

RESEARCH ARTICLE

## Differences between male and female mandibular length growth according to panoramic radiograph

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### ABSTRACT

Evaluation of the mandible was used for age and sex determination in the forensic field and it established the treatment planning in dentistry. The present study aims to determine mandibular length growth on male and female group aged 9-25 years old using panoramic radiograph. The research was conducted using analytical cross-sectional design method. The subject of this research was 412 panoramic radiographs of patients aged 9-25 years old. It involved a total samples of 207 males and 205 females. This research was conducted from May to October 2017 in RSGM Padjadjaran University Bandung to measure the length and height of mandibula from the point in condyleus to mentone. The Mann-Whitney test results showed a significant difference in mandibular length between men and women and no significant difference between the right and left mandibular length in men and women. There is a difference between male and female mandibular length growth, in which the increase of growth of mandibular length in female is earlier than that of male. Male mandibular length is greater than female.

**Keywords:** gender; growth; mandibular length; panoramic radiograph

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### INTRODUCTION

Growth and development is a process that runs parallel, and it is influenced by internal factors (e.g. heredity, race, sexual, genetic) and external factors (e.g. nutritional and functional). The mandibular growth process is a complex process including intramembranous ossification and endochondral ossification.<sup>1,2</sup> The mandible will be grown in various directions, such as vertical, horizontal, transverse, and rotational growth. The acceleration of mandibular growth is parallel with the accelerated phase of height growth. In other words, the increase and decrease in skeletal maturation has similar fluctuations with facial growth especially the mandibular growth.<sup>3,4</sup>

Evaluation of the mandible was used for age and sex determination in the forensic field and it established the treatment planning in dentistry (e.g. determination of peak mandibular growth).<sup>3,5,6</sup> The mandibular growth was a constant remodeling process. Bone apposition and bone resorption that

occur as the human gets older causes mandibular shape and size to change.<sup>7</sup> The mandible is a bone that has many morphological variations and it has the most post-natal growth, compared to other facial bones.<sup>8,9</sup>

Radiographic panoramic turned out to be used for viewing the bone growth, such as morphological changes, bone mineralization, and fusion in the center ossification. Panoramic radiographs are able to provide morphological information and bone morphometric during the growth process. Several studies have shown that panoramic radiographs also used to measure the vertical and horizontal dimensions of the mandible.<sup>8,10,11</sup> Calculating of the height of the mandibular ramus, the length of the mandibular corpus, the gonial angle, the bigonial width, and the height of the condyles, is the one technique to evaluate the growth of the mandible length. Mandibular growth also evaluated by measuring the distance of the landmark point on the mandible.<sup>8,9,10</sup> The aim of this study is to determine

mandibular length of male and female at the age of 9-25 years old using a panoramic radiograph.

## MATERIALS AND METHODS

This research used analytical cross-sectional design method and conducted from May until October 2017, at oral maxillofacial radiology department, Dental Hospital Padjadjaran University, Bandung, Indonesia. This research has been approved by the ethics committee of Medical Faculty, Padjadjaran University, Bandung (processing number: 745/UN6.C.10/PN/2017). The Panoramic X-ray has a current of 110, 230 V, 50/60 Hz, 1.3 KW of Picasso Trio type brand from Vatech, E-WOO Technology Co., Ltd. Korea.

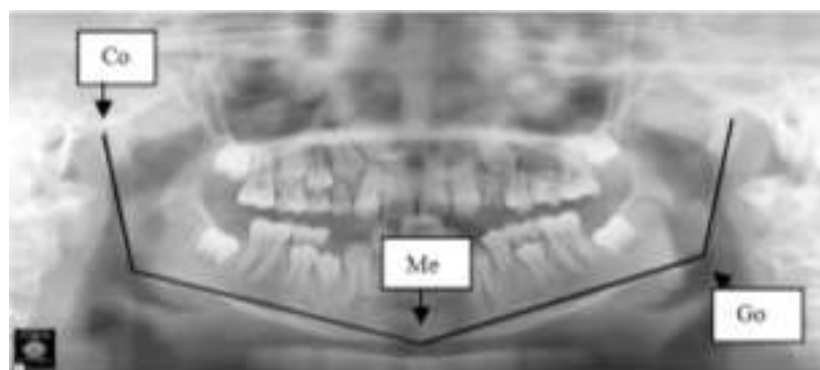
The inclusion criteria of the research objects are good quality panoramic radiographs taken in May to October 2017 of patient aged 9 to 25 years old. The exclusion criteria are mandibular panoramic radiographs showing growth abnormalities, pathological lesions, fracture, and orthodontic instruments. The samples in this study were divided into 3 groups of age groups based on Indonesian Ministry of Health 2009, i.e. age group A (9-11 years), age group B (12-16 years) and age group C (17-25 years). The mandibular length was measured with the the mandibular ramus height (measured from the condyle point to the gonion point) and the mandibular width (measured from the gonion point to the menton point), Figure 1.

