum age at start of treatment of 18 years to reduce growth effects.
3. Proclined upper & lower incisors & protrusive lips.
4. Patients in whom 4 first premolars were extracted to treat bimaxillary protrusion & to improve facial profile.
5. All patients were treated using either Begg or Preadjusted edgewise appliance (0.022" slot Roth prescription) with no Extraoral anchorage was used.
6. Both pre & post treatment lateral cephalograms were taken with patients' lips lightly closed & teeth in centric occlusion.

All lateral cephalograms were taken on a J. Morita X-Ray machine using high-speed polyester based on 18x24 cm Kodak Ektavision lateral head films. Double intensifying screens of Kodak X-Omat were used in the process. The unit was vertically adjustable to permit recording of standing subjects. The radiographs were exposed while the subjects had occluded the teeth in centric occlusion. All exposed films were developed and fixed under similar conditions to achieve uniformity of results. All the lateral cephalograms, which were obtained from the selected records, were traced under the same illumination and magnification.

For evaluation of dental & soft tissue changes by orthodontic treatment 11 linear & 5 angular cephalometric parameters were analyzed on lateral cephalograms. The following linear measurements were made:

a) Lower lip to H line - H line is the line joining soft tissue pog & upper lip.

b) Soft tissue chin thickness - Horizontal distance between two vertical lines representing hard tissue (line joining N & Pog) & soft tissue (line joining N' & Pog') facial planes.

c) Nose prominence - Line perpendicular to FH plane (line joining Porion & Orbitale) & running tangent to the vermillion border of upper lip is drawn. This measures the nose from the tip (PRN) in front of the line & the depth of the incuration of the upper lip to the line.

d) Upper lip sulcus depth - to determine upper lip form or curl, superior sulcus depth is measured to same perpendicular to FH plane, running tangent to the vermillion border to the upper lip.

e) Basic upper lip thickness (Basic ULT) - this is taken near the base of alveolar process, measured about 3mm below point A. This is at level below where nasal structures influence drape of upper lip. This measurement is useful, when compared to lip thickness overlying incisor crowns at the level of vermilion border, in determining amount of lip strain or incompetency present when patient closes his/her lips over protrusive teeth.
The cephalometric landmarks, linear & angular parameters used in this study are shown in figure 1, 2 & 3 respectively. The amount of retraction of upper & lower incisors was measured by readings of upper incisor to NA & lower incisor to NB line on pre & post treatment cephalograms of the patients. Since all individuals in the present sample had completed their growth, role of growth in causing soft tissue changes was eliminated. The amount of upper & lower lip fall was measured by readings of Ls-S line & Li-S line on pre & post treatment cephalograms of the patients. Using percentile groups for basic upper lip thickness, vermilion thickness & lip strain, statistical correlation between amount of lip fall & amount of retraction with respect to lip strain present in the study sample with orthodontic treatment were calculated. All linear measurements were measured to within 0.5 m. All angles were measured to within 0.5 degrees. All measured values were tabulated and statistically tested.

Statistical Procedure:
For each variable the mean, standard deviation & standard mean error were calculated. The differences between the means were calculated using the Student’s paired T test & correlation among various variables was calculated by using Carl Pearson Correlation Coefficient (r).

Observations and results:
Table I describes mean pre & post treatment readings & mean change in various parameters along with standard deviation & level of significance in 35 subjects. The mean changes in soft tissue facial angle, Lower lip to H line, nose prominence, upper lip to sulcus depth, nasolabial angle, interlabial angle, change in lip strain, interincisal angle, lower lip to S line, upper lip to S line, upper incisor to NA & lower incisor to NB were statistically significant whereas mean changes in down’s angle of convexity & soft tissue chin prominence were found to be statistically insignificant.

Table II describes ratio of upper & lower lip fall with upper & lower incisor retraction respectively.

Table III describes the positive correlation between amount of relief in lip strain with treatment & amount of upper lip fall with upper incisor retraction, which was statistically significant.

Table IV describes the negative correlation between amount of pre treatment lip strain & amount of upper lip fall with upper incisor retraction.

