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RESEARCH ARTICLE

# EFFECT OF FIRST PREMOLAR EXTRACTION ON NASAL AIRWAY DIMENSION IN ADULT BIMAXILLARY DENTO-ALVEOLAR PROTRUSION PATIENTS – A RETROSPECTIVE CEPHALOMETRIC STUDY

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ABSTRACT

**Aim:** First premolar extraction is the treatment option usually for bimaxillarydento-alveolar protrusion patients. Tongue space and length tends to be reduced after the retraction of anteriors and thus this study was done to determine the effects of first premolar extraction and retraction of the anteriors on the upper airway dimension.

**Materials and Methods:** This retrospective study was carried out on the available pre- and post-orthodontic treatment records of adult patients who had bimaxillarydento-alveolar protrusion. The study material consisted of 31 patients with bimaxillarydento-alveolar protrusion and underwent fixed orthodontic treatment with extraction of upper and lower first premolar teeth. Digitized cephalometric radiographs were used to measure airway dimensions with the help of Dolphin 2d software. A paired t-test was used to compare the effects at $p<0.5$.

**Results:** Results showed significant reduction in tongue length ($p<0.5$), Superior, middle and inferior airway space. SNA, SNB, ANB, Inter-incisal angle, Wits appraisal, Lower incisor Protrusion and Upper incisor – Palatal plane showed significant changes.

**Conclusion:** Even though there is statistically significant airway reduction, it is clinically non-significant. Unless the airway is severely compromised, first premolar extraction and retraction of anteriors does not greatly affect the airway dimensions.



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## INTRODUCTION

Bimaxillarydento-alveolar protrusion is a common problem among the patients who seek orthodontic treatment. Bimaxillarydento-alveolar protrusion is a condition where upper and lower incisors are protrusive, thatresults in lip procumbency (Bills *et al*., 2005). Since many years four first premolar extraction have been the most adopted treatment option for bimaxillarydentoalveolar protrusion cases (Diels *et al*., 1995). After retraction of the anteriors, tongue adapts to the newly positioned anteriors in a retrudedposition. Whether the retruded tongue position affects the airway dimension remains a controversy in the literature. Upper airway dimensions have been considered contributing factors to obstructive sleep apnea (Schwab *et al*., 2003).

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It is important for an orthodontist to avoid factors that might lead to airway dimension narrowing following orthodontic treatment and not to induce any iatrogenic problems. Lateral cephalograms have been used widely to study airway dimension. The reliability of lateral cephalograms in assessing airway dimension has been determined earlier and findings suggested that cephalometric head film can provide useful information about airway size (Aboudara *et al*., 2009). Also, the commonly used landmarks of the airway structures can be reliably identified. The upper airway has always been an area of focus because the oro-pharyngeal and nasopharyngeal structures play vital roles in the growth and development of the craniofacial structures (Valiathan *et al*., 2010). Digital tracings have not been used frequently to study the airway dimension following orthodontic extraction and to our knowledge the results from a conventional and digital tracings have not been compared. The aim of this study were to investigate the effect of fixed orthodontic treatment with four first premolar teeth extraction in patients with bimaxillarydento-alveolar protrusion on the airway dimensions using Dolphin 2D software.

## MATERIALS AND METHODS

This study is a retrospective cephalometric study. Digitized Lateral cephalograms of 31 patients with dento-alveolar protrusion and treated with all first premolar extractions were taken from the faculty of dental sciences database. Age group of the patients ranged between 18 to 30 years. Patients treated only with fixed orthodontic appliances were considered. Dolphin 2d software was utilized for airway analysis. Patients with medical history of pharyngeal pathology and/ or nasal obstruction, obstructive sleep apnea, adenoidectomy, and tonsillectomy were excluded. Pre and post treatment cephalogram of a patient included in the study is shown in the Fig.1 The cephalometric measurement parameters for airway analysis (Fig. 2)

