Surgical treatment for sleep apnea: changes in craniofacial and pharyngeal airway morphology in a child with achondroplasia

Kieko Sato1,2), Naoko Niikuni1,2), Ichiro Nakajima1,2), Tetsuo Shirakawa1,2) and Hideaki Sakata3)

1) Department of Pediatric Dentistry, Nihon University school of Dentistry, Tokyo, Japan
2) Division of Oral and Craniomaxillofacial Research, Dental Research Center, Nihon University school of Dentistry, Tokyo, Japan
3) Department of Otolaryngology, Saitama Children’s Medical Center, Saitama, Japan

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Case Report

The patient was brought to the Otolaryngology Outpatient Service, Saitama Children’s Medical Center, with chief complaints of snoring and frequent several-second apne during sleep. The patient had a systemic disorder, AP, and was diagnosed with obstructive sleep apnea. Because pharyngeal and palatine tonsillar hypertrophy was observed, bilateral tonsillectomy was performed. Using standard lateral cephalograms, the craniofacial and pharyngeal morphologies were compared before bilateral tonsillectomy and 1 year 2 months after surgery. The patient’s age was...
5 years 6 months at the time of surgery, and was 6 years 8 months at 1 year 2 months after surgery. For presentation of this case report, we obtained approval from the Ethics Committees of Saitama Children’s Medical Center and Nihon University School of Dentistry. We explained the study objective and contents in writing and orally to the patient and his parents, and obtained their informed consent.

Cephalometric evaluation
The methods used to analyze craniofacial and pharyngeal morphologies are shown in Figs. 1, 2 and 3, respectively. The standard analytical values of craniofacial and pharyngeal morphologies were derived from Ricketts analysis (8), McNamara analysis (9), and Deberry-Borowieskin analysis (10).

1) Measurements of the craniofacial morphology and the pharyngeal airway (Figs. 1, 2):
① facial axis: angle between the facial axis plane and BA-NA plane
② facial depth: angle between the facial plane and the FH plane
③ mandibular plane angle: angle between FH plane and the mandibular plane
④ lower face height: angle between ANS-Xi plane and Xi-Pm plane
⑤ mandibular arc: angle between Pm-Xi plane and Xi-DC plane
⑥ corpus length: distance between Xi point and Pm point
⑦ A-to-McNamara line: distance between the McNamara line and point A
⑧ pogonion-to-McNamara line: distance between the McNamara line and the pogonion
⑨ nasal floor length: the distance between the ANS point and PNS point.
⑩ D-AD1: the distance between the PNS point and the nearest adenoid tissue, measured along the PNS-Ba plane
⑪ D-AD2: the distance between the PNS point and the nearest adenoid tissue, measured along a line from the PNS plane perpendicular to the S-Ba plane
⑫ upper pharynx: the shortest distance from the upper surface of the palatine velum to the adenoid tissue
⑬ lower pharynx: the distance between the intersection point where the tongue base meets the lower contour of the mandible and the posterior pharyngeal wall.

2) Landmarks and lines (Fig. 3):
A: the deepest point on the concave outline of the upper labial alveolar process, extending from the anterior nasal spine to the prosthion
ANS: the most anterior point at the sagittal plane on the bony hard palate
Ar: the intersection point of the ramus plane (a tangent line on the posterior contour of the ramus) and the occipital bone-fond interior margin
Ba: the most inferior posterior point of the occipital bone at the anterior margin of the occipital foramen
Gn: the intersection point of the mandibular plane and the facial plane
Go: the intersection point of the mandibular plane and the

Fig. 1 Measurements of the craniofacial morphology.
① facial axis ② facial depth ③ mandibular plane angle
④ lower face height ⑤ mandibular arc ⑥ corpus length
⑦ A to McNamara line ⑧ pogonion to McNamara line
⑨ nasal floor length

