ORIGINAL ARTICLE

EFFECT OF MANDIBULAR DISTRACTION OSTEOGENESIS ON AIRWAY IN PATIENTS WITH TEMPOROMANDIBULAR JOINT ANKYLOSIS

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ABSTRACT

Objectives: To assess clinically and cephalometrically the pharyngeal airway following distraction osteogenesis of the mandible in patients with Temporomandibular joint (TMJ) ankylosis and retrognathic mandible.

Material and Methods: A total of ten patients were included in this study. These patients were thoroughly evaluated pre-operatively and post-operatively both clinically and radiologically using McNamara analysis allowing comparison of pre-op and post-op findings.

Results: Out of 10 patients seven were females while three were male (Mean age 13.40 ±5.358 SD). The mean pre-operative UPPER airway width was 6.20±3.155 SD as compared to the mean post-operative upper airway (7.30±2.907 SD) with a statistically significant p-value (0.003). Mean The mean operative LOWER airway width was 4.90±1.969 SD as compared to the mean post-operative lower airway (7.10±2.9282 SD) with a statistically non-significant p-value (0.013). There was a negative correlation between post-operative lower airway and age (r= -0.26, sig=0.48).

Conclusion: Distraction Osteogenesis of the mandible can be used successfully in TMJ ankylosis patients with retrognathic mandible for the improvement of pharyngeal airway dimensions and relief from symptoms of obstructive sleep apnea due to decreased pharyngeal space.

Keywords: Mandibular distraction osteogenesis, airway assessment, Cephalometric analysis

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INTRODUCTION

Malocclusions and craniofacial malformations result from structural changes during the growth and development of the facial skeletal complex. The genetic polymorphisms may disturb the normal sequence of developmental events of the craniofacial complex and can lead to dentofacial anomalies.[1] The deformities in the craniofacial region are fairly common due to certain acquired and congenital conditions. In the dentofacial region, the most common anomaly is due to the short mandible, leading to retruded lower face profile.[2] The common causes of acquired mandibular retrognathia include Juvenile idiopathic arthritis (JIA), Temporomandibular joint (TMJ) ankyloses, and infections.[3-5] Congenital causes include Pierre robin sequence, Nager syndrome, and Treacher Collins syndrome. The most common acquired condition related to mandibular retrognathia is TMJ ankylosis.[3] Temporomandibular joint ankylosis leads to limited mouth opening and alters the pattern of growth of the mandible in pre-pubertal patients. The decreased proportion of the mandible and its retro position leads to displacement of the tongue posteriorly and results in a decrease of the oropharyngeal airway orifice, causing airway obstruction and can lead to obstructive sleep apnea syndrome (OSAS).[6] Patients affected by TMJ ankylosis usually suffer from OSAS due to mandibular retrognathia.[7]

Distraction is an advanced and relatively safe procedure for increasing the length and height of the mandible, particularly in children. Mandibular distraction osteogenesis is being used for upper airway obstruction in growing children due to mandibular retrognathia or hypoplasia. In this regard, a case series was issued in 1992, for the first time.[8] Majority of the patients managed with this technique were having mandibular hypoplasia. Mandibular distraction may result in relieving sleep-related upper airway obstruction. These patients are at risk for constant obstructive sleep apnea (OSA) and are reported with com-

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plaints of snoring, gasping, respiratory pauses, and disturbed sleep.[9,10] Polysomnography is the well-established tool for the assessment and analysis of OSA.[10] Several studies have confirmed the effectiveness of distraction osteogenesis in the management of sleep apnea in patients having TMJ ankylosis for initial management. This procedure will also help in the improvement of the aesthetic concerns of the patient by lengthening the mandible. However, published studies are deficient in the long-term usefulness of distraction osteogenesis of the mandible for the management of sleep apnea in patients having TMJ ankylosis.

This study aimed to analyze the pharyngeal airway clinically and radiographically through cephalometric analysis, following distraction osteogenesis of the mandible in patients having TMJ ankylosis and retrognathic mandible.

MATERIALS AND METHODS

A prospective evaluation of patients was performed who presented to the Department of Oral and Maxillofacial Surgery at Khyber College of Dentistry with temporomandibular joint (TMJ) ankylosis, symptoms of obstructive sleep apnea (OSA) and managed with distraction osteogenesis of the mandible. A total of ten patients were included in the study.

