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Original Research Article

Lip, tongue, airway changes after first premolar extraction and incisor retraction in orthodontically treated bimaxillary protrusion

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Abstract

Introduction: In cases of bimaxillary proclination, orthodontic treatment often involves retraction of the incisors to correct the protrusion of the lips. This can have a significant impact on the oral and pharyngeal structures, particularly the tongue and airway dimensions.

Aim & Objectives: To investigate post orthodontic lip position, tongue position and pharyngeal airway changes after all first premolars extraction with retraction of the incisor teeth in patients with bimaxillary protrusion.

Materials and Methods: Twenty patients fulfilling the criteria was selected. Two lateral cephalometric headfilms of the patients, one at the beginning of treatment (T0) and other at the end of treatment (T1), was obtained.

Parameters assessed for lip position was: Basic upper lip thickness (BULT) upper lip thickness (ULT), basic lower lip thickness (BLLT), lower lip thickness (LLT), upper lip length (ULL), lower lip length (LLL).

Parameters used to assess tongue, pharyngeal airway was: Tongue length (TGL), tongue height (TGH), superior posterior airway space (SPAS) (mm), middle airway space (MAS) (mm), inferior airway space (IAS) (mm), vertical airway length (VAL).

Result: This study showed significant decrease in BULT, LLT, TGL (P <0.05), while there was no significant changes SPAS and MAS (p<0.005). On the contrary, an increase in TGH, IAS and VAL (p<0.05) was seen.

Conclusion: Extraction of the first premolars for the treatment of bimaxillary proclination does not affect upper airway dimensions despite there was significant reduction in TGL, BULT, LLT and significant increase in TGH, IAS, VAS.

Keywords: Bimaxillary protrusion, Pharyngeal airway, Lip position, Tongue position, Cephalometric analysis

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1. Introduction

The complicated nature of Bimaxillary Proclination (BMP) appears to be influenced by a combination of environmental and genetic variables, including lip-sucking, tongue-pushing, mouth breathing, and increased tongue volume. A primary cause of bimaxillary proclination is the disparity in tooth sizes between the arch lengths. Reducing the proclination of the mandibular and maxillary incisors will enhance the patient's profile by lowering convexity and soft-tissue procumbency. This is the goal of orthodontic treatment for bimaxillary proclination. It's crucial to keep in mind that altering the position of the incisors, soft tissues, and arch will alter the position of the tongue and, therefore, the dimensions of the airway, as the majority of extraction spaces in patients with Bimaxillary Proclination are utilized for incisor retraction and lip procumbence correction.[1]

While the goals of Orthodontic therapy are stability, function, and aesthetics. Stability, masticatory function, and aesthetics are the main concerns of most treatments. Since respiratory function may have an impact on the stability of treatment outcomes, it should be considered while diagnosing and treating orthodontic patients.[2]

Since the goal of treating Bimaxillary Protrusion cases is to achieve an aesthetically superior profile and harmonious lip relationship, it is imperative to understand how changes in

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the relationship of soft tissues to skeletal and dental structures actually affect the treatment outcome with orthodontic tooth movement.[3]

The nasopharynx, oropharynx, and hypopharynx form the upper airway. The size and relative development of the soft tissues around the dentofacial skeleton largely influence the pharyngeal space. In addition to facilitating better nasal breathing, a healthy upper airway is thought to be crucial for the growth and development of craniofacial features. When obstructive processes of morphological, physiological, or pathological nature take place, such as when the tonsils and adenoids hypertrophy, allergies and chronic rhinitis, irritant environmental factors, infections, congenital nasal deformities, nasal traumas, polyps, and tumor's cause functional imbalance and lead to oral breathing patterns, the result is an obstructive upper airway.[4]

Airway dimension has been widely studied using lateral cephalograms. Prior research has examined the validity of lateral cephalograms in determining airway dimensions; the results indicated that cephalometric head film can offer useful data on ventilation capacity. Furthermore, it is possible to identify the airway structures frequently utilized landmarks with accuracy.[5]

Ever since they were first introduced to orthodontics, extraction has been a source of clinical dispute. Permanent tooth extractions are still being debated, but this time, issues with temporomandibular joints and upper airway volumes are being considered in addition to aesthetics and stability. The question of whether tooth extractions, which shorten the dental arch, would rob the tongue of its necessary room and impact the upper airways is one of the central concerns of the ongoing debate.[6,7,8]

The current study was aimed to investigate the possibility of a reduction in oropharyngeal dimensions after orthodontic therapy and four premolar extractions. To make sure that doctors are aware of possible airway effects from orthodontic treatment.

