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Clinical Paper
Orthognathic Surgery

Effects of orthognathic surgery on pharyngeal airway and respiratory function during sleep in patients with mandibular prognathism

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Abstract. The aim of this study was to determine changes in overnight respiratory function and craniofacial and pharyngeal airway morphology following orthognathic surgery. The subjects were 40 patients in whom mandibular prognathism was corrected by orthognathic surgery: a one-jaw operation in 22 patients and a two-jaw operation in 18 patients. Morphological changes were studied using cone beam computed tomography immediately before surgery and at more than 6 months after surgery, and the apnoea–hypopnoea index (AHI) was measured with a portable polysomnography system. Pharyngeal airway volume was decreased significantly after surgery, especially in the one-jaw operation group. AHI was not changed significantly after surgery in either group, although AHI in one patient in the one-jaw operation group was increased to 19 events/h. There was no significant change in pharyngeal airway morphology in that patient, but he was obesity class 1 and was 54 years old. In conclusion, some patients who are obese, have a large amount of mandibular setback, and/or are of relatively advanced age may develop sleep-disordered breathing after mandibular setback; a two-jaw operation should therefore be considered in skeletal class III patients who have such risks because it decreases the amount of pharyngeal airway space reduction caused by mandibular setback surgery.

Key words: mandibular setback surgery; jaw deformity; cone beam computed tomography; pharyngeal airway; respiratory function during sleep.

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Mandibular setback surgery for mandibular prognathism can reduce the space in the pharyngeal airway,[1–14] and it has been suggested that it might induce sleep-disordered breathing, typified by obstructive sleep apnoea syndrome (OSAS).[4–6,12] We have previously reported cases in whom reduction of the pharyngeal airway space and OSAS were caused by mandibular setback surgery.[5] OSAS is a potentially life-threatening disorder caused by repetitive narrowing and obstruction of the pharyngeal airway during sleep, and it has been associated with loud snoring and apnoea. OSAS is regarded as one of the risk factors of hypertension, ischaemic myocardial diseases, and cerebral vascular diseases.[15] It is also thought to be one of the causes of traffic accidents.

Lateral cephalograms have been used widely to evaluate craniofacial and pharyngeal airway morphology,[1,2,4–9,12–14,16–18] and lateral cephalometric measurements are useful for analyzing airway size on the sagittal plane; however, they do not accurately reflect the three-dimensional (3D) airway anatomy. Therefore, 3D imaging has been preferred in recent years for evaluating changes of the pharyngeal airway after orthognathic surgery.[3,7,10,11,19–25] Conventional spiral computed tomography (CT) and magnetic resonance imaging (MRI) have been the methods of choice for obtaining 3D information on craniofacial and pharyngeal morphology,[3,7,11,19,24–26] but their use is limited because of the costs and/or the greater radiation exposure. Cone beam computed tomography (CBCT) is a recently introduced technology that has been used for 3D analyses of craniofacial and pharyngeal morphology because the radiation exposure and the cost are decreased compared with those of conventional CT.[10,20–23,27]

We are interested in the effects of orthognathic surgery on the pharyngeal airway and respiratory function during sleep in patients with mandibular prognathism. The aim of this study was to determine whether orthognathic surgery causes OSAS with morphological changes after orthognathic surgery in patients with mandibular prognathism. In this study we investigated changes in overnight respiratory function with a portable polysomnography (PSG) system and examined 3D morphological changes in the maxillomandibular skeleton and pharyngeal airway using CBCT before and after orthognathic surgery.

Materials and methods

This prospective study included 40 patients (21 males and 19 females) in whom mandibular prognathism was corrected surgically during the period June 2010 to March 2012; agreement to participate in this study was obtained before surgery. There were no drop-outs. The patients were divided into two groups according to the type of orthognathic surgery done. Bilateral sagittal split osteotomies were performed in 22 patients with simple mandibular prognathism (group A), and a combination of Le Fort I osteotomy and bilateral sagittal split osteotomy was performed in 18 patients who had mandibular prognathism combined with maxillary retrusion, asymmetry, and/or open bite (group B). None of the subjects had symptoms of OSAS such as snoring or apnoea, and no cases of cleft palate or craniofacial syndrome were included. The mean age of the subjects at surgery was 23 years (range 16–54 years). All of the subjects received pre- and postoperative orthodontic treatment, and osteosynthesis was achieved using a titanium miniplate and resorbable fixation devices. Maxillomandibular fixation was performed 1 day after surgery and was maintained for 14 days.

