The relationship between tongue-base position and craniofacial morphology in preschool children

Naoko Niikuni* / Ichiro Nakajima* / Morito Akasaka*

The association between tongue-base position and craniofacial morphology was investigated in 35 preschool children (17 girls and 18 boys), 3 to 6 years of age, by the lateral cephalometric radiographs. There was no statistical difference in the measurements of those between girls and boys. Posterior facial height, nasal floor length, mandibular corpus length and tongue-base position were positively correlated with age, and tongue-base position was correlated with maxillary position, vertical mandibular rotation and the nasopharyngeal airway space. The results of this study showed that tongue-base position influenced maxillo-mandibular growth even in young preschool children.
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INTRODUCTION

The position of the tongue has been suggested as an important local factor for malocclusions associated with various skeletal and dentoalveolar deformities, while the dentofacial structure is altered by the orofacial muscular function led by the position of the tongue.[1,2] In addition, the relationship between the tongue-base position and a narrowed pharyngeal airway of young children with adenotonsillar hypertrophy has been reported.[3] The lymphoid tissues develop rapidly after birth, reach the maximum size in early childhood, begin to regress around 8 to 10 years of age, and are usually completely atrophied by 12 to 14 years of age.[4] Some authors have reported that malocclusion, such as anterior open bite and lateral cross bite, seem to be the result of obstruction by hyper lymphoid tissues, since significant improvements occurred after adenotonsillectomy[5] (whereas self-correction is not common). Generally, occlusal aberrations tend to deteriorate during the growth period in children, especially during the transition from preschool to school age.[6,7] However, the relationship between craniofacial morphology and tongue-base position in preschool children has received little attention. Therefore, the purpose of this study was to describe the relationship between the craniofacial morphology and tongue-base position in a sample of healthy preschool children without adenoid hypertrophy and/or tonsillar hypertrophy.

MATERIALS AND METHODS

The subjects consisted of 35 preschool children, who are patients at Nihon University Dental Hospital. The children were informed by pediatric dentists that they would need more detailed examinations since they had trauma to teeth or maxilla and/or mandibular crowding. Cephalometric radiographs of all patients were taken before further examinations. During the cephalometric registration, the children sat in a chair in upright position, keeping the dentition in natural occlusion, and they were instructed to breathe slowly through the nose (this was practiced) and not to swallow. The lateral cephalograms were taken with the Frankfort horizontal (FH) parallel to both the floor and the lower border of the radiograph, although this position was sometimes difficult to achieve. The radiographs of the 35 children were selected from a larger sample and included if the head position fell within the range of ±5 degrees between the bottom line of the radiograph and the Frankfort horizontal.

Firstly, 35 preschool children with deciduous dentition were divided according to gender. One group consisted of 18 girls, the other of 17 boys. Clinical manifestations of the children did not include chronic mouth breathing and/or snoring during sleep. None of the 35 subjects was obese, and none had anatomic craniofacial abnormalities, neurological or cardiac disease. In addition, they did not have a skeletal malocclusion and none had missing teeth, crowns, dental caries or a thumb-sucking habit.

* Department of Pediatric Dentistry, School of Dentistry, Nihon University, Tokyo, Japan.

Send all correspondence to Dr. Naoko Niikini, Department of Pediatric Dentistry, School of Dentistry, Nihon University, Kandasurugadai 1-8-13, Chiyoda-ku, Tokyo, 101- 8310, Japan

