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RESEARCH ARTICLE

COMPARATIVE CEPHALOMETRIC EVALUATION OF CHANGES IN TONGUE AND HYOID BONE POSITION IN CLASS I BIMAXILLARY DENTOALVEOLAR PROTRUSION AFTER ORTHODONTIC TREATMENT

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ABSTRACT

Background and objective: Facial esthetics is one of the major concerns of most patients seeking orthodontic treatment. Bimaxillary proclination can be characterized as a condition where the upper and lower incisors are proclined and protrusive which results in increased lip procumbancy. The aim of the study is to determine the effect of anterior teeth retraction on hyoid bone position, tongue position and posture in Angle's Class I bimaxillary dentoalveolar protrusion cases with first premolar extraction. **Materials and methods:** Pre and post treatment lateral cephalogram of twenty Class I bimaxillary dentoalveolar protrusion patients in the age group of 15-25years treated orthodontically as maximum anchorage cases with Pre-adjusted Edgewise Appliances (MBT prescription) with extraction of all first premolars were compared. **Conclusion:** extraction of four first premolars for retraction of anteriors in bimaxillary dentoalveolar protrusion cases showed significant posteroinferior displacement of hyoid bone. There was a reduction in the total tongue space, tongue length and air way.

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INTRODUCTION

Increased upper labial procumbancy is usually associated with Angle Class II Division 1 and Class I malocclusions with bimaxillary dentoalveolar protrusion. In such conditions, the major orthodontic treatment objective is to decrease the proclination of the maxillary anterior by retraction into premolar extraction spaces utilizing maximum anchorage.¹ The etiology of bimaxillary proclination is multifactorial and comprises of hereditary and environmental variables like; mouth breathing, tongue thrusting and lip biting habits, and tongue volume.² In most of these cases first premolar extraction are used for incisor retraction and correction of lip procumbancy which in turn will result in reduction of arch dimension and this could affect tongue and hyoid bone position and the upper airway dimension.² The hyoid bone is connected to the tongue, pharynx, mandible, and cranium through muscles and ligaments. The hyoid bone and its connecting muscles are also a part of the oropharyngeal complex and it moves during various oral functions such as deglutition and respiration in close association with tongue due

to its attachment with genioglossus and geniohyoid muscle which intermingles with each other.³ Treatment done to structures closely related with mandible or tongue can influence the hyoid bone position. Thus, researching the impacts of extraction on hyoid bone position would be helpful since a modification of the incisor position might influence tongue position.⁴ Rakosi (1978)⁵ suggested that the position and function of tongue are important. Abnormal Variations of either posture or normal activities might add to development of malocclusion and other speech problems. It may additionally possible that malocclusion could be the reason for unusual posture of tongue. The objective of orthodontic treatment isn't just the coordination and stability of dentofacial structure and facial appearance yet in addition the normal functioning of the stomatognathic system and airway. Some studies shows that there is a significant correlation exist between airway dimension and changes of tongue and hyoid bone position.⁶ The proposed advantages and negative sequels related with the extraction of teeth have for quite some time been debated in orthodontics. Some studies found that there are significant changes in position of hyoid and tongue after the extraction treatment^{7,6,8} while others^{2,9,10} found no significant change.

Varying results were obtained, probably because of the confounding factor like age and the accuracy of the diagnostic methods. Thus, the current study was done to investigate the effects of extraction of four first premolars and maximum anchorage retraction in bimaxillary dentoalveolar extraction cases on the hyoid bone position, tongue position and posture.

MATERIALS AND METHODS

This study was performed at the Department of Orthodontics and Dentofacial Orthopedics, Azeezia College of Dental Sciences and Research, Kollam, Kerala. Patients who were clinically diagnosed with Angle’s Class I bimaxillary dentoalveolar protrusion were considered for the study. Study sample included 20 patients between age group of 15 to 25 years. All patients were strapped-up with 0.022” X 0.028” Preadjusted Edgewise Appliances – (PEA: MBT prescription) after extraction of all four first premolars. Pre and post treatment lateral cephalograms were obtained with good hard and soft tissue outlines; teeth in full occlusion and lips at rest. All radiographs were taken by the same operator and were traced by the same investigator using Nemoceph software. Each Lateral cephalometric radiograph were scanned, digitally standardised and loaded into Nemoceph software for landmark tracing and measurements. The tongue position and posture were evaluated using Rakosi’s analysis based on modified Rakosi’s template (Table 4 and 5).³