Data of patients included in the study was recorded on a specifically designed proforma after taking informed consent. It included the biodata of the patients, followed by detailed history, clinical examination, and radiographic examination including orthopantomogram and lateral cephalogram for airway assessment using McNamara analysis.

On follow-up visits after lengthening of the mandible with distraction osteogenesis, history, clinical examination, and postoperative cephalogram analysis were carried out to compare preoperative airway status with post-operative status.

Radiographic Airway Assessment McNamara Analysis was used to assess the airway status. The width of the upper airway was taken from the point on the posterior soft palate outline to the nearest point on the posterior side of the pharyngeal wall, taken on the anterior half of the soft palate. The intersection of the posterior border of the tongue and the inferior border of the mandible to the nearest point on the posterior pharyngeal wall was taken as reference points to measure the width of the lower airway. The normal range of upper airway space is 15-20 mm and the range of lower airway space is 11-14 mm.

Information so collected was analyzed using SPSS version 22. Means were calculated for age and UPPER and LOWER airway widths. A T-test was applied to compare the mean values while Pearson correlation analysis was carried out to determine the relationship between airway widths and the age of the patient.

RESULTS

A total of 10 patients were included in the study where seven were females while three were male (Mean age 13.40 ±5.358 SD). All patients reported an improvement in their clinical symptoms 6 months postoperatively. Results of t-test analysis showed that the mean pre-operative UPPER airway width was 6.20±3.155 SD as compared to the mean post-operative upper airway (7.30±2.907 SD) with a statistically significant p-value (0.003) see Table 1. Similarly, the mean pre-operative Lower airway width was 4.90±1.969 SD as compared to the mean post-operative lower airway (7.10±2.9282 SD, p-value=0.013) Table 2.

Pearson correlation test was applied to find out the statistics of the correlation between post-operative lower airway and age. The result of this test showed that there was a negative correlation between post-operative lower airway and age (r= -0.26, sig=0.48) Fig 1,2,3,4.

Table 1: Descriptive statistics of baseline characteristic

Variable	Minimum	Maximum	Mean	Std. Deviation
Age	6.00	22.00	13.4000	5.35828
Pre-operative upper airway	2.00	11.00	6.2000	3.15524
Post-operative upper airway	3.00	12.00	7.3000	2.90784
Pre-operative lower airway	2.00	7.00	4.9000	1.96921
Post-operative lower airway	4.00	11.00	7.1000	2.28279

Table 2: Mean difference in airway width (Pre-operative and Post-operative)

Variable	Mean	95% Confidence Interval of the Difference		t	P value
		Lower	Upper		
Mean difference of upper airway (pre-operative post-operative)	-1.10000	-1.72636	-.47364	-3.973	.003
Mean difference of lower airway (pre-operative post-operative)	-2.20000	-3.81022	-.58978	-3.091	.013

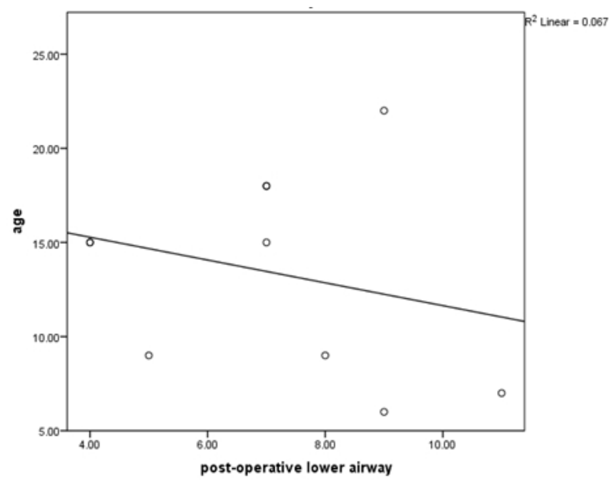

Fig 1: Correlation between age and Post-operative Lower airway (R2=-0.258)