Fig. 2 Measurements of the pharyngeal airway.
⑩ D-AD1 ⑪ D-AD2 ⑫ upper pharynx ⑬ lower pharynx
ramus plane
N: the most anterior point of the frontonasal suture
Or: the most interior point on the lower border of the bony orbit
Pm: the point where the curvature of the anterior border of the symphysis changes from concave to convex
PNS: the most posterior point at the sagittal plane on the bony hard palate
Po: the most superior point on the radiolucency of the external and internal auditory meati; it is located posterior to the mandibular condyle and posterior clivus
Pog: the most prominent point of the chin
PT: the intersection point of the inferior border of the foramen rotundum and the posterior wall of the pterygomaxillary fissure
S: the center of the pituitary fossa of the sphenoid bone
Xi: a point located at the center of the ramus; the location of Xi is keyed geometrically to the FH and PTV plan in 4 steps: 1) planes are constructed perpendicular to the FH and PTV planes; 2) these constructed planes are tangent to points (R1, R2, R3 and R4) on the borders of the ramus; 3) the constructed planes form a rectangle enclosing the ramus; 4) Xi is located in the center of the rectangle at the intersection of its diagonals.
facial axis plane: line connecting the PT and Gn points
facial plane: line connecting the Na and pog points
frankfort horizontal (FH) plane: line connecting the Po and Or points
McNanara line: line, perpendicular to the FH plane, that passes through N
mandibular plane: line tangent to the lower border of the mandible
Pterygoid vertical (PTV) plane: line, perpendicular to the FH plane, that passes through the PT

Results and Discussion

The results of analyses of craniofacial and pharyngeal morphologies are shown in Table 1.

A recent study indicates that the characteristics of craniofacial and airway morphology of AP can induce sleep apnea (7). Other studies indicate that adenoidectomy of a child is an effective means of improving sleep apnea, daytime sleepiness and quality of life (11,12). However, there have been no reported studies of craniofacial and airway morphology after adenoidectomy and tonsillectomy. Therefore, in the present study, we compared craniofacial and pharyngeal morphologies before and after adenoidectomy and tonsillectomy in a child with AP diagnosed with sleep apnea accompanied by tonsillar hypertrophy.

In the present comparison of preoperative craniofacial morphology using standard values, both the maxilla and mandible (point A, point pog) were retruded, and the lower facial height was high. The preoperative lower facial height was +1 s.d., relative to the standard value, but the postoperative lower facial height was within the standard range. At point A, the preoperative value was -4 s.d. relative to the standard value, but the postoperative value (-3 s.d.) was close to the standard value. At point pog, the preoperative value was -4 s.d., relative to the standard value, but the postoperative value (-2 s.d.) was close to the standard value. The items that differed significantly between preoperative and postoperative measurements in the present study were the same items that differed significantly between AP patients and healthy subjects in previous studies. Tanimoto et al. (13) evaluated association between snoring and craniofacial morphology in subjects aged 6 to 15 years, and reported that more marked retrusion of the mandibular position was associated with a higher frequency of snores during sleep at night. In the present study, the patient’s sleep apnea was improved after surgery. We speculate that this improvement in sleep apnea was due to the change in the mandibular position to a more anterior position. These results suggest that adenoidectomy and tonsillectomy lead to prostusive restoration of craniofacial morphology. In the present patient, all postoperative analytical values of the laryngo-nasal and oropharyngeal regions were larger than the preoperative values. Studies show that in children, respiratory impairment during sleep inhibits somatotropin secretion related to body growth.
(14). In the present case, we speculate that the improvement in the sleep disorder, as a result of adenoidectomy and tonsillectomy, led to some improvement of the AP-associated growth impairment.

In summary, in the present case, adenoidectomy and tonsillectomy in a child with AP dilated the pharynx and changed the craniofacial morphology, leading to improvement of sleep apnea.

References

Table 1 Standard values of analysis of craniofacial and pharyngeal morphologies, and measured values