The “Rubber Band” and “Slingshot” Effects of the Posterior Airway Space in Mandibular Orthognathic Surgeries

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Abstract

Introduction Mandibular surgeries are the most common orthognathic procedures that are undertaken. The pharyngeal airway space (PAS) is influenced by the changes in the sagittal changes of the mandible. Mandibular advancement surgeries are used to an advantage in obstructive sleep apnea cases to improve the airway space. On the contrary, there can be a considerable decrease in the airway space during mandibular setback procedures. Numerous studies have been conducted to study the effect of changes in the PAS during mandibular procedures. However, a combined radiographic and endoscopic analysis of the airway space has been sparsely done in recent literature

Materials and methods Thirty-one patients with mandibular discrepancies who needed mandibular surgeries were chosen. The assessment of PAS was done using both lateral cephalograms and endoscopic examination.

Results As lateral cephalograms can study only the two-dimensional changes in the PAS, endoscopic examination both pre operatively and post operatively enabled the exact

assessment of mandibular surgeries on the PAS. The PAS responds to setback mandibular surgery by modifying itself- called the “Rubber band” effect and in advancement surgeries as “Slingshot effect”.

Keywords Posterior Airway Space (PAS) · Mandibular surgery · Ramdas’ Slingshot effect · Ramdas’ Rubber band effect

Introduction

Combined orthodontic–orthognathic surgical treatment has made it possible to treat skeletal and dental deformities in patients where orthodontics alone cannot produce a desirable result. By altering the position of the jaws, the size and shape of the external and internal surrounding soft tissues are affected, including the pharyngeal airway.

Surgery to setback or advance the mandible is considered a standard treatment for mandibular discrepancies. As surgery markedly shifts the position of the mandible, large amounts of setback are thought to alter tongue position and narrow the pharyngeal airway space (PAS), potentially causing obstructive sleep apnea (OSA). Also, advancing the mandible markedly would result in more chances of relapse [1]. Numerous studies have been done to study the effect of mandibular orthognathic surgery on the respiration and craniofacial morphology-airway anatomy, nasal flow.

Many studies examined changes in the pharyngeal airway size utilizing lateral cephalograms which allow two dimensional measurements of a three dimensional object, and measurements are taken in the sagittal or antero-posterior dimension [3, 4–6, 12]. In order to better understand how the airway is affected, it is important to study the size

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and shape of the airway in both antero-posterior and lateral direction. By measuring the PAS, both in the antero-posterior and lateral dimensions, we can more accurately determine the airway changes following maxillo-mandibular orthognathic procedures [1, 2].

In the present study, the airway changes were studied using both pre and post operative lateral cephalograms and endoscopic examination.

Materials and Methods

The ethics review committee at the hospital approved the study protocol, and all patients and their parents provided informed consent.

Thirty-one patients with mandibular discrepancies who needed mandibular surgeries were chosen. Such patients were assessed using lateral cephalograms and models.

Table 1 Mandibular advancement

Name	Age/sex	Predicted (mm)	Achieved (mm)	Retropalatal space (2 mm)		Retroglossal space (4 mm)	
				Pre-op	Post-op	Pre-op	Post-op
Priya	26/F	6	5	9	12	7	12
Sowbhagaya	25/F	6	5	8	10	7	11
Keerthika	21/F	6	5	7	9	5	8
Prakash	30/M	7	6	8	11	8	12
Ganesh	22/M	7	6	7	9	7	11
Bhargavi	24/F	5	4	9	10	9	11
Ramesh	26/M	5	4	9	10	8	12
Kavitha	28/F	6	5	8	10	8	12
Mary	24/F	6	5	7	9	7	11
Kamala	26/F	5	4	7	10	7	10
Raji	22/F	6	6	8	10	5	8
Tomraj	29/M	5	5	8	11	7	10
Kavya	28/F	6	5	7	9	7	11
Ameena	26/F	6	5	9	11	8	11
Somen	22/M	5	4	7	9	5	9
Gopal	28/M	7	6	7	9	8	12

