Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, issue 2s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

Evaluation Of Changes In Pharyngeal Airway: In Angle's Class I Patients With Bi-Dentoalveolar Proclination Following Retraction, Angle's Class Ii Patients Following Functional Appliance Therapy And Angle's Class Iii Patients Following Mandibular Setback Surgery

Karthick Shetty [1], Aparna Khamatkar [2], Veera Sawant [3], Anuradha Bhagwat[4], Pranita Jadhav[5], Vighanesh Kadam[6], Shonali Patankar[7]

[1]Department of Orthodontics and Dentofacial Orthopaedics, Padmashree Dr. DY Patil University, School of Dentistry, Nerul, Navi Mumbai

[2]Associate Professor, Department of Orthodontics and Dentofacial Orthopaedics, Padmashree Dr. DY Patil University, School of Dentistry, Nerul, Navi Mumbai

[3]Reader, Department of Orthodontics and Dentofacial Orthopaedics, Padmashree Dr. DY Patil University, School of Dentistry, Nerul, Navi Mumbai

[4]1st Year Post Graduate, Department of Orthodontics and Dentofacial Orthopaedics, Padmashree Dr. DY Patil University, School of Dentistry, Nerul, Navi Mumbai

[5]Lecturer, Department of Orthodontics and Dentofacial Orthopaedics, Padmashree Dr. DY Patil University, School of Dentistry, Nerul, Navi Mumbai

[6]Lecturer, Department of Orthodontics and Dentofacial Orthopaedics, Padmashree Dr. DY Patil University, School of Dentistry, Nerul, Navi Mumbai

[7]Department of Orthodontics and Dentofacial Orthopaedics, Padmashree Dr. DY Patil University, School of Dentistry, Nerul, Navi Mumbai

Corresponding Author:

Anuradha Bhagwat,

Email ID : anuradhab.1112@gmail.com

Cite this paper as: Karthick Shetty , Aparna Khamatkar , Veera Sawant , Anuradha Bhagwat, Pranita Jadhav, Vighanesh Kadam, Shonali Patankar, (2025) Evaluation Of Changes In Pharyngeal Airway: In Angle's Class I Patients With Bi-Dentoalveolar Proclination Following Retraction, Angle's Class Ii Patients Following Functional Appliance Therapy And Angle's Class Iii Patients Following Mandibular Setback Surgery. *Journal of Neonatal Surgery*, 14 (2s), 699-707.

ABSTRACT

Objective: This study aimed to evaluate the changes in pharyngeal airway dimensions in patients with different malocclusions following orthodontic or orthognathic treatment. Specifically, the study assessed airway changes in Class I patients with bi-dentoalveolar proclination treated with premolar extractions and retraction, Class II patients treated with functional appliances, and Class III patients treated with mandibular setback surgery.

Materials and Methods: A retrospective cephalometric analysis was conducted on 45 patients, equally segregated into three groups based on malocclusion type and treatment modality. Pre- and post-treatment lateral cephalograms were used to measure changes in the dimensions of the pharyngeal airway at six anatomical levels. Data were statistically examined using both paired t-tests and ANOVA.

Results: Class I patients exhibited a significant reduction in oropharyngeal and hypopharyngeal airway dimensions following anterior retraction. After receiving functional appliance therapy, Class II patients showed a notable increase in airway dimensions, primarily in the velopharyngeal area. After mandibular setback surgery, Class III patients had the most significant reduction in pharyngeal airway space, with the base of the tongue showing the most noticeable constriction.

Conclusion: Both orthodontic therapy and surgery have a discernible impact on the pharyngeal airway's size. Functional appliances in growing Class II patients improved airway space, whereas mandibular setback surgery and incisor retraction were associated with airway narrowing, underscoring the need for airway-focused treatment planning

Keywords: *Pharyngeal airway, malocclusion, functional appliance, mandibular setback, orthodontic extraction, cephalometry*

.

