

Correlation of Mandible Length and Dental Calcification Stages on the Deutero-Malay Group Aged 8–16 Years

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ABSTRACT

Evaluation of individual maturity status takes an important role in selecting of the orthodontic treatment plans, especially for the growing age patient. This is mostly related to use of functional appliances and surgical approaches in some cases of skeletal discrepancy. Previous researches have demonstrated the significant correlation between the mandible length and the cervical vertebrae maturation in Deutero-Malay group. The significant correlation between the cervical vertebrae and the middle phalanx maturity, and the dental calcification within group of Deutero-Malay has been proven. **Objective:** To confirm the correlation between the mandible length and the dental calcification. **Methods:** This was an observational research with a cross sectional design, done on 160 Deutero-Malay subjects, aged 8–16 years. The length of mandible was measured from *Condylion* to *Gnathion*, and the dental calcification was evaluated by Demirjian method. **Results:** of Spearman nonparametric correlation test indicated the significant correlation between the mandible length and the canine calcification ($r=0.713$), the second premolar ($r=0.753$), and the second molar ($r=0.772$). The result of *Multiple Classification Analysis* showed that the highest correlation to the mandible length was the second molar calcification ($\beta= 0.495$).

Key words : mandible length, dental calcification, Deutero-Malay

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INTRODUCTION

Evaluation on the biological aspect of mandible growth is very important in orthodontics, especially related to functional appliance therapy to correct class II skeletal malocclusion. Clinical studies demonstrated that the greatest influence of functional appliances could be acquired when treatment was undertaken during the peak of mandible growth.^{1,2}

To know whether the peak mandible growth is still on going, or finished, is by evaluating the individual growth status. The individual growth status can be known by observing the characteristics of growth such as chronological age, morphological age through evaluation of body weight and height, dental age through evaluation of dental eruption and or dental calcification stages, skeletal maturation through observation of handwrist and or cervical vertebrae maturation stages, and sexual maturation.

Generally, positive correlation could be acquired at the majority level of skeletal maturation,² specially in relation to mandible growth. According to Widjaja,³ there was relation between cervical vertebrae maturation stages and mandible length at Deutero-Malay groups. Later, Wibisana⁴ reported the existence of relation between cervical vertebrae maturation stages and middle finger at Deutero-Malay groups. There was a relation between dental maturation stages and cervical vertebrae maturation at Deutero-Malay group.⁵ Therefore, it could be

concluded that indirectly, there was a relation between mandible length and dental calcification maturation. However, according to Demirjian,⁶ dental maturation had no significant relation to handwrist skeletal maturation, somatic sizes, and sexual maturation. Also O³ Reilly and Yanniello⁷ and Mappes⁸ indicated that dental maturation was not reliable predictor in the evaluation of individual skeletal maturation. Chance⁹ also reported that dental mineralization stages had less significant relation to craniofacial growth. Otherwise Krailassiri¹⁰ and Uysal¹¹ indicated that there was a relation between dental calcification stages and handwrist maturation.

The aim of this research was to investigate whether there was a relation between mandible length and dental calcification stages at Deutero-Malay aged 8 to 16 years old.

MATERIALS AND METHODS

In the study, it was collected 160 subjects, 80 male and 80 female, originating from 4 public elementary schools, one public junior high school, and one senior high school, in the district of Duren Sawit, East Jakarta. Rontgent photographs were taken from May 7th to December 4th 2008. Dental calcification stages found in these subjects, in about 8 to 16 years old, consisted stage D until stage H. Subjects of the study were classified into 8 age groups, namely group 1 (8-9 years old) 20 children, group 2 (9-10 years old) 20 children, group 3 (10-11 years old) 21 children, group 4 (11-12

years old) 19 children, group 5 (12-13 years old) 20 children, group 6 (13-14 years old) 20 children, group 7 (14-15 years old) 20 children, and group 8 (15-16 years old) 20 children.

This was an observational research with cross sectional design. Population of the research consisted of school children, male and female aged 8 to 16 years old in the district of Duren Sawit, East Jakarta. Subject of the research should fulfill the criteria such as: (1) originated from second level Deutero-Malay group; (2) having proportional body weight and height based on Roehrer index,¹² surrounding 11.3 – 13.2; (3) class I Angle of permanent first molar relation; (4) normal anterior relation (normal overjet and overbite). And the exclusive criteria for samples were: (1) had or having orthodontic treatment; (2) unavailable permanent first molar; (3) lost of permanent canine, second premolar and second molar at the below quadrant left and right; and (4) caries exceeding half teeth at permanent canine, second premolar, and second molar at the left and right quadrants. Subjects fulfilling the inclusive criteria should understand and fill the volunteer/subject participation forms.