Table 2 Mandibular setback

Name	Age/sex	Predicted	Achieved	Retropalatal space (1 mm)		Retroglossal space (3 mm)	
				Pre-op	Post-op	Pre-op	Post-op
Neha	20/F	6	5	12	11	9	7
Durga	22/F	7	6	12	11	11	8
Kritika	21/F	5	5	11	10	12	11
Praveen	27/M	6	5	10	9	11	9
Kavitha	23/F	7	6	10	9	11	7
Shiva	29/M	6	6	12	10	14	9
Komala	26/F	6	6	11	10	12	9
Raju	28/M	5	5	10	10	13	11
Shaiju	29/M	5	5	12	11	12	9
Thomas	26/M	6	5	12	11	11	9
Ramesh	26/M	7	6	10	10	13	10
Minni	23/F	5	5	11	10	12	9
Azar	27/M	5	5	12	11	12	10
Dhrona	29/M	6	6	12	11	13	11
Mahesh	27/M	5	5	11	10	14	11
Rahul	27/M	7	6	10	9	12	9

Also, all patients underwent a pre-operative endoscopic assessment of the PAS. The assessment included the evaluation of the PAS in respect to the antero-posterior diameter, i.e., the distance from the posterior aspect of the epiglottis to the posterior wall of the pharynx, and the lateral measurement between the lateral pharyngeal walls.

Sixteen patients who required advancement of the mandible were grouped under group 1 and other 15 requiring setback surgeries were under group 2. The amount of advancement and setback were estimated using lateral cephalograms and clinical evaluation and were carried out accordingly.

All patients underwent bilateral sagittal split osteotomies of the mandible for both advancement and setback. The amount of setback achieved and the changes in the retropalatal and retroglottal airway dimensions were tabulated as in Table 1.

The amount of advancement achieved and the changes in the retroglottal and retropalatal airway dimensions are tabulated in Table 2.

Results

The pre operative and post operative measurements of the patients who underwent mandibular setback surgery and advancement are given in the Tables 1 and 2 respectively along with the amount of proposed mandibular setback and advancement.

As predicted in the lateral cephalogram tracings, there was a significant decrease in the PAS in all the patients. However, the lateral cephalograms do not evaluate the 3-dimensional changes that occur in the PAS. This, in the present study was effectively evaluated through pre and post operative endoscopic examinations. Though there was an evident change in the anterior posterior dimension of the PAS, one worthy finding was noted through the endoscopic pictures—an appreciable increase in the lateral dimension of the PAS during setback, which we have termed as “*Ramdas’ Rubberband Effect*” and a decrease in the lateral but an increase in the sagittal dimension in advancement surgeries which we have termed as the “*Ramdas’ Slingshot effect*”.

It has been proved beyond doubt that the setback of the mandible does produce a variable decrease in the antero posterior dimension of the PAS, the increase in the lateral dimension has never been noted. In the present study, this was well documented and proved through endoscopic examination.

Discussion

Mandibular advancement surgery has been shown to increase oro PAS and is recognized as one of the most

Fig. 1 Pre operative endoscopic view of the PAS before mandibular setback

Fig. 2 Endoscopic view of the PAS after mandibular setback, note the decrease in the antero posterior dimension and a measurable increase in the lateral dimension-“*Rubber Band Effect*”

successful approaches to treat oro-pharyngeal airway deficiencies. It is one of the most frequently performed procedures for OSA.

Mandibular hyperplasia is often treated using the bilateral sagittal split osteotomy and the intraoral ramus osteotomy for setback procedure. It is known to cause a narrowing of the pharyngeal airway owing to the changes in the position of the tongue and the hyoid bone [8–11, 13]. The mandible, base of the tongue, hyoid bone and pharyngeal wall are intimately related by their muscular and ligamentous attachments. A reduced PAS results from the tongue falling back along with the hyoid bone being pushed inferiorly and posteriorly. In a few cases, it can be the initiating factor in the development of OSA. Several studies have reported that the setback of the mandible is the sole factor for development of OSA (Riley et al.) [1, 7]. However, the main disadvantage of these studies is that

Fig. 3 Ramdas' Rubber band Effect

Fig. 4 Ramdas' Slingshot effect

they were all based on lateral cephalogram tracings and thus a 2D analysis.

