Majalah Kedokteran Gigi Indonesia
Vol 8 No 2 – August 2022
ISSN 2460-0164 (print), ISSN 2442-2576 (online)
Available online at https://jurnal.ugm.ac.id/mkgi
DOI: http://doi.org/10.22146/majkedgiind.74688

RESEARCH ARTICLE

Relationship between premolar extraction on the dimension of upper airway and tongue posture in skeletal class II malocclusion

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ABSTRACT

Correction of skeletal Class II malocclusion with camouflage orthodontic treatment generally requires the extraction of the maxillary first premolars to provide space for retraction of the maxillary incisors. Retraction of incisors changes the position of the incisors and the dimensions of the dental arch, which can cause changes in tongue posture and affect the upper airway. The purpose of this study was to determine the relationship between premolar extraction on the dimensions of upper airway and tongue posture in skeletal Class II malocclusion. This study was designed as a retrospective cohort using lateral cephalometric radiographs before and after orthodontic treatment. The samples in this study consisted of 44 samples of adult patients (n = 44) aged 18-40 years, who were divided into 2 groups: 22 subjects treated without premolar extraction and 22 subjects treated with premolar extraction. Lateral cephalometric radiographic analysis were used to measure the dimensions of the upper airway by analyzing superior posterior airway space (SPAS), middle airway space (MAS), inferior airway space (IAS), vertical airway length (VAL), and tongue posture (tongue length and height tongue) using imageJ software. No Statistically significant different changes were observed as seen from the following results: SPAS (p = 0.709), MAS (p = 0.365), IAS (p = 0.562), (p = 0.401), tongue length (p = 0.578), tongue height (p = 0.086) in the sample group without extraction premolar. No significant alterations in the upper airway and tongue posture measurement were observed in the sample group with extraction premolar. Premolar extraction with retraction on upper incisors did not affect upper airway dimensions and toung posture in skeletal Class II malocclusion.

Keywords: class II malocclusion; tongue posture; upper airway

INTRODUCTION

Premolar extraction in orthodontic treatment is still under debate. Considerations of premolar extraction include aesthetic problems, stomatognatic function, temporomandibular joint function and upper airway dimensions. The normal upper airway is an important factor for the normal growth and development of the dentocraniocycial structure. The narrow upper airway is a predisposing and etiological factor for the occurrence of mouth breathing and obstructive sleep apnea (OSA) as a respiratory disorder.[1]

There has been an increasing need for orthodontic treatment along with the soaring percentage of malocclusion prevalence in different countries. Based on the results of the National Basic Health Research (Riskesdas), the prevalence of maloclusion in Indonesia is still quite high, amounting to 80% of the population.[2] Utari and Putri reported that 61% of 100 subjects need orthodontic treatment among Indonesian adolescents aged 13-15 years, where 63% had Class I maloclusion, 28% had Class II maloclusion, and 9% had Class III maloclusion. Malocclusion is defined as a misalignment or incorrect relation between the teeth of the upper and lower dental arches when they approach each other.[2] Many different factors are involved in mallocclusion. One of the factors is breathing pattern. Mouth breathing is one of the most common causes of malocclusion in skeletal Class II malocclusion.[3]

The balance of the tongue and the surrounding soft tissues is necessary to achieve harmonious growth and development of the dental arches.[4] Mouth breathing can change the posture of the head, jaw and, tongue. This situation can change the balance pressure on the jaw and teeth that affect the growth of the jaw and the position of the teeth.[5] Skeletal malocclusion is an incorrect relation between the upper jaw and lower jaw against cranium.[6] It was revealed that class II skeletal malocclusion is due to the incorrect maxillary relationship to cranium prognati and normal mandibles, the maxillary relationship to normal cranium and retrognati mandibles, and a combination of the two, or a maxillary relation to cranium prognati and mandible relationship to aluminum retrognati.[7] Horani et al stated that class II division 1 maloclusion has a narrow upper airway and breathing patterns through the mouth.[4]

Several factors are known to contribute to class III malocclusion, and thus the treatment is also different depending on the causative factor. Correction of Class II skeletal malocclusion with camouflage orthodontic treatment generally requires the first premolar extraction to get sufficient space to retract the anterior teeth of the maxillary.[8]