1. INTRODUCTION

The pharyngeal airway plays a vital role in respiration, craniofacial development, and orthodontic treatment outcomes. Its morphology is influenced by dentoskeletal factors such as jaw position, incisor inclination, tongue posture, and soft tissue dynamics, all of which may be altered during orthodontic or orthognathic interventions【1】. Malocclusion, a prevalent condition affecting nearly one-third of the population, is often associated with variations in airway dimensions and functional adaptations【1-3】.

In Class I bimaxillary dentoalveolar proclination, therapeutic extraction of premolars with subsequent retraction improves facial esthetics and lip competence. However, this approach has been reported to reduce oral cavity volume and displace the tongue posteriorly, potentially compromising airway patency【2,9】.

Class II malocclusions, frequently attributed to mandibular retrognathism, are commonly managed in growing patients with functional appliances such as the Twin Block or Herbst. These appliances not only enhance mandibular growth but also improve airway volume through anterior repositioning of the mandible and associated soft tissues【3–7】.

Conversely, mandibular prognathism in Class III patients is often corrected via mandibular setback surgery. While this procedure improves occlusion and esthetics, it has been linked to significant reductions in pharyngeal airway dimensions due to posterior displacement of the tongue and hyoid, thereby increasing the risk of obstructive sleep apnea (OSA)【1,8】

Cephalometric radiographs, though two-dimensional, remain a practical diagnostic tool for assessing pre- and post-treatment airway changes. Despite advancements in three-dimensional imaging modalities such as CBCT and MRI, cephalometry continues to be widely used due to accessibility, reproducibility, and clinical relevance【2,10】.

Accordingly, this study evaluates airway changes across three treatment modalities—extraction and retraction in Class I, functional appliance therapy in Class II, and mandibular setback surgery in Class III—to better understand their implications for airway health and treatment planning.

2. AIMS & OBJECTIVES:

Aim

To assess variations in the dimensions of the pharyngeal airway in patients with different malocclusion types following orthodontic or orthognathic treatment, specifically:

Class I patients with bi-dentoalveolar proclination treated with premolar extraction and retraction

Those presenting with Class II malocclusion, with mandibular retrognathism treated using functional orthopedic appliances

Individuals with Class III malocclusion characterized by mandibular prognathism who underwent mandibular setback surgery.

Objectives

To assess the effect of orthodontic incisor retraction (post-premolar extraction) on pharyngeal airway dimensions in Class I bimaxillary proclination patients.

To determine the changes in pharyngeal airway space following functional appliance therapy in growing patients with Class II malocclusion due to mandibular retrognathism.

To evaluate the impact of mandibular setback orthognathic surgery on the pharyngeal airway dimensions in skeletal Class III patients with mandibular prognathism.

3. MATERIALS & METHODS:

Study Design and Setting

This retrospective observational study was conducted in the Department of Orthodontics and Dentofacial Orthopaedics at D. Y. Patil School of Dentistry, Navi Mumbai. The study evaluated changes in pharyngeal airway dimensions before and after orthodontic or orthognathic treatment using standardized lateral cephalometric radiographs.

Ethical Considerations

The Institutional Ethics Committee reviewed and granted approval for the research protocol. All patient records were anonymized to ensure confidentiality, and the study adhered to the principles outlined in the Declaration of Helsinki.

Sample Selection

Patients were selected from departmental archives based on the availability of complete pre-treatment and post-treatment lateral cephalograms. A total of 45 patients were included and stratified into three equal groups (n=15 per group) based on the type of malocclusion and treatment received.

Inclusion Criteria

Group I (Class I): Patients diagnosed with Angle's Class I malocclusion with bimaxillary dentoalveolar proclination, treated with extraction of all first premolars followed by orthodontic retraction.

Group II (Class II): Patients with Angle's Class II malocclusion due to mandibular retrognathism, treated with removable or fixed functional appliances (e.g., Twin Block).

Group III (Class III): Patients with skeletal Class III malocclusion, treated via mandibular setback surgery (bilateral sagittal split osteotomy) following presurgical orthodontics.

