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Assessment of airway changes after extraction of premolars in adult orthodontic patients

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Abstract

Introduction: the premolar extraction is a commonly done procedure during orthodontic treatment. The pharyngeal airway changes have been shown to occur following bicuspid extractions.the aim of the present study was to evaluated the changes in airway after completing fixed orthodontic treatment involving premolar extraction.

Material And Methods: a total of 50 lateral cephalograms of patients treated orthodontically with bicuspid extraction were selected and evaluated for airway changes using 6 cephalometric anatomical landmarks as described by Abu Allhaija and Al-Khateeb (2005), and two cephalometric reference planes, the mandibular plane and the tongue plane. Afterwards, eight linear readings were measured to check the pharyngeal airway along with maxillary and mandibular incisor inclination and protrusion.

Results: No statistically significant changes were seen in the pharyngeal airway dimensions following bicuspid extractions. The only significant changes were associated with dental parameters calculating upper and lower incisor proclamation.

Keywords: Airway Changes, Bicuspid Extraction, Obstructive Sleep Apnoea

Introduction

The premolar extraction is most commonly done procedure in orthodontic treatment. Various malocclusions like tooth size arch length discrepancy, crowding, bimaxillary protrusion and excessive overjet can be treated by premolar extractions.1-4 Most of the orthodontic treatments function on aesthetics, stability and masticatory functions. However, respiratory function should also be given equal importance during orthodontic treatment. For proper growth and development of craniofacial structures, it is important to have a normal airway5.

Airway space is divided into a nasopharynx, oropharynx, and hypopharynx and consists of hard tissues—such as maxilla, mandible, palatine bone, vomer, and cervical spine—and muscles of the tongue and soft palate, oral cavity, nasal cavity, and oral and retropharyngeal mucosa. The upper airway is closely related to the hyoid bone, as the hyoid bone is attached to the suprahyoid and infrahyoid muscles6.

Various studies have been carried out which have shown that premolar extraction caused a significant decrease in the airway7. Narrow pharyngeal airway can lead to various problems like mouth breathing and obstructive sleep apnea. In OSA patients the oropharyngeal and hypopharyngeal space was reduced by 25%8. Contrasting results have been found in some studies showing no conclusive findings regarding airway changes and premolar extraction.9

Hence, the purpose of this study was to find out the relationship of airway changes and premolar extraction in adult patients.

Material And Methods

The sample consisted of lateral cephalograms of 50 patients in the age group of 18- 25 years. All the patients were treated with premolar extractions and the lateral cepahalograms of pretreatment and post treatment were selected with the following inclusion and exclusion criteria:

Inclusion Criteria

1.Patients in age group of 18- 25 were included with class I molar relationship.

2.All four premolars were extracted and treatment consisted of fixed orthodontic appliances followed by retraction of the anterior teeth.

3. A set of diagnostically acceptable pre and post treatment lateral cephalograms.

Exclusion Criteria

1. History of previous orthodontic treatment

2. History of cleft lip/ palate, mouth breathing, permanent snoring and tonsillectomy/ adenoidectomy.

3. Enlargement of tonsils or adenoids on lateral cephalogram.

All cephalometric radiographs were taken with the patient situated in a natural head position, teeth in maximum intercuspation, and the lips relaxed as described by Burstone (1967)10All the patients were treated with fixed mechanotherapy using 0.022 MBT and sliding mechanics involving anterior retraction. The Dolphin Imaging Software was used for the cephalometric analysis. Magnification was controlled by calibrating the software using the ruler markings on the cephalometric head positioner. Afterwards, landmark identification was done on the digital images manually, and linear measurements were done. Airway space and incisor changes in figure 1.

