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A cephalometric evaluation of the pharyngeal airway space in patients with mandibular retrognathia and prognathia, and normal subjects

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Abstract. The antero-posterior diameter of the pharyngeal airway space (PAS) at the level of the soft palate and base of the tongue was assessed in age-matched females with a normal mandible ($n = 31$), mandibular retrognathism ($n = 30$) or mandibular prognathism ($n = 38$). All subjects were examined by lateral cephalometry. Measured variables were corrected with the use of appropriate regression equations to eliminate the effects of head posture on the PAS. The corrected data showed more clear-cut differences in the PAS among the three groups than did the measured data. Pharyngeal airway diameter was largest in the group with mandibular prognathism, followed by the normal mandible and mandibular retrognathism groups. These results indicate that the antero-posterior dimension of the PAS is affected by different skeletal patterns of the mandible.

Key words: pharyngeal airway space; lateral cephalogram; craniofacial morphology; mandibular retrognathism; mandibular prognathism.

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Advancement and setback operations are standard procedures for the correction of mandibular retrognathism and prognathism. Surgery for mandibular deformity alters skeletal and soft-tissue components, including the pharyngeal airway space (PAS)[1,2]. The possibility of obstructive sleep apnoea (OSA) after setback surgery has been reported and discussed[2].

Evaluation of the PAS thus has a very important role in diagnosis and treatment planning in patients with OSA and dentofacial deformity. Cephalometric radiography, computed tomography (CT) and magnetic resonance imaging (MRI) have been used to study the PAS. Although CT and MRI can provide a three-dimensional assessment, the results of different studies are difficult to compare owing to a lack of standardized protocols defining the thickness, direction and precise location of sections[14]. Cephalometry cannot be applied at a constant head posture, as is also the case for the above two methods, and does not provide information on the transverse dimension of the airway. Cephalometric analysis of the airway does permit precise measurements in a sagittal plane, and has the advantages of convenience, low cost and minimal exposure to radiation[10,11].

Changes in head posture can affect the size of the PAS[4,10,11]. A significant relation ($r = 0.807$) between head posture and

Table 1. Characteristics of subjects

	Group		
	Normal mandible	Mandibular retrognathism	Mandibular prognathism
Subjects (*n*)	31	30	38
Age (years)	20–30	17–30	18–32
SNB (°)	$76 \leq \text{SNB} \geq 82$	SNB < 76	SNB > 82

SNB: angle between SN and NB. See Fig. 1 for cephalometric variables.

the PAS has previously been demonstrated[10]. Since craniofacial morphology is related to the PAS in non-obese patients with OSA, cephalometric radiographs have been used to measure the craniofacial and upper airway structures[5–9]. Previous studies attempting to measure the PAS did not take head posture into account, so the precise relationship between the craniofacial morphology and the PAS remains unclear. The measured values were corrected in the authors' previous study[11] to avoid the effects of head posture, and this demonstrated that craniofacial morphology was related to the PAS in normal subjects. To extend these findings, the present study examined the relationship between craniofacial morphology and the PAS in patients with mandibular deformities (mandibular retrognathism and mandibular prognathism), as compared to normal subjects.

Materials and methods

All subjects were selected from the files of patients registered at the Department of Orthodontics at the Health Sciences University Hospital (Table 1). Female subjects were divided into three groups: mandibular retrognathism ($n = 30$; mean age 22.3 years, range 17–30; defined by angle SNB < 76°), normal mandible ($n = 31$; mean age 23.5 years, range 20–30; $76^\circ \leq \text{SNB} \leq 82^\circ$) and mandibular prognathism ($n = 38$; mean age 21.7 years, range 18–32; SNB > 82°).

Lateral cephalograms were taken with the orbital-auricular plane parallel to the floor and the teeth in centric occlusion or centric relation at the end of the expiratory phase. All subjects received the same instructions for radiographic positioning and were told to place the tongue in a relaxed position and to breathe through their nose after swallowing.

