THE RELATIONSHIP OF CERVICAL VERTEBRAL MATURATION (CVM) STAGE AND ANTEROPOSTERIOR FACIAL DIMENSIONS IN INDONESIAN POPULATION

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Mahindra Awwaludin Romdlon, Setiadi W. Logamarta, Yulia Anggraeni
Dental Medicine Science, Medical Faculty, Jenderal Soedirman University,
Purwokerto, Indonesia

Correspondence: mahindra.ar@unsoed.ac.id

ABSTRACT

Background: Growth and development are two different but interrelated and difficult to separate factors. The growth spurt in boys is different from girls. Facial growth is closely related to overall body growth, one of which is the growth of the cervical vertebrae.

Objective: The objective of this study was to determine the anteroposterior dimensions of the face based on the maturation levels of cervical vertebrae in 12-14 years old children.

Method: Quantitative research using an analytic observational method with a cross-sectional approach was conducted on 21 boys and 21 girls. Measurement of anteroposterior facial length (S-A' and PTM-A) and assessment of cervical vertebral bone maturation level using the Hassel and Farman method.

Results: Independent t-test results showed that there was a significant difference ($p < 0.05$) in facial length (S-A') between male and female subjects at all maturation levels of cervical vertebrae. There was a significant difference ($p < 0.05$) in facial length (S-A') based on the maturation level of the cervical vertebrae (CVMS) in male subjects. Independent t-test results showed that there was a significant difference in facial length (PTM-A) based on the maturation level of cervical vertebrae in female subjects ($p < 0.05$).

Conclusion: There was a difference in facial length (S-A') between male and female subjects at all maturation levels of the cervical vertebrae. There is a difference in facial length (S-A') based on the maturation level of the cervical vertebrae (CVMS) in male subjects. There are differences in anteroposterior facial length (PTM-A) based on the maturation level of the cervical vertebrae in female subjects. There is a relationship between the maturation level of the cervical vertebrae with the anteroposterior dimensions of the face S-A' and PTM-A in male subjects.

Keywords: Cervical Vertebrae, Growth and Development, Anteroposterior Dimension, Hassel and Farman Method, Cephalometry

INTRODUCTION

Growth and development are continuous processes that starts in the womb to adulthood which is influenced by genetic and environmental factors. The growth spurt in boys is different from girls. Women experience a growth spurt earlier than men. Puberty in girls are 2 years earlier than boys.^{1,2} Dentocraniofacial is a unitary soft tissue component with the hard tissue that makes up the facial cranium and cranium as well as the teeth and mouth tissue. Dentocraniofacial growth takes place in three directions, namely anteroposterior, vertical, and lateral. The three growth directions differ both in function, potential, speed, and acceleration in growth. The components forming the anteroposterior dimension of the face are the growth of the maxilla and mandible and the development of the alveolar process.³ Assessment of facial anteroposterior dimensions was measured through cephalometric points linearly, namely at points S-A' and PTM-A. These points are the points that are quite effective in measuring the maxillary length.⁴

Facial growth is closely related to overall body growth. The facial growth rate reaches its peak at birth. The rate of facial growth will decline sharply and reach a minimum in prepubertal. The growth rate then increases to reach a peak at puberty, decreases again, and slows down until growth stops at the end of adolescence. The facial growth rate follows roughly the same pattern as the body's growth rate.⁵ Cephalometric features show that the facial growth rate is not constant during the growth period. Somatic, sexual, skeletal, and dental maturation are several indicators to evaluate the facial growth of an individual. Knowledge of growth and

development and the ability to determine when the right time is for treatment are one of the important factors in the success of dental care in a child.⁶

The shape of the cervical vertebrae is closely related to skeletal maturation. Several studies have shown that cervical vertebrae can be a way of assessing skeletal maturation. Cervical Vertebral Maturation Indicators (CVMI) is one of the indicators used in a radiographic analysis to determine the maturation of the cervical vertebrae through the curvature of the lower edge of the body, the height of the corpus, and the shape of the cervical vertebrae. Previous studies suggest that the shape of the head in craniofacial morphology is related to the cervical vertebrae. Subjects with a dolichocephaly head often have long, straight cervical vertebrae. Subjects with a brachycephalic head shape have curved cervical vertebrae.⁷ Based on this; researchers are interested in researching the anteroposterior dimensions of the face based on the maturation level of the cervical vertebrae.

METHODS

This research was an analytic observational study. The study of differences in facial anteroposterior dimensions of boys and girls aged 12-14 years based on the maturation level of the cervical vertebrae was conducted at RSGM UNSOED Purwokerto with 21 boys and 21 girls as the study subjects. Facial anteroposterior dimensions (S-A' and PTM-A) was measured and maturation level of cervical vertebrae assessed in each research subject.