2. Materials and Methods

Ethical approval was obtained from our Institutional Ethical committee no CSMSS/DCH/EC/SS/2023-28. Cephalometric radiographs of BMP (bimaxillary protrusion) undergoing orthodontic treatment with all four first premolar extractions were followed by the retraction of the anterior teeth. The sample frame comprised 20 patients who met the following inclusion criteria and reported to a dental center.

2.1. Study design

Retrospective study.

2.2. Study setting

The study will be carried out in the Department of Orthodontics & Dentofacial Orthopaedics.

2.3. Study population

Individuals aged between 12-30 years.

2.3. Sample size and source

Sample size calculation

$$N = \frac{2\left[Z\alpha + Z\beta\right]^2}{\left(\frac{\mu 1 - \mu 2}{\sigma}\right)^2}$$

$\left(\frac{\mu 1 - \mu 2}{\sigma}\right)^2$ is defined as effect size (ES) while μ1 and μ2 are means of two groups and σ is the standard deviation of the population being studied.

The probability of falsely rejecting a true null hypothesis (Type II error) β = 0.20

Power = 1- β = 0.80, i.e power if the test is 80%. For which = 0.84 and

For an effect size of 0.90.

$$N = \frac{2\left[1.96 + 0.84\right]^2}{\left(0.90\right)^2}$$

$N = 19.36$

The total sample size will be 20.

2.4. Study type

Retrospective study

2.5. Software used

Software used IBM SPSS 20.

2.6. Statistical tests

Paired t-test.

Source: The study were conducted on 20 patients selected among patients visiting the Department of Orthodontics based on inclusion and exclusion criteria.

1. Sampling Technique: The samples were selected by the method of Convenience Sampling.
2. Study Instruments:
    a. Diagnostic instruments
    b. Lateral cephalometric radiographs of adult

bimaxillary protrusion patients who underwent orthodontic retraction of anterior teeth following extraction of all first or second premolars were taken using cephalostat. Lateral cephalometric radiographs were traced manually.

c. Software used IBM SPSS 20

2.7. Inclusion criteria

1. 18-30 years of age.
2. Protruded Upper and lower lips.
3. Before and after treatment radiographs with good soft-tissue outlines.
4. Indication of therapeutic extraction of four first premolars.
5. Indication of retraction of anterior teeth as a standard care of treatment.
6. Treatment includes fixed orthodontic appliance with MBT mechanotherapy.
7. There is no medical history of tonsillectomy, adenoidectomy, snoring, pharyngeal pathology, nasal blockage, or obstructive sleep apnea.

2.8. Exclusion criteria

1. Patient presenting with medical history of pharyngeal pathology or nasal obstruction, obstructive sleep apnea, snoring, adenoidectomy, and tonsillectomy were not included.
2. History of cleft lip/palate, mouth breathing, permanent snoring, and tonsillectomy/adenoidectomy.
3. Enlargement of tonsils or adenoids on lateral cephalogram.
4. Teeth not in occlusion.
5. Bimaxillary Protrusion cases treated with extraction of teeth other than 1^{st} premolar.
6. Patient undergoing orthodontic treatment with appliance other than MBT mechanotherapy.