Exclusion Criteria

Presence of craniofacial syndromes or congenital anomalies

History of facial trauma or previous orthognathic surgery

Missing posterior teeth

Active periodontal disease with alveolar bone loss

Incomplete records or low-quality radiographs

Cephalometric Analysis

Standard lateral cephalometric images were recorded while maintaining natural head alignment, occluded teeth, and relaxed lips. All radiographs were traced manually by a single trained investigator to eliminate inter-examiner variability.

A total of 34 anatomical landmarks and four reference planes were identified using definitions based on previous studies by Lowe et al., Liu et al., and Zhong et al. Of these, 17 landmarks were used to assess skeletal and dental relationships, while the remaining 17 landmarks were employed to evaluate airway dimensions and hyoid bone position.

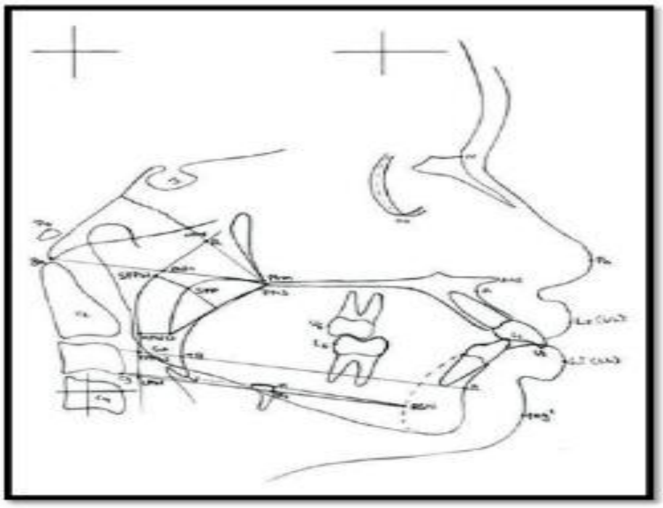

Figure 1.1 Cephalometric tracing

Figure 1.2 Cephalogram showing pharyngeal airway

Reference Planes

Frankfort Horizontal (FH) Plane

Palatal Plane (ANS–PNS)

Mandibular Plane (Go–Gn)

Sella–Nasion (S–N) Plane

Airway Measurements

Airway space was assessed using six linear measurements at different anatomical levels from nasopharynx to hypopharynx:

Measurement	Definition
PNS–R	Distance from posterior nasal spine to posterior pharyngeal wall (nasopharynx)
PNS–Ad1	Distance from PNS to adenoid tissue (upper nasopharynx)
SPP–SPPW	Soft palate to posterior pharyngeal wall (velopharynx)
U–MPW	Tip of uvula to middle pharyngeal wall (oropharynx)
TB–TPPW	Tongue base to posterior pharyngeal wall (glossopharynx)
V–LPW	Vallecula to lower pharyngeal wall (hypopharynx)

Each measurement was recorded in millimeters (mm). Hyoid bone position was assessed qualitatively but not included in the statistical comparison.

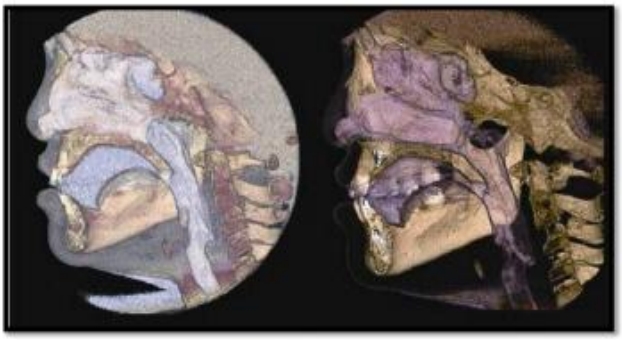

Figure 1.3 pharyngeal airway

Data Grouping and Comparisons

Group I (Extraction + Retraction): Evaluated to identify changes in airway space due to anterior retraction following premolar extractions.

