Correlation in mandibular length and third molar maturation based on radiography appearances

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ABSTRACT

Introduction: Growth and development is a dynamic process that is influenced by many factors, this is why children of the same age do not have the same growth rate, therefore growth can not be evaluated only by chronological age, but also by maturation skeletal and dental. Previous research has shown a strong relationship between mandibular length and Cervical Vertebral Maturation (CVM). The aim of the present study was to determine the correlation between mandibular length and mandibular third molar maturation using panoramic radiograph. **Method:** This research is an observational analytic cross sectional study. Total 412 panoramic radiographs of 207 male and 205 female aged 9-25 years were evaluated. The mandibular length measured from the point of condylion (Co) to menton (Me). M3 maturation of the mandible was evaluated by Demirjian methods. **Results: S**pearman non-parametric correlation was used for analysis. A strong correlation was found between mandibular length and third molar development (in males: r = 0.705 on the right side and 0.729 on the left side; in females: r = 0.755 on the right side and 0.707 on the left side) **Conclusion:** There is a strong correlation between mandibular length and mandibular third molar maturation in both male and female individuals.

Keywords: Age, mandibular length, third molar, tooth maturation.

p-ISSN: 1979-0201; e-ISSN: 2549-6212; Available from: http://jurnal.unpad.ac.id/pjd/editor/submission/18321
DOI: http://dx.doi.org/10.24198/pjd.vol30no2.18321
Submission: May 24, 2018; Accepted: June 29, 2018; Published online: July 31, 2018

INTRODUCTION

Growth and development is a dynamic process that includes cellular and somatic processes. Growth and development are influenced by several factors, including hereditary, ethnic, genetic, environmental, social, nutrition, sex and functional. This is why children of the same age do not have the same growth rate, therefore growth can not be evaluated only by chronological age, but also by biological age.[1,2] The sequence changes of bone and tooth are relatively consistent. During growth, every bone and tooth go through a series of changes that can be observed radiologically.[3,4]

Because of the individual variation in timing, duration and velocity of growth, skeletal

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and dental maturation assessment is essential in formulating viable orthodontic treatment plans. The maturation assessment in adulthood is more difficult, when the skeletal and dental growth almost complete. The third molar offers a unique advantage over other teeth because its development tends to continue over a longer period and until a later age.[5,6-8]

Previous research showed there is a correlation between mandible growth and skeletal maturation. According to the research conducted by Subramaniam[8] and Serafim et al[10] suggested that there was a high correlation between hand-wrist maturation and mandible growth. Mohammed et al reported there is a high correlation between cervical vertebrae maturation and mandible growth in both male and female.[8,10]

The correlation between mandibular third molar development and skeletal development was investigated in several studies. Some studies showed a strong relationship between third molar development and skeletal maturity. Suma[12] and Cho et al[13], have reported that there was a strong correlation between third molar mandibular maturation and hand-wrist maturation observed using Demirjian score.[12,13]

Mehta[14] and Felemban et al[15], also reported there was strong correlation between third molar maturation and cervical vertebra maturation. In contrast, Mittal[16] and Saglam et al[17], have reported poor relationship between third molar maturation and skeletal maturity. Demirjian et al. also reported that dental development is unrelated to the other developmental systems, such as skeletal, somatic, and sexual maturity.[18] The aim of the present study was to determine the association between mandibular length and mandibular third molar at male and female group aged 9-25 years old using panoramic radiograph.

METHODS

The samples were derived from panoramic radiograph archives of 207 male and 205 female subjects registered as patients in the oral and maxillofacial radiology department of the dental hospital at Padjadjaran University during August 2016 to August 2017. This research have had an approval from medical faculty committee ethics Padjadjaran University. The age range of the sample was from 9 to 25 years old. The selection of sample was based on the following criteria:

The inclusion criteria is good quality in panoramic radiograph and the subject mush be has mandibular third molar on the right and left side. The exclusion criteria consists of: no congenital oral or maxillofacial anomalies, panoramic radiograph with the mandible that has a pathological lesion such as a cyst or tumor; using orthodontic appliances; had third molar mandibular bucco-verse or lingo-verse impaction also panoramic radiograph with fracture mandibles or fracture third molar in mandibular.