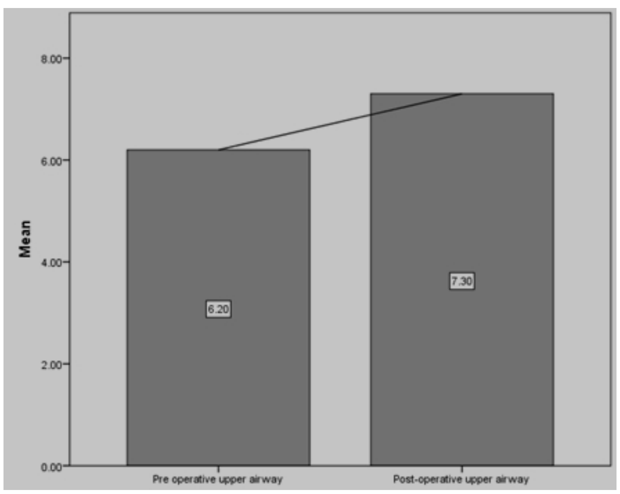

Fig 2: Mean difference between Pre-op upper airway and Post-op upper airway

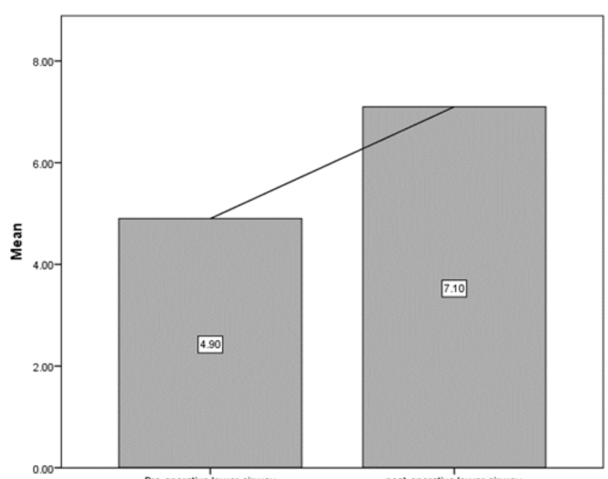

Fig 3: Mean difference between Pre-op Lower airway and Post-op Lower airway

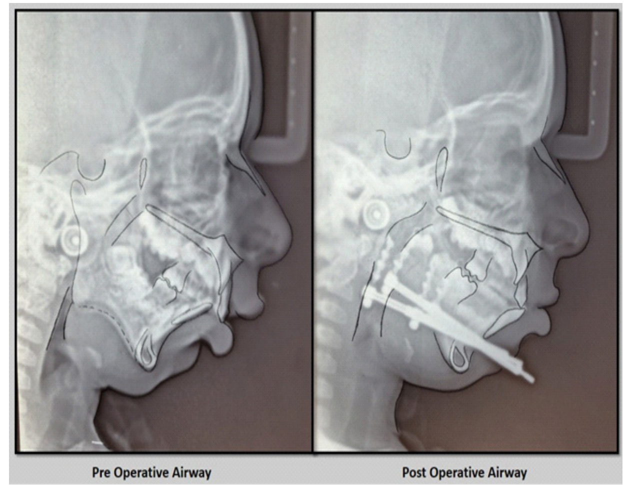

Fig 4: Pre-op and Post-op airway widths

DISCUSSION

It is important to look for clinical signs and symptoms of obstructive sleep apnea (OSA) in patients with TMJ ankylosis and retrognathia.[7] Orthognathic surgical procedures are used for treating dentofacial anomalies and adaptation of ideal skeletal relationship.[11] the mandibular advancement through distraction osteogenesis surgery, alters the pharyngeal airway dimensions, and the breathing patterns. [11,12]

The structure of the pharyngeal airway can be evaluated in a three-dimensional evaluation through cephalometric analysis. The radiographic cephalometry provides direct visualization of airway structures and is easily executed; having low cost and minimal radiation exposure.[1] the airway dimensions were evaluated by lateral. This radiographic cephalometry is a valuable tool to analyze the important structures in relation to airway obstruction and is an equally valuable means for assessment of the airway after surgical intervention. The role of cephalometric analysis gains more importance in patients with ankylosis of the TM joint, because of the inability of direct visualization of the airway due to limited mouth.[13]Thorough physical examination, nasopharyngoscopy, CT scan, MRI, and certain other advanced investigatory procedures are also mentioned in the literature which is used for upper airway evaluation and assessment of OSAS. [14] However, due to cost and availability; these methods were not used for patients in this study. Moreover, the cephalometric analysis is a safer and easily cost-effective investigatory tool for the assessment of the airway.