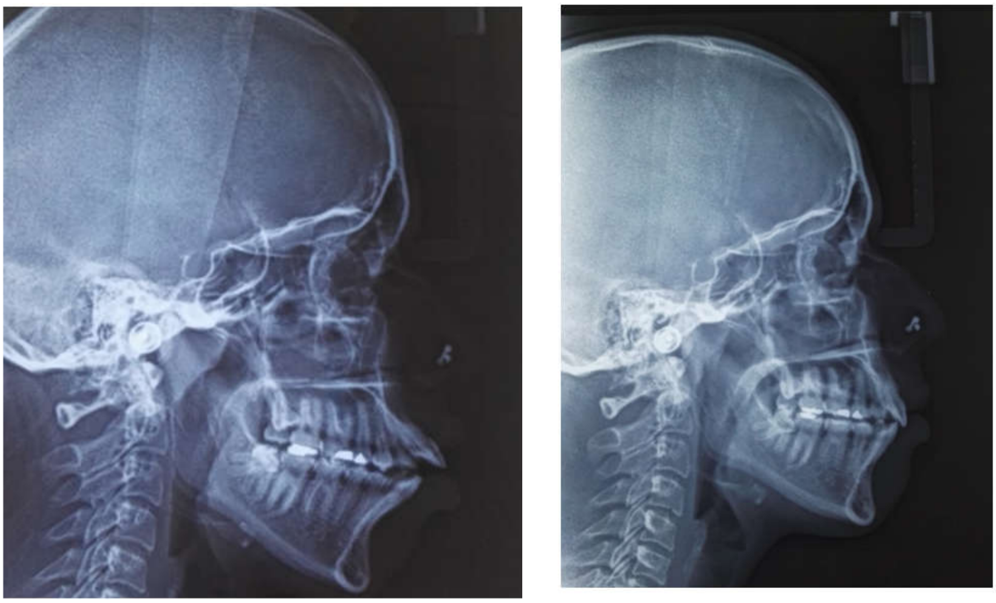

**Figure 1. Pre and post treatment lateral cephalogram**

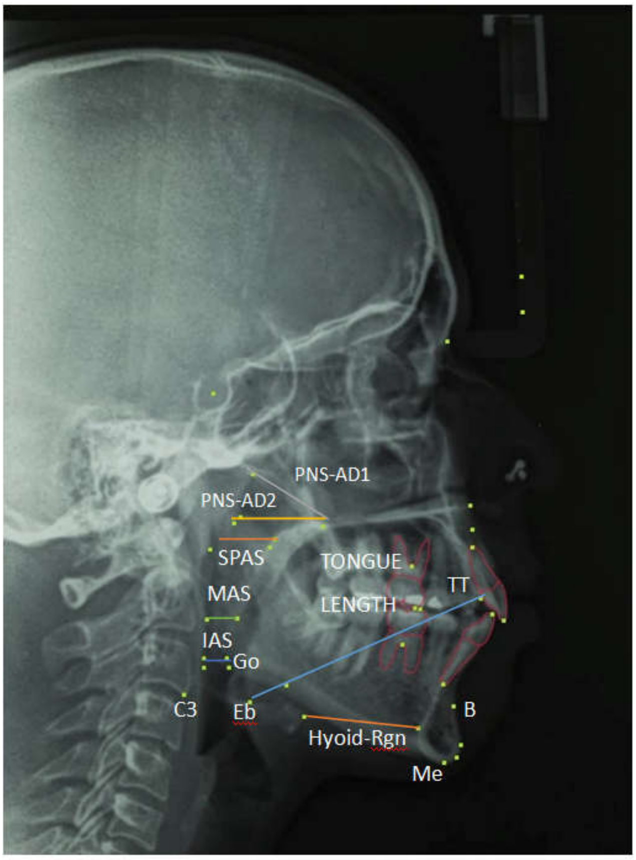


**Figure 2. Cephalometric landmarks**

were obtained from the previous studies (Maaitah *et al*, 2012) and the landmarks taken are described in table 1 and Table 2.

### Statistical Analysis

Wilcoxon signed rank test was used to assess the changes in airway parameters from pre to post orthodontic treatment. P< 0.05 was considered to be significant

## RESULTS

Results showed significant reduction in the tongue length ($p<0.05$), Superior, middle and inferior airway space.SNA, SNB, ANB, Inter-incisal angle, Wits appraisal, Lower incisor Protrusion and Upper incisor– Palatal plane showed significant changes (Table 3). The comparison of pre and post treatment parameters are shown in the Figure 3.