Pre- and post-treatment cephalometric radiographs of adult patients (age range 18-30 years) who underwent orthodontic therapy for bimaxillary protrusion were obtained (Gendex Orthoralix 9200 machine, Gendex Dental Systems, Hatfield, PA, 19440) without any artifacts that could interfere with locating cephalometric landmarks. All the lateral cephalographs obtained from the selected record were carefully hand-traced by the same observer under the same illumination and magnification on single matte lacquered polyester acetate tracing paper. Fixed orthodontic therapy following first premolar extraction were the absolute inclusion criteria. Cephalometric measurements of lip, tongue, and pharyngeal airway (tongue length and height, soft palate height, superior, middle and inferior airway spaces, vertical airway length) variables were identified. Collected data was analyzed with SPSS® software.

Two conventional lateral cephalometric headfilms of the patients, one at the beginning of treatment (T0) and the other at the end of treatment (T1), were obtained. Total 12 cephalometric parameters were analyzed 6 parameters for lip position (**Figure 2** and **Table 1**, **Table 2**), two parameters for tongue position (**Figure 3, Table 1**) and 4 parameters for pharyngeal airway changes (**Figure 3** and **Table 1**, **Table 2**).

*2.9. Following soft tissue parameters was used to assessed lip position: (**Figure 1**)*

1. Labrale superius [Ls]: the point indica ting the mucocutaneous border of the upper lip.
2. Labrale inferius [Li]: the median point in the lower margin of the lower membranous lip.
3. Stomion superius [Stms]: the lower most point on the vermillion of the upper lip.
4. Stomion inferius [Stmi]: the uppermost point on the vermillion of the lower lip.

*2.10. Following lip position parameters was assessed: (**Figure 2**)*

1. Basic upper lip thickness (BULT)—linear distance from 2 mm below A- point to subnasale.
2. Upper lip thickness (ULT)—linear distance from the most prominent labial point of the maxillary incisor [U1] to the labrale superius [Ls].
3. Basic lower lip thickness (BLLT)—linear distance from B-point to the deepest point of the labiomental fold.
4. Lower lip thickness (LLT)—linear distance from the most prominent labial point of the mandibular incisor [L1] to the labrale inferius [Li].
5. Upper lip length (ULL)—vertical distance from the subnasale to the lowest point on the upper lip [Stms] perpendicular to the F–H plane.
6. Lower lip length (LLL)—vertical distance from the highest point of the lower lip [Stmi] to the soft tissue B-point perpendicular to the F–H plane.

*2.11. Following soft tissue parameters was used to assess tongue, soft palate, pharyngeal airway: (**Figure 3**)*

1. Tongue length (TGL) (mm): a line extending from TT (tip of tongue) to EpB (deepest point in the base of the epiglottic fold).
2. Tongue height (TGH) (mm): perpendicular line to TGL extending to the tongue dorsum; represents the maximum thickness of the tongue.
2. Superior posterior airway space (SPAS) (mm): a line extending from dorsal midpoint of soft palate to posterior pharyngeal wall, parallel to Go-B Line.
3. Middle airway space (MAS) (mm): a line passing through point P to the posterior pharyngeal wall (parallel to the Go-B line).
4. Inferior airway space (IAS) (mm): the depth of the airway along the Go-B line.
5. Vertical airway length (VAL) (mm): the distance

between PNS and EpB.