There has been a significant impact of orthodontic treatment on retraction, since most of the space removal will be used for incisor retraction.[8] Incisor tooth retraction results in some changes in the position of the incisor teeth and some changes in the arch dental and skeletal dimensions that can alter the posture of the tongue and affect the upper airway.[9] The upper airway is one of the important parts of cephalometric analysis, because the width of the upper airway can also be determined by any respiratory barriers that may eventually lead to malocclusion.[10,11] Analysis of width of upper airway is reportedly performed at three different levels based on their parallelism with a cephalometric reference line connecting point B (most concave point on mandibular symphysis) to gonion (Go) (most postero –inferior point of angle of mandible). The first level is the superior posterior airway space (SPAS), the second level is the middle airway space (MAS), the third level is inferior airway space (IAS) and analysis of length of upper airway using vertical airway length (VAL).[12]

There has been an ongoing debate on the use of orthodontic camouflage treatment with premolar extraction in terms of its relation to the dimensions of the upper airway. Bhatia et al reported that premolar extraction followed by anterior retraction induced the width of the upper airway reduced.[13] In contrast, some different results were reported by Patel et al and Maurya et al who disclosed that premolar extraction in adult patients did not affect the width of the upper airway despite the length of the tongue and the reduction of the arch skeletal dimensions.[14,15] On this basis, this study aims to determine the relationship between upper incisor retraction, upper incisor retroclination, upper incisor retraction and upper incisor retroclination to tongue posture in skeletal class II malocclusion.

MATERIALS AND METHODS

This study was designed as a retrospective cohort using lateral cephalometry radiographs before and after orthodontic treatment. The research samples consisted of 44 samples of adult patients aged 18 - 40 years, who were divided into 2 groups: 22 subjects treated without premolar extraction and 22 subjects treated with premolar extraction. Photographic taking of lateral cephalogram radiographs placed on top of the tracing box (the middle of the black cardboard that has been cut) was conducted using a Nikon D90 camera with a Nikon DX AF-S NIKKOR 18-105 millimeter lens mounted on a tripod with a zero tilting position and 50 cm from the lateral cephalometric radiograph.

This study was carried out in the PPDGS Orthodontics Clinic of the USU Hospital to see the relationship between retraction and retroclination of the upper incisors on the dimensions of the upper airway and tongue posture in skeletal Class II malocclusion before and after orthodontic treatment.

The research samples were patients from the population who met the inclusion criteria and exclusion criteria before and after treatment. Inclusion criteria were patients with skeletal Class II relation with ANB angle > 4°, patients aged 18-40 years, patients with good and clear cephalometric radiography, patients with extraction of two maxillary premolars, patients with orthodontic treatment using edgewise standard brackets, and patients with orthodontic treatment using edgewise standard brackets.

Majalah Kedokteran Gigi Indonesia. August 2022; 8(2): 130-136
ISSN 2460-0164 (print)
ISSN 2442-2576 (online)

Measurement of the upper incisor retraction (UI-APog) is the linear difference in the pre and post treatment position of upper incisor in relation to A-Pog (point A to pogonion) line, while measurement of the upper incisor retroclination (UI-PP) is the angular difference in the pre and post treatment inclination of the upper incisor and palatal plane (line from PNS to ANS points).

Data normality test of Shapiro-Wilk was used in both groups of these samples. T-Paired t-test was used to analyze the changing dimension on the upper airway (superior posterior airway space, middle airway space, inferior airway space, vertical airway length and tongue posture (tongue length and tongue height) before and after treatment in the sample group without extraction and the sample group with extraction.

RESULTS

Table 1 showed the upper airway dimension and tongue posture change before and after treatment in sample group without extraction. The table showed the following results: p- value of SPAS, MAS, IAS, VAL, tongue length, tongue height were greater than 0.05 (p > 0.05). Hence, based on statistical analysis of mean values before and after treatment, there was no significant change on upper airway dimensions of SPAS, MAS, IAS, VAL, tongue length, tongue height in sample group without extraction.

