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가

2001 6

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1 ..... 1

2 .....2

2.1 .....2

2.2 .....4

3 ..... 9

4 ..... 19

5 ..... 25

.....26

..... 31

.....43

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가,  
 . Angle Ricketts<sup>9</sup> respiratory obstruction  
 syndrome, Schendel<sup>10</sup> long face syndrome vertical maxillary excess  
 . Tomes<sup>11</sup>  
 V - shape 가 , Woodside<sup>12</sup> Harvold<sup>13</sup>  
 II . Nordlund<sup>14</sup>,  
 Block<sup>15</sup>, Michel<sup>16</sup> 가  
 . , Kingsley<sup>17</sup>, Tulley<sup>18</sup>  
 , McKenzie<sup>19</sup>, Whitaker<sup>20</sup>, Howard<sup>21</sup> Leech<sup>22</sup>

23,24,25,26

cross - sectional

23,24

26

가

가

가

가

(bone age)

2  
 2.1

6 17 15  
 180 , 6  
 가 , 6  
 17 15 180 .

2.1.1 (criteria)

2.1.1.1

- 1) , Angle Class I
- 2) , 가
- 3) 가

2.1.1.2

- 1) , 가
- 2) ,

2.1.2

McNamara<sup>28</sup> , upper airway ( ½ )가 5mm , 5mm

2.1.3

grouping

Hassel Cervical Vertebrae Maturation Index (CVMI)<sup>28</sup>

6

15

(fig.1) (Table 1)

Table 1. Mean ages of subjects for all stages

(unit : years)

bone age	control group		experimental group	
	male	female	male	female
CVMI <sup>a</sup> 1	9.08 ± 1.49	6.92 ± 0.53	8.83 ± 0.51	6.90 ± 1.06
CVMI 2	10.58 ± 1.07	8.62 ± 0.97	9.83 ± 1.83	8.45 ± 0.60
CVMI 3	12.72 ± 1.09	10.91 ± 1.45	11.94 ± 1.38	10.81 ± 0.57
CVMI 4	13.97 ± 1.06	11.84 ± 1.32	13.29 ± 0.77	11.97 ± 1.26
CVMI 5	14.69 ± 0.73	13.58 ± 1.06	14.49 ± 0.62	13.05 ± 1.15
CVMI 6	15.69 ± 1.00	14.81 ± 0.97	15.14 ± 0.71	14.34 ± 1.17

<sup>a</sup> : Cervical Vertebrae Maturation Index (CVMI) by Hassel

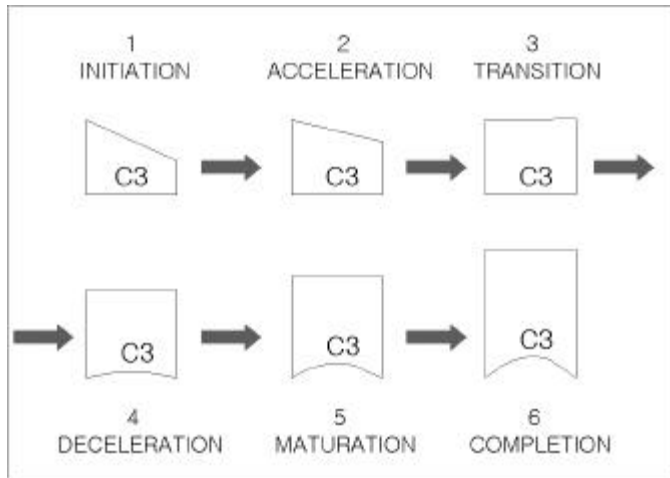


Figure 1. CVMI stages using 3rd cervical vertebrae.

## 2.2

### 2.2.1

#### 2.2.1.1

가 8" × 10" X-ray  
75 Kvp, 6mA, 0.8, 1.0 sec

#### 2.2.1.2

0.003 inch

#### 2.2.1.3

Corel DRAW 7<sup>®</sup> 2

0.01mm, 0.01mm<sup>2</sup>

## 2.2.2 ,

### 2.2.2.1 (fig.2)

- 1) ad<sub>1</sub> (adenoid 1) : pm - ba
- 2) ad<sub>2</sub> (adenoid 2) : pm - ho
- 3) ba (basion) : Occipitale clivus 가
- 4) gn (Gnathion) : Symphysis nasion 가
- 5) ho (Hormion) : 가
- 6) n (Nasion) : Frontonasal suture 가
- 7) pm (Pterygomaxillare) :
- 8) s (Sella) : Sella turcica - sella turcica tuberculum  
dorsum sella .
- 9) sm (Supramentale=B point) : alveolar arch 가
- 10) sp (Spinal point=ANS) : Anterior nasal spine
- 11) sp' : NL n - gn
- 12) ss (Subspinale=A point) : alveolar arch 가
- 13) ss' : ss NL
- 14) t<sub>1</sub> (tongue 1) : NSL pm
- 15) t<sub>2</sub> (tongue 2) : s - ba ba
- 16) PP (posterior pharyngeal wall) : NL H
  
- 17) H (Hyoid) : Hyoid
- 18) Stm<sub>s</sub> (Stomion superius) :
- 19) Stm<sub>i</sub> (Stomion inferius) :

### 2.2.2.2 (fig.2)

- 1) NSL (nasion - sella line) : na s
- 2) NL (nasal line) : sp pm
- 3) ML (mandibular line) : gn

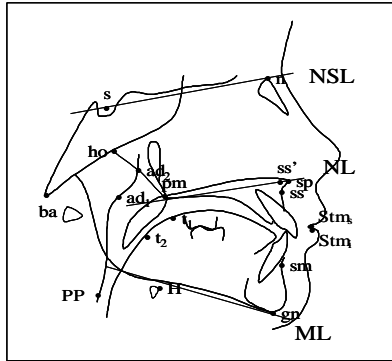


Figure 2. Landmarks and reference lines.

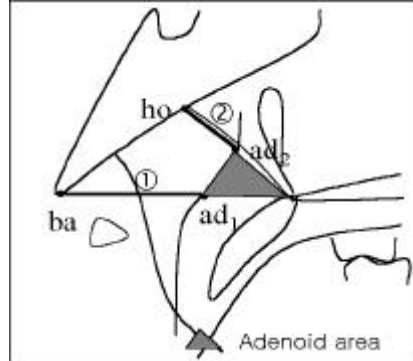


Figure 3. Adenoid measurements.

ad<sub>1</sub>-ba  
ad<sub>2</sub>-ho

### 2.2.2.3

#### 1) Adenoid measurements (fig.3)

가) ad<sub>1</sub>-ba

) ad<sub>2</sub>-ho

#### 2) Skeletal measurements (fig.4)

가) Linear measurements

- (1) n-s : length of anterior part of basis cranii
- (2) s-ba : length of posterior part of basis cranii
- (3) n-gn : anterior face height
- (4) n-sp' : upper anterior face height
- (5) sp'-gn : lower anterior face height
- (6) ss'-pm : length of basis maxillae and an expression for the length of the floor of the nasal cavity
- (7) pm-ba : depth of bony nasopharynx
- (8) ho pm-ba : height of bony nasopharynx

