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ORIGINAL ARTICLE

Correlation Craniofacial Growth, Body Height and Cervical Vertebrae Maturation Stages

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ABSTRACT

Growth and development period has benefit for treating patient who need orthodontic treatment. In this period craniofacial development can be modified. Indicators that can be used to assess the growth and development among others are through body height and cervical vertebrae maturity stages (CVMS). Several previous studies have indicated that craniofacial growth is similar to body growth and there is gender difference between boys and girls. **Objectives:** Identifying correlation between craniofacial growth, body height and CVMS between gender in Deutero-Malay group aged 10-17 years old. **Methods**: A cross sectional study was conducted with samples of 158 subjects (72 males and 86 females). Craniofacial growth assessed in five dimensions (N-Me, S-Go, S-NA, PNS-A, Go-Pog), CVMS as described by Baccetti's method, body height was measured. **Results**: Pearson and Spearman's correlation coefficient revealed body height has stronger relationship with CVMS than craniofacial growth (r=0.838; p<0.05) (r=0.647; p<0.05). Correlation coefficient craniofacial height (Na-Me, S-Go) and mandibula length (Go-Pog) have stronger relationship with CVMS (r= 0.458; r=0.465; r=0.545; respectively p<0.05) than the length of craniofacial (S-N, PNS-A) in boys and girls group (r=0.283; r=0.237; p<0.05). T-test revealed difference in body height (p<0.05) and craniofacial growth between boys and girls in group age 13-15 years old (p<0.05). Mann-Whitney test revealed differences in CVMS between males and females in age 10-17 years old (p<0.05). **Conclusions**: Body height, craniofacial height and mandibular length were correlated with CVMS.

ABSTRAK

Hubungan pertumbuhan kraniofasial, tinggi badan, dan tahapan maturasi tulang servikal. Periode tumbuh kembang bermanfaat untuk mengobati pasien yang memerlukan perawatan orthodontik. Dalam periode pertumbuhan kraniofasial dapat dimodifikasi. Indikator yang dapat digunakan untuk menilai tumbuh kembang antara lain adalah tinggi tubuh dan tahap perkembangan vertebra servikalis (CVMS). Beberapa studi sebelumnya telah menunjukkan bahwa pertumbuhan kraniofasial mirip dengan pertumbuhan badan dan ada perbedaan antara anak laki-laki dan perempuan. **Tujuan:** Mengidentifikasi korelasi antara pertumbuhan kraniofasial, tinggi tubuh dan CVMS pada anak laki-laki dan perempuan dalam kelompok *Deutero-Malay* berusia 10-17 tahun. **Metode:** Studi potong lintang dilakukan dengan sampel 158 subjek (72 lelaki dan 86 perempuan). Pertumbuhan kraniofasial dinilai dalam lima dimensi (N-Me, S-Go, S-NA, PNS-A, Go-Pog), CVMS dijelaskan oleh metode Baccetti, selanjutnya dilakukan pengukuran tinggi tubuh. **Hasil:** Koefisien korelasi Pearson dan Spearman menunjukkan tinggi tubuh memiliki hubungan yang lebih kuat dengan CVMS daripada dengan pertumbuhan kraniofasial pada kelompok anak laki-laki dan perempuan (r=0,838; p<0,05) (r=0,647; p<0,05). Koefisien korelasi kraniofasial tinggi (Na-Me, S-Go) dan panjang mandibula (Go-Pog) memiliki hubungan yang kuat dengan CVMS (r=0,458; r=0,465; r=0,545; p<0,05) dibandingkan dengan panjang kraniofasial (S-N, PNS-A) pada kelompok anak laki-laki dan perempuan (r=0,283; r=0,237; p<0,05). *T-test* mengungkapkan perbedaan ketinggian tubuh (p<0,005) dan pertumbuhan kraniofasial antara anak laki-laki dan perempuan pada kelompok usia 13-15 tahun (p<0,05). Tes *Mann-Whitney* mengungkap perbedaan CVMS antara anak laki-laki dan perempuan pada kelompok usia 10-17 tahun (p<0,05). **Simpulan**: Tinggi tubuh, tinggi kraniofasial, dan panjang mandibula berhubungan dengan CVMS.

Key words: body height, cervical vertebrae, craniofacial, Deutero-Malay

INTRODUCTION

Growth period has benefits for early orthodontic treatment. Clinical modificationof the growth of the bones comprising craniofacial complex is of major interest to orthodontists. Therefore, somatic growth should be well understood. The most reliable somatic growth measurement is body height.[1] Growth in height depends on endochondral bone growth at the epiphyseal plates of the long bones and the impact of the sex hormone on endochondral bone growth is two fold. First, the sex hormones stimulate the cartilage to grow faster and this produces the adolescent growth spurt. Moreover, sex hormones also stimulate an increase in skeletal maturation rate, such as cartilage to bone tranformation. The acceleration in maturation is even greater than the acceleration in growth. Thus during the rapid growth at adolescence, the cartilage is generated faster than it is replaced. Towards the end of adolescence, the last cartilage is transformed into bone, and the epiphyseal plates close, marking the end of growth. Therefore, there is a correlation between body height and puberty period.[2]