Tel: 81-3-3219-8106
Fax: 81-3-3219-8353
E-mail: niikuni@dent.nihon-u.ac.jp

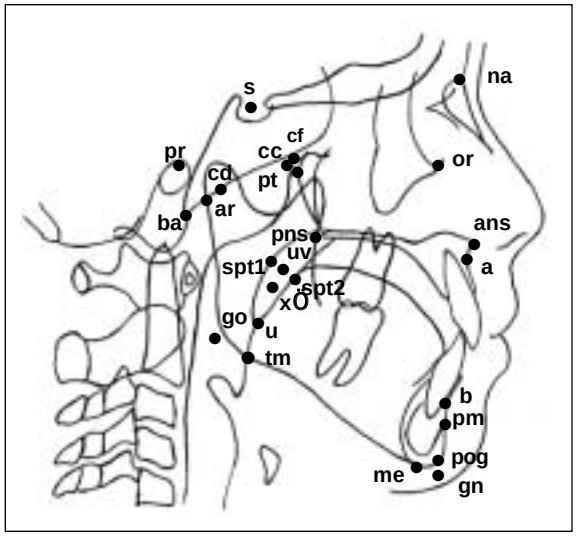

Figure 1. Cephalometric reference points.

CEPHALOMETRIC ANALYSIS

The variables of the tongue-base position, craniofacial skeleton, pharyngeal airway space and soft palate were measured using cephalometric landmarks as illustrated in Figure 1.

MEASUREMENTS OF THE TONGUE-BASE POSITION, CRANIOFACIAL SKELETON, PHARYNGEAL AIRWAY SPACE AND SOFT PALATE[8-11]

- tongue-base position: the shortest distance between tm and the posterior pharyngeal wall
- na-s-ba: the angle between na-s and s-ba
- sna: the angle between na-s and a
- snb: the angle between na-s and b
- facial taper: the angle between the mandibular line (ML, go-me) and the FL
- maxillary height: the angle between na-cf and cf-a
- mandibular arc: the angle between the line xI- pm and the line
- mandibular plane angle: the angle between the FH and the ML
- posterior facial height: the distance between go and cf
- nasal floor length: the distance between ans and pns
- corpus length: the distance between xI and pm
- lower facial height: the angle between ans-xI and xI-pm
- d-ad1: the shortest distance from pns to the adenoid tissue measured along the line pns-ba
- d-ad2: the shortest distance from pns to the adenoid tissue measured along a line through pns perpendicular to s-ba
- upper pharynx: the shortest distance point on adenoid soft tissue to the upper surface of the palatine velum
- soft palatal length: the distance between pns and u (tip of soft palate)
- soft palatal thickness: the distance between spt1 and spt2.

All cephalometric landmarks were identified and digitized by two pediatric orthodontists, and the mean values were used. The calculations were performed by means of the computerized Win Ceph, cephalometric system (Rise Corporation–).

STATISTICAL PROCEDURE

Differences in gender were investigated by Mann-Whitney's U test. In addition, tongue-base position was correlated with age and with cephalometric variables using the Pearson product moment correlation coefficients.

RESULTS

There were no differences in the features of craniofacial skeleton, pharyngeal airway and soft palate between girls and boys (Table 1). Correlation with age revealed statistically significant results in the posterior facial height ($p<0.05$), nasal floor length ($p<0.01$), mandibular corpus length ($p<0.001$) and tongue-base position ($p<0.05$) (Table 2). Correlation with tongue-base position revealed statistically significant results in horizontal maxillary position (sna: $p<0.01$), vertical mandibular position (facial taper: $p<0.05$, madibular arc: $p<0.05$) and pharyngeal airway space (d-ad1: $p<0.05$) (Table 3).

DISCUSSION

Handelman and Osborne[12] reported the growth of the nasopharynx from nine months to 18 years and different growth patterns were found between girls and boys. In the present study, to investigate any differences between the genders, the data were divided according to gender and a Mann-Whitney's U test was performed. Since there was no significant difference between the genders, the data were combined.

It has been reported that increased age is associated with an increased posterior facial height, nasal floor length and mandibular corpus length in preschool children.[13] Thus, while mandibular ramus height, corpus length, nasal floor length, i.e. mandibular horizontal and vertical length grew according to age, these were sometimes influenced by local factors, such as ENT problems, habits and so on. However, in the case of healthy preschool children without ENT disorders, the nasopharyngeal airway space shows standard growth from 3 to 6 years of age. The relationship between tongue-base position and mandibular rotation (facial taper and mandibular arc) appeared clearly, so it is documented that a direction of the mandibular growth might be affected by the tongue-base position, as the anterior tongue pressure might influence to the rotation of the mandibular corpus. In addition, this result indicated the relationship between the tongue-base position and long-face syndrome, because an increased tongue-base position correlated with an increased lower anterior facial height.[13] Trenouth and Timms[14] reported that there was a relationship between tongue-