) Angular measurements

- (1)  $\angle s-n-ss$  : angle between apical base of maxilla and NSL
- (2)  $\angle s-n-sm$  : angle between apical base of mandible and NSL
- (3)  $\angle ML-NSL$  : relative dimension between anterior & posterior face height
- (4)  $\angle NL-NSL$  : relative dimension between anterior & posterior upper face height
- (5)  $\angle n-s-ba$  : cranial base angle, expresses curvature in midsagittal plane of the borderline between the visceral cranium and the neurocranium
- (6)  $pm-ho-ba$  : roof angle of the bony pharynx

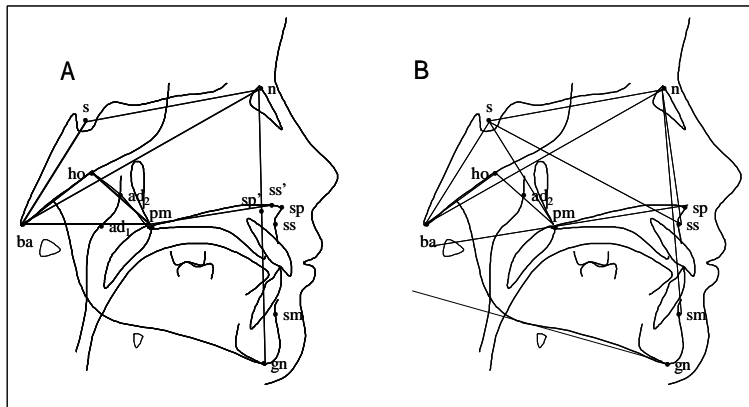


Figure 4. Skeletal measurements.

A. linear measurements

B. angular measurements

3) Tongue measurements (fig.5)

- 가)  $pm-t_1$  : pterygomaxillare to the contour of the tongue, this distance measured along a perpendicular to NSL through pterygomaxillare
- )  $ba-t_2$  : basion to the contour of the tongue, this distance measured along a perpendicular to the line  $s-ba$  through basion

4) Lip measurements (fig.5)

가)  $Stm_s \perp NL$  : height of upper lip

)  $Stm_i \perp ML$  : height of lower lip

5) Hyoid measurements (fig.5)

가) H-PP : nasal plane to the most anterior point of the body of the hyoid bone, parallel to nasal line

)  $H \perp NL$  : nasal plane to the most anterior point of the body of the hyoid bone, parallel to nasal line

6) Ratios

가)  $ANR_1$  (adenoidal-nasopharygeal ratio<sub>1</sub>) =  $\frac{ad_1 - ba}{pm - ba}$

)  $ANR_2$  (adenoidal-nasopharygeal ratio<sub>2</sub>) =  $\frac{ad_2 - ho}{pm - ho}$

) Airway ratio =  $\frac{pm - ho - ba - pm}{pm - s - ba - pm}$

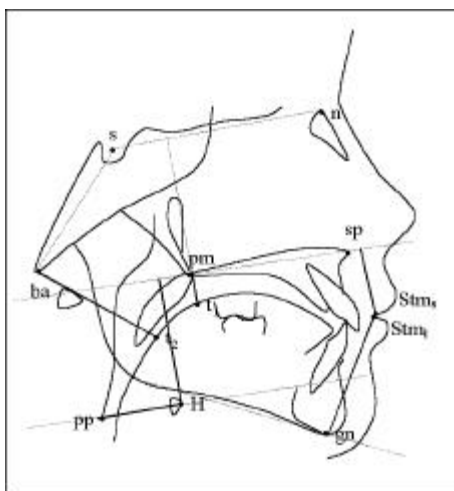


Figure 5. Tongue, lips and hyoid bone measurements.



2.2.3

2.2.3.1

2.2.3.2

2.2.3.3

(Student's *t*-test)

### 3

3.1

(Table 2)

가

3.2

Table 2. Significant differences in age between control group and experimental group in same gender.

	control group	experimental group
CVMI 1	0.0001***	0.0001***
CVMI 2	0.0065**	0.0196**
CVMI 3	0.0035**	0.0082**
CVMI 4	0.0002***	0.0037**
CVMI 5	0.0017**	0.0004***
CVMI 6	0.0446*	0.0284**

\* :  $p < 0.05$

\*\* :  $p < 0.01$

\*\*\* :  $p < 0.001$



3.3

3.3.1 (fig.7, Table4,11- 14)

3.3.1.1 Length of anterior part of basis cranii (n-s)

CVMI 2, CVMI 1,5,6  
 CVMI 3, CVMI 2, CVMI 2, CVMI 2, CVMI 3, CVMI 2,3,5,6

3.3.1.2 Length of posterior part of basis cranii (s-ba)

CVMI 2,3, CVMI 2, CVMI 2, CVMI 3, CVMI 2, CVMI 1,2

3.3.1.3 Cranial base angle, expresses curvature in midsagittal plane of the borderline between the visceral cranium and the neurocranium ( $\angle n-s-ba$ )

CVMI 3, CVMI 4, CVMI 6

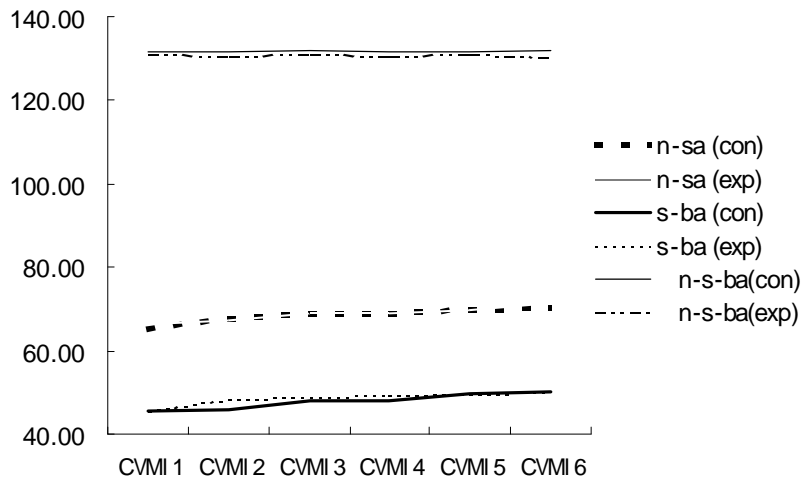


Figure 7. Change of cranial base structures at each bone age. (con : control group, exp : experimental group)

3.3.2 (fig.8, Table5,11- 14)

3.3.2.1 Anterior face height (n-gn)

CVMI 5  
 가  
 , CVMI 3  
 CVMI 3

3.3.2.2 Upper anterior face height (n-sp')

CVMI 3 , CVMI 4  
 가  
 CVMI 3  
 , CVMI 2 CVMI

3.3.2.3 Lower anterior face height (sp'-gn)

CVMI 5  
 가  
 CVMI 2 , CVMI 6  
 가

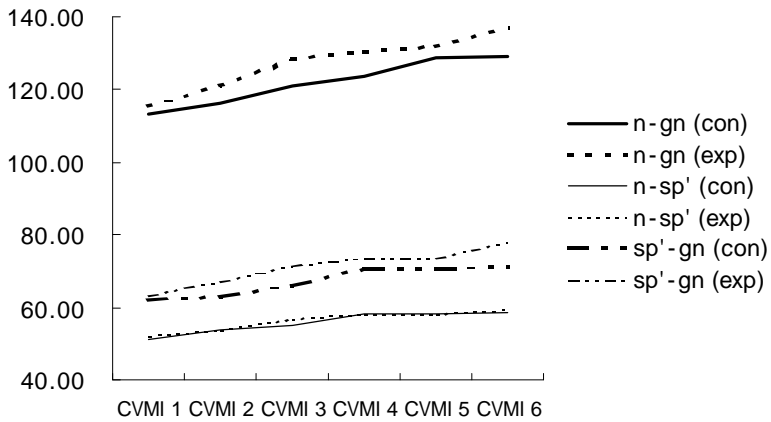


Figure 8. Change of anterior facial height at each bone age.  
 (con : control group, exp : experimental group)

3.3.3 (fig.9, Table6,11- 14)

3.3.3.1 Length of basis maxillae and an expression for the length of the floor of the nasal cavity (ss'-pm)

CVMI 2 , CVMI 4 ,  
 CVMI 1,2,6 , CVMI 5 ,  
 CVMI 2 ,  
 CVMI 2 ,

3.3.3.2 Angle between apical base of maxilla and NSL ( $\angle s-n-ss$ )

3.3.3.3 Relative dimension between anterior & posterior upper face height ( $\angle NL-NSL$ )

, 가 .