The land marks used are as follows

Table 1. Land marks for hyoid and tongue analysis

A: HYOID ANALYSIS	
C3	The point at the most inferior anterior position on the third cervical vertebra
HYOIDALE[H]	The most superior, anterior point on the body of the hyoid bone
RETROGNATHION [RGn]	The most inferior posterior point of the mandibular symphysis
HYOID PLANE	The plane from H along the long axis of greater horns of the hyoid bone
HYOID PLANE ANGLE	The most superior posterior angle made by the intersection of the hyoid plane with C3-RGn
AA	The most anterior point on the body of the atlas vertebrae seen on the lateral cephalometric radiograph
PNS [POSTERIOR NASAL SPINE]	The tip of the posterior nasal spine seen on the lateral cephalometric radiograph
B: TONGUE ANALYSIS	
ANS	Apex of the anterior nasal spine
E	Most inferior and anterior point on the epiglottis
tg	Tongue point
Ii	Incisal tip of most prominent mandibular incisors
Is	Incisor tip of the most prominent maxillary incisor
Mc	Point on the cervical, distal third of the last erupted permanent molar
mc	Distobuccal cusp tip off the maxillary first permanent molar
O	Middle of the linear distance U-ii on Mc-ii line
Pt	Intersection point between occlusal line and contour of the tongue
Pw	The intersection point between the occlusal line (OL) and the pharyngeal wall
TT	Tip of the tongue
U	Tip of the uvula or its projection on Mc-ii line

RESULTS

The pre and post treatment lateral cephalograms were evaluated to find out, whether orthodontic treatment of class I bimaxillary dentoalveolar protrusion causes any changes in dentoalveolar structures, hyoid bone position and tongue position and posture. Results were tabulated on MS EXCEL and statistical evaluation was done. The results showed a statistically significant increase in hyoid plane angle by 2.25+/- 1.94° (p < 0.001), H-H1 by 0.75+/- 1.55 mm (p = 0.044) and significant decrease in C3-H by 1.70+/- 2.00 (p = 0.001).

Table 2. Parameters for Hyoid triangle analysis

H-C3	Distance from hyoidale to C3
H-RGn	Distance from hyoidale to Retrognathion
C3-RGn	Distance from C3 to retrognathion
H – H ¹	Distance from hyoidale to H ¹
HYOID PLANE ANGLE	The most superior posterior angle made by the intersection of the hyoid plane with C3-RGn
AA-PNS	Distance from AA to PNS

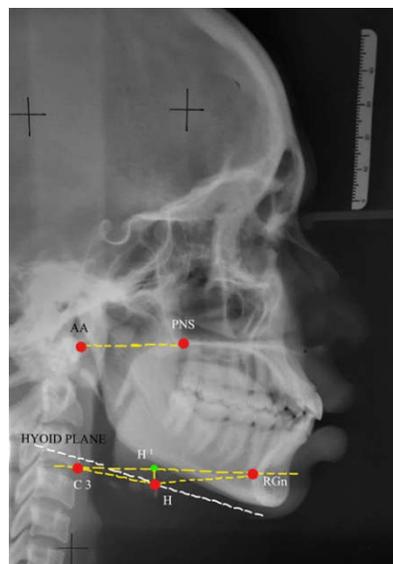


Figure 1. Landmarks and lines for hyoid triangle analysis

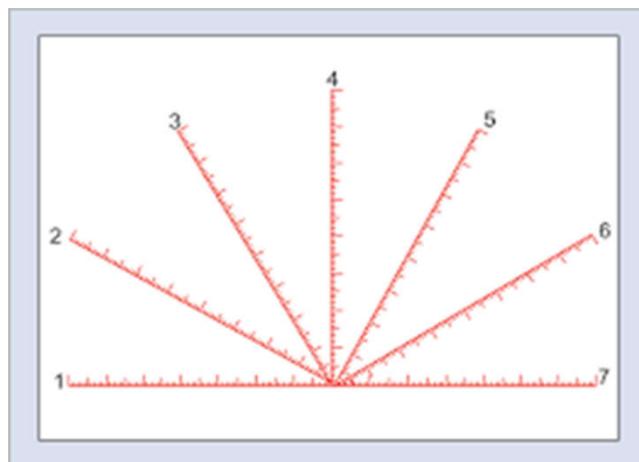


Figure 2. Rakosi Tongue template

H-H1, C3-H showed statistically significant change postoperatively. Post treatment H-H1 value significantly increased while C3-H value significantly decreased. Post treatment value of RGn-H is increased but the change is statistically insignificant.