Evaluation of mandibular third molar maturation on the panoramic radiograph was performed by studying the development of the third molars with the method adapted by Demirjian for eight different stages as follows: The first stage was the calcification of single occlusal points without fusion of calcification; the second stage was the unification of mineralised cusps to defining the mature coronal morphology; the third stage was performed when the enamel formation has been completed at the occlusal surface, and dentin formation has commenced, the pulp chamber was then curved, so no pulp horns will be visible; the fourth stage was performed when the crown formation had already completed to the dentino-enamel junction, then the pulp chamber has a trapezoidal form; the fifth stage was the formation of the inter-radicular bifurcation, and the root length will be less than the crown length; the sixth stage was performed when the root length was at least as much as the crown length, and the roots have funneled-shaped endings; the seventh stage was performed when the root walls were already in the parallel position, but the apices part remained pen; and the last stage, or the eighth stage was performed when the apical ends of the roots have completely closed.

The observer was used Ez-Implant software to evaluate mandibular third molar on the right and left side. Intraobserver study error was made with 40 panoramic radiographs were randomly chosen and were retraced by the same examiner 14 days after the first panoramic tracing.

The length of the mandible is measured from the total of high mandibular ramus, measured from the point of condyle to the point of gonion (Co-Go) and the mandibular width measured from the

gonion point to menton point (Go-Me). The length of the mandible was measured on both right and left sides. The mandibular length is measured using Ez-Implant software. Measurements were noted in millimeters, down to two decimal numbers.

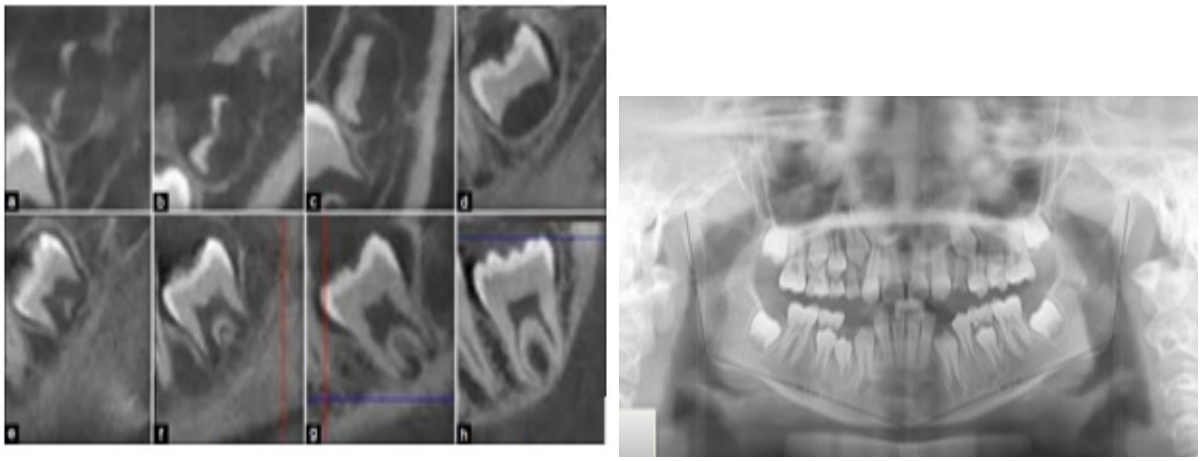
All data obtained were analyzed using the IBM® SPSS 24.0 statistical program. In order to obtain mean value and standard deviation, descriptive statistics were used. The agreement of intraobserver was assessed by weighted kappa statistics. Kappa was (0.87 ± 0.07) for determination of tooth calcification stages. The Spearman rank correlation analysis was used to assess the correlation between third

RESULTS

The study was done on 412 samples consisting 207 male and 205 female groups aged 9-25 year old. The measurement of mandibular length resulted as shown in Figure 3 and Figure 4, Average of mandibular length at age group from 9 to 25 years old showed the existence increase along with chronological age.