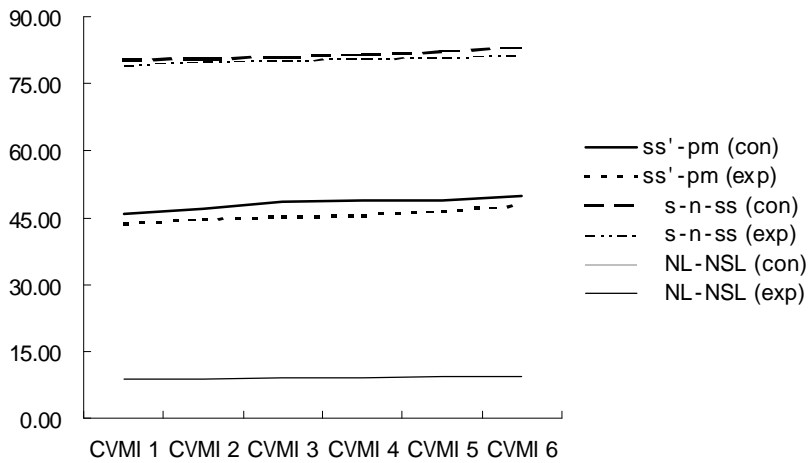


Figure 9. Growth of maxilla.

(con : control group, exp : experimental group)

3.3.4 (fig.10, Table7,11-14 )

3.3.4.1 Angle between apical base of mandible and NSL ( $\angle$ s-n-sm)

CVMI 2 CVMI 4 , CVMI 2 ,  
CVMI 2 CVMI 4 ,  
CVMI 5

3.3.4.2 Relative dimension between anterior & posterior face height ( $\angle$ ML-NSL)

CVMI 2 가  
CVMI 3 ,  
CVMI 2 가  
CVMI 3 , CVMI 2

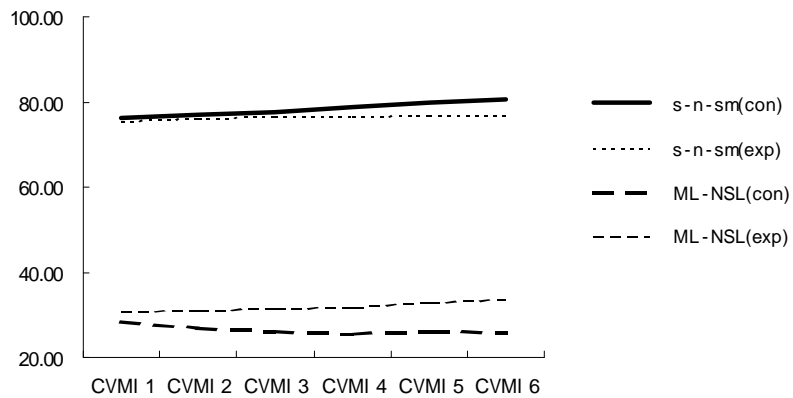


Figure 10. Growth of mandible.

(con : control group, exp : experimental group)

3.3.4 (fig.11, Table8,11- 14)

3.3.4.1 Depth of bony nasopharynx (pm-ba)

가 , CVMI 1,5  
 CVMI 4 , CVMI 6가 ,  
 가 ,

3.3.4.2 Height of bony nasopharynx (ho pm-ba)

CVMI 1 CVMI 2 CVMI 4 CVMI 5  
 , CVMI 3 ,  
 CVMI 1,5 CVMI 3  
 , CVMI 4 ,  
 CVMI 4,6

3.3.4.3 Roof angle of the bony pharynx ( pm-ho-ba)

CVMI 3,5 가 ,  
 CVMI 5

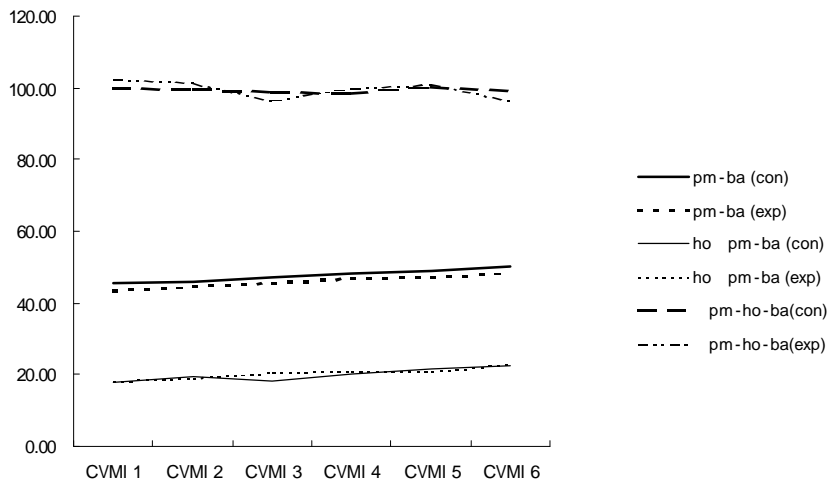


Figure 11. Growth of nasopharynx.

(con : control group, exp : experimental group)

3.4 (fig.12, Table9,11- 14)

3.4.1 Pterygomaxillare to the contour of the tongue, this distance measured along a perpendicular to NSL through pterygomaxillare (pm-t<sub>1</sub>)

CVMI 4 , CVMI 6 가  
 , CVMI 3,6 , CVMI 2,3,4,6

3.4.2 Basion to the contour of the tongue, this distance measured along a perpendicular to the line s-ba through basion (ba-t<sub>2</sub>)

CVMI 5 가 ,

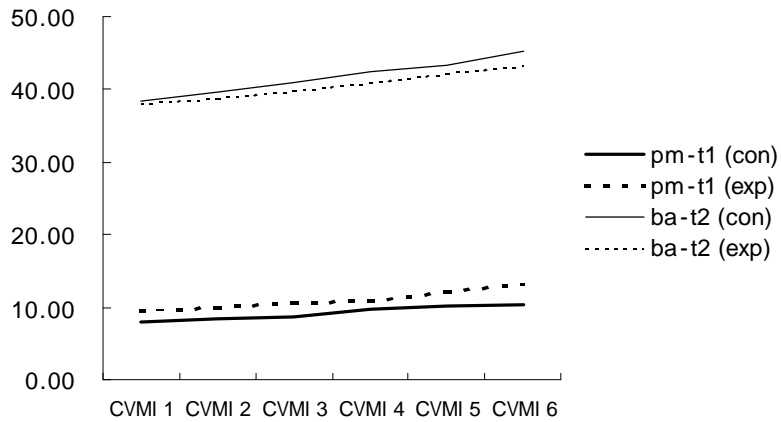


Figure 12. Change of tongue position at each bone age.  
 (con : control group, exp : experimental group)