Table 3. Evaluation of tongue position

Tongue position (mm)	Measurements using the template
tg1	Partial length of tongue: Line through the O and U or its projection. It measures the length of the tongue in the posterior portion (root) of the tongue.
tg2	Partial length of tongue: Line constructed on O at 30° Mc-ii line. It indicates the partial length of the tongue in the posterior region of the dorsum.
tg3	Partial length of tongue: Line constructed on O at 60° Mc-ii line. It indicates the partial length of the middle part of the dorsum of the tongue.
tg4	Partial length of tongue: Line constructed on O at 90° Mc-ii line. It indicates the partial length of the tongue in the middle of the dorsum of tongue.
tg5	Partial length of tongue: Line constructed on O at 120° Mc-ii line.
tg6	Partial length of tongue: Line constructed on O at 150° Mc-ii line. It indicates the partial length of the tongue in the anterior region of the tongue.
tg7	Partial length of tongue: Line constructed on O at 180° Mc-ii line. It indicates the partial length of the tongue in the tip region.
TGH	Tongue height: This is perpendicular to the mid of E-TT line (line between the most antero-inferior point of epiglottis and tongue tip). It measures the height of the tongue during the rest and centric occlusion.
TGL	Tongue length. This is measured by distance between tongue tip (TT) and epiglottis (E) point.
Pt- Pw	Distance of tongue from pharyngeal wall. It measures the distance of root part and posterior part of dorsum of tongue from the pharyngeal wall.

Table 4. Evaluation of tongue posture

Tongue posture (mm)	Measurements using the template
Point 1	Distance between the soft palate and the root of the tongue
Point 2-6	Relationship of the dorsum of the tongue to the roof of the mouth
Point 7	Position of the tip of the tongue relative to lower incisors

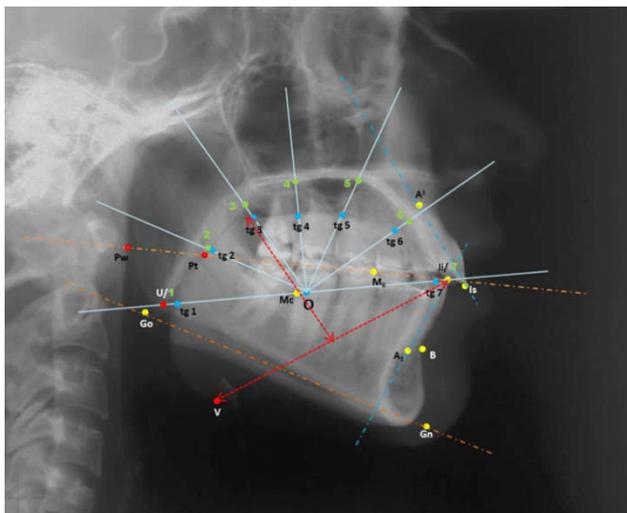


Figure 3. Landmarks and lines used for Tongue analysis

The results displayed a significant decrease in tg1 by 2.03 +/- 1.38 mm (p < 0.001), TGL by 4.38 +/- 3.71 mm (p < 0.001) and Pt-Pw by 1.23 +/- 1.95mm (p=0.011). Only tg1 showed statistically significant change. Post treatment values of all parameters except tg6 were decreased. The results displayed a significant increase in Point 6 by 1.55 +/- 2.85 mm (p = 0.025), significant decrease in Point 7 by 1.40 +/- 2.38mm (p = 0.016).