Table 1 shows the mean of upper airway and posture tongue before and after treatment in sample group with extraction. The mean of SPAS before treatment was 16.09 mm and after treatment was 15.70 mm. Alteration in the upper airway SPAS was 0.39 mm, but this change was not significant because the p SPAS = 0.784 (p > 0.05). Alteration also occurred in upper airway MAS, IAS, VAL with p MAS = 0.519, p IAS = 0.603 and p VAL = 0.950 but this alteration was not significant becausep the value was > 0.05. Alteration also occurred in tongue length and tongue height with p tongue length of = 0.666 and p tongue height = 0.168, but this alteration was not significant because p value was > 0.05. Statistical analysis of the mean before and after treatment of the upper airway of SPAS,

Table 1. The mean of upper airway and tongue posture before and after treatment in sample groups without extraction

Variable		Mean ± SD Before treatment	Mean ± SD After treatment	p value
Upper airway dimensions (mm)	SPAS	20.55 ± 5.69	19.94 ± 5.12	0.709
	MAS	16.72 ± 5.07	15.27 ± 5.42	0.365
	IAS	15.58 ± 0.99	15.41 ± 0.85	0.562
	VAL	116.99 ± 9.92	119.21 ± 10.52	0.401
Tongue posture (mm)	Tongue length	155.01 ± 11.36	153.03 ± 12.05	0.578
	Tongue height	76.25 ± 8.01	79.84 ± 5.29	0.086

Table 2. The mean of upper airway dimension and tongue posture before and after treatment on sample groups with extraction

Variable		Mean ± SD before treatment	Mean ± SD after treatment	p value
Dimension of upper airway (mm)	SPAS	16.09 ± 4.89	15.70 ± 4.59	0.784
	MAS	10.073 ± 3.56	9.39 ± 3.35	0.519
	IAS	6.237 ± 3.04	5.81 ± 2.26	0.603
	VAL	90.777 ± 4.35	90.63 ± 10.37	0.950
Tongue posture (mm)	Tongue length	115.76 ± 11.36	117.63 ± 18.55	0.666
	Tongue height	61.27 ± 5.08	63.44 ± 5.17	0.168

Table 3. Relationship between retraction and retroclination upper incisor on the upper airway dimension on sample with extraction

Variable	Dimension of upper airway	p value	r
UI – APog (mm)	SPAS	0.035	- 0.319
	MAS	0.994	- 0.001
	IAS	0.092	- 0.257
	VAL	0.739	- 0.052
UI – PP (°)	SPAS	0.100	- 0.251
	MAS	0.084	- 0.263
	IAS	0.270	- 0.170
	VAL	0.182	- 0.205

Table 4. Relationship between retraction and retroclination upper incisor on tongue posture insample group with extraction

Variable	Dimension of upper airway	p value	r
UI – APOG (mm)	Tongue length	0.939	- 0.012
	Tongue height	0.377	0.136
UI – PP (º)	Tongue length	0.663	0.067
	Tongue height	0.566	0.089

MAS, IAS, VAL, tongue length and tongue height was not significant in sample group with extraction.

The relationship between retraction and retroclination of upper incisor with upper airway dimensions of SPAS, MAS, IAS and VAL were statistically tested with Pearson correlation test. The relationship between retraction and retroclination of upper incisor with upper airway dimensions of SPAS, MAS, IAS and VAL are presented in Table 3. Pearson correlation test in Table 3 showed negative correlation between UI-Apog and upper airway SPAS with $p = 0.035$ ($p < 0.05$) and $r = -0.319$. Negative correlation coefficient value showed that the relationship between retraction and the changing dimensions of upper airway were in the opposite direction. In other words, the higher the retraction value the lower the upper airway value. There was a weak correlation coefficient value between UI-Apog and upper airway SPAS with the value of $r = -0.319$. De Vaus reported that the correlation coefficient was classified as strong if the value of r was > 0.50, but since the value of r was < 0.50), the correlation coefficient was considered weak. The relationship UI-Apog with upper airway MAS, IAS and VAL showed insignificant negative correlations. Pearson's analysis between UI-PP with upper airway SPAS, MAS, IAS and VAL indicated a negative correlation, which showed that there was no significant correlation between UI-PP with upper airway SPAS, MAS, IAS and VAL.