3.5 (fig.13, Table 10, 11-14)

3.5.1

(Stms ⊥ NL)  
 CVMI 2 가 ,  
 가 CVMI 2 CVMI 4

3.5.2

(Stmi ⊥ ML)  
 CVMI 1,2,4 , CVMI 6 가  
 , CVMI 2

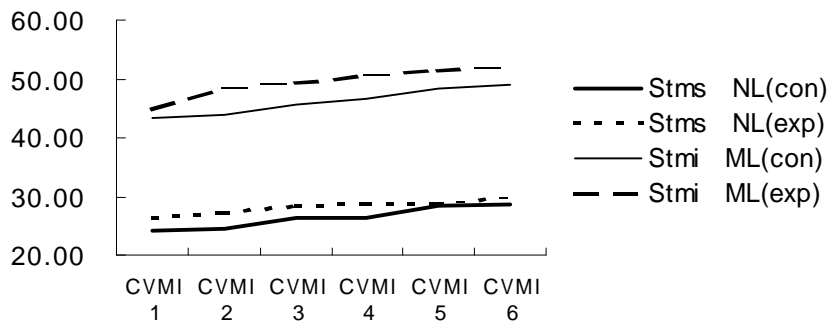


Figure 13. Change of upper and lower lip position at each bone age.  
 (con : control group, exp : experimental group)

3.6. (fig.14, Table10,11- 14)

3.6.1. Nasal plane to the most anterior point of the body of the hyoid bone, parallel to nasal line (H-PP)

CVMI 3 , CVMI 1,3,4 가  
 ,  
 , CVMI 5 .

3.6.2. Nasal plane to the most anterior point of the body of the hyoid bone, parallel to nasal line (H ⊥ NL)

CVMI 3 , CVMI 5 가  
 , CVMI 1,2  
 , CVMI 2 CVMI 4

group

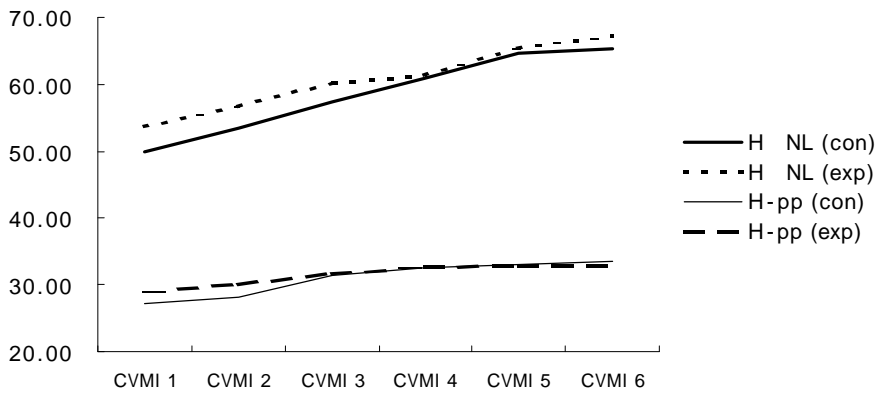


Figure 14. Change of hyoid bone position at each bone age.  
 (con : control group, exp : experimental group)

4 .

가  
가 . Linder-Aronson<sup>29</sup>  
, , 가,  
, 가,  
30-33 가 가<sup>30-32</sup>,  
34 . Schlenker<sup>34</sup> tracheotomy  
, basilar length, , facial  
length, skull length, cranial length  
가  
가 . Trenouth Timms<sup>35</sup> 10  
13 (functional oropharynx)가  
, 가 ,  
(upper facial height)  
, (cranial base angle: n-s-ba)  
, Sosa<sup>36</sup> (xerographic  
cephalogram) I II 1 ,  
, O'Ryan<sup>37</sup>  
, 가  
, 가  
( ) 가  
가  
(chronologic age) (bone  
age) 가 Björk<sup>38</sup> (skeletal  
, Fishman<sup>39</sup> maturation index :SMI) 가  
Hassel<sup>28</sup>

cervical vertebrae maturation index (CVMI) . 40 CVMI  
SMI 가

가 , 가 , 가

ss'-pm, bony nasopharynx pm-ba, ho  
pm-ba 가

가 2 , 가  
Holmberg Linder-Aronson<sup>29</sup> 가가 가

Pruzansky<sup>41</sup> ,  
McNamara<sup>27</sup> 가 5mm , Holmberg<sup>30</sup>

rhinoscope 가 5 ,  
(r=0.71) , Kemaloglu<sup>32</sup>  
가  
(adenoidal-nasopharyngeal ratio:ANR)  
(r=0.54 0.68)

Bergland<sup>33</sup> pterygomaxillare, basion, hormion  
, Schulhof<sup>42</sup> Handelman<sup>43</sup> 가 Bergland  
가 , basion nasopharynx  
, sphenoidal line, palatal line, anterior atlas  
line pterygomaxillary line  
Poole<sup>44</sup> Handelman sphenoidal line basion-nasion  
line

McNamara가  
 Bergland atlas body가 basion  
 tuberculum pharygeum baso-occiput head position  
 basion  
 Scammon<sup>45</sup>  
 Kemaloglu<sup>32</sup> ANR 가  
 ANR<sub>1</sub>(ad<sub>2</sub>-ho/pm-ho)  
 CVMI 2 가  
 CVMI 1  
 ANR<sub>2</sub>(ad<sub>1</sub>-ba/pm-ba) CVMI 1  
 Scammon 가<sup>41</sup>  
 가  
 1920 가  
 Waldeyer's ring Hollender Szanto<sup>31</sup>  
 group 가  
 CVMI 1  
 Pruzansky<sup>41</sup>  
 Tourne<sup>46</sup> (nasopharynx) (oropharynx)  
 hormion,  
 80% 가  
 (bihamular width 가 ) 2  
 choanal width(medial pterygoid plate 가 )  
 23%가 가 , Posterior nasal  
 spine(PNS; pm ) basion  
 pharyngeal depth 9%가 가가  
 Pharyngeal depth 1-2 <sup>33,43,47</sup>  
 (pm) 2 , SN line  
<sup>48</sup>. Pharyngeal depth cranial base angle(  
 n-s-ba) pm-ba 가  
 10% , pharyngeal depth

가 . 가 pharyngeal depth 가  
CVMI 6  
, cranial base angle 가  
. Cranial base angle  
pharyngeal height(ho pm-ba)  
가 . Vomer ( pm-ho-ba) sphenoc- occipital synchondrosis pharyn- geal depth . Vomer sphenoc- occipital synchondrosis(s-ba) pm ba , pm-ho-ba(bony pharynx roof ) , clivus pm-ba s-ba가 , pm-ho-ba  
anterior cranial base(n-s) secondary displacement  
<sup>49</sup> bone remodeling 가 , 가가 s-n-ss ss'-pm  
<sup>47,48,50</sup> vertebral body <sup>47</sup> 3,4  
<sup>51</sup> set-back 가 ( 가 )  
CVMI 2 CVMI 4 , CVMI 1,2,4,5  
(H-pp) , ( s-n-sm)  
CVMI 5,6