This study used SPSS version of IBM version 24 for statistical data analysis. The Kolmogorov-Smirnov assumption test was used to assay the normality of data distribution of mandibular length. The Mann-Whitney U test was used to determine the differences in mandibular length between male and female. It was also used to determine the differences between right and left mandibular length for both male and female.

## RESULTS

The study used 412 panoramic radiographs consisting of 207 panoramic radiographs of male patients and 205 radiographs of female patients aged 9-25 years. The males and females mandibular length in each age group are presented in Table 1.

The result of the Kolmogorov-Smirnov normality test (Table 2) on the left-right mandibular variables in males and females showed p-value of  $<0.05$ , which means that the data are not normally distributed. Thus, the researchers used the Mann-Whitney U test, and the result of which is presented in Table 3. Mann-Whitney test results show a significant difference in mandibular length between male and female. Mann-Whitney U test was also used to evaluate the difference between the right and left mandibular length of both male and female (Table 4). The results show that there is no significant difference between right and left mandibular length of both male and female patients.



**Figure 1.** The mandibular length of both the right and left side was measured using Ez Implant software in millimeter. The Ez Softwear implant is a softwear carried by Picaso 3D x-ray machine Co (Condylion): the most superior point in the mandibular condyle; Go (Gonion): the most inferior and posterior point of the angle of the mandible; Me (Menton): the lowest point on the mandibular symphysis on the mid-sagittal line

**Table 1.** The mandibular length based on gender in 9-25 years old

Sex	Age group	Age	Right mandibular length (mm)	SD	Left mandibular length (mm)	SD	
Male	A	9	115.94	3.99	116.01	4.67	
		10	118.60	3.36	117.18	2.76	
		11	122.24	3.77	121.41	4.28	
	B	12	133.32	2.92	132.31	1.78	
		13	135.87	3.24	134.52	2.74	
		14	144.96	3.82	145.04	4.05	
		15	147.75	3.87	145.30	3.68	
		16	148.57	3.62	147.23	2.12	
		C	17	152.42	4.97	151.34	4.92
	18		152.21	4.03	150.47	4.71	
	19		152.22	5.36	151.86	4.36	
	20		153.77	5.43	152.95	5.81	
	21		153.12	4.95	152.03	4.96	
	22		153.12	4.87	151.72	4.86	
	23		153.16	5.05	151.84	4.99	
	24		153.45	4.51	152.01	4.43	
	25		154.59	3.77	153.74	4.41	
	Female	A	9	109.12	2.89	108.85	4.07
			10	124.90	3.87	122.75	4.54
			11	129.47	3.54	129.34	4.07
		B	12	131.81	3.78	129.97	4.79
			13	135.75	4.74	135.17	4.75
			14	137.85	1.47	137.94	1.95
			15	139.31	1.96	139.31	1.96
			16	142.67	3.59	141.96	3.42
C		17	142.56	5.84	141.49	5.79	
		18	142.61	3.57	142.09	4.60	
		19	142.16	4.52	141.47	4.49	
		20	143.18	3.28	141.80	3.55	
		21	143.70	3.66	142.28	3.97	
		22	143.10	4.69	142.32	4.20	
		23	144.73	4.35	145.33	3.21	
24	145.50	4.01	145.33	4.21			
25	147.84	3.38	147.47	4.51			

