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Cephalometric appraisal of the effects of orthodontic treatment on total airway dimensions in adolescents

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ABSTRACT

Aim: This retrospective study was performed to rule out any jeopardizing effect of extraction therapy of four first premolars on airway at any level of its anatomic course.

Materials and methods: Lateral cephalograms of 50 adolescent patients divided into two groups of 25 each, based on orthodontic treatment by first premolar extraction as group I and without extraction as group II, were selected for the study. 13 angular and 11 linear measurements were compared pre-and post-treatment via statistical analyses using SPSS (Version 17.5, SPSS, Chicago) software. Paired 't' tests were used to assess the variability. P-value < 0.05 was considered to be statistically significant.

Results: Comparison of angular parameters showed that the average percentage (%) change in SNA, SNB, ANB, IMPA, FMA, saddle, articulare, gonial, total angle and hyoid did not differ significantly across two study groups ($P > 0.05$), but values of UI/LI, UI/NA, LI/NB, differed significantly among both groups. Similarly, linear parameters showed that the average % change in nasopharyngeal airway space (NAS) and width of soft palate differed significantly across two study groups (P-value < 0.05), whereas the average % change in posterior airway space (PAS), hypopharyngeal airway space (HAS), hyoid distance and length of tongue did not differ significantly (P-value > 0.05). However, no significant differences were observed during intragroup and intergroup comparisons of the combined angular and linear measurements of both groups.

Conclusions: Present study showed no significant change on airway after therapeutic orthodontic tooth movement with or without extraction treatment.

1. Introduction

The airway has always been an area of interest to an orthodontist because the oro- and naso-pharyngeal structures play an indispensable role in the growth and development of the craniofacial complex.[1]

Brodie et al.[2] contended that movement of the teeth for resolution of malocclusion must be confined to the existing dental arch. Proponents of orthodontic extractions contend that functional limits of arch size are genetically predetermined.[3] Consequently, extracting teeth is necessary for orthodontic correction in order to respect the limits of the dentition and achieve proper esthetics, health of the oral tissues and occlusal stability.[2–6]

On the contrary, dramatic reduction in tongue space is one of the prominent concerns of extraction therapy.[7] Some clinicians theorize that by closing extraction spaces, the maxilla and the mandible retrude,[8] resulting in constriction of the oro-pharyngeal airway.[9,10] A retruded mandibular position may be associated with airway constriction via the lingual musculature and its attachment to the hyoid bone.[11] According to orthotropists, a retrusive mandibular position results in excessive vertical facial growth which leads to downward and backward positioning of the mandible.[12] It further leads to stretching of the lingual muscular attachment to the hyoid bone, with resultant dorsal and inferior positioning of hyoid bone. An inferior displacement of the hyoid bone along with increased lower facial height are predisposing factors for upper airway obstruction.[13]

Various studies have analyzed the impact of airway physiology on

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the craniofacial complex development, dental arch morphology and occlusion. However, to the best of our knowledge, no studies have been performed investigating the effects of dento-alveolar movement by orthodontic extraction and non-extraction therapy on total pharyngeal air way starting from naso-pharynx to laryngo-pharynx. With consideration of the hypothesis that orthodontic treatment with extraction of four premolars would not affect airway passage at nasal, oral and laryngeal level in comparison to non-extraction treatment modality, a retrospective cross-sectional study was planned to rule out any jeopardizing effect of extraction therapy of four first premolars on airway at any level of its anatomic course.

2. Materials and methods

Considering the test power of 0.80 (with an allowable error of 15%), calculated for an effect size (r) equal to 0.38 at an ά level of 0.05 and 95% confidence coefficient, the sample consisted of randomly selected lateral cephalograms of 50 adolescent patients who had undergone orthodontic treatment from 2009 to 2015 in the Department of Orthodontics at Government service hospital, India. Good quality records of all the treated patients were collected and analyzed. Two groups were established based on the treatment procedure: Group 1 consisted of pre-and post-treatment lateral cephalograms of 25 patients (8 males, 17 females) who had been treated by therapeutic extraction of four first premolars. Similarly, group 2 comprised pre-and post-treatment lateral cephalograms of 25 patients (9 males, 16 females) that had been treated without extraction of any teeth. The subjects were aged from 13 to 18 years (mean age 14.2 ± 3.2 years; median, 15 years for group 1; and mean age 15.8 ± 3.5 years; median, 16 years for group 2).

Inclusion criteria were as follows:

(i) Group 1 included subjects with Angle's Class I type 2 malocclusion with bidental protrusion treated with extraction of four premolars with maximum anchorage.
(ii) Subjects in group 2 had been classified as borderline Angle's Class I type 2 malocclusion cases with moderate maxillary and mandibular spacing, and treated without extractions by means of the consolidation of existing spaces, interproximal stripping and en-masse distalization for retraction of upper and lower incisors.
(iii) Cephalometrically, the subjects in groups 1 and 2 were skeletal Class I with upper incisor to maxillary plane angle (U1-Max) > 115°, lower incisor to mandibular plane angle (L1-Mand) > 99°, and interincisal angle less than 124.8°, and normal to mild hyperdivergent growth pattern.