Table 4 showed that the Pearson correlation of UI-APOG and tongue length with r value= -0.012 and p value= 0.939 was not significant ($p > 0.05$). This results showed that there was no significant correlation between UI-APOG and tongue length. Table 4 showed that the Pearson correlation coefficient between UI-PP and tongue length was $r = 0.067$ and $p = 0.663$. The correlation coefficient value between UI-PP and tongue height was $r = 0.089$ and $p = 0.566$. The correlation coefficient value of UI-PP with tongue length and tongue height was insignificant because p was > 0.05. The analysis of the data presented in Table 1 revealed that there was no significant retraction and retroclination of the upper incisors with tongue posture.

DISCUSSION

One of treatments for Class II skeletal malocclusion in adult patients is camouflage

Majalah Kedokteran Gigi Indonesia. August 2022; 8(2): 130-136
ISSN 2460-0164 (print)
ISSN 2442-2576 (online)

treatment. Camouflage treatment combined with extraction is usually performed by extraction of the upper premolars followed by retraction of the upper incisors.[16] Space of premolar extraction will be closed by retractionanterior segment at about 56% to 66% and the remainder is closed by mesial movements of posterior segment.[17] During growth, the dimensions of the upper airway can change. The upper airway of the nasopharynx develops rapidly until the age of 13 years. The size of the nasopharyngeal airway is tightened at the age of 5 years due to an increasing thickness of the adenoid tissue, then on the age of 11 years old, the dimensions of the upper airway increase again. This study was carried out on adult patients aged 18-40. Therefore, there was no further growth of the upper airway that could affect the size of the upper airway.

This study revealed the mean value of the changing dimensions of the upper airway and tongue posture before and after treatment in sample group without extraction and with extraction. Based on the statistical results, the mean upper airway values of SPAS, MAS, IAS, VAL and the mean value of tongue length and tongue height before and after orthodontic treatment showed insignificant changes in sample group without extraction and sample group with extraction.

The results of this study was analogous with the study of Truong et al, which was conducted on 20 patients aged 12-14 years, who were treated without extraction and 20 patients who were treated with extraction. This study showed that there was no significant change in the dimensions of the oropharynx upper airway. The alteration on incisor angulation and position in patients with premolar extraction did not lead to any significant differences in oropharynx. This was due to size of the upper airway, which was influenced by the position of the head and breathing patterns.[18]

The study by Uslu Akcam, which was conducted on 40 subjects, who were treated with premolar extraction, showed no alteration in the upper airway although inclination of incisor teeth, tongue length, arch length, and intermolar width changed significantly. This was due to the growth effect, which affected the dimensions of the pharyngeal upper airway. The alteration of soft tissue on posterior pharyngeal wall occurred at the age 6 and 9 years old of and at 12 and 15 years of age.[18] This study was conducted on patients aged 18-23 years old, whose upper airway had reached adult size, and thus the effect of growth will not affect the results.[19]

Previous studies showed that the retraction of the upper incisors did not have any significant relationship with the upper airway MAS, IAS and VAL. The retraction of the incisors above only had a significant negative correlation with the SPAS upper airway with weak correlation strength ($r < 0.50$). The results of this study were analogous with Patel et al, who showed that the removal of premolars in 20 subjects with 16-25 years old in Class II division I malocclusion cases and 20 subjects with Class I malocclusion cases of bimaxillary protrusion did not affect the upper airway although statistically there was a change in size, and anterior tooth retraction.[20]

The results of this study was different from those of Nasser et al. This study was conducted on 46 subjects aged 18-30 years old, who received an orthodontic treatment with premolar extraction in cases of Class I malocclusion bimaxillary protrusion affecting the upper airway SPAS (0.69 mm) and MAS (0.66 mm). Retraction of upper incisor caused some changes in dental arch dimensions and affected tongue posture. Dental arch dimensions that changed tongue posture affect upper airway dimensions.[12]