**Table 1. Cephalometric Landmarks**

| | | |
|---|---|---|
| 1. | TT | Tongue tip |
| 2. | Eb | Base of epiglottis |
| 3. | P | Tip of soft palate |
| 4. | PNS | Posterior nasal spine |
| 5. | Go | Gonion |
| 6. | Me | Menton |
| 7. | B | Point B |
| 8. | RGN | Retrognathion |
| 9. | H | Hyoidale |
| 10. | C3 | Anterio-inferior limit of third cervical vertebra |

**Table 2. Cephalometric linear measurements**

| | | |
|---|---|---|
| 1. | PNS-AD1 | Lower airway thickness; distance between PNS and the nearest adenoid tissue measured through the PNS-Ba line (AD1) |
| 2. | PNS-AD2 | Upper airway thickness; distance between PNS and the nearest adenoid tissue measured through a perpendicular line to S-Ba from PNS (AD2) |
| 3. | PNS-Ba | Total lower sagittal depth of the bony nasopharynx |
| 4. | Ptm-Ba | Posterior sagittal depth of the bony nasopharynx |
| 5. | PNS-H | Total upper airway thickness |
| 6. | McNamara's upper pharynx dimension | Minimum distance between the upper soft palate and the nearest point on the posterior pharynx wall |
| 7. | McNamara's lower pharynx dimension | Minimum distance between the point where the posterior tongue contour crosses the mandible and the nearest point on the posterior pharynx wall |
| 8. | TGL | Tongue length (Eb-TT) |
| | TGH | Tongue height (maximum height of tongue along perpendicular line of Eb-TT line to tongue dorsum) |
| 9. | PNSP | Soft palate length (PNS-P) |
| 10. | SPAS | Superior posterior airway space (width of airway behind soft palate along parallel line to Go-B line) |
| 11. | MAS | Middle airway space (width of airway along parallel line to Go-B line through P) |
| 12. | IAS | Inferior airway space (width of airway space along Go-B line) |
| 13. | VAL | Vertical airway length (distance between PNS and Eb) |
| 14. | MPH | Perpendicular distance from hyoid bone to mandibular plane |
| 15. | HH1 | Perpendicular distance from hyoid bone to the line connecting C3 and RGN |
| 16. | C3H | Distance between hyoid and C3 |
| 17. | HRGN | Distance between hyoid bone and RGN |

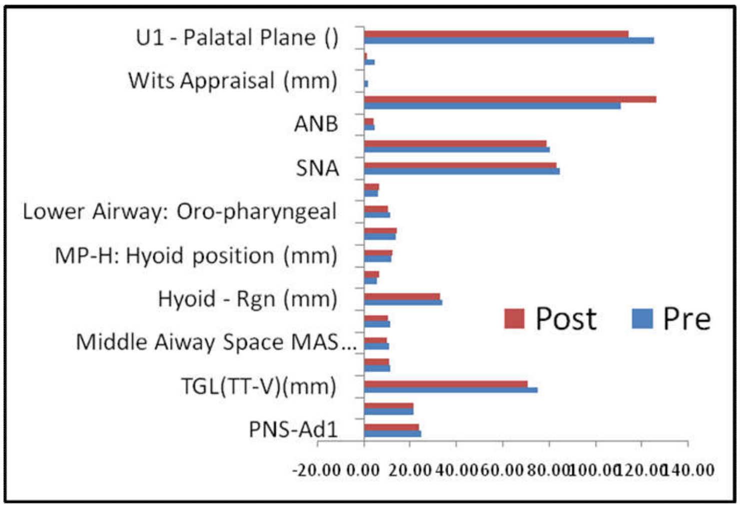


**Figure 3. Comparison of Pre and Post treatment of all study parameters**

**Table 3. Descriptive statistics and comparison of changes between pre and post treatment values of the study parameters analyzed by Wilcoxon Signed Ranks test**