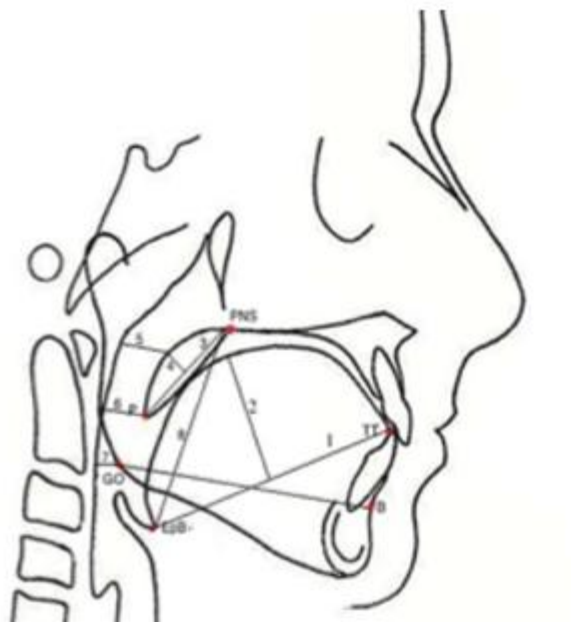

Fig. 1: Cephalometric landmarks and planes used in the cephalometric analysis (adapted from Abu Allhaija and Al-Khateeb, 2005)11. PNS: The posterior tip of the nasal spine of the palatal bone comprising the hard palate. B: deepest concavity of the anterior symphysis. Go: (Gonion) The most posterior, inferior point on the mandibular angle. P: Tip of Uvula. TT: Tip of the tongue. EpB: Base of the Epiglottic fold; deepest point in the epiglottic fold.

Reference line definitions and measurements are in Table 1.

A total of 6 cephalometric anatomical landmarks as described by Abu Allhaija and Al-Khateeb (2005),11 were included (Fig. 1) and two cephalometric reference planes were used in this study, the mandibular plane and the tongue plane. Afterwards, eight linear readings were measured as described in Table 1 along with maxillary and mandibular incisor inclination and protrusion.

Table 1: Abbreviations and definitions of the cephalometric planes and linear measurements performed on the pre-and post-treatment lateral cephalometric radiographs.

Reference line	Abbreviation	Definition
Tongue measurements	Go-B line 1.(TGL)Tongue Length 2.(TGH)Tongue Height	The tongue plane; line from point B to Gonion Line extending from TT to EpB Perpendicular line to TGL extending to the tongue dorsum; it represents the maximum thickness of the tongue
Soft palate	3.(PNSP)soft palate length 4.(MPT)soft palate thickness	Line extending from the PNS to P The largest thickness of the soft palate along a line at a right angle to PNS- P
Pharyngeal airway	5. SPAS) Superior Posterior Airway Space 6. (MAS) Middle Airway Space 7. (IAS) Inferior Airway Space 8. (VAL) Vertical Airway Length	Measuring from the dorsal midpoint of the soft palate to the posterior pharyngeal surface (adjacent to Go-B Line) Line passing throughP to the posterior pharyngeal surface (parallel to Go-B Line) The depth of the airway along Go-B line The distance between PNS and EpB

Table 2: The mean and standard deviations of pre-and post-treatment measurements of the airway, and the mean difference, p-value, of airway measurement changes. (*denotes significance at p < 0.05)

Measurement	Pretreatment	SD	Post treatment	SD	P-value
Tongue Length (mm)	71.29	6.91	70.55	6.09	0.46
Tongue Height (mm)	30.48	2.99	29.99	2.77	0.59
Soft palate thickness (mm)	8.21	1.22	8.32	1.23	0.43
Soft palate length (mm)	31.92	4.44	33.23	4.39	0.053
Superior Airway space (mm)	10.21	2.50	10.80	2.19	0.14
Middle Airway space (mm)	8.36	2.60	8.11	2.50	0.74
Inferior Airway space (mm)	11.00	2.81	10.52	2.70	0.92
Vertical Airway Length (mm)	57.66	6.31	59.55	5.03	0.45

Table 3: The mean and standard deviations of pre-treatment and post-treatment dental measurements and the means of the changes in the dental measurements. (*denotes significance at p < 0.05).

Measurement	Pre treatment	SD	Post treatment	SD	p-value
U1 - Palatal Plane ()	118.50	3.74	109.81	5.22	0.0001
U1 Protrusion (U1-APo) (mm)	10.17	1.63	6.15	1.89	0.0001
FMIA (L1-FH) ()	47.79	5.44	54.23	6.69	0.0001
L1 to APOG ()	6.23	2.07	3.09	1.95	0.0001
L1-MP ()	98.22	7.44	90.21	5.92	0.0001
L-NB (mm)	8.84	1.65	6.10	2.74	0.0001
L1 to A-Po ()	31.10	4.62	25.33	3.93	0.0001

Statistical analysis

All statistical tests were performed using Stata 14.2 software (StataCrop, College Station, TX). Quantitative variables were described using means and standard deviations. The pre- and post-test mean values of the quantitative variables were compared using Student's paired t-test. Statistical significance set at 5% and 95% confidence intervals were used to report the results.

For reliability testing, six randomly selected cephalometric radiograph pairs were selected. The same investigator did land- mark identification and cephalometric tracing and measurements. These were done in two sperate instances two weeks apart. A two-way mixed-effect intraclass correlation assessment was utilized to test the reliability of the measurements.