Discussion:
Orthodontic diagnosis & treatment planning have been influenced to a large extent by the existing views on changes occurring in the skeletal structures in connection with growth & treatment. Since skeletal structures form the foundation on which the soft tissues rest, it is understandable that the opinion has been widely held that changes in skeletal structures would be accompanied by corresponding soft tissue changes. Soft tissue profile does not in all respects, directly reflect changes in the underlying skeletal profile during orthodontic treatment. The actual situation is that certain parts of the soft tissue profile show a greater correlation with changes in underlying skeletal structures, while other parts tend to be more independent of changes in the skeletal profile. Gross
tooth movement may not always mean marked reduction of profile contour. Lip morphology is partly dependent on underlying hard tissue foundation.

Careful selection of patients for the present study substantially reduced many of the variables, which may have adversely affected the results of earlier studies. Samples were limited to adults with age greater than 18 years, which significantly reduced the effects of growth.

There are varying lip responses to retraction of the anterior teeth. Responses vary with type of lip structure & also with patients’ age & sex. Lips cannot close without conscious strained effort in great many of protrusive cases. Lips have to be strained or stretched over protrusive teeth for closure, which is seen as “Lip Strain” in these patients.

According to Holdway in 1983, lip strain must be considered when one is doing VTO if such objective is to be realistic. The basic upper lip thickness is measured at the level where nasal structures does not influence the drape of the lip. Usual thickness at vermilion border level is 13-14mm. Excessive taper is indicative of thinning of upper lip as it is stretched over protrusive teeth.

In order to study the effect of lip strain on amount of upper lip fall with upper incisor retraction, it was planned to test in 35 orthodontically treated subjects who had lip strain with protrusive lips & bimaxillary dentoalveolar protrusion. It was seen in the study undertaken that there was positive correlation between amount of relief in lip strain & amount of upper lip fall with upper incisor retraction (r=0.395, p=0.019). As lip strain is relieved more, excessive taper of upper lip is relieved & upper lip will follow upper incisor retraction more closely. This is in agreement with Holdway’s study (1983) & Oliver’s study (1982).

A negative correlation between amount of pretreatment lip strain & amount of upper lip fall with upper incisor retraction was also seen (r=-0.139, p=0.0327) i.e if pre treatment lip strain is more, there will be less amount of upper lip fall with upper incisor retraction.

A wide range of ratios have been reported in earlier studies relating upper lip to upper incisor retraction but it is of great importance to emphasize that this ratio may not be valuable in every patient because other factors- some of them still unknown- can modify it in a manner that is still not understood.

In the present study, the mean upper lip to upper incisor retraction was 0.46:1, while the lower lip to lower incisor retraction was 0.8:1 respectively. Greater fall of lower lip with lower incisor retraction may be explained by the influence of upper incisor on lower lip. Direct influence of both lips on lower lip could ensure retraction of that lip more, compared to upper lip. These values are in agreement with Nils Roos (0.4:1 for upper lip to upper incisor retraction & 0.9:1 for lower lip to lower retraction), Kenneth Lew (0.45:1 for upper lip to upper incisor retraction & 0.7:1 for lower lip to lower retraction). The correlation coefficients (r) were 0.72 & 0.80, respectively. These were comparable to those published by Rudee (1964) & Hershley (1972). Low correlation of upper lip fall with upper incisor retraction may be due to complex anatomy of upper lip. With upper lip retraction, there was increase in nasolabial angle, interlabial angle, interincisal angle & nose prominence while upper lip sulcus depth & lip strain decreased which showed a significant amount of retraction after four premolar extraction.

Summary & conclusion:

The following conclusions are drawn from the study:

- As the amount of lip strain is relieved during the orthodontic treatment by retraction of upper incisors, upper lip will start following upper incisors more closely.

- If pretreatment lip strain is more, there will be less amount of upper lip fall with upper incisor retraction during the treatment.

- The lower lip follows lower incisors more closely compared to upper lip to upper incisors.

- There was mean increase in nasolabial angle, interlabial angle, interincisal angle & nose prominence with treatment, whereas decrease was seen in soft tissue facial convexity, upper lip Sulcus depth & lower lip - H line. No significant change was seen in Down’s angle of convexity & soft tissue chin thickness.

