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Changes in tongue and hyoid positions, and posterior airway space following mandibular setback surgery

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SUMMARY. Introduction: **The postural response of the tongue after mandibular setback is clinically important for maintaining normal respiration. Although the hyoid bone moves progressively to adapt physiologically to the altered orofacial configuration following such surgery, it is not clear whether repositioning of the hyoid has an effect on the pharyngeal airway. In the present study, postoperative changes in hyoid position and pharyngeal airway space were assessed retrospectively in patients who had undergone mandibular setback surgery.** Material and methods: **Digitized lateral cephalograms from 30 mandibular setback surgery cases taken preoperatively, and 1 month and more than 1 year postoperatively, were used to examine pharyngeal airway morphology and the position of hyoid bone.** Results: **A significant downward movement of the hyoid bone was found 1 month after surgery, while the pharyngeal airway dimensions at the tongue were maintained. More than 1 year after surgery, the hyoid position returned to its original position, resulting in a significant decrease in retrolingual airway dimension.** Conclusion: **The results indicate that mandibular setback causes airway narrowing late after surgery, while the early postoperative airway dimension is maintained. Long-term observations should be performed because of the changes of oropharyngeal configuration following mandibular setback. © 2004 European Association for Cranio-Maxillofacial Surgery**

Keywords: **Cephalometry; Orthognathic surgery; Pharyngeal airway; Mandibular prognathism; Hyoid bone**

INTRODUCTION

Surgical orthodontic treatment changes orofacial skeletal and soft tissue components, though tongue position and function compensate for those changes in the oral environment (*Wickwire* et al., 1972). The postural response to mandibular setback is of particular interest and importance, because of its relationship to maintaining normal respiration (*Proffit* and *Phillips*, 2003). Shortly after mandibular setback the hyoid bone goes downward for physiologic adaptation to the soft tissue, including the tongue mass, and the altered tongue posture in the reduced oral cavity prevents airway obstruction. Additional observations have revealed that the hyoid bone progressively returns to its original position (*Wickwire* et al., 1972; *Lew*, 1993), while the postoperative decrease in hypopharyngeal airway space is maintained during the follow-up period (*Greco* et al., 1990; *Enacar* et al., 1994). *Wenzel* et al. (1989) found that the anterior–posterior distance of the upper airway was decreased at 1 year postoperatively and the patients tended to extend their head after the surgery. Since head position may camouflage morphological changes in the upper airway, it is unclear whether repositioning of the hyoid bone has an effect on the relationship of soft and hard tissues late after surgery. Two case reports of mandibular setback surgery leading to sleep-related breathing disorder and obstructive sleep apnoea (OSA) showed an association with airway narrowing after more than 18 months (*Guilleminault* et al., 1985; *Riley* et al., 1987), and both suggested that mandibular setback may contribute to further development of OSA after surgery. In the present study, changes in hyoid position and pharyngeal airway space were assessed retrospectively. Long-term adaptations of soft tissues, including the tongue base, accompanying the change in hyoid bone position were also examined.

MATERIAL AND METHODS

Data from 30 patients (10 males and 20 females) with mandibular prognathism, who had each received orthodontic treatment prior to surgical correction were evaluted. The mean preoperative age was 22.7 years for the females and 21.5 years for the males, with an overall age range of 18–37 years. A bilateral sagittal split ramus osteotomy (SSRO) was performed in each patient using the Obwegeser–Dal Pont method to set back the mandible. Patients who underwent bimaxillary surgery and/or those with a craniofacial anomaly, such as cleft lip, alveolus and palate, were excluded. After setback of the mandible, all patients underwent bicortical fixation (between the

Table 1 – Demographic data before surgery.

Variable		Mean (SD)
Age (years)	Male	21.5 (1.5)
	Female	22.7 (4.8)
Body mass index (kg/m^2)	Male	21.3 (4.0)
	Female	20.4 (1.1)
Mandibular setback (mm)	Right	6.3 (3.9)
	Left	5.6 (3.4)