가 가<sup>53</sup>  
 50,53 CVMI 2 가 CVMI 5  
 (pm - t<sub>1</sub>)  
 가  
 55 freeway  
 가 CVMI 3, 5 CVMI 2 CVMI 4, CVMI 6  
 (ba - t<sub>2</sub>)  
 CVMI 2 CVMI 4 가  
 가 CVMI 2 CVMI 4  
 가 CVMI 4  
 CVMI 5 가 CVMI 4  
 가  
 가<sup>14</sup> 15,16  
 Harvold<sup>13</sup> , Yamada<sup>55</sup> posterior facial height  
 가 . Nanda<sup>54</sup> McNamara<sup>56</sup>  
 anterior facial height(n - gn)  
 CVMI 3 CVMI 1 가  
 Anterior facial height 가 lower anterior facial height(sp' - gn) 가  
 Upper anterior facial height(n - sp') (NL - NSL) 가 가 ( ML - NSL)  
 CVMI 3 CVMI 2  
 가<sup>57</sup>

<sup>58</sup>, lower anterior facial height 가<sup>59</sup> Trotman<sup>60</sup>  
 가 bony pharynx  
 (Stm<sub>s</sub> ⊥NL) CVMI 2-4  
 (Stm<sub>i</sub> ⊥ML)  
 CVMI 2  
 가  
 CVMI 4 가 CVMI 3,4 가  
 가  
 CVMI 1 가  
 가 CVMI 2,3 (sp'-gn, s-n-sm,  
 ss-n-sm)  
 (ss'-pm), bony nasopharynx  
 (ho pm-ba), 가  
 cross-sectional 가  
<sup>23,24</sup>  
<sup>26</sup> 가 가  
 , CVMI 4 가  
 CVMI 4  
 2 가  
 (patency)  
<sup>30,54</sup> 가 3-dimensional computerized tomogram (3-D CT)  
 가 3D-CT  
 가



5 .

가 ,  
가 (bone age)

1. ; CVMI 3  
CVMI 4( ) 가 , CVMI 1
2. .
3. CVMI 4 , CVMI 5 .
4. CVMI 3 , CVMI 1 .
5. CVMI 2( ) .
6. CVMI 2( $10.58 \pm 1.07$  , )  
 , CVMI 1( $6.92 \pm 0.53$  )  
가 .  
 , CVMI 4 가  
CVMI 4 가  
 ,

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Table 3. The means and standard deviations(S.D.) of adenoidal-nasopharyngeal ratio(ANR) and airway ratio measurements

			CVMI 1		CVMI 2		CVMI 3		CVMI 4		CVMI 5		CVMI 6	
			Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
ANR <sub>1</sub>	control group	M	0.47	0.06	0.49	0.07	0.40	0.09	0.36	0.07	0.35	0.07	0.33	0.06
		F	0.47	0.07	0.44	0.06	0.44	0.07	0.41	0.08	0.38	0.06	0.36	0.08
	experimental group	M	0.56	0.04	0.67	0.09	0.58	0.08	0.56	0.08	0.53	0.09	0.53	0.07
		F	0.56	0.09	0.57	0.06	0.55	0.09	0.56	0.11	0.51	0.07	0.53	0.06
ANR <sub>2</sub>	control group	M	0.50	0.07	0.49	0.07	0.46	0.07	0.43	0.07	0.43	0.07	0.43	0.06
		F	0.53	0.10	0.49	0.07	0.49	0.07	0.48	0.07	0.46	0.05	0.46	0.06
	experimental group	M	0.67	0.08	0.67	0.09	0.66	0.04	0.65	0.04	0.64	0.05	0.63	0.09
		F	0.66	0.06	0.62	0.08	0.61	0.06	0.61	0.06	0.59	0.08	0.59	0.04
Airway ratio	control group	M	0.27	0.06	0.28	0.03	0.32	0.08	0.37	0.07	0.37	0.04	0.38	0.06
		F	0.25	0.07	0.29	0.05	0.29	0.07	0.31	0.05	0.34	0.05	0.35	0.08
	experimental group	M	0.15	0.04	0.15	0.05	0.14	0.05	0.15	0.03	0.17	0.04	0.18	0.06
		F	0.15	0.05	0.17	0.04	0.17	0.06	0.17	0.05	0.20	0.05	0.19	0.03

Table 4. The means and standard deviations(S.D.) of the cranial base measurements

(unit : mm)

		CVMI 1		CVMI 2		CVMI 3		CVMI 4		CVMI 5		CVMI 6		
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	
n-s	contro	M	104.04	3.28	106.22	2.20	107.53	2.65	108.14	4.43	110.13	2.91	113.31	3.11
	group	F	97.26	1.81	100.78	3.97	105.20	4.55	106.11	3.93	106.25	3.18	106.77	2.58
	experi-	M	104.35	4.50	107.43	4.86	109.07	4.16	109.94	4.63	111.34	3.38	113.60	4.18
	mental	F	101.90	4.66	103.06	4.76	105.77	4.15	105.88	4.74	107.81	3.56	108.78	2.83
s-ba	contro	M	118.28	4.65	120.30	4.04	124.79	5.85	128.46	5.37	132.53	6.87	133.15	4.92
	group	F	107.86	4.37	112.20	3.34	117.68	4.46	118.50	6.05	125.39	3.66	125.48	5.09
	experi-	M	116.63	4.57	123.13	6.34	131.44	7.72	133.58	6.72	134.28	3.81	142.13	8.03
	mental	F	114.56	7.19	118.66	6.70	125.35	7.53	127.77	7.76	129.60	6.51	132.02	4.44
∠ n-s-ba	contro	M	131.40	3.50	131.73	4.06	131.87	3.70	131.33	3.85	131.13	4.52	131.27	2.66
	group	F	131.33	4.35	131.40	3.27	132.20	4.51	132.13	3.81	132.33	3.31	132.80	2.98
	experi-	M	130.33	5.23	129.07	5.60	129.13	3.91	129.00	5.37	130.20	3.97	130.20	6.06
	mental	F	132.13	4.10	132.47	4.39	132.80	5.72	132.67	3.18	131.67	4.33	130.33	3.06



Table 5. The means and standard deviations of the facial measurements

(unit : mm)

			CVMI 1		CVMI 2		CVMI 3		CVMI 4		CVMI 5		CVMI 6	
			Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
n-gn	control group	M	118.28	4.65	120.30	4.04	124.79	5.85	128.46	5.37	132.53	6.87	133.15	4.92
		F	107.86	4.37	112.20	3.34	117.68	4.46	118.50	6.05	125.39	3.66	125.48	5.09
	experimental group	M	116.63	4.57	123.13	6.34	131.44	7.72	133.58	6.72	134.28	3.81	136.13	8.03
		F	114.56	7.19	118.66	6.70	125.35	7.53	127.77	7.76	129.60	6.51	132.02	4.44
n-sp <sup>i</sup>	control group	M	53.23	2.59	55.00	2.70	56.47	4.07	59.75	2.91	59.75	3.02	59.96	2.82
		F	48.97	2.43	52.21	2.68	54.53	2.15	56.65	3.63	56.65	1.83	56.70	2.61
	experimental group	M	52.84	3.09	54.59	2.21	58.29	3.75	59.21	2.21	59.21	1.66	59.63	8.26
		F	51.86	3.20	53.21	3.56	55.25	3.56	57.20	3.11	57.20	2.37	59.09	2.51
sp <sup>i</sup> -gn	control group	M	65.06	3.67	65.30	3.77	68.32	5.28	72.78	4.44	72.78	7.21	73.19	3.58
		F	58.89	2.76	59.99	2.13	63.16	3.03	68.73	4.52	68.73	3.81	68.78	5.23
	experimental group	M	63.79	3.58	68.54	4.65	73.15	5.21	75.07	5.34	75.07	3.18	82.50	11.53
		F	62.70	4.88	65.44	3.94	70.10	5.17	72.40	5.28	72.40	5.32	72.93	4.49