The patients with craniofacial anomalies and mandibular retrognathia were usually managed with a tracheostomy, endotracheal intubation, and extended nasal airways, before the introduction of mandibular distraction.[15] In 1992, McCarthy et al[8] presented a series of patients who underwent distraction osteogenesis of the mandible, aided in the avoidance of tracheotomy in some children with the hypoplastic mandible. The hypoplasia of the mandible is addressed by lengthening the mandible through distraction osteogenesis which provides support supraglottic and pharyngeal airway. Though the original study published by McCarthy et al.[8] was aimed at the improvement in the aesthetic outcome in children with craniofacial anomalies through the use of mandibular distraction. This was followed by several subsequent studies that demonstrated the improvement of the airway dimensions in children with mandibular hypoplasia through the use of mandibular distraction. In a study by Carls and Sailer[16] a series of seven children having severe mandibular hypoplasia and secondary breathing difficulty were treated with distraction osteogenesis. All of these patients were having improvement in their respiratory symptoms after the procedure.

In the present study, an improvement in the clinical symptoms was reported post-operatively by all the patients included. This finding was reinforced by an increase in the dimensions of the airway measured radiographically. Results of the t-test analysis showed that the mean pre-operative upper airway width was 6.20±3.155 SD as compared to the mean post-operative upper airway (7.30±2.907 SD) with a statistically significant p-value (0.003). Similarly, the mean pre-operative lower airway width was 4.90±1.969 SD as compared to the mean post-operative lower airway (7.10±2.9282 SD) with a statistically non-significant p-value (0.013).

Several studies have reported similar findings including a local case report by Qiam et al, who document findings consistent with our study results. Zeitoun, in his study of nine patients having bilateral ankylosis of the TM joint, was treated in two stages. [17,18] In the first stage the body length or ramus height was increased and in the second stage, the ankylotic mass was resected after achieving the consolidation neo bone formed as a result of distraction. This was followed by post-operative radiographic and clinical assessment. He reported that six patients out of seven showed that there was a significant reduction of snoring and improvement in obstructive sleep apnea, which is in accordance with the results of our study. Similar study results were reported by Prado et al and Lin et al[1, 15].

Our results showed a negative correlation between post-operative lower airway and age ($r= -0.26$, sig=0.48). Martin et al.[19] studied the association of age, gender, and posture with upper and lower airway size in Edinburgh UK, and demonstrated similar results. They showed that the Pearson correlation coefficient between age and upper airway was in the range of -0.25 to -0.34 in seated and supine positions respectively.

The results of the study carried out by Eikermann[20] and his colleagues were also in agreement with our study. They showed that increased age was significantly correlated with the collapse of the pharyngeal wall ($r = 0.69$; $p < 0.01$) and pharyngeal resistance while sleeping ($r = 0.56$; $p < 0.01$). This correlation was independent of gender and body mass index. These data from the literature may explain the underlying mechanisms of the tendency for pharyngeal collapse in advanced age. The only difference between the present investigations and the studies done by Martin et al. and Eikermann is that our study has been conducted on post-operative Distraction osteogenesis patients while the former has on non-operated individuals [19,20].

The small sample size is one of the major limitations of our study. Large-scale studies are needed with bigger sample sizes to address the issue with better clinical reliability and significance. Moreover, mass awareness programs on print and electronic media should be initiated to address the gravity of this problem in the initial stages of trauma-related ankylosis and subsequent changes in the airway.

Otolaryngologists should work in close liaison with the maxillofacial surgical team so that procedures like lower airway dilatation can also be performed along with upper airway widening by distraction osteogenesis.

CONCLUSION

Distraction osteogenesis for mandibular lengthening is an effective means of increasing the dimensions of the pharyngeal airway in patients with TMJ ankylosis who have signs and symptoms of airway obstruction. It leads to obvious clinical and radiological improvement in the nasopharyngeal airway improving the quality of life.

REFERENCES

1. Prado FB, Rossi AC, Freire AR, Groppo FC, Moraes M.De, Caria PHF. Pharyngeal airway space and frontal and sphenoid sinus changes after maxillomandibular advancement with counterclockwise rotation for class II anterior open bite malocclusions. Dento-maxillo-facial Radiology 2012; 41: 103–9.
2. Burden D, Johnston C, Kennedy D, Harradine N, Stevenson M. A cephalometric study of Class II malocclusions treated with mandibular surgery. Am J Orthod Dentofacial Orthop 2007; 131: 7–8.
3. Anantanarayanan P, Manikandhan R. Cephalometric evaluation of airway changes following mandibular distraction in patients with nocturnal desaturations during sleep Secondary to TMJ Ankylosis. Journal of maxillofacial and oral surgery. 2013;12(1):17 20
4. Pirttiniemi P, Peltomäki T, Müller L, Luder HU. Abnormal mandibular growth and condylar cartilage. European journal of orthodontics.2009;31(1):1-11
5. Hameed H, Alamgeer, Shad S, Din QU. Etiology clinical and radiographic features of temporomandibular joint ankylosis. Pakistan oral and dental journal.2013;33(1):26-30
6. Andrade NN, Raikwar KR. Management of patients with obstructive sleep apnea induced by temporomandibular joint ankylosis: a novel two-stage protocol and report of