**Table 2.** Kosmogorov-Smirnov normality test

Variable	Sex	Statistic	Df	p-value
Right mandbular length	Male	.202	207	.000
	Female	.146	205	.000
Left mandibular length	Male	.211	207	.000
	Female	.172	205	.000

**Table 3.** Mann-Whitney test of mandibular length of male and female

Mandibular length	Sex	Mean rank	Z	p-value
Right mandibular length	Male	256.94	-8.640	.000
	Female	155.57		
Left mandibular length	Male	255.24	-8.348	.000
	Female	157.29		

**Table 4.** Mann-Whitney U test of right and left side of mandibular length based on gender

Sex	Mandibular length	Mean rank	Z	p-value
Male	Right side	215.44	-1.350	.177
	Left side	199.56		
Female	Right side	211.39	-1.006	.314
	Left side	199.51		

## DISCUSSION

Based on the the study, the increase of mandibular length for group A and B in both male and female is parallel with the increase of the age. Mandibular length growth in female increases dramatically between the ages of 9-11 years. The mandibular length of female aged 10-11 years old is greater than the male mandible. The female mandibular size increased by 109.12 mm to 124.90 mm in the right side and 108.85 mm to 122.75 mm in the left side between 9 and 10 years of age. It indicates that the mandibular growth rates in female aged 9-10 years are faster than that of the males.

The male mandibular length increased by 122.24 mm to 133.32 mm in the right side and 121.41 mm to 132.31 mm in the left side between 11 and 12 years of age. It show that the increase of mandibular growth rate in male began at 11 years old. The mandibular growth rate in male is greater than that of female at 11 years old and the growth continues until the end of puberty.

Research on different ethnicities performs that there is a variation of the mandibular growth peak time. The study by Bordini and Mellion et al<sup>12,13</sup> in the United States reports that the peak growth during puberty in female starts at 9-10 years old, whereas in male it starts at 11-12 years old. Research conducted by Jeelani et al in Pakistan highlights that the peak of skeletal growth in female occurs at the age of 11.7 years in female and 13.3 years old in male.<sup>14</sup> Research conducted in French-Canadian female reveals that the peak growth in female occurs between the ages of 11.4-12.8 years.<sup>15</sup>

Mandibular growth has unique characteristics, both in terms of size and in terms of the rate of growth. Bone growth and biological maturation at puberty is a dynamic process that is regulated by genetic and

environment factors. Skeletal maturation changes and bone mineral deposition that coincides with the period of puberty is an important component in the evaluation of growth during the period of puberty. Puberty is characterized by increasing skeletal growth acceleration, including mandibular bone.<sup>16,17</sup>

The cellular factor that affects bone growth at puberty is the proliferation and differentiation of chondrocytes. This process will slow down with age, and once proliferation of chondrocytes stops, growth will stop in adulthood. The most influential hormone in puberty bone growth is growth hormone, insulin-like growth factor, estrogen and testosterone. These hormones will increase about 1.5-3 times during puberty.<sup>16-18</sup>

The growth pattern of each individual is different, one of the factors that play an important role in influencing the growth pattern is sex factor. Sex will affect growth tempo, growth time, skeletal maturity and dental maturity. The difference in puberty timing between male and female affects skeletal maturity. Female growth peak is earlier than that of male. The pattern of female skeletal growth is rapid and brief, while the pattern of male skeletal growth is slow and long.<sup>8,19</sup>

Mandibular growth in the post pubertal age group (17-25 years) in both male and female showed a relatively constant mandibular size, indicating a decreased mandibular growth. The decrease of mandibular growth is due to decreased hormones that play an important role in bone growth, such as sex hormone steroids, growth hormone and insulin-like growth factor-1 (IGF-1).<sup>20</sup>

The results of this study are similar to those of Olayemi et al research. The results of Olayemi's study on 83 Nigerian population subjects aged 16-23 years shows that, after the age of 17, the mandibular growth had decelerated.<sup>21</sup> The research

of a craniofacial post-pubertal growth in subjects aged 16, 18, and 20 years using a cephalogram shows that the craniofacial growth from 16-18 years is greater than that of 18-20 years of age.<sup>22</sup> The average growth of mandibular in Danish male is about 3 mm at 16-17 years, and the growth declines until it reaches the state of no growth at the age between 21-22 years.<sup>23</sup>

Based on Table 1, at the age of 25 (group C), the male mandibular length was  $\pm 154.59$  mm in the right side and  $\pm 153.74$  mm in the left side, whereas female mandibular length was  $\pm 147.48$  mm in the right side and  $\pm 147.47$  mm in the left side. The Mann-Whitney U test results showed that there was a significant difference between male and female mandibular length.