Based on the resulting radiograph, the shape of the 2nd, 3rd, and 4th of the vertebrae was traced afterward. Tracing the anteroposterior dimensions of the

face was conducted by the points S, PTM, and A'. Points S and A' were connected linearly to form a line between S-A', by determining point S first, because point S is a stable point, then determining point A' to be projected perpendicular to the S-N line to get point A'. Subsequently measurements were taken linearly at point S-A' and PTM-A and then recorded. Data analysis utilized statistical package for social science (SPSS) version 17. The normality test was performed first using the Shapiro Wilk test ($n < 50$) and the homogeneity test with Levene's test. The data were normally distributed and homogenous, then an independent t-test was performed to compare data of boys and girls. Pearson Correlation Test was used to determine the relationship between the maturation level of the cervical vertebrae with the anteroposterior dimensions of the face in boys and girls. One way ANOVA test was used to determine the difference in the length of the face S-A' between cervical vertebrae maturation levels (CVMS) in male and female subjects

RESULTS

Each research subject was measured in anteroposterior dimensions of the face, namely the length of S-A' and PTM-A, then an independent t-test was carried out to

determine the level of significance of the difference in the mean size of S-A' and PTM-A between male and female subjects. The mean and standard deviation of S-A' anteroposterior facial length based on cervical vertebral bone maturation level (CVMS), as well as a summary of the results of the independent t-test between male and female subjects are presented in Table 1. It can be seen from Table 1 that the increase in the maturation stage of the cervical vertebrae in male subjects was followed by an increase in the length of the face S-A'. The size of S-A' anteroposterior face length in female subjects was greater than that of men, except at the maturation stage 5, the anteroposterior face length of S-A' in male subjects had a greater value than that of women. Independent t-test results showed that there was a significant difference ($p < 0.05$) in S-A' face length between male and female subjects at all maturation levels of cervical vertebrae.

The results of the One Way Anova test in Table 2 show that there is a significant difference in the anteroposterior face length of S-A' based on the maturation level of the cervical vertebrae in male subjects ($p < 0.05$). Post Hoc LSD test was carried out to determine the significance of the inter-maturation levels of cervical vertebrae in male subjects and the results are presented in Table 3.

Table 1. Mean and Standard Deviation of S-A' Facial Anteroposterior Dimensions based on the Maturation Level of the Cervical Vertebrae and Summary of Independent t-test in Male and Female Subjects

Length of face	CVMS	Males		Females		t	p
		n	Mean $\pm$ SD	n	Mean $\pm$ SD		
S-A'	2	3	54.167 $\pm$ 1.102	0	00,00	-2.073	0.045
	3	3	59.067 $\pm$ 4.496	3	61.833 $\pm$ 5.054		
	4	6	60.4833 $\pm$ 3.129	3	67.200 $\pm$ 0.721		
	5	9	63.0667 $\pm$ 2.193	12	62.683 $\pm$ 3.688		
	6	0	00,00	3	61.067 $\pm$ 3.100		

Table 2. One Way Anova Test Results in S-A' Facial Anteroposterior Dimensions Between Maturation Levels of Cervical Vertebrae in Male and Female Subjects

	Males		Females	
	F	P	F	P
S-A'	8.081	0.001	1.780	0.189

Table 3. Post Hoc LSD Test Results Maturation Level of Cervical Vertebrae S-A' Facial Anteroposterior Dimensions in Male and Female Subjects

CVMS	2	3	4	5
2	-	0.045 *	0.005 **	0.000 **
3		-	0.479	0.045 *
4			-	0.095
5				-

Table 3 shows that there is a significant difference ($p < 0.05$) in male subjects between CVMS 2 and CVMS 3, CVMS 2 with CVMS 4, CVMS 2 with CVMS 5, and between CVMS 3 and CVMS 5. The mean and standard deviation of the facial length of PTM-A based on the cervical vertebrae maturation level (CVMS), as well as a summary of the results of the independent t-test between male and female subjects are presented in Table 4. Table 4 shows that the increase in the maturation stage of the cervical vertebrae in male subjects is followed by an increase in the length of the face PTM-A. The size of the anteroposterior face length of PTM-A in female subjects was greater than that of males, except at the maturation stage of 5, the anteroposterior face length of PTM-A male subjects had a greater value than that of females. Independent t-test results showed no significant

difference ($p > 0.05$) between male and female subjects at all maturation levels of cervical vertebrae.