The reference points, lines (Fig. 1) and variables in the cephalometric analysis have been reported elsewhere[11]. Head posture (OPT/NSL) was defined as the craniocervical angulation at the uppermost part of the cervical spine, and PAS was defined as the minimal sagittal linear distance between the uvula and the posterior pharyngeal airway space (PAS–UP), and the back of the tongue and the posterior pharyngeal airway space (PAS–TP). To minimize the effect of head posture on the PAS, measurements were corrected using regression equations[10]: $y = -14.063 + 0.258x$, $r = 0.628$ for PAS–UP (y: PAS–UP, x: head posture) and $y = -27.177 + 0.39x$, $r = 0.807$ for PAS–TP (y: PAS–TP, x: head posture). Correlations of cephalometric variables with the measured PAS and the corrected PAS were tested by linear regression analysis, performed with StatView for Macintosh. The same statistical package was used for descriptive statistics and simple linear regression. Statistically significant differences were noted as $P < 0.01$ or $P < 0.05$.

Twenty lateral cephalograms obtained from randomly selected subjects were retraced and reanalysed on another day by the same investigator, and the method error for each variable was calculated to determine measurement reproducibility. The method error was calculated as method error = $(\sum d^2/2n)^{1/2}$, where d represents the difference between the first and second measurements, and n denotes the sample size.

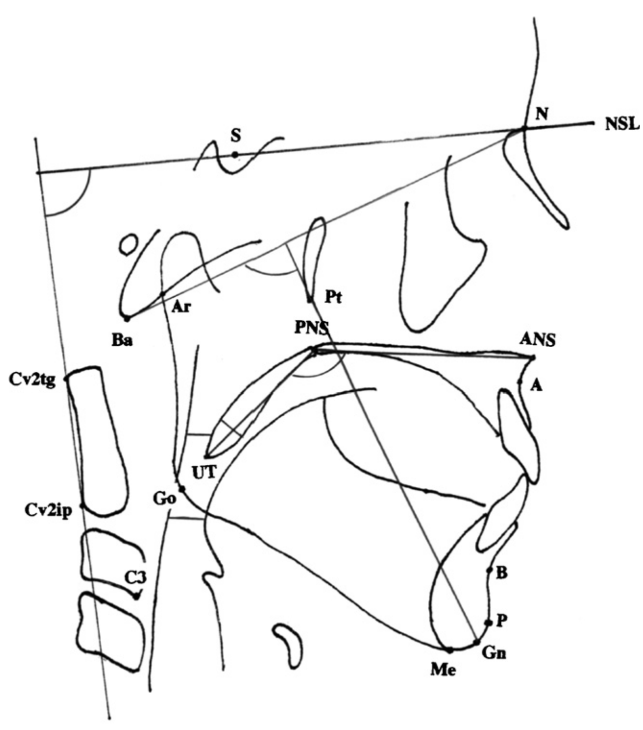

Fig. 1. Reference points and lines on the lateral cephalogram.

Results

Method errors for each variable were within 1 mm and similar to those in previous studies[10,11]. No statistically significant differences were noted and the results were considered highly reproducible.

The craniofacial morphologic variables obtained in the three groups are shown in Table 2. The size of the mandible (SNA, SNP, Go–Gn) and the developmental direction of the mandible (facial axis) characteristically differed among the three groups.

The length and angulation of the uvula significantly differed among the three groups (34.7 mm and 126.6° in the normal mandible, 36.9 mm and 132.1° in mandibular retrognathism, and 31.7 mm and 118.8° in mandibular prognathism). Both of these variables were large when the mandible was small.

A decreased OPT/NSL ratio correlated with a large mandible. As compared with the measured PAS–UP, PAS–TP, the corrected data were greater in the normal mandible and mandibular prognathism and smaller in mandibular retrognathism. The corrected data showed more clear-cut differences in the PAS among groups than did the measured data.

The relationship between the PAS and craniofacial morphology was examined with the corrected data because the PAS