

CEPHALOMETRIC CHANGES OF THE UPPER AIRWAY AFTER ADVANCEMENT OF MICROGNATHIC MANDIBLE OF LONG-STANDING BILATERAL TMJ ANKYLOSIS

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الاشعاعات السفالومترية بعد تقديم الفك الأسفل وتحرير مفاصل الفك

يتكون هذا البحث من تسعة مرضى بالغين مصابين بالانصاقات مزمنة للمفصل الفكي الصدغي لفترات طويلة وكان جميعهم يعانون من شخير أثناء النوم مع كثرة النعاس بأوقات النهار، وقد تمت دراسة الأشعاعات السفالومترية الخاصة بهم قبل وبعد مرحلتي العلاج الجراحي التي شملت تقديم الفك السفلي للأمام ثم تحرير مفصل الفك من الانصاقات، وتبين للباحث حدوث زيادة في الأبعاد الأمامية الخلفية للمسالك الهوائية العلوية بعد المرحلة الأولى التي تبعتها نقص في هذه الأبعاد بعد المرحلة الثانية، ولكن النتيجة النهائية بعد أكثر من عام من المرحلة الثانية كانت زيادة في هذه الأبعاد وقد لاحظ أقارب المرضى أن شخيرهم أثناء النوم قد قل بدرجة كبيرة، وتؤكد هذا بصور الأشعة السفالومترية.

Nine adult patients with protracted bilateral TMJ ankylosis are the material of this work. All of them suffered from snoring during sleep and excessive daytime somnolence. Their cephalometric radiographs before and after staged surgical advancement and release of ankylosis were studied. The author found increases in the antero-posterior dimensions of the upper airway spaces after the first stage of advancement. Such increases were followed by decreases after the second stage of release of ankylosis. The final outcome, 1 to 2 years after surgery, was a significant increase of the upper airway space. This increase noticed both by the patient's relatives who had no more complains of the troublesome snoring and objectively by the lateral cephalometric changes.

Introduction

Snoring is a part of a spectrum of airway embarrassment extending to complete shutdown of the upper airway and obstructive sleep apnea syndrome (OSAS). The site of upper airway obstruction is usually the area of the nasopharynx and/or oropharynx. Snoring can occur at three basic sites; the nose, oropharynx and hypopharynx.¹ Pharyngeal changes were clearly recognized to play a role in OSAS. Menashe and co-workers²

reported on four pediatric patients with *cor-pulmonale* resulting from severe OSAS secondary to enlarged adenoids and tonsils. Subsequently, tracheostomy was reported to be an effective treatment for OSAS.³ The introduction of uvulopalatopharyngoplasty (UPPP) represented a major advance in the treatment of OSAS.⁴

Maxillary advancement was found to led to increases in both nasopharyngeal and hypopharyngeal airway spaces.⁵ No explanation was found for the hypopharyngeal increased dimensions after advancing the maxilla alone.

Fifty-five patients were treated for OSAS by Riley and associates.⁶ They adopted the technique of sagittal mandibular osteotomy and advancement of the genial tubercles coupled with hyoid myotomy suspension. They reported both

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subjective and objective success in 37 cases. Twenty six of the cases received UPPP because presurgical evaluation determined obstruction at both oropharyngeal and hypopharyngeal levels.

Therefore, multiple surgical procedures designed to increase the posterior airway space as described in the literature, have been devised.⁷ However, the literature is deficient in correlating sleep apnea and micrognathia secondary to protracted bilateral TM) ankylosis. The purpose of this study was to elaborate on whether both mandibular advancement and release of ankylosis will increase the posterior airway space and improve the symptoms of airway obstruction during sleep.

Materials and Methods

Nine patients (8 females, 1 male) were included in this study. The mean age was 20 years, with a range from 15 to 33 years. The mean duration of ankylosis was 11.7 years ranging from 7 to 24 years. Six patients presented with recurrence after one, two or even three operations for release of ankylosis.

The chief complaints of all patients and their relatives were snoring by night and excessive daytime sleepiness (EDS). Most of them were neither concerned with their appearance nor their stiff jaws. All of them were submitted to the following program:

1. Full clinical examination especially for causes of upper respiratory tract narrowing such as deviated septum, enlarged turbinates, nasal polyp, etc.
2. Routine laboratory investigations.
3. Specific investigations:
 - a. Cephalometric tracing before and after surgery
 - b. Study models
 - c. Labiobuccal model of teeth + preliminary occlusal wafer
 - d. Arterial blood gas studies
4. Operative treatment: 2 stages:
 - Stage 1: Mandibular advancement + bone grafting
 - Stage 2: Release of ankylosis, 3 months later

Eight patients were submitted to arterial blood sampling during wakefulness and the ninth was examined for arterial blood gaseous changes

during an apneic episode at night. The blood samples were collected before and after the first stage of mandibular advancement. No blood samples were obtained after the second stage. Obtaining another blood sample might have necessitated re-admitting the patients to the hospital just for collecting arterial blood during sleep. Readmitting the patients was impractical especially after finishing the whole treatment program. Moreover, the author was not aware initially of the full blown picture of the syndrome or of the optimum time to collect the blood samples for gas studies. All samples were collected during wakefulness which eventually proved to be false normal except in Case 9.