Research variables were:

Mandible length sized in the antero posterior direction from *Condylion* to *Gnathion* (Co-Gn), in millimeter, up to 2 decimal digits.

Dental calcification stages, its evaluation using Demirjian method. The observed teeth were permanent canine, second premolar, lower left second molar. Dental mineralization stages

according to Demirjian were calcification process of permanent dental germ starting from dental germ without calcification until the end of dental root formation (Figure 1) namely:

Stage A: Calcification of single occlusal points without fusion of different calcification.

Stage B: Fusion of mineralization points; the contour of the occlusal surface is recognized.

Stage C: Calcification of crown is complete; beginning of dentin deposits.

Stage D: Crown formation is complete up to the cemento-enamel junction.

Stage E: Root length shorter than crown height

Stage F: Root length longer than crown height

Stage G: Root formation finished, but apical foramen still open

Stage H: Apical foramen is closed



Figure 1. Permanent calcification stages of teeth according to Demirjian⁶ cit. Rakosi¹⁹
Upper : Developmental stages of a single-rooted tooth
Lower : Developmental stages of a multi-rooted tooth

METHOD

At the adopted school, samples were chosen based on inclusive criteria, then measured the height and body weight, and the chosen subjects should have Roehrer value index between 11.3 to 13.2. Then observation should be done on permanent canine, second

premolar, and second molar to see any loss or caries more than half teeth. Then we took panoramic radiograph and lateral cephalograph. And so we did cephalographic analysis, measurement of effective mandible length, and examination of dental calcification stages. Examination of dental calcification stages could be directly conducted on the computer screen, and the picture could be enlarged as needed for clearness. The measurement of effective mandible length was done by directly clicking on the point of Co or Gn, which then appeared number in mm with magnification factor 1.1. The measurement of effective mandible length and the examination of calcification status were done twice by the researcher. The second evaluation was done 2 weeks after the first evaluation.

RESULTS

The study was done on 160 samples consisting of 80 male and 80 female children. The total age groups from 8 to 16 years old were represented equally in this study. Number of subject in each age group followed estimate number of samples for correlation test.¹⁴ Average and standard deviation of mandible length at group 1 until 8 were 97.07±2.76 mm until 112.65±5.43 mm.

Average and standard deviation of mandible length at 8 groups showed the existence of increase (Table 2) along with chronological age. The biggest increase appeared at group 6 (13-14 years old) to group 7 (14-15 years old), i.e. increase 5,76 mm. This

showed the peak of mandible growth at about 13 – 14 years old.

Table 1. Average and standard deviation of mandible length based on age group

Group	Mandible length
	\bar{x} dan SD
1	97.07 ± 2.76 mm
2	98.04 ± 2.93 mm
3	98.43 ± 3.70 mm
4	101.83 ± 4.52 mm
5	102.50 ± 4.97 mm
6	103.69 ± 3.37 mm
7	109.45 ± 5.03 mm
8	112.65 ± 5.43 mm

Table 2. Distribution of calcification stages of canine, second premolar, and second molar at the total age group (n = 160)

Group	Canine	Premolar 2	Molar 2
1	D,E,F	D,E	D,E
2	E,F,G	D,E,F	D,E,F
3	E,F,G,H	D,E,F,G	D,E,F,G
4	F,G,H	E,F,G,H	D,E,F,G,H
5	F,G,H	F,G,H	E,F,G,H
6	G,H	F,G,H	E,F,G,H
7	H	F,H	G,H
8	H	H	G,H

- D : Crown formation is complete up to the cemento-enamel junction.
- E : Root length shorter than crown height
- F : Root length larger than crown height
- G : Root formation finished, but apical foramen still open
- H : Apical foramen is closed

Average value and standard deviation of mandible length at group 1 to 8 is presented at Table 1, increased along with chronological age. Distribution data of calcification stages of canine, second premolar, second molar, at the whole samples aged 8 – 16 years old was shown at Table 2.

nonparametric correlation test of Spearman, it was appeared the existence of significant correlation between mandible length and calcification stages of permanent canine, second premolar and second molar (see Table 3).

Table 3. Results of inter variables correlation test of Spearman (n=160)

	Mandible length	Canine	Premolar 2	Molar 2
Mandible length	1	0.713**	0.753**	0.772**
Canine	0.713**	1	0.872**	0.850**
Premolar 2	0.753**	0.872**	1	0.911**
Molar 2	0.772**	0.850**	0.911**	1

** . Correlation is significant at the 0.01 level (2-tailed).

Table 4. Results of MCA test of mandible length and indicators of permanent canine, second premolar, and second molar.