According to Figure 3 and Figure 4, it is shown that the mandibular length of 10-11 years old the size of the female mandible is greater than the size of the male mandible. It indicates that the mandibular growth rates in female aged 9-11 years are faster than males.

Male mandibular size was starting to increase between 11 and 12 years of age (Figure 3, Figure 4). It indicates increased mandibular growth rate in male began at 11 years old. The mandibular growth rate in male is greater than female at 11 years old and it continues until the end of puberty. The mandibular size begins to be constant in males seen in 17 years old, whereas the mandibular size in female begins to be constant at 16 years old.



A B

Figure 1. A. Radiographic presentation of the Demirjian methods; B. Radiographic presentation of mandibular length measurement

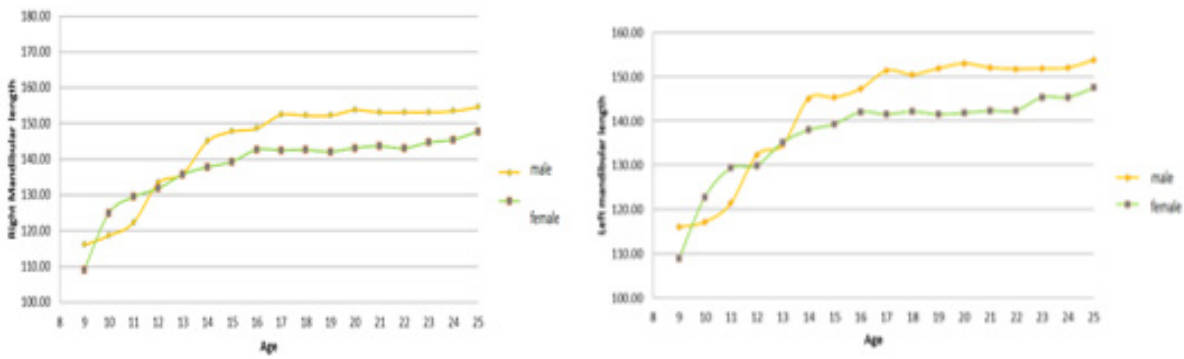


Figure 4. Graphic of the mandibular length on group aged 9-25 years old; (a) right and (b) left.

Table 1. The average age of third molar maturation

Sex	M3 maturation	Right M3		Left M3	
		Mean	SD	Mean	SD
Male	A	9	0.71	9.11	0.33
	B	10.17	1.03	9.75	1.14
	C	10.77	0.66	10.87	0.64
	D	13.30	1.30	13.17	1.34
	E	14.62	0.77	14.67	0.91
	F	17	1.47	17.22	1.54
	G	20.77	2.03	20.40	1.88
	H	22.63	1.81	22.74	1.70
Female	A	9.20	0.42	9.13	0.35
	B	10.38	0.74	10	0.53
	C	11.00	1.08	10.89	1.10
	D	13.34	1.33	13.30	1.37
	E	15.77	1.50	15.25	1.21
	F	17.35	1.30	17.53	1.31
	G	20.63	1.51	20.80	1.90
	H	23.28	1.78	23.33	1.76

Table 2. Correlation between mandibular length and third molar maturation on male group and female group

Group	Variable	Spearman RHO	p-value(sig)
Male	Right mandibular length and mandibular third molar maturation	0,705	0.000
	Left mandibular length and mandibular third molar	0.729	0.000
Female	Right mandibular length and mandibular third molar maturation	0,755	0.000
	Left mandibular length and mandibular third molar	0.707	0.000