Clinical implications:

Most of the patients seek orthodontic treatment for improvement in facial profile & most of them have bimaxillary protrusion. The common orthodontic treatment in these patients is extraction of four first premolars followed by retraction of incisors & reduction of procumbency of lips. But many factors influence
the outcome & presence of pretreatment lip strain is one of the most important factor. In the patients with excessive amount of lip strain, there will be less amount of profile improvement than the patients with less amount of lip strain & patient should be made aware of this fact before starting the treatment.

**Limitations of the study:**
In this study, one of the major problems in investigating soft tissue changes was the lip posture of the patients when cephalograms were taken. According to many studies, it has been established that soft tissue changes can be best evaluated when patients' cephalograms are taken in relaxed lip position. In this study however, all the cephalograms were taken with patients' lips lightly closed (closed lip position), as main aim of the study was to see the effect of lip strain on amount of upper lip fall with upper incisor retraction. This in agreement with lip posture used by Oliver\(^5\) (1982) in his study to see the influence of lip thickness & strain on upper lip response to incisor retraction. Hence, the soft tissue changes seen in this study might differ from soft tissue changes seen in other studies where relaxed lip posture was taken.

Improvement in methodology of this research may be obtained by use of electromyographic equipment & lip strain gauges to accurately record lip posture at rest.

**References:**

Figure Legends:

**Figure I:** Cephalometric landmarks. Nasion (N), Pogonion (Pog), Point A, Point B, Pronasale (PRN), Subnasale (Sn), Labrale Superius (Ls), Labrale Inferius (Li), Soft tissue pogonion (Pog’), Incisal edge and most labial point of the upper incisor and lower incisor, Soft tissue Nasion (N’), Soft tissue A point (A’), Inferior labial sulcus (ILs), Porion (Po), Orbitale (Or).

**Figure II:** Cephalometric linear parameters. Lower lip to H line, Soft tissue chin thickness, Nose prominence, Upper lip sulcus depth, Basic upper lip thickness, Upper vermillion thickness (ULT), Lip strain, Upper lip to S line, Lower lip to S line, Upper incisor to NA, Lower incisor to NB.