| Parameter | | Mean | Std. Dev | Percentiles | | | Z-value, p-value and significance |
|---|---|---|---|---|---|---|---|
| | | | | 25th | 50th (Median) | 75th | |
| PNS-Ad1 | Pre | 24.72 | 5.53 | 20.40 | 23.70 | 28.00 | -1.806 |
| | Post | 24.15 | 5.19 | 20.50 | 23.80 | 26.60 | 0.071, Not significant |
| PNS-Ad2 | Pre | 21.47 | 6.84 | 15.90 | 20.60 | 26.20 | -0.411 |
| | Post | 21.34 | 5.79 | 15.70 | 22.50 | 24.10 | 0.681, Not significant |
| TGL(TT-V)(mm) | Pre | 75.02 | 10.90 | 65.30 | 75.00 | 83.10 | -4.185 |
| | Post | 70.86 | 10.79 | 61.90 | 69.90 | 77.40 | <0.001, Significant |
| Sup Airway Space SPAS (PSP to PSPh)(mm) | Pre | 11.73 | 4.51 | 9.60 | 10.40 | 12.30 | -3.191 |
| | Post | 10.84 | 4.15 | 8.30 | 9.60 | 11.40 | 0.001, Significant |
| Middle Aiway Space MAS (PA to MPA) (mm) | Pre | 10.91 | 3.77 | 8.40 | 9.70 | 15.00 | -2.729 |
| | Post | 9.94 | 3.71 | 8.00 | 8.40 | 11.30 | 0.006, Significant |
| Inferior Airway Space IAS (I (AA to IPA) (mm) | Pre | 11.48 | 5.01 | 8.80 | 10.50 | 13.30 | -2.564 |
| | Post | 10.40 | 4.48 | 8.00 | 9.70 | 11.30 | 0.010, Significant |
| Hyoid - Rgn (mm) | Pre | 33.89 | 6.08 | 28.80 | 32.50 | 39.10 | -1.547 |
| | Post | 33.18 | 5.50 | 28.80 | 31.50 | 38.10 | 0.122, Not significant |
| Hyoid Position | Pre | 6.00 | 4.48 | 2.60 | 5.80 | 7.20 | -.0951 |
| | Post | 6.73 | 3.84 | 5.00 | 6.30 | 9.30 | 0.342, Not significant |
| MP-H: Hyoid position (mm) | Pre | 11.93 | 5.49 | 8.10 | 12.50 | 14.20 | -0.736 |
| | Post | 12.46 | 5.66 | 7.50 | 14.10 | 16.30 | 0.462, Not significant |
| Upper Airway: Naso-pharyngeal | Pre | 13.98 | 5.25 | 10.60 | 13.30 | 16.50 | -1.441 |
| | Post | 14.50 | 5.48 | 12.10 | 12.80 | 15.80 | 0.150, Not significant |
| Lower Airway: Oro-pharyngeal | Pre | 11.49 | 4.71 | 9.00 | 11.00 | 12.70 | -1.608 |
| | Post | 10.72 | 4.37 | 8.20 | 10.40 | 12.00 | 0.108, Not significant |
| Hyoid to C3-Retrognathion (mm) | Pre | 6.10 | 4.49 | 2.60 | 5.80 | 7.90 | -0.970 |
| | Post | 6.82 | 3.84 | 5.70 | 6.30 | 9.30 | 0.332, Not significant |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SNA | Pre | 84.76 | 4.60 | 81.10 | 84.70 | 88.60 | -2.912 |
| | Post | 83.15 | 3.99 | 78.90 | 83.70 | 85.80 | 0.004, Significant |
| SNB | Pre | 80.08 | 4.45 | 76.30 | 79.90 | 83.40 | -1.983 |
| | Post | 78.99 | 3.61 | 76.50 | 79.00 | 81.20 | 0.047, Significant |
| ANB | Pre | 5.05 | 1.62 | 4.00 | 5.20 | 6.60 | -3.311 |
| | Post | 4.31 | 1.92 | 3.10 | 4.70 | 5.80 | 0.001, Significant |
| Interincisal Angle (U1-L1) | Pre | 111.07 | 8.49 | 104.60 | 113.20 | 117.10 | -4.860 |
| | Post | 126.35 | 6.77 | 119.70 | 127.90 | 130.90 | <0.001, Significant |
| Wits Appraisal (mm) | Pre | 1.94 | 2.56 | -0.90 | 3.00 | 4.40 | -2.906 |
| | Post | -0.09 | 2.08 | -1.10 | -0.30 | 1.20 | 0.004, Significant |
| L1 Protrusion (L1-APo) (mm) | Pre | 4.70 | 2.73 | 3.00 | 4.00 | 5.50 | -4.667 |
| | Post | 1.67 | 2.26 | 0.20 | 1.00 | 2.60 | <0.001, Significant |
| U1 - Palatal Plane () | Pre | 125.20 | 5.18 | 121.60 | 124.40 | 127.70 | -4.841 |
| | Post | 114.09 | 5.15 | 110.10 | 114.00 | 118.50 | <0.001, Significant |

Interpretation: The post treatment values changed significantly when compared to pre-treatment values for airway spaces (Superior, middle as well as inferior), SNA, SNB, ANB, Inter-incisal angle, Wits appraisal, Lower incisor Protrusion and Upper incisor– Palatal plane. Other parameters did not show any significant change.

## DISCUSSION

In orthodontic treatment plan, first four premolar extraction is considered for many malocclusions and specifically for bimaxillarydento-alveolar protrusion patients whose maxillary and mandibular incisors are proclined with lip procumbency (Leonardi *et al*., 2010). In such patients, in order to reduce lip procumbency and proclination, first premolars are extracted to retract the anteriors leading to the backward positioning of the tongue and reduction in the tongue space.