As a control group, 16 subjects (nine males and seven females) with normal occlusion and no symptoms of sleep-disordered breathing underwent the same CBCT examinations as those performed in the patients. The mean age of the control subjects was 26 years (range 21–38 years).

The study protocol was approved by the institutional ethics committee and informed consent was obtained from all subjects.

Imaging procedure

All of the patients underwent CBCT examinations (CB MercuRay; Hitachi Medical Corporation, Tokyo, Japan) for assessment of craniofacial and pharyngeal morphology before surgery (T0) and at more than 6 months after surgery (mean 9 ± 2.1 months, range 6–12 months) (T1). For the control group, two CBCT images were taken repeatedly on separate days to assess the accuracy of CBCT analyses.

The subjects sat upright with the Frankfort horizontal plane parallel to the floor and with centric occlusion. CBCT data of the maxillofacial regions were acquired with a 0.38-mm voxel size and 512×512 matrices, using 120 kVp, 15 mA, 9.6-s scan time, and 12-inch detector field. The CBCT data were converted into DICOM (digital imaging and communication in medicine) format, and 3D images of the craniofacial and pharyngeal airway morphology were reconstructed with a 3D image analysis system (INTAGE Realia Pro; Cybernet Systems Co., Ltd, Tokyo, Japan).

Since small deviations in the position of the head from ideal are bound to occur, reconstructed 3D images taken before surgery were corrected and re-aligned using the Frankfort horizontal (FH) plane (*XY* plane), coronal plane (*XZ* plane), and midsagittal plane (*YZ* plane) as references. The FH plane was defined by the bilateral uppermost point on the bony external auditory meatus (porion) and lowest point on the right inferior borders of the bony orbit (orbitale). The coronal plane was defined as a plane passing through bilateral porions and perpendicular to the FH plane. The midsagittal plane was defined as a vertical plane passing through the most anterior point of the frontonasal suture (nasion) and perpendicular to the FH plane and coronal plane (Fig. 1). Next, the coordinates of the 3D images obtained at more than 6 months after surgery were adjusted and conformed to the coordinates of the preoperative standardized images by superposition of four anatomical landmarks: nasion (N), posterior clinoid process (PCP), and bilateral most inferior points of the mastoid process (MsR, MsL) (Fig. 2).

Measurements of skeletal changes

Unified 3D images were exported in DICOM format and imported into OsiriX (ver. 3.5.1; Pixmeo, Geneva, Switzerland)

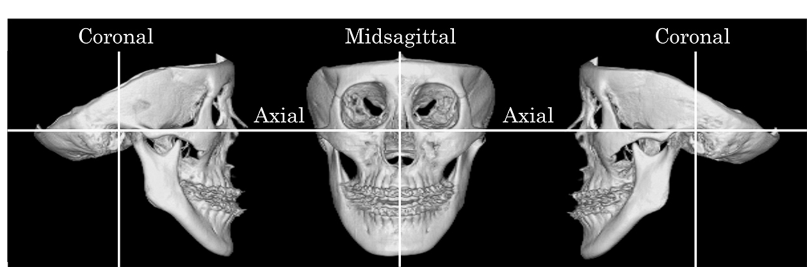

Figure 1. Configurations of the three reference planes. Axial (*XY*) plane: Frankfort horizontal (FH) plane passing through the bilateral uppermost points on the bony external auditory meatus (porion) and lowest point on the right inferior borders of the bony orbit (orbitale). Coronal (*XZ*) plane: plane passing through bilateral porions and perpendicular to the FH plane. Midsagittal (*YZ*) plane: vertical plane passing through the most anterior point of the frontonasal suture (nasion) and perpendicular to the FH plane and coronal plane.