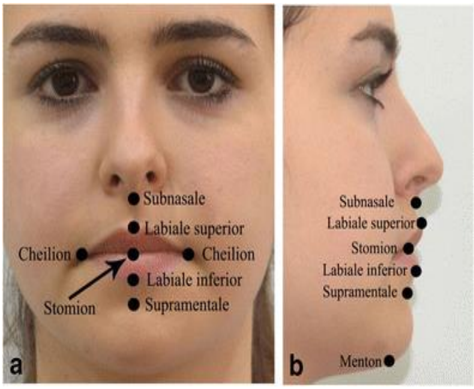

Figure 1: Landmarks used for lip position

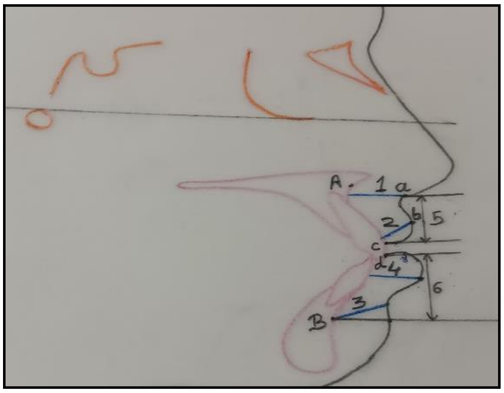

Figure 2: Cephalometric analysis for lip position parameters (1-BULT, 2-ULT, 3-BLLT, 4-LLT,5- ULL, 6-LLL) (a-subnasale,b-labrale superius, c-stomion superius, d-stomion inferius, e-labrale inferius.

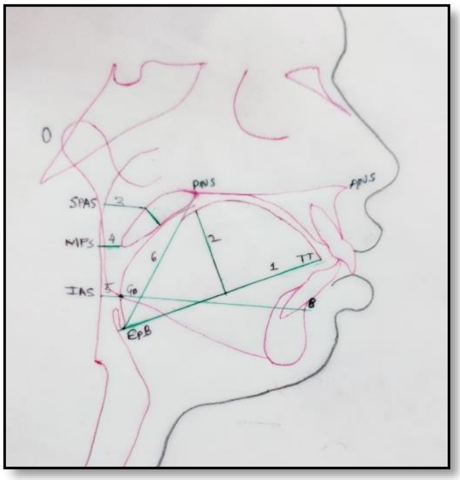

Figure 3: Cephalometric analysis for tongue position and pharyngeal airway parameters.
(1-TGL, 2-TGH, 3-SPAS,4-MPS, 5-IPS, 6-VAL)

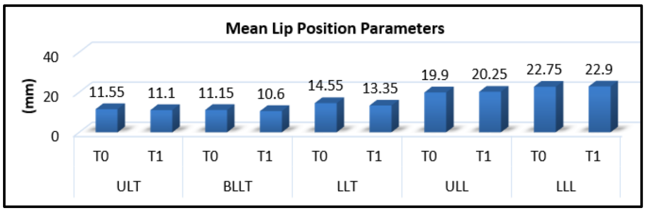

Figure 4: Mean amount of difference in lip position parameters.

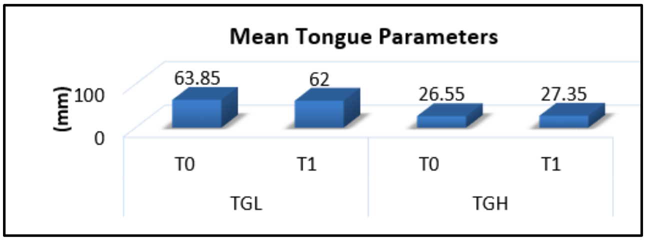

Figure 5: Mean amount of difference in tongue position parameters.

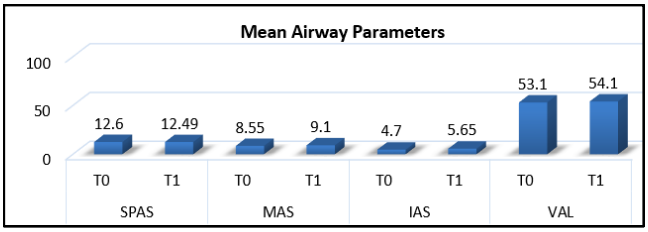

Figure 6: Mean amount of difference in pharyngeal airway parameter

3. Results

The study comprised 20 patient records in total, and met the inclusion criteria. Standardised cephalometric hard-tissue and soft-tissue landmarks, as shown in Figure 1, were the basis for pre- and post-treatment cephalometric analysis. As part of the orthodontic therapy for BMP, linear measures pertaining to the retraction of incisor teeth were obtained. Similarly, the cephalometric analysis was used to produce linear measures of the tongue position, lip position, and pharyngeal airway.