Results showed that there was no significant relationship between retraction and retroclination and the dimensions of the upper airway and tongue posture. The study of Adrienne et al, which examined 42 subjects aged 20-30 years treated without extraction and 41 subjects with extraction, showed that premolar extraction did not cause the alteration on the nasopharyngeal, retropalatal and retroglossal airways. This is caused by the diverse size of the upper airway, which depends on head posture and breathing patterns.[21] The habit of mouth breathing is due to the increasing head posture (hyperextension), and that the adaptation of this head posture in long term will make changes in upper airway. The dimensions of the upper airway are reduced and can lead to OSNA.[22]

Study by Halwa et al, showed different results. A study on 39 subjects aged 15-22 in cases of bimaxillary protrusion showed premolar retraction with minimum anchorage, which caused an increase in upper airway dimensions of SPAS and MAS. Patients who were treated with maxillary anchorage premolar extraction resulted a decrease in the upper airway dimensions of MAS and IAS. Patients who were treated without extraction did not cause any changes in the dimensions of the upper airway.[23] Halwa et al stated that alteration in tongue was due to the adaptation of changing dimensions of the upper airway.[23] Upper airway dimensions increased in patients with mesial molar movement, upper airway dimensions decreased due to retraction of anterior teeth, and upper airway dimensions did not change if the teeth were stable during treatment. The results of studies that were not significant on orthodontic treatment without extraction or with extraction of the alteration in upper airway were limited to the anatomy of the upper airway, and therefore further research is needed on respiratory function, especially on the functional of neuromuscular complex associated with OSA with a larger sample.

CONCLUSION

There was a significant relationship between changes in the upper incisor retraction and upper airway SPAS with a weak correlation. There was no significant correlation between incisor retraction and upper airway dimensions of MAS, IAS, VAL and tongue posture. There was no significant correlation between incisor tooth retraction and upper airway dimensions of SPAS, MAS, IAS, VAL and tongue posture. Orthodontic camouflage treatment without premolars extraction and with premolars extraction revealed insignificant changes in the upper airway dimensions and tongue posture.

REFERENCES

1. Sukniyom P, Viteporn S. Pharyngeal airway changes following extraction versus nonextraction treatments of class ii division 1 growing patients. Int J Oral Dent Heal. 2019; 5(3): 1–9. doi: 10.23937/2469-5734/1510094
2. Singh DD, Chaturvedi DS, Kararia DV, Goyal DD, Chowdhary DS, Singh DBP. Cone beam evaluation of pharyngeal airway space in adult skeletal class II div I and class II div II patients with different growth patterns. Int J Appl Dent Sci. 2022; 8(2): 323–329.
3. Cho HN, Yoon HJ, Park JH, Park YG, Kim SJ. Effect of extraction treatment on upper airway dimensions in patients with bimaxillary skeletal protrusion relative to their vertical skeletal pattern. Korean J Orthod. 2021; 51(3): 166–178. doi: 10.4041/kjod.2021.51.3.166
4. Horani S, El-Bialy T, Barmak AB, Rossouw PE, Michelogiannakis D. Changes in airway dimensions following non-extraction clear aligner therapy in adult patients with mild-to-moderate crowding. J Contemp Dent Pract. 2021; 22(3): 224–230.
5. Khaskhanova LM, Razumova SN, Serebrov DM, Gureva ZA, Vetchinkin AV, Rebrii AV, Bait SOMH. Scanning Electron Microscopy. Journal of International Dental and Medical Research. 2022; 15(1): 107–115.
6. ElHabbak KS, Hussain F, Al-Dany AT. Three-dimensional evaluation of pharyngeal airway volume following treatment of post-pubertal patients with skeletal class II malocclusion via miniplate-anchored herbst appliance. Al-Azhar J Dent Sci. 2020; 23(4): 435–444. doi: 10.21608/AJDSM.2020.24966.1068
7. Feizi, AG. Evaluating oropharyngeal airway volume in patients with class II dental relationships with extractions vs non-extraction orthodontic treatment. University of Maryland Baltimore: Dissertation; 2021.
8. Araujo MT de S, Squeff LR. Orthodontic camouflage as a treatment alternative for skeletal class III. Dental Press J Orthod. 2021; 26(4): 1–28. doi: 10.1590/2177-6709.26.4.e21bbo4
9. Pliska BT, Tam IT, Lowe AA, Madson AM, Almeida FR. Effect of orthodontic treatment on the upper airway volume in adults. Am J