Adolescence is a sexual phenomenon, the period of life when sexual maturity is attained. This period is particularly important in dental and orthodontic treatment, because the physical change at adolescence significantly affect the face, body height and dentition. There is an acceleration in the overall rate of facial growth and body height. Puberty and adolescent growth spurt occur on the average nearly two years earlier in females than in males, it is called sexual dimorphism. Physical growth status also varies from chronological age in many children but does correlate well with skeletal age, which is determined by the relative level of maturation of the skeletal system. In planning orthodontic treatment, it is important to understand how much skeletal growth remains, therefore the evaluation of skeletal age is frequently needed.[3]

Recently, a similar assessment of skeletal age based on cervical vertebrae maturation stage (CVMS), as seen in a cephalometric radiographs, has been developed. The characteristics on which vertebral aging is based on morphology the second, third and fourth cervical vertebrae. Since cephalometric radiographs are obtained routinely for orthodontic patients, additional radiograph is not required. The assessment of skeletal age from vertebral development seem to be accurate as with hand-wrist radiographs. CVMS has correlation with hand and wrist maturation, which can inform developmental status of an individual.[4-7] This assessment is clinically useful for planning orthodontic treatment. If treatment is delayed for too long, the opportunity to utilize the growth spurt will be missed. Craniofacial bones grow in width, length and height. The growth in length and height continues throughout. In both sexes, growth in vertical height of the face continues longer than growth in length.[2] Considerable research on craniofacial growth in relation to the pubertal growth spurt in untreated persons and treated patients clearly indicates significancy of this period for orthodontic-orthopedic treatment.[8-10]

Several research had found many similarities between craniofacial growth spurt and body height spurts. Craniofacial growth is at peak after body height peak.[11] Peak craniofacial growth is nine month after body height peak.[12] Craniofacial growth peak and body height peak in males at 12 years but in females at 11 and 12 years, respectively.[13] The essential question is concerning the correlation between craniofacial growth, body height and CVMS in Deutero-Malay group aged 10-17 years. Secondly, it is concerning the difference in craniofacial growth, body height and CVMS between males and females in Deutero-Malay group aged 10-17 years. Modification of facial growth that should be addressed from clinical perspectives are how feasible, effective and predictable are specific treatment approaches with respect to modification of craniofacial growth. Previous studies have demonstrated the significant correlation between craniofacial growth and body height and correlation between craniofacial growth and CVMS in Caucasoid group. However, there was limited information about correlation between craniofacial growth, body height and CVMS in Deutero-Malay children.

The objectives of this research were to confirm the correlation between craniofacial growth, body height and cervical vertebrae maturation stages in Deutero-Malay group aged 10-17 year, and to determine whether there is significant difference between males and females from Deutero-Malay group aged 10-17 years in craniofacial growth, body height and CVMS. This study would add knowledge regarding the use of CVMS, body height to utilize the craniofacial growth spurt and to identify whether these method are appreciable for orthodontic diagnosis and treatment planning.

METHODS

This was an observational research with a cross sectional design, done on 158 Deutero-Malay subjects aged 10-17 years (72 males and 86 females). The children were selected by multistage random sampling from public elementary, junior high and senior high school at Tanjung Priok and Kelapa Gading, North Jakarta, who were divided into six age groups. The inclusion criteria were as follows: (1) the radiographs were taken in circumpubertal period at age 10-17 years for males and females; (2) Deutero-Malay children age 10-17 years selected well proportioned in height and weight between range 11.3-13.2 according to Roehrer's index; (3) the bones appeared clearly and were unaffected by systemic disease; (4) the inferior border of the first 4 vertebrae were clear; (5) no previous orthodontic treatment; (6) willing to follow the research procedure by signing the informed consent. Craniofacial growth assessed in five dimensions (N-Me, S-Go, S-NA, PNS-A, Go-Pog) (Figure 1). Cervical vertebrae maturity stages described by Baccetti's method (Figure 2). Body height was measured by microtoist at 8-10 am to avoid compression intervetebrae discus.