Table 1. Cepharometric variables in preschool children and the difference between genders.

	mean	s.d.	p-value
age (yrs)	4.6	0.8	0.829
tongue-base position (mm)	11.8	2.4	0.056
na-s-ba (deg.)	133.6	4.1	0.817
sna (deg.)	80.7	3.4	0.105
snb (deg.)	76.7	3.2	0.072
facial taper (deg.)	67.5	3.9	0.069
maxillary height (deg.)	54.8	2.8	0.137
mandibular arc(deg.)	29.7	4.0	0.399
mandibular plane angle (deg.)	28.2	4.4	0.447
posterior facial height (mm)	49.8	3.6	0.062
nasal floor length (mm)	45.0	2.7	0.120
corpus length (mm)	55.8	3.1	0.655
lower facial height (deg.)	46.8	3.3	0.477
d-ad1 (mm)	16.1	3.3	0.428
d-ad2 (mm)	11.4	2.1	0.608
upper pharynx (mm)	6.4	1.6	0.608
soft palatal length (mm)	25.9	1.8	0.563
soft palatal thickness (mm)	7.9	0.7	0.261

Table 2. Correlation of variables with age.

	r-value	p-value	
tongue-base position	0.358	0.0339	*
na-s-ba	-0.177	0.3118	
sna	0.196	0.2611	
snb	0.207	0.2345	
facial taper	-0.332	0.0511	
maxillary height	0.123	0.4858	
mandibular arc	-0.180	0.3042	
mandibular plane angle	0.254	0.1415	
posterior facial height	0.392	0.0190	*
nasal floor length	0.495	0.0021	**
corpus length	0.590	0.0001	***
lower facial height	0.104	0.5565	
d-ad1	0.252	0.1449	
d-ad2	0.005	0.9791	
upper pharynx	0.068	0.7016	
soft palatal length	0.226	0.1941	
soft palatal thickness	0.160	0.3610	

Table 3. Correlation of variables with tongue-base position.

	r-value	p-value	
age	0.358	0.0339	*
na-s-ba	-0.159	0.3628	
sna	0.428	0.0097	**
snb	0.283	0.1003	
facial taper	-0.365	0.0307	*
maxillary height	-0.237	0.1720	
mandibular arc	-0.345	0.0420	*
mandibular plane angle	0.279	0.1045	
posterior facial height	-0.082	0.6409	
nasal floor length	0.087	0.6213	
corpus length	0.295	0.0850	
lower facial height	0.079	0.6563	
d-ad1	0.344	0.0423	*
d-ad2	0.241	0.1652	
upper pharynx	0.296	0.0839	
soft palatal length	0.157	0.3706	
soft palatal thickness	0.049	0.7821	

base position and mandibular corpus length in the school children, who have the normal mandibular growth. Tongue protrusion led to increased lingual pressure on the anterior teeth, and finally led to a concomitant elongation of the dental arch and skeleton.[15-17] In the case of maxilla, the growth was more visible in this period than the mandibular,[16] so that the relationship between the maxillary position and tongue-base position was more clearer than mandibular position.[17]

Generally, a narrowed nasopharyngeal airway space with adeno-tonsillar hypertrophy led to a tongue-base to anterior position.[1,3,18-20] On the contrary, our results from healthy children showed both a narrowed nasopharyngeal airway space and posterior tongue-base position. This can be explained by the fact that it is necessary for children with adeno-tonsillar hypertrophy to maintain the airway space by changing the tongue-base position, whereas for healthy children without adeno-tonsillar hypertrophy changing the tongue-base position may not be necessary.

It was concluded that the tongue-base position was important for maxillo-mandibular growth in preschool children, while a narrowed nasopharyngeal airway space was associated with a posterior tongue-base position.

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