5 cases. Asian J Oral Maxillofac Surg 2009; 21:27–32.

7. Andrade NN, Kalra R, Shetye SP. New protocol to prevent TMJ reankylosis and potentially life-threatening complications in triad Patients. Int. J. Oral Maxillofac. Surg. 2012; 41: 1495–1500
8. McCarthy JG, Schreiber J, Karp N, et al. Lengthening the human mandible by gradual distraction. Plast Reconstr Surg. 1992; 89:1-10.
9. Brietzke SE, Katz ES, Roberson DW. Can history and physical examination reliably diagnose pediatric obstructive sleep apnea/hypopnea syndrome? a systematic review of the literature. Otolaryngol Head Neck Surg. 2004;131:827-832.
10. Relief of Upper Airway Obstruction With Mandibular Distraction Surgery Long-term Quantitative Results in Young Children Sandra Y. Lin, MD; Ann C. Halbower, MD; David E. Tunkel, MD; Craig Vanderkolk, MD Arch Otolaryngol Head Neck Surg. 2006;132:437-441
11. Eggensperger N, Smolka K, Johner A, Rahal A, Thu¨er U, Iizuka T. Long-term changes of hyoid bone and pharyngeal airway size following the advancement of the mandible. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2005; 99: 404–10.
12. Frost HM. The Utah paradigm of skeletal physiology: an overview of its insights for bone, cartilage and collagenous tissue organs. J Bone Miner Metab 2000; 18: 305–16.
13. Holmberg H, Linder-Aronson S. Cephalometric radiographs as a means of evaluating the capacity of the nasal and nasopharyngeal airway. Am J Orthod 1979;76:479-90.
14. Maria S T, Cauby M, Palombini L, Tufik S, Hora F, Nery LE. Evaluation of the upper airway in obstructive sleep apnoea. Indian J Med Res 2010;131: 230-5.
15. Lin SY, Halbower AC, Tunkel DE, Vanderkolk C. Relief of Upper Airway Obstruction With Mandibular Distraction Surgery, Long-term Quantitative Results in Young Children. Arch Otolaryngol Head Neck Surg. 2006; 132: 437-41
16. Carls FR, Sailer HF. Seven years of clinical experience with mandibular distraction in children. J Craniomaxillofac Surg. 1998; 26: 197-208
17. Qiam F, Mehboob B, Adil S, Bukhari SGA. Determining the improvement in nasopharyngeal airway following the release of a unilateral TMJ ankylosis-a case report. JKCD December 2013; 4(1): 38-42
18. Zeitoun IM. Cephalometric changes in the upper airway after advancement of the micrognathia mandible of long-standing bilateral TMJ ankylosis. The Saudi Dental J. 1993; 5(3): 121-6
19. Martin SE, Mathur R, Marshall I, Douglas NJ. The effect of age, sex, obesity, and posture on upper airway size. Eur Respir J 1997; 10: 2087–2090 DOI: 10.1183/09031936.97.10092087.
20. Eikermann M, Jordan AS, Chamberlin NL, Gautam S, Wellman A, White DP et al. The influence of aging on pharyngeal collapsibility during sleep. Chest. 2007;131(6):1702-9. doi: 10.1378/chest.06-2653.

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AUTHOR'S CONTRIBUTION

Following authors have made substantial contributions to the manuscript as under

Rehman AU:	Design, Concept, Data Collection, and proofreading
Rehman B:	Design, Writing manuscript and Data Collection
Ahmad T:	Measurements, Data Collection
Khan M:	Measurements, Data Collection
Shafi H:	Surgical procedure
Farhad A:	Data Analysis
Ayaz H:	Measurements, Data Collection
Rehman N:	Measurements, Data Collection
Bilal S:	Measurements, Data Collection
Jehan F:	Measurements, Data Collection

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.