**Figure III:** Cephalometric angular parameters. Nasolabial angle, Interlabial angle, Soft tissue facial angle, Interincisal angle, Down’s angle of convexity.
Table I: Statistical data for mean pre & post treatment readings & mean change in various parameters along with standard deviation & level of significance.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>N</th>
<th>Pre</th>
<th>Post</th>
<th>Mean change</th>
<th>Standard deviation</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft tissue facial angle (in degs)</td>
<td>35</td>
<td>91.1000</td>
<td>89.7000</td>
<td>1.40000</td>
<td>3.06258</td>
<td>.011 sig</td>
</tr>
<tr>
<td>Down’s angle of convexity (in degs)</td>
<td>35</td>
<td>7.4857</td>
<td>6.8571</td>
<td>.62857</td>
<td>2.40203</td>
<td>.131 ns</td>
</tr>
<tr>
<td>Lower lip-H line (in mms)</td>
<td>35</td>
<td>4.2714</td>
<td>1.9571</td>
<td>2.31429</td>
<td>1.39371</td>
<td>.001 vhs</td>
</tr>
<tr>
<td>Soft tissue chin thickness (in mms)</td>
<td>35</td>
<td>10.4286</td>
<td>10.4286</td>
<td>.00000</td>
<td>1.32842</td>
<td>1.000 ns</td>
</tr>
<tr>
<td>Nose prominence (in mms)</td>
<td>35</td>
<td>10.0143</td>
<td>13.9143</td>
<td>-3.90000</td>
<td>2.07860</td>
<td>.001 vhs</td>
</tr>
<tr>
<td>Upper lip Sulcus depth (in mms)</td>
<td>35</td>
<td>4.4286</td>
<td>2.4286</td>
<td>2.00000</td>
<td>1.62245</td>
<td>.001 vhs</td>
</tr>
<tr>
<td>Nasolabial angle (in degs)</td>
<td>35</td>
<td>93.3429</td>
<td>101.0857</td>
<td>-7.74286</td>
<td>8.87940</td>
<td>.001 vhs</td>
</tr>
<tr>
<td>Interlabial angle (in degs)</td>
<td>35</td>
<td>100.8529</td>
<td>114.1246</td>
<td>-13.26471</td>
<td>12.94349</td>
<td>.001 vhs</td>
</tr>
<tr>
<td>Basic ULT (in mms)</td>
<td>35</td>
<td>14.6857</td>
<td>14.0857</td>
<td>.60000</td>
<td>1.85028</td>
<td>.063</td>
</tr>
<tr>
<td>ULT (in mms)</td>
<td>35</td>
<td>9.3286</td>
<td>12.2000</td>
<td>-2.87143</td>
<td>2.42942</td>
<td>.001</td>
</tr>
<tr>
<td>Lip strain (in mms)</td>
<td>35</td>
<td>5.5286</td>
<td>1.7429</td>
<td>3.78571</td>
<td>1.96770</td>
<td>.001 vhs</td>
</tr>
<tr>
<td>Interincisal angle (in degs)</td>
<td>35</td>
<td>108.6571</td>
<td>128.8286</td>
<td>-20.17143</td>
<td>11.30457</td>
<td>.001 vhs</td>
</tr>
<tr>
<td>Ls-S line (in mms)</td>
<td>35</td>
<td>3.3429</td>
<td>.80000</td>
<td>2.54286</td>
<td>2.00504</td>
<td>.001 vhs</td>
</tr>
<tr>
<td>Li-S line (in mms)</td>
<td>35</td>
<td>6.1286</td>
<td>2.4857</td>
<td>3.64286</td>
<td>2.02765</td>
<td>.001 vhs</td>
</tr>
<tr>
<td>Upper incisor-NA (in degrees)</td>
<td>35</td>
<td>8.3429</td>
<td>2.4857</td>
<td>5.85714</td>
<td>3.51587</td>
<td>.001 vhs</td>
</tr>
<tr>
<td>Lower incisor-NB (in degrees)</td>
<td>35</td>
<td>10.1429</td>
<td>5.7429</td>
<td>4.40000</td>
<td>2.35397</td>
<td>.001 vhs</td>
</tr>
</tbody>
</table>

p < 0.05 - significant (sig), p < 0.001 - very highly significant (vhs), ns - Not significant n - Denotes number of subjects
Table II: Statistical data for range, mean, standard deviation & correlation coefficient (r) for ratio between upper & lower lip fall with upper & lower incisor retraction

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. deviation</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio 1</td>
<td>35</td>
<td>-1.50</td>
<td>2.00</td>
<td>0.4661</td>
<td>0.61741</td>
<td>0.72</td>
</tr>
<tr>
<td>Ratio 2</td>
<td>35</td>
<td>-2.00</td>
<td>6.00</td>
<td>0.8279</td>
<td>1.39121</td>
<td>0.80</td>
</tr>
</tbody>
</table>

r - Correlation coefficient, Ratio 1 - Ratio between upper lip fall with upper incisor retraction, Ratio 2 - Ratio between lower lip fall with lower incisor retraction

Table III: Correlation between lip strain relief vs ratio of upper lip fall with upper incisor retraction (Ratio 1)

<table>
<thead>
<tr>
<th>Lip strain relief</th>
<th>Ratio 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>r</td>
<td>0.395</td>
</tr>
<tr>
<td>p</td>
<td>0.019 sig</td>
</tr>
<tr>
<td>n</td>
<td>35</td>
</tr>
</tbody>
</table>

n - number of subjects.

Table IV: Correlation between pretreatment lip strain & ratio of upper lip fall with upper incisor retraction

<table>
<thead>
<tr>
<th>Pretreatment lip strain</th>
<th>Ratio 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>r</td>
<td>-0.139</td>
</tr>
<tr>
<td>p</td>
<td>0.0327</td>
</tr>
<tr>
<td>n</td>
<td>35</td>
</tr>
</tbody>
</table>