Cephalometric Analysis [Fig. 1]

Lateral cephalometric radiographs were taken preoperatively (P1) and postoperatively one week after the first stage (P2) and one year after the second stage (P3). The Frankfurt horizontal plane (F) was chosen as a fixed guide in each radiograph. Three lines were drawn parallel to it; the first (*line a*) extending from the posterior nasal spine, the

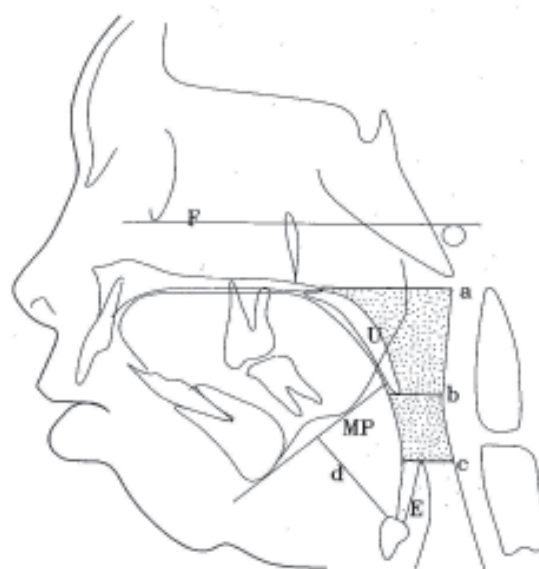


Fig. 1. Different cephalometric measurements used in this study.

- F: Frankfurt Horizontal Plane
- U: Uvula
- E: Epiglottis
- MP: Mandibular Plane

second (*line b*) from the free tip of the uvula and the third (*line c*) from the free tip of the epiglottis. All these lines ended posteriorly at the posterior pharyngeal wall. These lines marginally represent the nasopharyngeal, the oropharyngeal and the hypopharyngeal airways, respectively. The distance between the hyoid bone and the mandibular plane (MP) was also measured by drawing a line (*line d*) from the former perpendicular to the latter. Also, the angle between the MP and F was measured in all cases (*angle m*).

Results

Subjectively, snoring disappeared completely after the first stage. Only one patient reported infrequent snoring by night 2 months after the second operative stage. This patient (Case, 3) suffered from infection around the bone grafts on both sides. Grafts were removed one month after mandibular advancement. Excessive daytime sleepiness (EDS) became a no more troublesome complaint by all patients except for one who was obese.

Cephalometric Changes [Fig. 2, a - f]

Table 1 shows that the nasopharyngeal distance (*line a*) did not change altogether after both operations. The oropharyngeal distance (*line b*) increased significantly after the first operation and decreased slightly after the second operation but did not return to the presurgical measurement. Line c (the hypopharyngeal distance) increased after mandibular advancement in all cases (except case 3) whereas some decrease was noticed after the ankylosed joints were released. The distance between the hyoid bone and the mandibular plane (*line d*) was slightly diminished after both stages, except in case 3 where late necrosis and infection resulted in 100% loss of the bone graft one month after the first stage.

The mandibular angle decreased significantly in all cases after mandibular advancement and ramus lengthening, whereas an increase was noticed after the second stage.

Changes of Arterial Blood Gases

These showed no significant deviations from the normal ranges both pre and postoperatively in the first 8 cases of the study. In case 9, significant



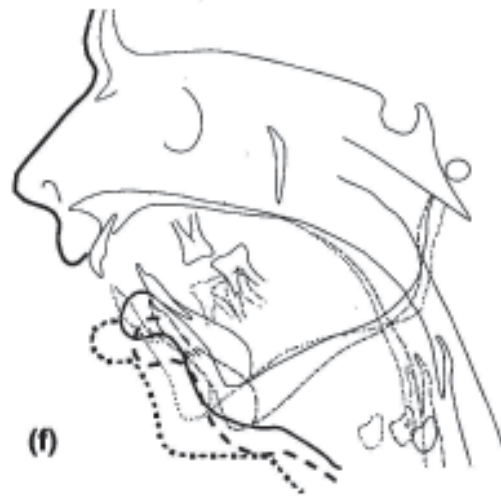


Fig. 2 (A) Severely micrognathic mandible due to protracted bilateral TMJ ankylosis.
 (B) After mandibular advancement and release of ankylosis.
 (C) Preoperative lateral cephalometric X-ray.
 (D) After mandibular advancement, upper airway greatly widened.
 (E) After release of ankylosis, there is some degree of loss of the upper airway as compared to (Fig. 2,d)
 (F) Cephalometric tracings of c (continuous); d (dotted) and e (interrupted)

Table 1. Different cephalometric measurements* of 9 cases included in this study.