Endoscopic evaluation (Fig. 1) does give a detailed picture of the PAS giving a 3D perspective of the same. Though we also reported the same decrease in the PAS

with the help of an endoscope, the lateral dimensions did show a reasonable increase in dimension anterior to the lateral pharyngeal wall (Fig. 2). All cases of mandibular setback should ideally result in OSA. However, though numerous studies have reported a significant reduction in the PAS, all these authors have not reported OSA in all their cases. This is attributed to the increase in the lateral dimension of the PAS—“*Ramdas' Rubberband Effect*”.

“The Rubber Band and the Slingshot Effects”

If we consider an elastic that is oval in shape and try to compress the longer dimension, the shorter dimension tends to increase. This is the rubber band effect. The PAS reacts to the setback of the mandible in a similar way—a decrease in the postero-anterior dimension and a noticeable increase in the lateral dimension (Fig. 3).

During the advancement of the mandible, the postero-anterior dimension of the PAS increases with a gradual decrease in the lateral dimension, similar to a “slingshot” (Fig. 4).

References

1. Hong J-S, Park Y-H, Kim Y-J, Hong S-M, Oh K-M (2011) Three-dimensional changes in pharyngeal airway in skeletal class III patients undergoing orthognathic surgery. *J Oral Maxillofac Surg* 69:e401–e408
2. Degerliyurt K, Ueki K, Hashiba Y, Marukawa K, Nakagawa K, Yamamoto E (2008) A comparative CT evaluation of pharyngeal airway changes in class III patients receiving bimaxillary surgery or mandibular setback surgery. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 105:495–502
3. Muto T, Yamazaki A, Takeda S, Sato Y (2008) Accuracy of predicting the pharyngeal airway space on the cephalogram after mandibular setback surgery. *J Oral Maxillofac Surg* 66: 1099–1103
4. Tselnik BSM, Pogrel MA (2000) Assessment of the pharyngeal airway space after mandibular setback surgery. *J Oral Maxillofac Surg* 58:282–285
5. Pereira-Filho VA, Castro-Silva LM, De Moraes M, Gabrielli MFR, Campos JADB, Juergens P (2011) Cephalometric evaluation of pharyngeal airway space changes in class III patients undergoing orthognathic surgery. *J Oral Maxillofac Surg* 69: e409–e415
6. Marsan G, Cura N, Emekli U (2008) Changes in pharyngeal (airway) morphology in class III turkish female patients after mandibular setback surgery. *J Craniomaxillofac Surg* 36:341–345
7. Gokce SM, Gorgulu S, Gokce HS, Bengi O, Sabuncuoglu F, Ozgen F, Bilgic H (2012) Changes in posterior airway space, pulmonary function and sleep quality following bimaxillary orthognathic surgery. *Int J Oral Maxillofac Surg* 41:820–829
8. Kawakami M, Yamamoto K, Fujimoto M, Ohgi K, Inoue M, Kirita T (2005) Changes in tongue and hyoid positions, and posterior airway space following mandibular setback surgery. *J Craniomaxillofacial Surg* 33:107–110

9. Muto T, Yamazaki A, Takeda S, Sato Y (2008) Effect of bilateral sagittal split ramus osteotomy setback on the soft palate and pharyngeal airway space. *Int J Oral Maxillofac Surg* 37:419–423
10. Eggensperger N, Smolka W, Iizuka T (2005) Long-term changes of hyoid bone position and pharyngeal airway size following mandibular setback by sagittal split ramus osteotomy. *J Cranio-maxillofac Surg* 33:111–117
11. Hochban W, Schurmann R, Brandenburg U, Conradt R (1996) Mandibular setback for surgical correction of mandibular hyperplasia—does it provoke sleep-related breathing disorders? *Int J Oral Maxillofac Surg* 25:333–338
12. Becker OE, Avelar RL, Göelzer JG, Dolzan ADN, Haas Júnior OL, De Oliveira RB (2012) Pharyngeal airway changes in class III patients treated with double jaw orthognathic surgery—maxillary advancement and mandibular setback. *J Oral Maxillofac Surg* 70:e639–e647
13. Kitagawara K, Kobayashi T, Goto H, Yokobayashi T, Kitamura N, Saito C (2008) Effects of mandibular setback surgery on oropharyngeal airway and arterial oxygen saturation. *Int J Oral Maxillofac Surg* 37:328–333