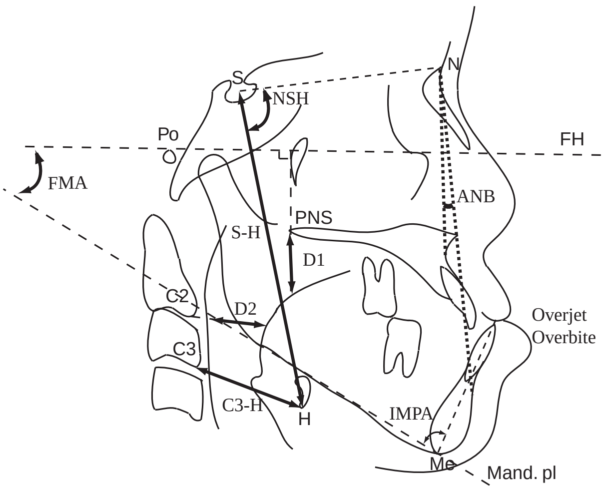

Fig. 1 – Landmarks used for cephalometry. S: sella; N: nasion; ANS: anterior nasal spine; FH: Frankfurt horizontal plane; Me: menton; Po: porion; PNS: posterior nasal spine; C2: second cervical vertebra; C3: third cervical vertebra; H: lowest point of hyoid bone; D_1: vertical distance between dorsum of the tongue and PNS on a line perpendicular to FH; D_2: horizontal distance between posterior pharyngeal wall and dorsum of the tongue on a line parallel to the palatal plane that runs through C2; S–H: vertical distance between S and H; C3–H: linear distance between H and the most anterior point of C3; NSH: angle of S–H to SN plane.

distal and proximal segments). The average of mandibular setback was 6.5 ± 2.5 mm (Table 1). Postoperative maxillo-mandibular fixation was maintained for 2 weeks with wires or elastics.

Lateral cephalograms were taken preoperatively (T_1), and 1 month (T_2) and more than 1 year (T_3) postoperatively. The subject was seated upright in the cephalostat with the Frankfurt horizontal plane (FH) parallel to the floor and the teeth in occlusion. To obtain a standardized position of the oropharyngeal structures, the cephalograms were taken at the end of expiration after swallowing. After the films were digitized, 3 serial cephalograms from each subject were traced by the same investigator, and the traditional contours and points of dentofacial structure were digitized to enable measurement of the tongue, pharynx, and hyoid positions. Linear and angular measurements were also determined according to a previous study. (*Kawakami* et al., 2004; Fig. 1).

Evaluation of error at measuring and calculation

To assess measurement error, the records of 10 subjects were re-evaluated 2 months later. The mean differences found were less than 1.0 mm and 1.0°, respectively. The standard error of a single measurement was calculated for each variable and the systematic error was determined using paired *t*-tests (*Houston*, 1983).

No significant systemic errors and an acceptable reliability were noted.

Statistical evaluation

Methodological errors in the cephalometric measurements were minimized by double recording. Time-dependent changes of the measurements were examined by a paired *t*-test. Spearman's rank was used to determine the statistical correlation between the changes in the airway space and hyoid position, and the amount of mandibular setback. Differences were considered to be significant at $p < 0.05$.

RESULTS

The body mass indices [weight (kg)/height (m)^2] of the subjects were within normal limits for both the male and female groups (Table 1).

Preoperative, postoperative, and 1 year-follow-up changes are shown in Table 2. Significant differences of dental and skeletal parameters (overjet, overbite, and ANB) reflected the surgical changes that occurred from T_1 to T_2 ($p < 0.05$). No significant changes were seen from T_2 to T_3. However, the mandibular plane showed a slight clockwise rotation with an increase of Frankfurt horizontal–Mandibular plane–Angle (FMA) and the lower incisors became retroclined during the postoperative orthodontic treatment (IMPA—Incisor axis–Mandibular plane–Angle).

Table 2 – Changes in dental and skeletal parameters measured preoperatively, postoperatively, and after the follow-up period.

Variables		Mean (SD)		Mean (SD)
Overjet (mm)	T_1	−3.4(2.8)		
	T_2	3.0(1.0)^a	T_2–T_1	5.8(3.1)
	T_3	3.1(0.7)	T_3–T_2	0.1(1.1)
Overbite (mm)	T_1	−1.1(3.4)		
	T_2	0.5(1.0)^a	T_2–T_1	1.6(3.1)
	T_3	0.9(1.0)	T_3–T_2	0.3(1.3)
ANB (degree)	T_1	−2.9(3.9)		
	T_2	0.3(3.0)^a	T_2–T_1	3.2(2.5)
	T_3	−0.1(3.1)	T_3–T_2	0.3(1.3)
FMA (degree)	T_1	32.5(6.4)		
	T_2	32.5(7.3)	T_2–T_1	0.0(5.8)
	T_3	34.3(6.2)^b	T_3–T_2	1.6(3.3)
IMPA (degree)	T_1	85.5(5.2)		
	T_2	84.1(5.3)	T_2–T_1	−0.7(4.5)
	T_3	82.1(5.9)^b	T_3–T_2	−1.9(3.5)

FMA—Frankfurt horizontal plane–mandibular plane–angle. IMPA—Incisor (axis)–mandibular plane–angle.

$^a p < 0.05$ between T_1 and T_2;

$^b p < 0.05$ between T_2 and T_3.