Table 6. The means and standard deviations of the maxillary measurements

(unit : mm, degree)

			CVMI 1		CVMI 2		CVMI 3		CVMI 4		CVMI 5		CVMI 6	
			Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
ss'-pm	control group	M	47.20	3.82	49.28	5.48	49.38	2.87	49.51	2.86	49.62	5.07	51.31	2.76
		F	44.05	2.36	45.03	3.47	47.94	1.63	48.28	1.95	48.32	1.86	48.49	3.21
	experimental group	M	44.58	3.97	44.70	2.56	45.63	3.77	46.07	3.49	47.20	2.39	47.72	3.24
		F	42.77	5.01	44.39	2.56	44.40	4.03	45.12	3.84	45.51	3.07	45.78	2.85
∠S-n-SS	control group	M	80.60	2.75	80.73	4.03	81.27	4.23	82.27	2.84	82.73	4.11	83.33	2.44
		F	80.07	2.49	80.73	3.15	80.80	3.75	81.00	2.62	81.40	1.99	82.73	2.89
	experimental group	M	78.47	4.39	79.53	3.93	79.73	3.75	80.40	3.68	80.87	3.16	81.27	2.86
		F	79.53	3.31	80.60	3.00	80.73	3.17	80.80	3.21	81.13	2.88	81.40	2.58
∠NL-NSL	control group	M	7.67	2.99	7.80	3.49	8.53	3.07	8.60	2.80	8.60	4.07	8.87	2.90
		F	7.80	3.28	8.73	3.31	9.40	2.69	9.47	4.16	9.67	1.40	9.67	4.53
	experimental group	M	8.00	2.24	8.07	5.31	8.13	4.58	8.47	5.10	8.67	2.64	8.80	1.86
		F	9.33	1.63	9.47	2.39	9.80	4.07	9.87	1.92	9.87	1.36	10.00	1.41

Table 7. The means and standard deviations of the mandibular measurements

(unit : degree)

			CVMI 1		CVMI 2		CVMI 3		CVMI 4		CVMI 5		CVMI 6	
			Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
∠S-n-sm	control group	M	76.53	2.80	76.73	3.01	78.20	3.97	79.80	2.48	80.33	3.44	80.60	2.23
		F	76.13	2.07	77.33	2.85	77.40	3.79	77.73	2.87	78.47	2.33	80.20	3.32
	experimental group	M	75.73	4.35	76.33	3.68	76.33	4.29	76.80	4.20	77.00	3.12	77.33	3.75
		F	75.53	4.24	76.40	2.90	76.47	3.72	76.47	3.20	76.53	2.50	76.73	2.79
∠ML-NSL	control group	M	27.67	3.48	28.27	3.88	25.73	4.20	25.40	6.37	26.00	5.64	25.47	3.04
		F	28.80	2.42	25.73	2.60	26.33	4.58	25.46	4.27	26.27	6.19	26.27	3.95
	experimental group	M	30.53	4.73	30.80	4.44	31.60	7.89	31.67	4.70	32.80	3.00	34.07	3.97
		F	31.13	5.64	31.20	5.54	31.47	5.87	32.07	5.72	32.87	5.78	33.00	2.54

Table 8. The means and standard deviations of the bony pharyngeal measurements

(unit : mm, degree)

		CVMI 1		CVMI 2		CVMI 3		CVMI 4		CVMI 5		CVMI 6		
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	
pm-ba	control group	M	45.01	2.75	45.98	5.37	46.78	3.55	47.57	4.10	49.15	3.28	50.07	3.73
		F	45.80	4.22	46.15	3.74	47.30	3.30	48.90	2.92	48.91	4.13	49.83	2.91
	experimental group	M	44.99	1.96	45.74	3.76	45.57	3.33	47.34	3.05	48.30	2.74	49.14	4.99
		F	41.53	1.98	43.47	2.22	45.87	4.34	45.97	3.97	46.04	2.63	47.34	3.34
ho ⊥ pm-ba	control group	M	18.34	1.51	20.26	1.90	20.47	1.66	20.81	2.25	24.12	5.65	25.13	2.82
		F	17.24	2.19	18.37	1.10	16.19	5.08	19.21	2.22	19.26	1.42	19.70	0.99
	experimental group	M	18.60	1.94	19.22	2.68	21.24	1.46	21.48	3.53	21.55	2.15	23.53	1.56
		F	18.02	1.90	18.89	2.67	20.03	1.96	20.18	1.92	20.22	2.95	22.04	2.62
∠ pm-ho-ba	control group	M	99.00	8.68	99.47	9.43	95.00	7.38	96.13	8.38	98.87	5.99	97.53	5.26
		F	100.80	7.67	99.47	5.72	102.40	8.87	100.73	8.62	101.53	5.88	100.67	6.53
	experimental group	M	100.53	6.21	102.13	8.43	95.33	7.02	97.69	8.09	100.83	4.92	94.33	8.02
		F	104.33	7.75	100.80	10.65	97.26	9.72	102.07	8.94	101.53	11.92	98.83	7.33

Table 9. The means and standard deviations of the tongue measurements

(unit : mm)

		CVMI 1		CVMI 2		CVMI 3		CVMI 4		CVMI 5		CVMI 6		
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	
pm-t <sub>1</sub>	control group	M	8.60	2.19	8.62	3.56	9.09	2.47	10.95	3.71	11.52	3.37	11.93	2.64
		F	7.48	1.61	8.01	1.31	8.24	1.40	8.42	1.11	8.66	1.79	8.88	2.52
	experimental group	M	9.56	3.24	10.07	1.25	10.71	1.55	11.04	2.56	13.32	1.76	15.31	2.01
		F	9.22	3.23	9.70	1.03	10.34	2.02	10.54	2.59	10.67	4.14	10.93	1.34
ba-t <sub>2</sub>	control group	M	40.51	2.58	40.43	2.75	42.23	3.10	44.66	2.75	45.15	3.58	46.62	3.99
		F	36.14	1.86	38.88	2.28	39.48	2.15	40.39	1.46	41.37	2.18	43.76	2.72
	experimental group	M	39.11	4.14	39.89	2.77	40.75	4.40	41.37	5.53	42.61	2.87	43.90	1.86
		F	37.19	3.47	37.86	1.73	38.99	3.71	40.41	3.39	41.78	2.99	42.17	3.23

Table 10. The means and standard deviations of the lip and hyoid bone measurements (unit : mm)