Figure 1.4 pre and post treatment lateral cephalograms comparison of pharyngeal airway size in Class I patients

Group II (Functional Appliance): Evaluated for airway changes resulting from mandibular advancement during growth.

Figure 1.6 pre and post treatment lateral cephalograms comparison of pharyngeal airway size in Class II patients

Group III (Mandibular Setback Surgery): Assessed to quantify postoperative reductions in airway space.

Figure 1.9 pre and post treatment lateral cephalograms comparison of pharyngeal airway size in Class III patients

Each patient had both pre-treatment and post-treatment cephalometric data Intra-group analysis involved calculating the variation in airway dimensions from pre- to post-treatment.

Statistical Analysis

All statistical procedures were conducted using IBM SPSS Statistics software version 20.0, developed by IBM Corporation, Armonk, NY.

Descriptive statistics (mean and standard deviation) were calculated for each measurement.

Paired t-tests were applied within each group to assess pre- and post-treatment differences.

One-way ANOVA with **post hoc Bonferroni correction** was used to compare mean changes across the three groups.

A p-value ≤ 0.05 was considered statistically significant.

4. RESULTS:

A total of 45 patients were included in the study and equally distributed among three treatment groups (15 patients per group). All groups were comparable in terms of age and baseline cephalometric measurements. Each group demonstrated distinct trends in pharyngeal airway changes following their respective treatment protocols.

Group I – Class I Malocclusion Treated with Extraction and Retraction

This group consisted of patients with bimaxillary dentoalveolar proclination who underwent extraction of all four first premolars followed by retraction of anterior teeth.

Nasopharyngeal Airway (PNS–R, PNS–Ad1):

A minor reduction in dimensions was observed at PNS–R (mean decrease = 0.17 ± 0.27 mm, $p = 0.002$) and PNS–Ad1 (mean decrease = 0.37 ± 0.59 mm, $p = 0.002$). Although statistically significant, these changes were not considered clinically substantial.

Velopharyngeal and Oropharyngeal Regions:

Significant reductions were noted in:

SPP–SPPW (soft palate level): 0.20 ± 0.28 mm ($p = 0.001$)

U–MPW (uvula level): 1.97 ± 1.45 mm ($p < 0.001$)

TB–TPPW (tongue base level): 1.07 ± 0.75 mm ($p < 0.001$)

V–LPW (vallecula level): 1.02 ± 0.92 mm ($p < 0.001$)

These findings suggest a narrowing of the oropharyngeal and hypopharyngeal airway space, most pronounced behind the tongue and uvula.

Group II – Class II Malocclusion Treated with Functional Appliance Therapy

This group comprised growing patients with retrognathic mandibles treated using functional orthopedic appliances.

Nasopharyngeal Airway (PNS–R, PNS–Ad1):

Slight, non-significant increases were noted at PNS–R (mean increase = 0.06 mm) and PNS–Ad1 (mean increase = 0.01 mm), with $p > 0.05$.

Velopharyngeal and Oropharyngeal Regions:

Marked and statistically significant increases were observed in:

SPP–SPPW: 0.16 mm ($p < 0.001$)

U–MPW: 1.45 mm ($p < 0.001$)

TB–TPPW: 0.37 mm

V–LPW: 0.22 mm

These increases suggest that functional appliances enhanced airway patency, particularly at the soft palate and uvula levels, likely due to anterior repositioning of the mandible and tongue.

Group III – Class III Malocclusion Treated with Mandibular Setback Surgery

Patients with prognathic mandibles underwent bilateral sagittal split osteotomy for mandibular setback.

Nasopharyngeal Airway (PNS–R, PNS–Ad1):

No significant changes were observed postoperatively in these regions.