Exclusion criteria for both groups were presence of:

(i) missing teeth
(ii) congenital anomalies affecting the craniofacial region
(iii) medical history of naso-oro-laryngopharyngeal obstruction
(iv) snoring
(v) obstructive sleep apnea
(vi) adenoidectomy and tonsillectomy

All subjects in the study had undergone fixed orthodontic treatment with 0.018" Roth bracket prescription (Gemini, 3M Unitek, Calif, USA). Maximum retraction of anterior teeth (Group 'A' anchorage) were ensured by using trans-palatal arch in maxilla and lingual arch in mandible along with mini-implants (AbsoAnchor, Dentos, Korea) placed between 1st molar and second premolar region for anchorage preservation. Case was included in the sample as maximum retraction in which more than 6 mm of retraction had been performed. The average maxillary and mandibular incisor retraction in Group 1 were 11.9 ± 4.5 and 9.3 ± 2.9 mm, respectively. The average maxillary and mandibular incisor retraction in Group 2 were 6.1 ± 1.3 and 5.2 ± 0.9 mm, respectively. Average treatment duration in Group 2 was 2 years, whereas average treatment duration in Group 1 was 2 years 6 months. The mean interval between pre- and post-treatment lateral cephalograms was 2 years 3 months.

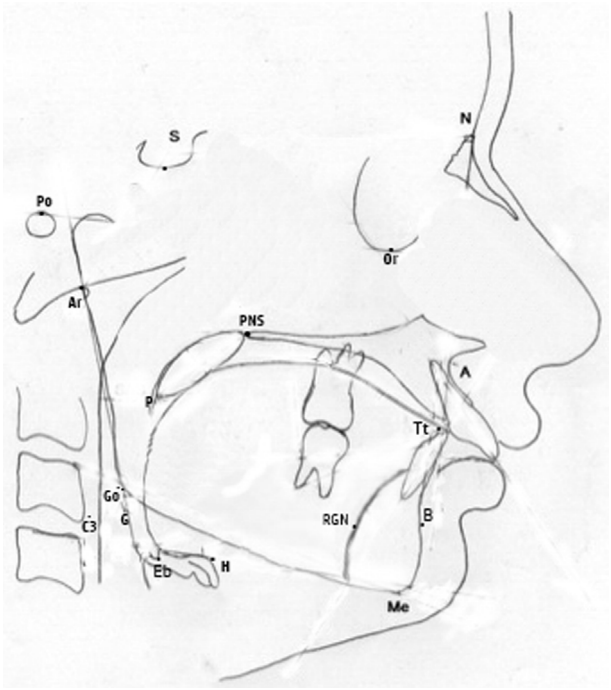

Fig. 1. Cephalometric tracing showing different points and landmarks used in the study.

Pre- and post-treatment lateral cephalograms of all patients were traced manually using 3H pencil on a 0.003" acetate matte tracing paper in 1 sitting by first investigator, and then randomly rechecked for anatomic contour and landmark identification and tracing superimpositions by a second investigator to rule out any error (Fig. 1). Any disagreements were resolved by retracing the landmark or structure to the satisfaction of both investigators. The tracing procedure was performed in the darkened room with the viewing screen blanked off, showing only the radiograph. All the radiographs were corrected for magnification and calibrated according to the consistent magnification factor (8%) using radiopaque metal ruler which had had been used retrospectively before and after taking radiographs. All cephalometric measurements were performed manually using a ruler & vernier caliper to the nearest 0.1 mm for linear measurements, and protractor to the nearest 1° for angular measurements. The parameters selected for analysis of total airway were derived from composite norms of Sharma et al.,[14] Valiathan et al.[15] and Stefanovic et al.,[16] who reported study on similar subjects. A customized digitization regimen and analysis were also used to generate 24 cephalometric measurements (13 angular and 11 linear) which were compared for total airway dimension (Fig. 2) Cephalometric landmarks, skeleto-dentoalveolar parameters and airway parameters assessed are depicted in Tables 1–3, respectively.

2.1. Statistical analysis

Data were processed using SPSS software for Windows (Version 17.5, SPSS, Chicago). Application of an exploratory Shapiro-Wilks t-test showed normality of data distribution. Application of Levene test indicated equality of variances for the examined parameters. Analysis was done by using the arithmetic means and the standard deviations calculated for all cephalometric measures. Inferential statistics included a Student's 't' test used to analyze the differences among means for intragroup and intergroup comparisons of the combined angular and