Orthod Dentofacial Orthop. 2016; 150(6): 937–944. doi: 10.1016/j.ajodo.2016.05.013

10. Hang WM, Gelb M. Airway Centric® TMJ philosophy/Airway Centric® orthodontics ushers in the post-retraction world of orthodontics. Cranio. 2017; 35(2): 68–78. doi: 10.1080/08869634.2016.1192315
11. Ng JH, Ward LM, Shea M, Hart L, Guerino P, Scholle SH. Explaining the relationship between minority group status and health disparities: a review of selected concepts. Health Equity. 2019; 3(1): 47–60. doi: 10.1089/heq.2018.0035
12. Nasser A, Alshammari R, Al-Jewair T, Aldosari M, Sahar A. Post-orthodontic pharyngeal airway changes following first premolar extraction and incisor retraction in bimaxillary protrusion patients-a retrospective study. Journal of Research in Medical and Dental Science. 2019; 7(5): 29–38.
13. Bhatia S, Jayan B, Chopra SS. Effect of retraction of anterior teeth on pharyngeal airway and hyoid bone position in class I bimaxillary dentoalveolar protrusion. Med J Armed Forces India. 2016; 72(S1): S17–23. doi: 10.1016/j.mjafi.2016.06.006
14. Maurya MR kumar, Kumar CP, Sharma LCM, Nehra LCK, Singh H, Chaudhari PK. Cephalometric appraisal of the effects of orthodontic treatment on total airway dimensions in adolescents. J Oral Biol Craniofac Res. 2019; 9(1): 51–56. doi: 10.1016/j.jobcr.2018.09.004
15. Patel P, Nagaraj K, Jain A, Doshi D, Ringane A. Assessment of cephalometric changes in pharyngeal airway involving first premolar extractions in Class II Division 1 Patients and Class I bimaxillary protrusion patients treated with fixed mechanotherapy: a retrospective study. IP Indian J Orthod Dentofacial Res. 2017; 3(1): 31–36.
16. Rédua RB. Different approaches to the treatment of skeletal class II malocclusion during growth: Bionator versus extraoral appliance. Dental Press J Orthod. 2020; 25(2): 69–85. doi: 10.1590/2177-6709.25.2.069-085.bbo
17. Miles P, Fisher E, Pandis N. Assessment of the rate of premolar extraction space closure in the maxillary arch with the AcceleDent Aura appliance vs no appliance in adolescents: A single-blind randomized clinical trial. Am J Orthod Dentofacial Orthop. 2018; 153(1): 8–14. doi: 10.1016/j.ajodo.2017.08.007
18. Truong L, Reher P, Doan N. Correlation between upper airway dimension and TMJ position in patients with sleep disordered breathing. Cranio. 2020; 8: 1–9. doi: 10.1080/08869634.2020.1853465
19. Uslu-Akcam O. Pharyngeal airway dimensions in skeletal class II: A cephalometric growth study. Imaging Sci Dent. 2017; 47(1): 1–9. doi: 10.5624/isd.2017.47.1.1
20. Wang T, Yang Z, Yang F, Zhang M, Zhao J, Chen J, Li Y. A three dimensional study of upper airway in adult skeletal class II patients with different vertical growth patterns. PLoS One. 2014; 9(4): 1–9. doi: 10.1371/journal.pone.0095544
21. Adrienne N, Budd L, Ison S. Grounded aircraft: An airfield operations perspective of the challenges of resuming flights post COVID. Journal of Air Transport Management. 2020; 89: 101921. doi: 10.1016/j.jairtraman.2020.101921
22. Purwanegara MK, Sutrisna B. Mouth breathing, head posture, and prevalence of adenoid facies in patients with upper respiratory tract obstruction. J Dent Indones. 2018; 25(1): 58–64. Doi: 10.14693/jdi.v25i1.1203
23. Halwa HK, Yadav SK, Dutta K, Gupta SK, Shrestha R, Shah AK. Bimaxillary protrusion - a case report. Journal of Universal College of Medical Sciences. 2019; 7(1): 70–73. doi: 10.3126/jucms.v7i1.24697