Velopharyngeal and Oropharyngeal Regions:

Significant reductions were observed in:

SPP–SPPW: 0.24 mm

U–MPW: 1.90 mm

TB–TPPW: 2.50 mm

V–LPW: 2.02 mm ($p < 0.001$ for all)

These results demonstrate a considerable narrowing of the oropharyngeal and hypopharyngeal airway, particularly behind the base of the tongue, suggesting a posterior displacement of the tongue and hyoid complex due to mandibular repositioning.

Intergroup Comparison

Using one-way ANOVA and post hoc Bonferroni correction, the **greatest airway increase** was observed in **Group II** (functional appliance group), while the **greatest reduction** occurred in **Group III** (surgical group).

Changes in **Group I** (extraction-retraction group) were intermediate, with significant narrowing at lower airway levels but less than Group III.

Summary Table of Key Findings

Region	Group I (Extraction)	Group II (Functional)	Group III (Surgery)
PNS–R	↓ 0.17 mm (p=0.002)	↑ 0.06 mm (ns)	≈ (ns)
SPP–SPPW	↓ 0.20 mm (p<0.001)	↑ 0.16 mm (p<0.001)	↓ 0.24 mm (p<0.001)

Region	Group I (Extraction)	Group II (Functional)	Group III (Surgery)
U–MPW	↓ 1.97 mm (p<0.001)	↑ 1.45 mm (p<0.001)	↓ 1.90 mm (p<0.001)
TB–TPPW	↓ 1.07 mm (p<0.001)	↑ 0.37 mm (p<0.001)	↓ 2.50 mm (p<0.001)
V–LPW	↓ 1.02 mm (p<0.001)	↑ 0.22 mm (p<0.001)	↓ 2.02 mm (p<0.001)

(*ns: not significant*)

5. DISCUSSION:

The relationship between orthodontic and orthognathic treatment and pharyngeal airway morphology is complex, multifactorial, and of increasing clinical importance, particularly with the growing emphasis on airway-focused orthodontics 【10】. The findings of this study highlight that different treatment modalities—extraction and retraction in Class I, functional appliance therapy in Class II, and mandibular setback surgery in Class III—have distinct and significant effects on airway dimensions.

Class I Malocclusion – Extraction and Retraction

Patients with Class I bimaxillary dentoalveolar proclination exhibited a statistically significant reduction in oropharyngeal and hypopharyngeal dimensions after anterior tooth retraction. These results align with previous reports by Germec-Cakan et al.【9】 and Nuvusetty et al.【2】, who demonstrated that extraction-based mechanics can lead to narrowing of the pharyngeal airway. Bhargavi et al. and Miles et al.【10】 have also suggested that such reductions may be linked to posterior displacement of the tongue and soft palate due to decreased oral cavity volume and neuromuscular adaptation. Although reductions at the nasopharyngeal level may not always be clinically significant, the narrowing of oropharyngeal space raises concern, especially in individuals predisposed to airway compromise.

Class II Malocclusion – Functional Appliance Therapy

Functional appliances are designed to enhance mandibular growth and correct retrognathic profiles. In this study, their use led to significant increases in airway space, particularly in the velopharyngeal and oropharyngeal regions. This is consistent with the findings of Ali et al.【3】, Ghodke et al.【4】, Jena et al.【5】, Yoon et al.【6】, Restrepo et al.【7】, and Liu et al.【11】, who reported that functional appliances anteriorly reposition the mandible, tongue, and hyoid bone, thereby improving airway patency. Hanggi et al.【12】 and Vinoth et al.【13】 further emphasized the long-term benefits of early Class II correction in improving both skeletal relationships and airway function. These outcomes are clinically significant, as pediatric sleep-disordered breathing has been strongly associated with craniofacial growth patterns【14,15】.