Results

Table 2 and Table 3 shows the means of pretreatment and post treatment measurements of airway and dental parameters. The tongue length and tongue height showed a decrease in the value after premolar extractions. However, these values were not significant statistically. Also, there was a decrease in the upper, middle and lower airways measurements post extraction but they were also of no statistical significance. All measurements of upper and lower incisor proclination and protrusion were significantly reduced after treatment. A high degree of reliability was found between pre- and post-treatment measurements. Average measure ICC was 0.841 or higher ($p < 0.009$).

Discussion

The aim of the present study was to evaluate the relationship of premolar extraction with airways changes. In the present study it was seen that the oropharyngeal and hypo pharyngeal airway was reduced after premolar extractions. However, these changes were not significant statistically. This was in contrast with previous study by Wang et al which showed a significant decrease in the pharyngeal airways after premolar extraction.12 According to them retraction of incisors after extraction with maximum anchorage decreased the oral space as a result of which tongue presses on the soft palate and this adaptation leads to decrease in the size of the upper airway.

Valiathan et al in their study showed that pharyngeal airway did not change significantly after retraction of anterior teeth with extraction of four premolars in adolescents.13 This was in accordance with our study where no significant changes were found.

In this study, the distance between the posterior nasal spine (PNS), and the base of the epiglottic fold, which represents the pharyngeal vertical airway length (VAR), showed non-significant increase when comparing the pre and post cephalometric measurements. This finding is in accordance with the study by Al Maaitah et al. where they found no significant changes in all measured airway dimensions including the vertical airway length (Al Maaitah et al., 2012)14, and to the study by Bhatia et al. (2016) 15where they found no changes in the vertical airway length as a result of first premolar extractions with maximum anchorage.

As a result of premolar extraction in the present study, the proclination of the incisors was reduced. There was a significant reduction in the axial inclination of the upper and lower incisors with respect to their apical bases in the present study. These findings are in accordance with previous studies by Chen et al. (2010)16, Ong and Woods (2001)17 among others (Williams and Hosila, 197618, Kim et al., 2005.19

The use of lateral cephalogram was justified as a number of studies in the literature have proved the reliability of lateral cephalograms in evaluating pharyngeal airway. However, the use of a lateral cephalogram was limiting factor in the current study as they only give a linear dimension of the airway. Airway should be evaluated in all its three dimensions as it is a three-dimensional soft tissue structure. Hence, a recent focus of the specialty is by a three-dimensional evaluation; 3D CBCT studies are proving the same differently and would definitely replace lateral cephalograms in the future.

Lateral cephalogram is a standard diagnostic aid that is taken for all patients undergoing orthodontic treatment. Prescribing 3D CBCT for these patients will expose them to unnecessary radiation exposure and may not be justified for patients.

Clinical relevance of the study

The reduced pharyngeal airway dimensions and its impact on breathing during sleep should be considered. We have to consider the impact of orthodontic extractions on tongue space. In patients treated orthodontically with premolar extractions, tongue posture and oral space are key variables to be considered. Dr William Hang, in his studies showed that bicuspid extractions had been associated with obstructive sleep apnoea.20 Also, the reopening of extraction spaces in such cases had resulted in the improvement of airway and had resolved OSA. Hence, upper airway dimension should never be compromised in order to achieve optimum results. A case of OSA may worsen following bicuspid extractions. Therefore, there is a need for further active research to correlate the impact of bicuspid extractions for orthodontic treatment on airway and merits consideration especially in a long-term study.

Moreover, there is a need to foresee these types of patients and treatment plan should be modified depending on the risk– benefit ratio for orthodontic extractions. It is also recommended to document the prognosis in these cases during diagnosis and treatment planning involving orthodontic extractions. The pharyngeal airway during retraction of incisors is reduced over a period of time. During retraction of anterior teeth, pharyngeal airway reduced only at the soft tissue level (tongue and soft palate) and they are highly correlated with incisor movement. There was minimal correlation between pharyngeal airway at hard tissue level and retraction of anterior teeth. There was no effect of retraction of anterior teeth on vertical airway length. That implies that the effect was observed more in horizontal dimensions rather than in vertical dimensions of pharyngeal airway.

Future recommendations of this study will be to assess the pharyngeal airway size, tongue adaptation, and hyoid bone positioning on the long-term basis with more advanced techniques like CBCT.

Conclusion

There was no statistically significant difference in the airway changes following premolar extractions. A slight decrease in the measurement of pharyngeal airway and increase in the vertical pharyngeal length was seen in post treatment cephalograms as compared to pretreatment lateral cephalograms. However, these are of no statistical significance. All the dental parameters studied in this study like upper and lower incisor proclamation and protrusion showed significant decrease with premolar retraction involving anterior retraction.

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