The results of the One Way Anova determining the difference in the length of the PTM-A face between the maturation levels of the cervical vertebrae in male and female subjects are shown in Table 5. It shows that there is a significant difference in the anteroposterior face length of PTM-A based on the maturation level of the cervical vertebrae in female subjects ($p < 0.05$). Post Hoc LSD test was carried out to determine the significance of the difference in the anteroposterior face length of PTM-A between maturation levels. cervical vertebrae in female subjects. The results are presented in Table 6. It shows that there is a significant difference ($p < 0.05$) in female subjects between CVMS 3 and CVMS 4, CVMS 4 and CVMS 5, and between CVMS 4 and CVMS 6.

Table 4. Mean and Standard Deviation of the facial length of PTM-A based on the Cervical Vertebrae Maturation Rate (CVMS), as well as a summary of the independent t-test on male and female subjects

Length of face	CVMS	N	Males Mean $\pm$ SD	n	Females Mean $\pm$ SD	t	p
PTM-A	2	3	44.667 $\pm$ 0.833	0	00,00	0.569	0.572
	3	3	45.367 $\pm$ 3.232	3	46.017 $\pm$ 2.704		
	4	6	46.025 $\pm$ 3.280	3	50.417 $\pm$ 1.037		
	5	9	48.844 $\pm$ 3.249	12	45.783 $\pm$ 1.457		
	6	0	00,00	3	45.567 $\pm$ 1.419		

Table 5. One Way Anova Test Results of PTM-A Facial Anteroposterior Dimensions Between Maturation Levels of the Cervical Vertebrae of Male and Female Subjects

	Males		Females	
	F	P	F	P
PTM-A	2.139	0.133	7.118	0.003

Table 6. Post Hoc LSD Test Results Maturation Levels of Cervical Vertebrae, Anteroposterior Dimensions of PTM-A Face in Male and Female Subjects

CVMS	3	4	5	6
3	-	0.004 **	0.825	0.737
4		-	0.000 **	0.002 **
5			-	0.837
6				-

Table 7. Pearson Test Results Cervical Vertebrae Maturation Rate with Facial Anteroposterior Dimensions in Male and Female Subjects

	Males		Females	
	r	P	r	P
CVMS with S-A'	0.751	0.000	-0.168	0.467
CVMS with PTM-A	0.487	0.025	-0.297	0.191

The results of the Pearson Correlation test for the maturation level of cervical vertebrae with facial anteroposterior dimensions in male and female subjects are shown in Table 7. There is a relationship between the maturation level of the cervical vertebrae with the anteroposterior dimensions of the face S-A' and PTM-A in male subjects ($p < 0.05$).

DISCUSSION

This study was conducted on boys and girls aged 12-14 years. Research on the cervical spine maturation level was carried out on all subjects using the Hassel and Farman method. The measurement of facial anteroposterior dimensions was carried out on cephalometric radiographs including facial length S-A' and PTM-A. Facial development generally follows the growth rate of other parts of the body, namely height growth and bone maturation.⁵ Hassel and Farman found skeletal growth and velocity based on the maturation level of the cervical vertebrae could be determined from the anatomical changes in C2, C3, and C4.⁸

The results of the cervical spine maturation level in this study showed that there was maturation of cervical vertebrae 3 to 5 in male and female subjects at the age of 12-14 years. The maturation of the cervical vertebrae 2 was only in male subjects while maturation of cervical vertebrae 6 was only found in female subjects. This finding is in line with that of Richard et al. who reported that women experience a growth spurt earlier than men. Puberty in girls is 2 years earlier than boys. Girls experience puberty at the age of 10-12 years, while boys do at age 13-14 years.² This study found that the maturation level of the 6th cervical vertebrae was only found in female subjects. This is in line with the finding of Javangula et al. that female subjects experience an acceleration earlier than men.⁹

The results of this study indicate that the maturation of the 4th cervical vertebra occurs in both boys and girls. Cervical vertebrae 4 maturation was found higher in boys than in girls. These results are consistent with the study by Carruitero in which maturation of the

cervical vertebrae 4 was found more in male than female subjects. This indicates that the growth acceleration of boys is slower than girls.¹⁰ CVMS 4 is a deceleration stage. At this stage there is a growth slowdown phase where growth is slowing down and 10% to 25% of the growth process is still expected. Peak bone growth that occurs at the interval between CVMS 3 and CVMS 4 affects the greatest increase in height and craniofacial measurements.¹¹