Class III Malocclusion – Mandibular Setback Surgery

The most pronounced reduction in airway dimensions was observed in Class III patients who underwent mandibular setback surgery. Significant narrowing occurred at the levels of the tongue base and hypopharynx, corroborating the results of Babu et al.【1】, Enacar et al.【8】, Kawamata et al.【16】, Tselnik et al.【17】, and Eggenberger et al.【18】, who consistently reported that mandibular setback displaces the tongue-hyoid complex posteriorly, leading to compromised airway space. More recent investigations (Chen et al.【19】, Park et al.【20】) have also highlighted an increased risk of postoperative obstructive sleep apnea (OSA), particularly in adults, males, and those with higher BMI. To address this, several authors【21–23】 advocate for bimaxillary surgery (mandibular setback combined with maxillary advancement), which has been shown to help preserve or even improve airway space. Preoperative airway assessment with CBCT, MRI, or polysomnography is therefore recommended, especially in high-risk patients【24,25】.

Limitations and Future Scope

This study has certain limitations. Its retrospective design limited control over confounding factors such as head posture and tongue activity. Airway evaluation was performed using two-dimensional cephalometry, which does not fully capture volumetric changes. Furthermore, functional outcomes such as snoring, sleep quality, or OSA symptoms were not assessed, which would have enhanced clinical applicability. Future research should incorporate three-dimensional imaging techniques (CBCT or MRI) and long-term follow-up to better evaluate airway stability and functional outcomes.

6. CONCLUSION:

The study demonstrates that different orthodontic and surgical approaches produce distinct and measurable changes in pharyngeal airway size.

Orthodontic retraction following extraction of premolars in Class I patients results in a statistically significant reduction in oropharyngeal airway dimensions, although changes at the nasopharyngeal level are minimal.

Functional appliance therapy in growing Class II patients significantly increases airway dimensions, particularly in the velopharyngeal and oropharyngeal regions, suggesting its role in improving airway function alongside skeletal correction.

Mandibular setback surgery in Class III patients significantly decreases airway dimensions, especially at the hypopharyngeal level, raising potential concerns about postoperative respiratory function.

Clinical Implications

Airway considerations should be integral to orthodontic and orthognathic treatment planning, especially in patients at risk for sleep-disordered breathing.

During growth, functional appliance therapy can provide both orthopedic benefits and improvements in airway function.

Extraction protocols and mandibular setback surgeries should be planned cautiously, considering alternative treatment options or adjunctive procedures (e.g., maxillary advancement) in at-risk individuals..

REFERENCES

[1] Babu RV, Narayanan V, Murugesan K. Pharyngeal airway changes following mandibular setback surgery. Indian J Dent Res. 2005;16:147.

[2] Nuvusetty B, Peddu R, Prakash AS, Kalyani M, Devikanth L, Chadalawada D. Assessment of changes in pharyngeal airway size and hyoid bone position following orthodontic treatment of Class I bimaxillary dentoalveolar protrusion. J Indian Orthod Soc. 2016;50:215–21.

[3] Ali B, Shaikh A, Fida M. Changes in oro-pharyngeal airway dimensions after treatment with functional appliance in Class II skeletal pattern. J Ayub Med Coll Abbottabad. 2015;27(4):759–63.

[4] Ghodke S, Utreja A, Jena AK. Effects of twin-block appliance on the anatomy of pharyngeal airway passage in Class II malocclusion subjects. Prog Orthod. 2014;15:68.

[5] Jena AK, Singh SP, Utreja AK. Effectiveness of twin-block and mandibular protraction appliance-IV in the improvement of pharyngeal airway passage dimensions in Class II malocclusion subjects with a retrognathic mandible. Angle Orthod. 2013;83(4):728–34.

[6] Yoon SH, Choi J, Chung CJ, Kim JY, Kim KH. Long-term pharyngeal airway changes after bionator treatment in adolescents with skeletal Class II. Korean J Orthod. 2014;44(1):13–19.

[7] Restrepo C, Santamaria A, Pelaez S, Tapias A. Oropharyngeal airway dimensions after treatment with functional appliances in growing patients with Class II malocclusion. Eur J Orthod. 2011;33(4):415–9.

[8] Enacar A, Aksoy AU, Taner TU. Changes in airway dimensions following mandibular setback surgery. J Oral Maxillofac Surg. 1994;52(5):510–5.