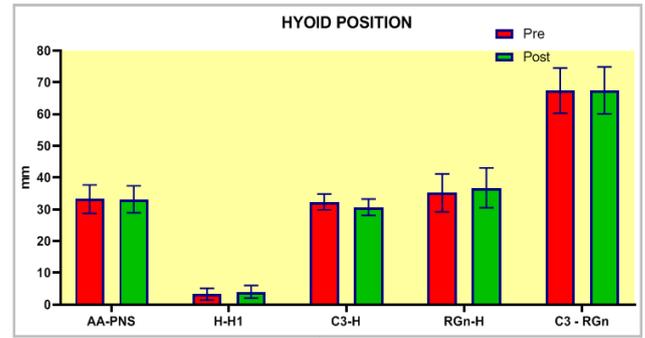


Figure 4. Graphical representation of changes in Hyoid bone position preoperatively and postoperatively

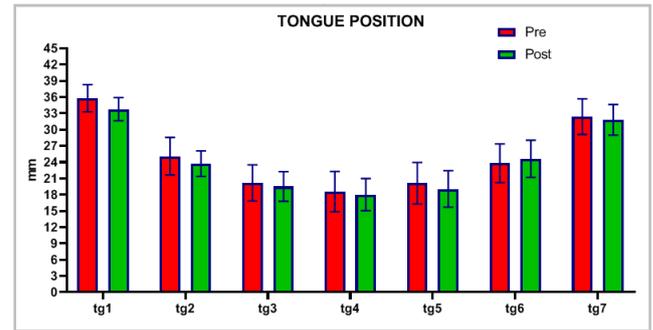


Figure 5. Graphical representation of changes in Tongue position preoperatively and postoperatively

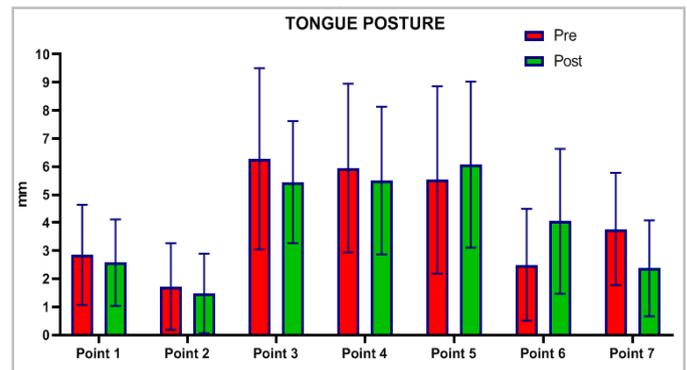


Figure 6. Graphical representation of changes in Tongue posture preoperatively and postoperatively

Point 6 and point 7 showed statistically significant change postoperatively. Post treatment value of point 6 significantly increased, while value of point 7 significantly decreased. Post treatment value of point 5 is increased but the change is statistically insignificant.

DISCUSSION

The present study was to evaluate the effects of retraction of anteriors on hyoid bone position, tongue position and posture following first premolar extraction in Angle's Class I bimaxillary dentoalveolar protrusion. Bimaxillary dentoalveolar protrusion cases usually exhibits normal occlusion, so that orthodontic treatment is often solely sought to correct the convex profile and to modify the facial esthetics. It is found that the alveolar arch width (intercanine width and intermolar width) doesn't change much after orthodontic treatment with retraction of anteriors following extraction of premolars. The main change happened in the anteroposterior plane of space i.e., alveolar arch length.⁷

Table 5. Changes in Hyoid bone position (n=20)

	Pre (n=20)		Post (n=20)		Paired Differences		se	95% CI of the Difference		p
	Mean	sd	Mean	sd	Mean	sd		Lower	Upper	
AA-PNS	33.25	4.48	33.20	4.24	0.05	1.15	0.256	-0.49	0.59	0.847
H-H1	3.30	1.84	4.05	1.99	-0.75	1.55	0.347	-1.48	-0.02	0.044*
C3-H	32.40	2.50	30.70	2.56	1.70	2.00	0.448	0.76	2.64	0.001*
RGn-H	35.20	5.98	36.80	6.28	-1.60	5.20	1.162	-4.03	0.83	0.184
C3 - RGn	67.45	7.14	67.50	7.40	-0.05	6.38	1.426	-3.04	2.94	0.972
Hyoid plane angle	14.60	4.33	16.85	3.79	-2.25	1.94	0.435	-3.16	-1.34	<0.001*

Table 6. Changes in Tongue position (n=20)