			CVMI 1		CVMI 2		CVMI 3		CVMI 4		CVMI 5		CVMI 6	
			Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Stm <sub>s</sub> ⊥ NL	control group	M	25.29	1.78	25.71	3.07	27.06	3.14	27.15	3.40	29.01	3.51	29.26	1.87
		F	23.13	1.74	23.42	2.78	25.39	2.22	25.12	2.06	27.51	4.52	27.92	3.52
	experimental group	M	25.88	3.46	27.75	5.78	28.95	2.22	29.65	5.32	30.24	2.12	30.66	2.43
		F	26.56	6.75	26.77	3.00	27.74	3.14	27.86	2.83	28.89	4.67	28.93	2.41
Stm <sub>i</sub> ⊥ ML	control group	M	45.01	1.51	45.16	3.15	46.42	3.29	48.07	4.06	49.25	2.53	49.86	2.82
		F	41.84	3.25	42.45	2.23	44.71	2.84	45.10	3.18	47.48	2.88	47.95	2.72
	experimental group	M	45.32	3.79	49.78	4.10	50.64	4.60	51.84	4.41	52.15	2.02	52.99	2.37
		F	44.27	4.46	46.91	3.76	48.03	5.72	48.94	3.07	50.30	3.66	50.84	2.06
H ⊥ NL	control group	M	51.66	9.28	54.30	5.40	60.52	5.85	66.49	6.32	69.75	5.63	69.88	6.18
		F	48.32	4.12	52.29	4.78	54.08	3.24	55.28	4.53	59.31	3.38	60.94	3.44
	experimental group	M	56.66	4.63	57.70	7.62	63.75	9.05	64.38	6.74	66.66	3.75	68.49	3.21
		F	50.65	3.35	55.63	6.93	55.76	7.09	58.46	6.23	63.87	5.21	65.94	5.49
H-pp	control group	M	27.43	2.72	28.00	3.76	33.19	3.18	35.05	4.38	36.22	3.25	36.12	2.39
		F	27.05	2.70	28.56	2.03	29.91	2.91	30.37	3.00	30.40	3.49	31.06	3.22
	experimental group	M	29.34	3.18	30.75	2.78	31.77	3.43	33.67	3.49	34.94	4.18	35.10	2.59
		F	28.38	2.82	29.30	2.45	31.51	3.88	31.67	2.08	30.74	2.06	30.41	2.34

Table 11. Comparison of measurements between male and female in control group

	CVM11	CVM12	CVM13	CVM14	CVM15	CVM16
n-s	0.0005***	0.0781	0.3999	0.1079	0.0003***	0.0001***
s-ba	0.0380*	0.0011**	0.0012**	0.0082**	0.0009***	0.0001***
n-gn	0.0000***	0.0000***	0.0008***	0.0001***	0.0018**	0.0002***
n-sp'	0.0001***	0.0082**	0.0174*	0.0010***	0.0020**	0.0028**
sp'-gn	0.0000***	0.0001***	0.0033**	0.0021**	0.0482*	0.0117*
ss'-pm	0.0111**	0.0171*	0.1051	0.1825	0.3650	0.0154*
pm-ba	0.0000***	0.0533	0.8356	0.1040	0.0289*	0.2551
ho pm-ba	0.1202	0.0030**	0.0295*	0.4649	0.0046**	0.0001***
s-n-ss	0.5820	1.0000	0.7515	0.2146	0.2718	0.5439
s-n-sm	0.6595	0.5793	0.5770	0.0439	0.0924	0.7015
ML-NSL	0.3095	0.0449*	0.7112	0.9734	0.9028	0.5981
NL-NSL	0.9082	0.4582	0.4179	0.5082	0.3500	0.5692
n-s-ba	0.9635	0.8062	0.8264	0.5720	0.4136	0.1482
pm-ho-ba	0.5521	1.0000	0.0194*	0.1497	0.0142*	0.1591
Stm <sub>s</sub> ⊥NL	0.0022***	0.0413*	0.1040	0.0571	0.3195	0.2076
Stm <sub>i</sub> ⊥ML	0.0027***	0.0111*	0.1385	0.0324*	0.0849	0.0701
pm-t <sub>1</sub>	0.1187	0.5412	0.2578	0.0222**	0.0085**	0.0031**
ba-t <sub>2</sub>	0.0000***	0.1035	0.0086**	0.0001***	0.0016**	0.1469
H-NL	0.2174	0.2922	0.0012**	0.0000***	0.0000***	0.0001***
H-pp	0.7002	0.6163	0.0063**	0.0020**	0.0001***	0.0000***
ANR <sub>1</sub>	0.6816	0.8168	0.1999	0.1008	0.4073	0.2976
ANR <sub>2</sub>	0.3554	0.9579	0.3881	0.0768	0.2045	0.1809
Airway ratio	0.3713	0.9496	0.1922	0.0137*	0.0775	0.2024

\* :  $p < 0.05$ , \*\* :  $p < 0.01$ , \*\*\* :  $p < 0.001$

Table 12. Comparison of measurements between male and female in experimental group

	CVMI1	CVMI2	CVMI3	CVMI4	CVMI5	CVMI6
n-s	0.0991	0.0156 <sup>*</sup>	0.0504	0.0697 <sup>*</sup>	0.0300 <sup>*</sup>	0.0010 <sup>***</sup>
s-ba	0.7068	0.0184 <sup>*</sup>	0.0067 <sup>**</sup>	0.0483 <sup>*</sup>	0.0020 <sup>**</sup>	0.0062 <sup>**</sup>
n-gn	0.3551	0.0706	0.0373 <sup>*</sup>	0.0169 <sup>*</sup>	0.0231 <sup>*</sup>	0.0003 <sup>***</sup>
n-sp'	0.4003	0.2145	0.0307 <sup>*</sup>	0.0018 <sup>**</sup>	0.0119 <sup>*</sup>	0.8114
sp'-gn	0.4926	0.0595	0.1188	0.2238	0.1065	0.0077 <sup>**</sup>
ss'-pm	0.2799	0.7392	0.3952	0.4852	0.1030	0.0920
pm-ba	0.5537	0.9243	0.6795	0.3144	0.8638	0.8495
ho pm-ba	0.4170	0.7356	0.0674	0.2239	0.1718	0.0681
s-n-ss	0.4588	0.4099	0.4373	0.7535	0.8107	0.9123
s-n-sm	0.8995	0.9564	0.9282	0.8086	0.6547	0.6232
ML-NSL	0.7547	0.8290	0.9585	0.8359	0.9688	0.3882
NL-NSL	0.0727	0.3632	0.3014	0.3328	0.1320	0.0565
n-s-ba	0.3034	0.0748	0.0499 <sup>*</sup>	0.0307 <sup>*</sup>	0.3421	0.9404
pm-ho-ba	0.1496	0.7066	0.5373	0.1889	0.8920	0.4263
Stm <sub>s</sub> ⊥NL	0.7339	0.5658	0.2351	0.2619	0.3195	0.0599
Stm <sub>i</sub> ⊥ML	0.4892	0.0561	0.1792	0.0474 <sup>*</sup>	0.0998	0.0129 <sup>*</sup>
pm-t <sub>1</sub>	0.7759	0.3802	0.5794	0.5984	0.0341 <sup>*</sup>	0.0000 <sup>***</sup>
ba-t <sub>2</sub>	0.1785	0.0793	0.2460	0.4704	0.4447	0.0871
H NL	0.0003 <sup>***</sup>	0.4448	0.0118 <sup>*</sup>	0.0186 <sup>*</sup>	0.1032	0.1310
H-pp	0.1933	0.1402	0.8670	0.0692	0.0023 <sup>**</sup>	0.0000 <sup>***</sup>
ANR <sub>1</sub>	0.5189	0.9171	0.4020	0.8947	0.5971	0.7756
ANR <sub>2</sub>	0.7265	0.1472	0.0673	0.6414	0.0639	0.1392
Airway ratio	0.9090	0.2121	0.1128	0.2380	0.1247	0.4223