Whether tongue space reduction causes narrowing or changes in the airway dimensions remains as a controversy from the previous evidences. Understanding the airway dimension changes following orthodontic extraction is critical to prevent any iatrogenic problems especially while treating patients with compromised oro-pharyngeal airway (Wang *et al*., 2012, Shannon 2012). The present study revealed, there is statistically significant reduction in airway dimension following the extraction of four first premolars and retraction of anteriors which might have occurred due to the significant reduction in tongue space. In this study, the age range was 18 to 30 years to ensure that the oro-pharyngeal structures had reached the adult size and that effect from growth would not affect the results. Skeletal and dental measurements showed significant reduction as the treatment aimed to reduce the proclination of teeth and lip procumbency. This study results are similar to some of the earlier studies and also controversial with certain studies. In the studyd one by Germec *et al* in 2010, Lateral cephalograms of 39 Class I subjects were divided into three groups (each containing 11 females and 2 males) according to treatment procedure: group 1, 13 patients treated with extraction of four premolars and minimum anchorage; group 2, 13 cases treated non-extraction and group 3, 13 bimaxillary protrusion subjects treated with extraction of four premolars and maximum anchorage. The mean ages of the patients were 18.1 ± 3.7, 17.8 ± 2.4, and 15.5 ± 0.88 years, respectively. The results showed that superior and middle airway space increased significantly ($P < 0.05$) in group 1. In group 2, none of the parameters showed a significant change, while in group 3, middle and inferior airway space decreased ($P < 0.01$). Their findings show that extraction treatment using maximum anchorage has a reducing effect on the middle and inferior airway dimensions. Group3 results supports the results of current study. According to the studyd one byValiathan *et al* in 2010, there was no significant change in the oro-pharyngeal volume between extraction and non-extraction groups. They used Dolphin imaging 11.0 version for predicting airway volume in the constructed lateral cephalograms taken from CBCT scans.The age of patients used in this study ranged from 12.1 years to 15.5 years for boys and 11.3 years to 15.6 years for girls. The mean ages for Extraction group were 13.8 years for boys and 13.5 years for girls. The mean ages for Non extraction group were 13.8 years for boys and 13.5 years for girls. The result of the study does not support the result of present study. Constructed lateral cephalograms from CBCT scans were used by Valiathan *et al* which could possibly account for the difference in the study results. In other study done by Maaitah *et al* 2012, Pre- and post-orthodontic treatment cephalograms and dental casts of 40 bimaxillaryproclination patients (ages ranged between 18 and 23 years) were used for the study. Patients were all treated with extraction of the four first premolars. Cephalometric radiographs were used to measure airway dimensions, and dental casts were used to measure the changes in the arch dimensions. The results showed statistically significant reductions in tongue length ($P < .05$), posterior adenoids thickness (AD2-H) ($P < .05$), upper and lower incisor inclination, and lower incisor to A-Pog line ($P < .001$). They concluded that extraction of the first premolars for the treatment of bimaxillaryproclination does not affect upper airway dimensions despite the significant reduction in tongue length and arch dimensions. Tongue length reduction is observed in the present study but there is a significant reduction in the superior, middle and inferior airway statistically in the present study. Possible difference might be because of the usage of digitized cephalograms in Dolphin 2D software in the present study whereas manual tracings were used by maaitah *et al*. According to the study done by Stefanovic *et al* in 2012, there were no statistically significant differences in the pharyngeal airway values between the extraction and non-extraction groups. The result did not support the present study result and the reason might be in study done by stefanovic *et al*, they have used lateral cephalogram generated from CBCT scans and analysis done on Dolphin 11.0 version. In a study done by Nuvusetty *et al* in 2016, there was a significant narrowing of pharyngeal airway behind soft palate, uvula, and at the base of the tongue following retraction. There is a change in the position of the hyoid bone in an inferior direction as an adaptation preventing an encroachment of the tongue into the pharyngeal airway. Pre- and post-treatment lateral cephalograms of twenty patients were obtained, and cephalometric analysis was done to assess skeletal and dental changes, airway dimensions, and hyoid bone position using 17 linear and 4 angular measurements. This study result supports the present study.

**Conclusion**

Even though there is statistically significant airway reduction, it is clinically non-significant. Unless the airway is severely compromised, first premolar extraction and retraction of anteriors does not greatly affect the airway dimensions. However, three dimensional methods to predict the accurate airway volume must be considered.

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