[9] Germec-Cakan D, Taner T. Effects of four premolar extractions on oropharyngeal airway volume: A cephalometric study. Eur J Orthod. 2011;33(5):515–20.

[10] Miles PG, Vig PS, Weyant RJ, Forrest TD, Rockette HE. Craniofacial structure and obstructive sleep apnea syndrome – a qualitative analysis and meta-analysis of the literature. Am J Orthod Dentofacial Orthop. 1996;109(2):163–72.

[11] Liu Y, Zeng X, Fu M, Huang X, Lowe AA. Effects of a functional appliance on the upper airway in Class II malocclusion: A systematic review. Am J Orthod Dentofacial Orthop. 2015;148(4):519–26.

[12] Hanggi MP, Teuscher UM, Roos M, Peltomäki TA. Changes in pharyngeal airway dimensions after mandibular advancement with functional appliances. Eur J Orthod. 2008;30(3):263–71.

[13] Vinoth SK, Thomas E, Krishnan S, Chitharanjan AB. Effect of functional appliances on pharyngeal airway space in growing Class II patients – A cephalometric study. J Clin Pediatr Dent. 2017;41(3):212–8.

[14] Guilleminault C, Huang YS, Glamann C, Li K, Chan A. Adenotonsillectomy and obstructive sleep apnea in children: A prospective survey. Sleep. 2007;30(7):871–5.

[15] Behrents RG, Shelgikar AV. Orthodontics and sleep-disordered breathing: An evidence-based review. Am J Orthod Dentofacial Orthop. 2013;144(1):13–27.

[16] Kawamata A, Fujishita M, Ariji Y, Ariji E. Three-dimensional computed tomography evaluation of morphologic airway changes after mandibular setback osteotomy. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2000;89(3):278–87.

[17] Tselnik M, Pogrel MA. Assessment of the pharyngeal airway space after mandibular setback surgery. J Oral Maxillofac Surg. 2000;58(3):282–5.

[18] Eggenberger B, Cornelius CP, Schwestka-Polly R, Hirschfelder U, Schmidt C. Airway changes after mandibular setback surgery: A cephalometric and MRI evaluation. J Craniomaxillofac Surg. 2006;34(8):491–6.

[19] Chen F, Terada K, Hua Y, Saito I. Effects of bimaxillary surgery and mandibular setback surgery on pharyngeal airway. Int J Oral Maxillofac Surg. 2007;36(5):388–93.

[20] Park JW, Kim NK, Kim JW, Kim MJ, Choi JY. Three-dimensional airway changes after bimaxillary surgery for skeletal Class III malocclusion. Oral Surg Oral Med Oral Pathol Oral Radiol. 2012;114(6):691–9.

[21] Gu G, Guo J, McGrath C, Hägg U. Changes in airway dimensions and hyoid bone position after surgical correction of mandibular prognathism. Int J Oral Maxillofac Surg. 2011;40(9):971–5.

[22] Saitoh K. Long-term changes in pharyngeal airway morphology after mandibular setback surgery. Am J Orthod Dentofacial Orthop. 2004;125(5):556–61.

[23] Achilleos S, Krogstad O, Lyberg T. Surgical mandibular setback and changes in uvuloglossopharyngeal morphology and head posture: A short- and long-term cephalometric study. Int J Adult Orthodon Orthognath Surg. 2000;15(1):15–25.

[24] Li KK, Riley RW, Powell NB, Guilleminault C. Obstructive sleep apnea and maxillomandibular advancement: An evidence-based review. Otolaryngol Head Neck Surg. 2000;122(1):48–52.

[25] Degerliyurt K, Ueki K, Hashiba Y, Marukawa K, Okabe K, Nakagawa K, Yamamoto E. A comparative study of pharyngeal airway changes after mandibular setback surgery with or without maxillary advancement. J Oral Maxillofac Surg. 2008;66(4):896–902.