Male and female subjects in this study showed maturation of the cervical vertebrae 5. CVMS 5 is a maturation stage where at this stage the final vertebral maturation occurs and 5% to 10% of the growth process is still expected.¹¹ The number of girls with cervical vertebrae maturation of 5 more than boys. This result is aligned with the study of Martins et al. where the maturation of the 5 cervical vertebrae was more common in female than male subjects.¹² This states that the growth rate of girls is faster than boys, where the puberty period in girls is 2 years earlier than boys, namely 10-12 years old. The growth spurt in girls begins at around the age of 8 years compared to boys, while the growth spurt in boys starts around the age of 10 years. Growth in girls stop earlier than in boys. The nature of growth during a growth spurt is the rate of growth over a certain period, a few years later it drops rapidly until it reaches normal growth. Boys will outgrow girls after experiencing an active growth center due to differences in the duration and strength of growth.²

The results of statistical tests showed that there was a significant difference in the size of facial anteroposterior dimensions (S-A') between male and female subjects at all maturation levels of cervical vertebrae (Table 1). This can be due to the difference in the peak time of the growth spurt between male and

female subjects.² The length of the anteroposterior face was related to the growth of the maxilla, mandible, and tooth eruption. The growth of the maxilla with the processus palatinus and the processus alveolaris is caused by the growth of the upper teeth. The eruption of these teeth will cause the alveolar process to increase in length. The process of increasing the length of the alveolar process causes an increase in the length of the anteroposterior face.¹¹ The facial growth rate in boys over two years experienced an increase in growth of <0.75mm / year in maxillary length, anterior face height, and cranial base.¹³ Lorenzo *et al.* state that the growth acceleration occurs between CVMS 2 and CVMS 3, while the peak bone growth occurs at the interval between the maturation levels of CVMS 3 and CVMS 4 so that the bones that make up the face and other parts of the head will increase with increasing chronological age and each will reach maximum size at a certain age.¹¹ The range of maturation stages between CVMS 2 and CVMS 5 is quite large, causing a significant difference in the length of S-A'.

The length of the anteroposterior face (PTM-A) in girls (Table 6) between CVMS 3 and CVMS 4, CVMS 4 and CVMS 5, and between CVMS 4 and CVMS 6 shows that there is a peak bone growth occurring at the interval between the maturation levels of CVMS 3 and CVMS 4, so that the bones that compose the face and other parts of the head will increase with chronological age and will each reach their maximum size at a certain age. Variations in the speed and acceleration of growth in each cause differences in reaching the peak of one's growth.¹¹ The maturation rate of cervical vertebrae with the anteroposterior dimensions of the face S-A' and PTM-A in boys (Table 7) indicates a relationship. The greater

the maturation of the cervical vertebrae, the greater the length of the anteroposterior dimensions of the face. Lorenzo et al state that the growth in the length of the face and also the bones forming the face and other parts of the head will increase with increasing chronological age and each will reach its maximum size at a certain age.¹¹ Ellyeus et al. (2011) stated that facial craniofacial growth has a positive relationship with the maturation level of the cervical vertebrae in boys.¹⁴ The facial growth rate in males over two years f <0.75mm increase per year in maxillary length, anterior facial height and cranial base (S-N).¹³

Genetic factors have an important role in the result of the growth and development processes. Various normal and pathological include genetic factors, gender, and ethnicity. Good genetic potential can interact with the environment positively to obtain optimal results. The environment is a factor that determines whether genetic potential is achieved. A suitable environment will enable the achievement of genetic potential, while an unsuitable environment will inhibit genetic potential. Environmental factors are divided into environmental factors that affect the child while still in the womb (prenatal) and environmental factors that affect the development of children after birth (postnatal). Prenatal environmental factors affect fetal growth and development from conception to birth, including maternal nutrition during pregnancy, mechanics, toxins, endocrine, radiation, infection, stress, immunity, and embryonic anorexia. The postnatal environment that affects the development of children is generally classified into the biological environment and the physical environment. Biological environments that influence child development include race, gender,

age, nutrition, health care (exercise), metabolic function, and hormones. Physical factors that influence growth and development include the geographical conditions of an area, sanitation, and the condition of the house.¹

CONCLUSION

There is a difference in facial length (S-A') between male and female subjects at all maturation levels of the cervical vertebrae. There is a difference in facial length (S-A') based on the maturation level of the cervical vertebrae (CVMS) in male subjects. There are differences in anteroposterior facial length (PTM-A) based on the maturation level of the cervical vertebrae in female subjects. Based on these findings, it can be concluded that there is a relationship between the maturation level of the cervical vertebrae with the anteroposterior dimensions of the face S-A' and PTM-A.

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