\* :  $p < 0.05$ , \*\* :  $p < 0.01$ , \*\*\* :  $p < 0.001$



Table 13. Comparison of measurements between control and experimental group in male

	CVMI1	CVMI2	CVMI3	CVMI4	CVMI5	CVMI6
n- s	0.5313	0.8170	0.9532	0.8838	0.2615	0.2345
s- ba	0.4109	0.0749	0.1440	0.2247	0.5911	0.6855
n- gn	0.3345	0.1553	0.0127*	0.0289*	0.0479*	0.0009***
n- sp'	0.7153	0.6551	0.2123	0.9131	0.5476	0.8853
sp'- gn	0.3452	0.0451*	0.0176*	0.0070**	0.0136*	0.0084**
ss'- pm	0.0768	0.0084**	0.0048**	0.0064**	0.0103*	0.0029**
pm- ba	0.9782	0.8889	0.3457	0.8633	0.4479	0.5710
ho pm- ba	0.6819	0.2322	0.1882	0.0199*	0.1162	0.6341
s- n- ss	0.1218	0.4155	0.3027	0.1311	0.1743	0.0908
s- n- sm	0.5540	0.7469	0.2261	0.0242*	0.0095**	0.0072**
ML- NSL	0.0691	0.1075	0.0188*	0.0048***	0.0005***	0.0000***
NL- NSL	0.7322	0.8721	0.7808	0.9300	0.9579	0.9408
n- s- ba	0.5171	0.1466	0.0592	0.1823	0.5525	0.5399
pm- ho- ba	0.5822	0.4211	0.9000	0.6221	0.0751	0.3863
Stm <sub>s</sub> ⊥ NL	0.5624	0.2386	0.0673	0.1636	0.2545	0.0867
Stm <sub>i</sub> ⊥ ML	0.7696	0.0018**	0.0073**	0.0207*	0.0017**	0.0027**
pm- t <sub>1</sub>	0.3524	0.1542	0.0394*	0.9372	0.0801	0.0005**
ba- t <sub>2</sub>	0.2739	0.3091	0.2957	0.0521	0.0608	0.1455
H NL	0.0764	0.1690	0.2559	0.3849	0.0880	0.4471
H- pp	0.0341***	0.0305*	0.3128	0.3477	0.3577	0.2241
ANR <sub>1</sub>	0.0001***	0.0001***	0.0000***	0.0000***	0.0000***	0.0000***
ANR <sub>2</sub>	0.0000***	0.0000***	0.0000***	0.0001***	0.0000***	0.0000***
Airway ratio	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***

\* :  $p < 0.05$ , \*\* :  $p < 0.01$ , \*\*\* :  $p < 0.001$

Table 14. Comparison of measurements between control and experimental group in female

	CVMI1	CVMI2	CVMI3	CVMI4	CVMI5	CVMI6
n - s	0.1081	0.6548	0.8215	0.8977	0.5472	0.2366
s - ba	0.0048**	0.0311*	0.2052	0.2789	0.5441	0.3532
n - gn	0.0046**	0.0032**	0.0021**	0.0002***	0.0398*	0.0008***
n - sp'	0.0950	0.3901	0.5046	0.4616	0.4903	0.0616
sp' - gn	0.0152**	0.0001***	0.0001***	0.0001***	0.0384*	0.0269*
ss' - pm	0.3813	0.5674	0.0054**	0.0099**	0.0051**	0.0210*
pm - ba	0.0021**	0.0241*	0.0177*	0.0066**	0.0312*	0.0380*
ho pm - ba	0.3034	0.4963	0.0579	0.0146*	0.2225	0.0046**
s - n - ss	0.6222	0.9063	0.9584	0.8531	0.7700	0.1937
s - n - sm	0.6275	0.3810	0.5019	0.2634	0.0369*	0.0044**
ML - NSL	0.1576	0.0025**	0.0125*	0.0013**	0.0054**	0.0001***
NL - NSL	0.1201	0.4917	0.7535	0.7387	0.6938	0.7889
n - s - ba	0.6086	0.4566	0.7521	0.6805	0.6397	0.0336
pm - ho - ba	0.2200	0.6735	0.1434	0.6808	1.0000	0.5806
Stm <sub>s</sub> ⊥ NL	0.0750	0.0036**	0.0250*	0.0051**	0.4195	0.3681
Stm <sub>i</sub> ⊥ ML	0.0990	0.0005***	0.0475*	0.0026**	0.0265*	0.0028**
pm - t <sub>1</sub>	0.0748	0.0005***	0.0026**	0.0088**	0.1010	0.0100**
ba - t <sub>2</sub>	0.3138	0.1771	0.6620	0.7962	0.6727	0.1570
H - NL	0.1002	0.1355	0.4152	0.1204	0.0082**	0.0057**
H - pp	0.1982	0.3783	0.2118	0.1785	0.7465	0.5354
ANR <sub>1</sub>	0.0018***	0.0000***	0.0008***	0.0002***	0.0000***	0.0000***
ANR <sub>2</sub>	0.0005***	0.0001***	0.0001***	0.0000***	0.0000***	0.0000***
Airway ratio	0.0002***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***

\* :  $p < 0.05$ , \*\* :  $p < 0.01$ , \*\*\* :  $p < 0.001$

## ABSTRACT

# A comparison study of the effects of hypertrophied adenoid tissue on craniofacial morphology

**Sun-Hyung Park**

Department of Dentistry, The Graduate School, Yonsei University  
(Directed by Assistant Professor **Hyung-Seog Yu**, D.D.S.,Ph.D.)

To investigate the association between the hypertrophy of adenoid and craniofacial morphology during growth, this paper was based on children patients with experimental adenoids (male-15 subjects at each bone age group, female-15 subjects at each bone group) and comparing them to data taken from a control group (male-15 subjects at each bone age group, female-15 subjects at each bone group) with normal respiratory function. The comparisons between the groups were done at each growth stage using cervical vertebrae maturation index (CVMI) of Hassel.

The obtained results were as follows;

1. The differences in craniofacial morphology between experimental group and control group were appeared from CVMI 3 and CVMI 4 (around adolescent period) in males, and from CVMI 1 in females.
2. Hyoid bone and tongue were inferiorly positioned in experimental group.
3. The mandibular position of experimental group was more inferior than control group. The difference appeared from adolescent period (male : from CVMI 4, female : from CVMI 5).
4. Experimental group seemed greater anterior facial height than control group. This difference seemed a relation with lower anterior facial height. The difference appears from CVMI 3 ( $11.94 \pm 1.38$  years old, at adolescent period) in male and from CVMI 1 in female.
5. In lower lip position, the difference was seen after CVMI 2 (just before adolescent) in both gender.

6. Adenoid size of control male group increased until CVMI 2( $10.58 \pm 1.07$  years old, just before adolescent growth peak) and then decreased, but in female adenoid size decreased from CVMI 1( $6.92 \pm 0.53$  years old).

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Key words : Adenoids, CVMI(Cervical Vertebrae Maturation Index),  
Craniofacial morphology