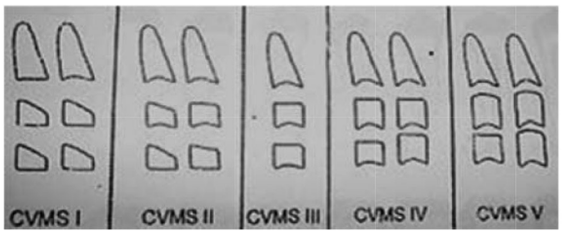

Figure 1. Craniofacial growth assessed in five dimensions (N-Me, S-Go, S-NA, PNS-A, Go-Pog)

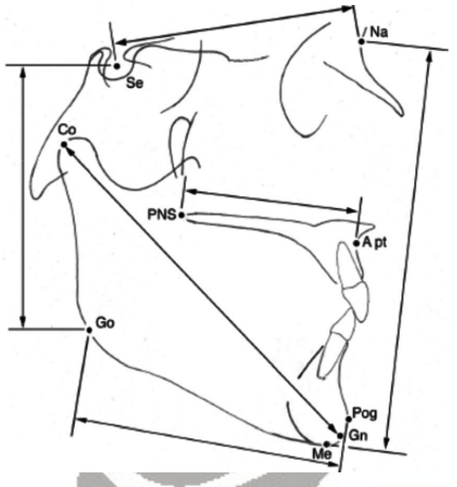

Figure 2. Cervical vertebrae maturity stages described by Baccetti's method

Table 1. Summary of Pearson correlation coefficient test between craniofacial and body height in males and females

Age	Varible	Males		Females	
		CVMS		CVMS	
		r	*p*	*r*	*p*
10-17 years n=72	Body height	0.458	*0.000	0.647	*0.000
	Na-Me	0.465	*0.000	0.607	*0.000
	S-Go	0.283	*0.000	0.596	*0.000
	S-N	0.237	*0.000	0.456	*0.000
	PNS-A	0.545	*0.000	0.309	*0.000
	Go-Pog	0.611	*0.000	0.680	*0.000

*significant different (p<0.05)

Table 2. Summary of Mann-Whitney test between body height and craniofacial between males and females

Age	Median CVMS		*p*
	Female	Male	
10-12 years n=60	3(2.3)	2(1.3)	*0.000
13-15 years n=51	4(3.5)	3(2.3)	*0.000
16-17 years n=47	5(5.5)	4(4.5)	*0.000

*significant difference (p<0.05)

Table 3. Summary of t-test between body height and craniofacial between males and females group

Variable	10-12 years (n=60)			13-15 years (n = 51)			16-17 years (n=47)		
	Mean		*p*	Mean		*p*	Mean		*p*
	F	M		F	M		F	M	
Body height	141.5	139.4	0.344	153.0	158.4	*0.008	155.5	164.8	*0.000
Na-Me	102.8	105.7	0.222	107.5	111.8	*0.016	110.3	112.0	0.212
S-Go	64.6	66.8	0.014	69.1	73.4	*0.001	73.2	77.5	*0.005
S-N	58.9	59.9	0.219	60.8	63.7	*0.007	62.6	64.5	0.057
PNS-A	29.3	31.1	0.065	32.4	34.9	*0.031	33.1	37.1	*0.005
Go-Pog	62.3	62.5	0.88	68.5	71.4	*0.011	71.4	73.1	0.186

* significant difference (p<0.05)

RESULTS

The Pearson and Spearman's correlation coefficient revealed body height has stronger relationship with CVMS than craniofacial growth in males and females group (Table 1). Correlation coefficient craniofacial height (Na-Me, S-Go) and mandibular length (Go-Pog) have stronger relationship with CVMS than the length of craniofacial (S-N, PNS-A) in males and females group (Table 1). Mann-Whitney test revealed significant difference in CVMS between boys and girls in group age 10-17 years old (p<0.05) (Table 2). T-test revealed significant difference in body height and craniofacial growth between boys and girls in group age 13-15 years old (p<0.05) (Table 3).

Craniofacial height (Na-Me, S-Go) and mandibular length (Go-Pog) have stronger relationship with CVMS

than craniofacial length (S-N, PNS-A) in both sexes. Craniofacial height (Na-Me, S-Go) and mandibular length (Go-Pog) has stronger relationship with body height than craniofacial length (S-N, PNS-A) in both sexes. Craniofacial growth was paralel with the velocity curves for growth.[16]

DISCUSSION

Correlation between body height and CVMS was stronger than correlation between craniofacial and CVMS in both sexes, but difference in correlation values. This study agreed with others that stature offers a potentially useful indicator to predict the timing of peak facial growth.[13] This study revealed the difference in body height and craniofacial growth between males and females in group age 13-15 years old. This study agree with a study that puberty age in Deutero-Malay start at age 13 for girls and at age 14 for boys.[17] There are differences between Deutero-Malay and Caucasoid studies. Mann Whitney test revealed difference in CVMS between males and females in group age 10-17 years old. This study agreed with a study that CVMS was different between males and females and ethnic group.[18] Growth in height and mandibular length was similar with cervical vertebrae maturation stages. This finding was inline with previous study stated that CVMS pararel with mandibular growth and there was a correlation between CVMS and craniomaxilla.[14,15]

CONCLUSION

The craniofacial height (Na-Me, S-Go) and mandibular length (Go-Pog) can be assessed from CVMS. The stages of development of secondary sexual characteristics provide a physiologic calendar of adolescence that correlates with individual's physical growth status, such as body height. Finally, this study concluded CVMS as a clinically useful tool for orthodontic treatment planning.

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