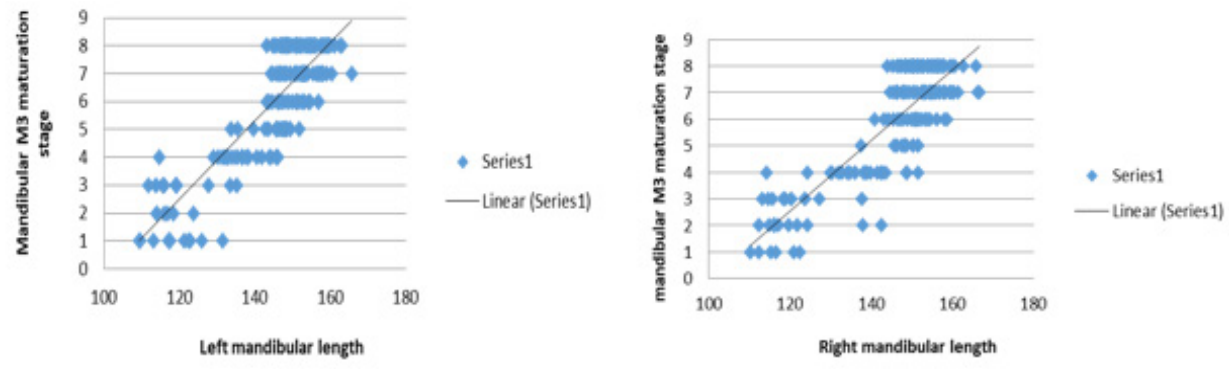


Figure 5. The graphic shows the correlation between mandibular length and mandibular M3 maturation on male group in left and right

The initial stage of mandibular third molar right-left crown formation (stage A) in both male and female occurs at 9 years old. There is a different timing of third molar root formation among male and female. The early stage root formation (stage E) in male begins at 14 years old, whereas early stage root formation in female begins at 15 years old. The male right-left mandibular third molar is perfectly formed at 22 years old, whereas the female mandibular third molar formation complete at 23 years old. It indicates that mandibular third molar maturation in male is earlier than female.

A strong correlation was found between mandibular length and mandibular third molar maturation both in male and female. It is shown in Table 2 and Table 3.

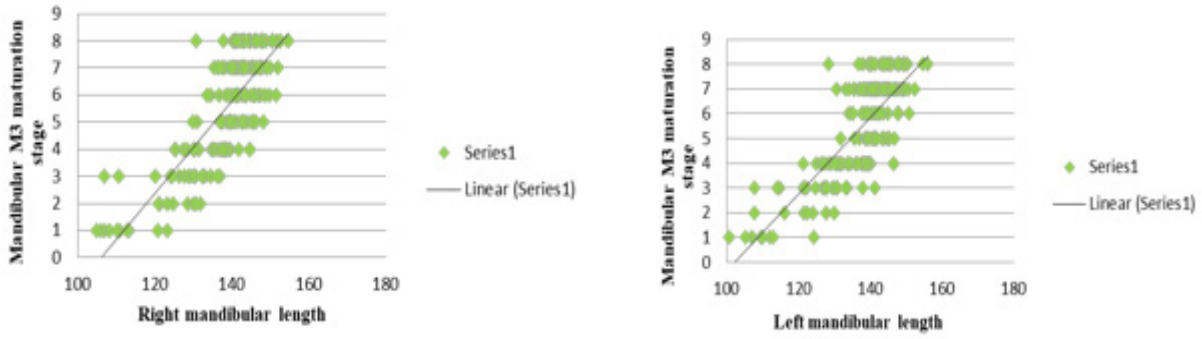


Figure 6. The graphic shows the correlation between mandibular length and mandibular M3 maturation on female group right and left