This study shows significant reduction of Basic upper lip thickness (BULT) and Lower lip thickness (LLT) (**Table 1, Figure 4**). There was significant reduction in tongue length and increase in tongue height (**Table 1, Figure 5**). Study shows no significant reduction in upper airway space. While there was significant increase in Inferior airway space (IAS) and vertical airway length VAL (Error! Reference source not found.**, Figure 6**). While there was significant increase in Inferior airway space (IAS) (**Table 1, Figure 6**). As there was decrease in tongue length and increase in tongue height, thus there was no change in upper airway space but significant increase in lower airway space.

Table 1: Paired t test for lip position tongue position and airway parameters.

Parameter	Mean Difference (T0-T1)	SE	T-Statistic	DF	P-value	Inference
BULT	1.15	0.37	3.09	19.00	0.01	Significant
ULT	0.45	0.31	1.44	19.00	0.17	Not Significant
BLLT	0.55	0.27	2.07	19.00	0.05	Not Significant
LLT	1.2	0.34	3.48	19.00	0.00	Significant
ULL	-0.35	0.29	-1.20	19.00	0.25	Not Significant
LLL	-0.35	0.29	-1.20	19.00	0.25	Not Significant
TGL	1.85	0.48	3.88	19.00	0.00	Significant
TGH	-0.8	0.16	-5.14	19.00	0.00	Significant
SPAS	0.115	0.06	1.95	19.00	0.07	Not Significant
MAS	-0.55	0.43	-1.27	19.00	0.22	Not Significant
IAS	-0.95	0.18	-5.15	19.00	0.00	Significant
VAL	-1	0.16	-6.16	19.00	0.00	Significant

Table 2: Descriptive statistics for Lip Position, tongue position and pharyngeal airway parameters.

Variable		Mean	SD	SE	95% CI	
					Lower	Upper
ULT	T0	11.55	1.76	0.39	10.73	12.37
	T1	11.1	2.00	0.45	10.17	12.03
BLLT	T0	11.15	1.53	0.34	10.43	11.87
	T1	10.6	1.57	0.35	9.87	11.33
LLT	T0	14.55	2.68	0.60	13.29	15.81
	T1	13.35	2.50	0.56	12.18	14.52
ULL	T0	19.9	2.29	0.51	18.83	20.97
	T1	20.25	2.22	0.50	19.21	21.29
LLL	T0	22.75	2.45	0.55	21.60	23.90
	T1	22.9	2.57	0.58	21.70	24.10
TGL	T0	63.85	6.73	1.50	60.70	67.00
	T1	62	6.50	1.45	58.96	65.04
TGH	T0	26.55	3.75	0.84	24.80	28.30
	T1	27.35	3.72	0.83	25.61	29.09
SPAS	T0	12.6	1.79	0.40	11.76	13.44
	T1	12.49	1.75	0.39	11.66	13.30
MAS	T0	8.55	1.54	0.34	7.83	9.27
	T1	9.1	2.05	0.46	8.14	10.06
IAS	T0	4.7	2.13	0.48	3.70	5.70
	T1	5.65	2.37	0.53	4.54	6.76
VAL	T0	53.1	8.43	1.89	49.15	57.05
	T1	54.1	8.33	1.86	50.20	58.00

4. Discussion

This retrospective research assessed the impact of premolar extraction on lip position, tongue position and pharyngeal airway dimensions in individuals with bimaxillary protrusion as part of fixed orthodontic therapy.

A person's body mass index, age, gender, tongue hypertrophy, and ethnicity are some of the variables that can alter their posture or the position of their tongue and soft palate. These variables can also change the size of their airways.3 A potentially fatal disorder like obstructive sleep apnea can result from this alteration in airway size, which can also negatively impact quality of life.[9]

The effect of growth may have an impact on the pharyngeal airway's measurements. The soft tissue measures of the posterior pharyngeal wall have been seen to undergo further modifications between the ages of 6 and 9 years and 12 and 15 years.[10,11]