Case No.	P1a	P2a	P3a	P1b	P2b	P3b	P1c	P2c	P3c	P1d	P2d	P3d	P1m	P2m	P3m
Case 1	21	21	20	6	16	13	10	14	12	19	18	16	18	15	36
Case 2	22	22	23	8	13	11	11	16	15	24	20	20	30	28	50
Case 3	20	20	20	9	14	10	12	14	10	23	20	27	43	29	48
Case 4	20	20	20	4	11	10	8	10	10	25	21	20	28	23	30
Case 5	21	21	20	9	20	16	11	19	14	14	14	12	31	25	37
Case 6	20	19	21	5	10	13	8	11	10	23	15	14	49	42	58
Case 7	17	17	17	7	17	15	6	9	9	30	21	21	28	20	32
Case 8	23	23	22	10	16	15	7	12	10	25	20	18	41	29	50
Case 9	20	20	20	19	14	12	10	15	15	23	21	20	33	28	38

* All linear measurements are in millimeters.

desaturation was encountered before mandibular advancement where the blood samples were collected during an apneic episode. Marked improvement happened after the first stage and continued thenceforth.

Discussion

The relationship between snoring with or without sleep apnea and micrognathia due to prolonged TMJ ankylosis is not completely clear in the literature. The prime concern of the maxillofacial surgeon is to release the restricted mouth opening for mastication. However, airway obstruction is a more life-threatening sequel because of its impact on the cardiopulmonary system. When apneic episodes occur in rapid succession, systemic and pulmonary arterial pressures can rise.

Multiple surgical procedures have been suggested to help patients with obstructive sleep apnea syndrome (OSAS). These include tracheostomies, uvulopalatopharyngoplasties (UPPP) and osteotomies. Tracheostomy is described as a consistently successful surgical treatment for OSAS by excluding the upper airway passages altogether. It has been suggested that bimaxillary surgery is the best alternative to tracheostomy which has very high morbidity.^{7,8} Furthermore, maxillomandibular advancement with adjunctive procedures such as UPPP has been considered the most successful method for treating OSAS.⁹

In this study, mandibular advancement alone improved the problem of obstruction, both subjectively and on cephalometric tracings. Increasing the posterior facial height together with mandibular advancement shared in widening of the upper airway spaces by bringing the tongue forward and expanding the mouth cavity to host the tongue. The subjective relief of symptoms after the first operative stage of mandibular advancement obviated the need for maxillary osteotomies.

Cephalometric tracings *per se* do not provide an objective judgment in the treatment of OSAS. However, in the absence of other sophisticated investigatory procedures cephalometric tracings stand as an invaluable simple means in the diagnosis of the obstruction site of the upper airway. Such tracings are vital especially in those patients who have long-standing ankylosis of the jaw joints where unaided visualization of the airway could be impossible. Besides, Holmberg and Aronson¹⁰ found a significant relationship between the results of the cephalometric appraisal of the airway patency and those obtained by posterior rhinoscopy and nasal airflow measurements. This relationship has been used as evidence for the diagnostic validity of the cephalometric method.

The differences in cephalometric linear and angular measurements between P2 and P3 are attributed to: (1) partial loss of bone graft due to resorption, (2) anterior open bite developing after bilateral condylectomies and (3) P2 measurements

are taken with an acrylic occlusal wafer and IMF wires in place giving passive advancement of the mandible.

Riley and associates reported on a case of sagittal inferior mandibular osteotomy with hyoid myotomy and suspension with *fascia lata*.¹¹ The concept of surgical procedure was to incorporate the genial tubercles in the osteotomy and simultaneously advance and suspend the hyoid bone to the mandible. This was achieved cephalometrically in this study where the distance between the hyoid bone and the mandibular plane decreased after the first stage of mandibular advancement.

Conclusion

There is a definite cause-and-effect relationship between post-ankylosis micrognathia and OSAS which can be solved by surgical advancement of the mandible along with release of the ankylosed joints. The post-advancement resolution of the symptoms of snoring, sleep apnea and EDS stand strongly as evidence of a definite cause-and-effect relationship between the small mandible of protracted ankylosis and OSAS. Amelioration of symptoms along with objective gain in the upper airway dimensions after finishing the staged surgery proved a definite cause effect relationship. Further polysomnographic investigations and arterial blood gas studies during apneic episodes are highly recommended for definitive evaluation of the amplitude of the problems of such patients.

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