Dependent Variable	Indicator	Beta (β)
Mandible length	Canine	0.206
	Molar 2	0.447
	Premolar 2	0.237

β : an approximate measure of the relationship between a predictor and the dependent variable, while holding constant all other predictors

In this study, the strongest correlation of dental calcification stage and mandible length was analysed by *Multiple Classification Analysis*.¹³ Among the 3 teeth used as indicator against mandible length, appeared that dental calcification stages of second molar had the strongest correlation with $\beta = 0.447$, then followed by second premolar ($\beta = 0.237$), and canine ($\beta = 0.206$) (Table 4).

DISCUSSIONS

Distribution of dental calcification stages at age group on Table 3 showed variety of calcification stages. This indicated that chronological age was less representing individual growth status. For clinical application of functional appliance, the age factor as could not be taken as the only consideration in the treatment plan and the expected from the use of functional appliance.

Based on radiographic dental calcification, we found the length of dental root as long as the height of crown, that's why we considered it as stage F. The other finding was the height of second molar root shorter than the height of crown but the root canal appeared lengthened, then this manifestation was in stage E. And so on second molar, the root length had not grown maximum though apical foramen already closed, which then was considered into stage G.

Spearman correlation test demonstrated that dental calcification stages had strong relation to mandible length. This was different from investigation of Chance

(2006), which indicated that canine mineralization stages had less significant relation to craniofacial growth. The study of Chance⁹ with 106 female and 77 male subjects had inclusive criteria namely class II division I Angle which needed 4 premolar extraction. Evaluation of dental mineralization stages used dental root crown formation by Moorrees¹⁵, and so measurement used to represent mandible length were *Sella – Gnathion*, *Sella – Gonion*, and *Sella – B point*. In this research, evaluation of dental calcification stages used Demirjian method and measurement for mandible length was from point of *Condylion – Gnathion*, and inclusive criteria was class I Angle subject.

The strong correlation between mandible length and dental calcification stages, specially second molar, represented relation to the need for eruption space of second molar to posterior from mandible corpus so that the size of mandible corpus grew to posterior. Bone resorption in anterior side and bone deposition in posterior side would increase anteroposterior growth in mandible corpus. Otherwise the existence of second molar eruption vertically would balance condyle growth upside, which then would increase effective mandible length^{16,17}. This was reconfirmed by Profitt¹⁸ that level of dental eruption was parallel to level of mandible ramus growth. Therefore, it's acceptable that the puberty rate in dental eruption went together with puberty rate in mandible growth.

Orthodontic practitioners believed that orthodontic treatment which needed modification of mandible growth with functional appliances (Herbst, twin block, bionator, activator combined with high pull headgear) was proven more effective when it was done during the peak of ongoing mandible growth rather than before that. To know the peak of mandible growth in Deutero-Malay group, we should know the increase of mandible growth through longitudinal data. Cross sectional data in this research with different subjects in each group was less accurate if used to calculate increase of mandible growth. Therefore we needed further research to know about which stages of dental calcification the peak of mandible growth would be happened. By doing so we knew the most accurate time to use functional appliance for skeletal II care based on second molar calcification stages, considering its strongest relation to mandible length. It's interesting to do further investigation on Deutero-Malay group to compare Chance's finding⁹ that rate of craniofacial growth spurt was happened more often before closing of lower apex canine rather than after the closing.

There were many researches about the effective use of functional appliances based on cervical vertebrae and hand-wrist maturation stages. Research on the effective use of functional appliance based on dental calcification stages had not been done up to now, may be because of the nowadays belief

about less significant relation between craniofacial growth and dental calcification. If based on Chance's finding then the use of functional appliances would be very effective when used during second molar stage G running.

Lina⁷ investigated that dental calcification stages could predict CVMS I and CVMS IV by looking at the dominant percentage. Stage E could be used to predict CVMS I, while stage H could be used to predict CVMS IV. Consequently, CVMS II and III could not be predicted from dental calcification stages. Therefore, we needed to do further research with longitudinal data to know directly the peak of mandible growth based on dental calcification stages in Deutero-Malay group.

CONCLUSION

Based on this research about, it could be concluded that, there was a correlation between mandible length and dental calcification stages. Furthermore, calcification stage of second molar would be used as the strongest indicator of growth toward mandible length compared with second premolar and canine.

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