The results of this study are similar to those of Generosos' et al, Marquizin et al, and Liu' et al studies.<sup>24-26</sup> Generoso et al conducted a study on 40 male and 40 female puberty ages in Brazil. It revealed that the male mandibular length was greater than that of female in various malocclusion classes.<sup>24</sup> The longitudinal studies conducted by Weber et al in a Caucasian race sample aged 16-18 years showed that the male mandibular length was longer than that of females.<sup>25</sup> The size of the mandible in female over the age of 14 years is relatively constant, whereas in male it is still increasing.<sup>24,25</sup>

The longitudinal studies conducted by Liu et al in 48 samples consisting of 24 females and 24 Caucasian race males showed that there were significant differences in mandibular size between males and females. The size of the male mandible is greater than that of female. The mandibular size differences between male and female are due to different bone remodeling activities, which are influenced by genetic condition, muscle mass, and sex hormone differences secreted in males and females.<sup>26</sup>

The bone and muscle growth difference between male and female on children until adolescent are affected by testosterone and estrogen hormone. Bone and muscle growth in male during puberty is dominated by elevated levels of testosterone and Insulin Growth Factor

(IGF-1). The increase of testosterone cause increased muscle mass and muscle strength. IGF-1 will stimulate the proliferation of muscle progenitor cells, affecting the calcium-regulating pathway that stimulates contractile muscle fiber. IGF-1 also has a role in bone anabolism. The muscles release the muscle-specific phosphatase (MIP/ MTMR14; MIPKO) factor to be detected by the bone and affect bone structure and strength. The combination of high-pressure changes and tense moments will cause the bone growth pattern to be dominated by the periosteal apposition. Thus, muscle and bone growth in males naturally runs in a parallel way.<sup>27,28</sup>

Females have high estrogen levels and low testosterone levels resulting in a rapid bone mass increase, but not with the width of the bone. The increase of bone mass occurs because the increase of endosteal apposition is greater than that of the periosteal apposition. In young adults, there is a muscle-bone relationship difference between males and females.<sup>27,28</sup>

The average difference between mandibular length of the right and left sides of male and female is relatively small and the statistical test reveals that there is no significant different between the right mandibular length and the left mandibular length in both males and females. The average mandibular length of the right mandible is relatively greater than the length of left mandibular in both male and female. The difference between the right and left mandibular lengths is 1-2 mm. Al-Zubair and Agrawal et al, reported that the mandibular dimension was considered asymmetric when the difference between the two sides was more than 2-3 mm, while Gribel BF et al also reported that the left and right mandibular differences of 4-5 mm was still considered as a normal asymmetry of face dimensions.<sup>29,30</sup>

Some researches reveal that facial asymmetry is more common to occur on the right side with the same distribution between males and females.<sup>31,32</sup> This condition is probably because the growth on the right side of the face is more dominant than that of the left side; it happens to the larger brain dimensions on the right side as well. Another mechanism that is considered to affect facial

asymmetry is the unbalanced development of neural crest cells. Some researchers reveal that neural crest cell migration occurs earlier on the right side, resulting in development delays on the left side.<sup>31,32</sup>

The result of this study shows that there is a large standard deviation, which indicates the existence of individual variations. Since this is a cross sectional study, it is necessary to do further research with a longitudinal method to get a better bone and dental growth description.

## CONCLUSION

It is possible to conclude that there is a difference in mandibular length growth between males and females. The increase of mandibular growth on females is earlier than that of males. Similarly, the female mandibular growth decrease is earlier than that of the male. The mandibular length on males has increased dramatically in the early adolescent age group so that by the end of puberty, the size of the mandible on male is greater than that of female.

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