This study shows statistically significant reduction of Basic upper lip thickness (BULT)($p<0.05$) and Lower lip thickness (LLT) by mean of about 1.15 mm and 2 mm. there is statically non-significant reduction in upper lip thickness (ULT) ($p>0.05$) and non-significant increase in upper lip length (ULL) ($p>0.05$) and lower lip length (LLL) ($p>0.05$) (**Table 1**, **Figure 4**). Similar results were seen in the study done by Viral A. Kachiwala et al on the impact of incisor retraction and first premolar extractions on the lips of adult South Indian women with Bimaxillary protrusion. Weak connections were seen in the changes between the lower lip depth and the lower incisors and the upper lip depth and the upper incisors.[12]

The results of this study showed significant reduction in tongue length ($p<0.05$) by 1.85 mm and increase in tongue height ($p<0.05$) by 0.8 mm (**Table 1**, **Figure 5**). In accordance with our study, study by Emad Al Maaitah also showed reduction in tongue as a result of orthodontic treatment; the mean reduction was 1.75 mm. This reduction in the tongue length was statistically significant ($p<0.05$) (**Table 1**, **Figure 5**).[5]

In our study there was no significant changes in upper airway space were seen (**Table 1**, **Figure 6**). Similar result were found by CBCT study of Manish Valiathan[13] and Adrienne Joy et al2 showed that despite anticipated alterations in incisor angles and positions, no statistically significant differences in airway capacity were seen between subjects treated with the extraction of four premolars.

There have been conflicting findings on the decrease in upper airway space after premolar extraction, specifically among orthodontically treated adults. However, Alqahtani Nasser.[14] reported a decrease in upper and middle air way space by 0.66 mm and 0.69 mm. These results were in accordance with Sharma et al, who have also reported decrease in PAS.[15] The difference found between the two studies may be due to variation in the age group among the samples studied.

Contrary results were found by Sunilkumar Nagmode et al who reported an increase in upper airway space.[16] This may be due to lymphoid mass regression which is a natural phenomenon seen in young patients.

Conversely, the inferior airway space (IAS) was increased significantly by -1mm ($p< 0.05$) (table 1). Similar result was found in study by A Karaman et al there was increase in inferior airway space.[17] This increase in inferior airway space may be attributed to decrease in tongue length and increase in tongue height. On the contrary our results are not in agreement with the results obtained by Sunilkumar Nagmode et al.[16] and Alqahtani Nasser[15] who showed decrease in inferior airway space. The difference in the findings between these two studies may be attributed to the fact that maximum anchorage conservation was done in their study, hence the forward movement of tongue was prohibited, where as in this study, cases were of moderate anchorage allowing some mesial migration of posteriors and hence of the tongue.

Clinical importance of this is that when undergoing fixed orthodontic treatment with bicuspid extractions, the position of the tongue and the oral cavity are the most important considerations. The reduction in the pharyngeal airway's size and how it affects breathing when you sleep must be taken into account. Understanding how these treatments affect the pharyngeal airway is crucial for doctors. The understanding of this would be crucial, particularly in the management of class I BMP patients who have pharyngeal airway compromise conditions such obesity, dolichocephalic face pattern, and obstructive sleep apnea.

5. Limitations

Since the airway is a three-dimensional structure, lateral cephalograms have the drawback of only providing a linear dimension of the airway; instead, the airway needs to be studied in three dimensions so that each of its components can be assessed as they behave independently. For this reason, 3D CBCT studies are superior to lateral cephalograms. Future research may use CBCT to examine the long-term effects of orthodontic treatment on the patient's paranasal airway, but doing so will expose the patients to needless radiation exposure and may not be justified.

6. Conclusion

When first premolars are extracted to cure bimaxillary protrusion, the tongue position and pharyngeal airway spaces are also affected. These effects extend beyond the exterior soft tissue. The case selection and anchoring requirements will be the only factors influencing these modifications.

Increased inferior airway space results from a cumulative impact of the tongue's height being significantly raised and its length being reduced as a result of anterior positioning of tongue. The vertical airway room significantly increased while the upper airway space remained same.

7. Ethical Committee Approval

Ethical approval was obtained from our Institutional Ethical committee no CSMSS/DCH/EC/SS/2023-28.

8. Source of Funding

None.

9. Conflict of Interest

None.

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