	Pre (n=20)		Post (n=20)		Paired Differences		se	95% CI of the Difference		P
	Mean	sd	Mean	sd	Mean	sd		Lower	Upper	
tg1	35.80	2.50	33.78	2.14	2.03	1.38	0.309	1.38	2.67	<0.001*
tg2	25.10	3.46	23.73	2.36	1.38	3.06	0.683	-0.06	2.81	0.059
tg3	20.18	3.33	19.53	2.74	0.65	3.63	0.812	-1.05	2.35	0.433
tg4	18.58	3.70	18.03	2.96	0.55	3.73	0.834	-1.20	2.30	0.518
tg5	20.13	3.82	19.08	3.37	1.05	4.43	0.991	-1.02	3.12	0.302
tg6	23.80	3.57	24.63	3.44	-0.83	3.75	0.838	-2.58	0.93	0.337
tg7	32.40	3.28	31.83	2.83	0.58	3.04	0.680	-0.85	2.00	0.408
TGH	33.05	3.29	32.15	2.82	0.90	3.37	0.754	-0.68	2.48	0.247
TGL	74.83	5.26	70.45	6.56	4.38	3.71	0.830	2.64	6.11	<0.001*
Pt-Pw	18.00	3.88	16.78	3.68	1.23	1.95	0.436	0.31	2.14	0.011*

Table 7. Changes in Tongue posture (n=20)

	Pre (n=20)		Post (n=20)		Paired Differences		se	95% CI of the Difference		p
	Mean	sd	Mean	sd	Mean	sd		Lower	Upper	
Point 1	2.85	1.79	2.58	1.54	0.28	2.09	0.467	-0.70	1.25	0.563
Point 2	1.73	1.54	1.48	1.42	0.25	1.90	0.425	-0.64	1.14	0.564
Point 3	6.28	3.23	5.45	2.18	0.83	3.59	0.803	-0.86	2.51	0.317
Point 4	5.95	3.00	5.50	2.63	0.45	3.58	0.800	-1.22	2.12	0.580
Point 5	5.53	3.34	6.08	2.96	-0.55	3.82	0.854	-2.34	1.24	0.527
Point 6	2.50	1.99	4.05	2.58	-1.55	2.85	0.637	-2.88	-0.22	0.025*
Point 7	3.78	2.00	2.38	1.71	1.40	2.38	0.531	0.29	2.51	0.016*

Pre and post treatment lateral cephalograms were used in the present study to evaluate the changes in hyoid bone position. In the present study, the hyoid tend to move posteroinferiorly after retraction of anteriors. Statistically significant increase in hyoid plane angle, H-H1 and significant decrease in C3-H occurs suggestive of posteroinferior movement of hyoidbone. Similar results were shown in the studies by Wang et al. (2012)⁷, Sharma et al. (2014)¹¹. Rakosi's tongue template was used by Verma et al. (2012)¹², Subhramanya RM et al. (2014)¹³, Tarkar et al. (2016)³ to assess the tongue position and posture was also used in the present study. In the present study, there was a significant decrease in the overall tongue length (TGL), particularly in the posterior region (tg1). The present study also showed a significant reduction of Pt-Pw value postoperatively suggestive of narrowing of airway near root of the tongue which might be due to posterior displacement of tongue. The present study showed statistically significant changes in tongue posture in the anterior area of dorsum of the tongue to the roof of the mouth and tip of the tongue to the lower anteriors. Comparison of overall parameters of this study revealed that, statistically significant increase in hyoid plane angle, H-H1 and significant decrease in C3-H occurs suggestive of posteroinferior movement of hyoid bone. Significant decrease in tg1, TGL and Pt-Pw can also be seen suggestive of posterior movement of tongue and narrowing of airway. There was an inferior positioning of anterior area of dorsum of tongue to the roof of palate and significant reduction in the distance between tip of the tongue and lower incisor postoperatively indicating of decrease in tongue space due to retraction of anterior, which leads distal movement of tongue.

Above findings of this study suggest that the retraction of anterior teeth may leads to displacement of tongue and hyoid bone in posterior and posteroinfrior direction respectively

CONCLUSION

Findings of this study suggest that the retraction of anterior teeth may leads to displacement of tongue and hyoid bone in posterior and posteroinfrior direction respectively. The study also showed a significant narrowing of airway near root of the tongue which may be due to posterior displacement of tongue.

DECLARATION OF CONFLICT OF INTRESTS

The authors declared no potential conflicts of interests with respect to the research authorship and publication of the article.

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STATEMENT OF INFORMED CONSENT: Informed consent was obtained from the subject for the use latero cephalometric radiographs

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