DISCUSSION

Mandibular growth has a unique characteristic of both size and speed of growth. Bone growth and biological maturation at puberty is a dynamic process that is regulated by genetic and environmental factors. Changes in skeletal maturation and bone mineral are important components in the evaluation of growth during puberty.[19,20]

The growth pattern of each individual varies, one of the factors that play an important role in influencing the growth pattern is gender. Gender will affect growth tempo, growth time, skeletal maturity and dental maturity. The difference in puberty time between men and women affects overall skeletal maturity. In general, peak growth in females is earlier than male.[21,22]

The Fig. 3 and 4 shows the relationship between age and mandibular length. The developmental mandibular length increased with age. Development acceleration was seen between ages 9 to 12 years (Fig. 3 and 4). Post puberty mandibular growth in both male and female shows a relatively constant, indicating acceleration mandibular growth slowing (Fig 3 and 4).

The Spearman correlation test performed in this study (Table 2 and 3) shows a strong correlation between mandible length and mandibular third molar maturation stage both in both male and female. The correlation between mandible length and mandibular third molar maturation stage are positive linear, the greater mandibular third molar maturation stage, the longer mandibular length (Fig. 5, Fig.6).

Based on the study result indicates that mandibular third molar mineralization can be used as growth indicator. The initial female mandibular growth peak is between 9 years old to 10 years old, while mandibular third molar maturation stage is at intervals A and B stage. The initial male mandibular growth peak is between 11 years old to 12 years old, while mandibular third molar maturation stage is at maturity stage interval B and C stage. The mandibular growth in female began to be constant at 16 years old (post pubertal), at this age mandibular third molar maturation reaching the E-F stage. Male mandibular growth started constant at 17 years old (post pubertal), at this age mandibular third molar maturation reaching the F stage.

Teeth and mandible are derived from the first pharyngeal arch, so it is possible if there is a correlation between dental developmental and mandibular growth since both of both of them derived from the same origin tissue.[23,24] Mechanistically, linear relationship between mandible length and mandibular third molar maturation shows the need for molar tooth eruption, so that the mandibular corpus grew in the posterior direction. The increase mandibular corpus length occurs due to the bone resorption on the anterior mandibular ramus and the bone deposition on the posterior mandibular corpus.[22,25]

The teeth are one of the functional matrices on the mandibular growth, its affecting the shape and size of the mandible.[26-28] Tooth follicles and stellate reticulum of the enamel organ will produce factors that regulate the formation of osteoclasts and osteoblasts during the eruption of teeth. The coronal tooth follicle cells stimulate osteoclast formation through the interaction of the receptor activator of nuclear factor kappa B (RANK) on the

surface of the cell membrane having RANK ligand (RANKL). The bone morphogenetic protein-2 (BMP-2) gene expressed in the apical half of the dental follicle, an increase of gene expression associated with the increased alveolar bone formation.[27,28]

The results of our study are similar to the research conducted by Conquerell et al[24], Ara et al[29], and Siswanto et al. Conquerell et al study's results show a strong correlation between mandibular development and dental maturation up through the full emergence of deciduous dentition, but this correlation subsides during postnatal development, about 2 years of age.[24]

In a study done by Ara et al[29] shows high correlation between developmental stages of mandibular third molar and retromolar distance. They conclude that the mineralization of mandibular third molars is an indicator of the space availability in the mandibular arch, so mineralization would represent the association between dental formation and mandibular skeletal growth.[29]

Siswanto et al.[30] conducted a study correlation between mandibular length and C, P2, and M2 maturation in 160 children aged 8-16 years of Deutero-Malay race. The results showed that there was a correlation between the maturation stage of C, P2, and M2 with mandibular length. The strongest relationship was seen in the correlation between M2 maturation and mandibular length.[30]

CONCLUSION

Based on this research, it could be concluded that, there was a correlation between mandibular length and mandibular third molar maturation in both male and female. Therefore, calcification stage of mandibular third molar could be used as the indicator of mandibular length growth.

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