To assess the usefulness of the Mandibular Ramus in determining Age and Gender among Malaysians in digital OPGs

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Abstract

Dentists are becoming an essential part of the forensic team in identifying remnants at catastrophic disasters site. Mandible is the most unique and durable bone which retain its morphology and is easily retrievable from the tragedy site without much damage. Mandibular parameters can help in assessing age and gender of the individuals.

A study of mandibular measurements on 180 OPGs at SEGi University was conducted. Measurement of the ramus was done utilizing VixWinTM Platinum 3.0 to assess the usefulness of the mandibular morphology in age and gender determination.

Statistical analysis of the record of 180 patients was done using SPSS software. 40% (n = 72) were male and 60% (n = 108) were female. The height of coronoid and maximum ramus breadth between male and female of all age groups showed a statistically significant result ($p<0.05$) for gender determination. Maximum ramus breadth ($p=0.008$) shows significant result for ethnic determination whereas the minimum ramus breadth ($p=0.021$) show significance in age estimation.

Maximum ramus breadth and height of coronoid can be used effectively for the gender determination. Although only the maximum ramus breadth can be used for ethnic determination whereas minimum ramus breadth can be used for age estimation.

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Introduction

The mandible is known to be one of the strongest bones in the human body, it also known to be well preserved, being able to remain intact in traumatic accidents. Unfortunately, there are some cases of mass disasters as well criminal acts where the remains of the victims are barely recognizable, so forensic odontology can be utilized in aiding the identification of the victims of such nature. In the forensic and physical anthropologic fields, mandible is the toughest facial bone and preserves its form better than other bones. Various studies have shown that the occlusal status and age of the subject tend to affect mandibular morphology.[1]

Many authors have previously reported the use of tooth development staging in the age estimation of the adolescents.[2,3]

The purpose of this paper is to compare the mandibular measurements (condylar height and ramus width) among the different ethnicities in Malaysia that can aid in the identification of the individuals. Being the most used diagnostic imaging tool, Digital Orthopantomogram (OPG) was used in the study to do the mandibular measurements.

There is scarce evidence of the published literature on the dental forensic studies conducted amongst Malaysians. The current study aims at assessing the practicality of the mandibular measurements (coronoid height, mental index and ramus width) in determining age and genders among the different ethnicities in Malaysia.

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Materials and methods

A retrospective study was conducted using the 180 digital OPGs (June2017 till December 2017) from the radiology database at Faculty of Dentistry, SEGi University. Ethical clearnce was taken for the study with reference number SEGi EC/SR/FOD/2018-19/12. OPGs were selected (60 from each ethnicity: 60 Indians, 60 Malays and 60 Chinese) within age range of 21-60 years and mandibular measurements were done using the Vixwin Platinum 3.0 software.

Radiographs with TMJ disorders, mandibular fractures, congenital anomalies, image distortion were excluded from the study. OPGs were categorized in 4 groups with the Group I - 21 to 30 years old: A1, Group II – 31to 40 years old: A2, Group III – 41 to 50 years old: A3 and Group IV- 51 to 60 years old: A4. Parameters like Maximum Ramus Breadth, Minimum Ramus Breadth, Height of Coronoid Process and Mental Index were measured using mouse driven method in Computer Software VixWin Platinum 3.0 by the two independent observers. Ethical clearance was obtained from the institutional review board. The mean magnification of radiographs taken by GENDEX was constant at 1.25, like the previous studies.[4]

Maximum ramus breadth (A) was the distance between the most anterior points on the mandibular ramus to the most posterior point on the mandibular ramus whereas the minimum ramus breadth (B) was the line drawn between the smallest anterior posterior widths of the ramus. The height of coronoid process (C) was the projective distance between coronoid process and 2mm from the angle of the mandible. Lastly, the mental index (D) was measured which was the mandibular cortical width at the mental foramen. (Figure 1)

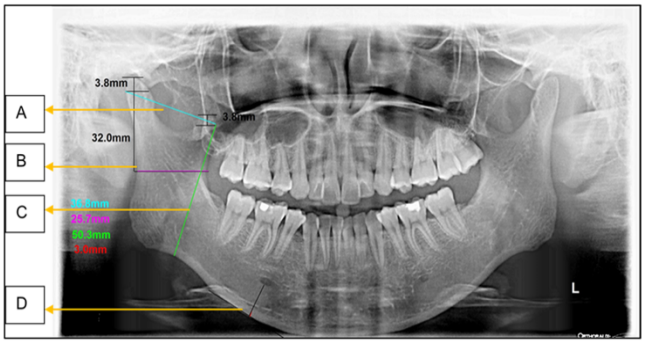

Figure 1. Mandibular parameters measured on the OPG.

After the data was collected and examined for the missing information and internal consistency, data analysis began with descriptive statistics, followed by the tests for the research question using Paired t-test, and ANOVA. The conventional level of $\alpha < .05$ (alpha level) was used to represent statistical significance. Effect sizes were calculated using Cohen's d. We aimed at the power of ≥ 0.8 for the current study, as used in the previous studies. All statistical analysis was performed using the statistical software SPSS version 22.

Results

A statistically significant correlation was found between the maximum ramus breadth with ethnicity with p= 0.008 (Table 1, Figure 2).

		Mean	Std. Deviation	Std. Error	P value
Mental Index	Malay	3.995	.91	.11	0.548
	Chinese	4.062	.93	.12	
	Indian	3.883	.84	.10	
Maximum Ramus Breadth	Malay	39.035	4.33	.55	0.008
	Chinese	37.112	3.78	.48	
	Indian	39.070	3.49	.45	
Minimum Ramus Breadth	Malay	28.915	3.86	.49	0.599
	Chinese	28.973	3.38	.43	
	Indian	28.360	3.70	.47	
Coronoid Height	Malay	54.915	7.42	.95	0.214
	Chinese	52.483	8.67	1.11	
	Indian	53.522	6.45	.83	

Table 1. Descriptive statistics for mandibular measurements in various ethnicities.

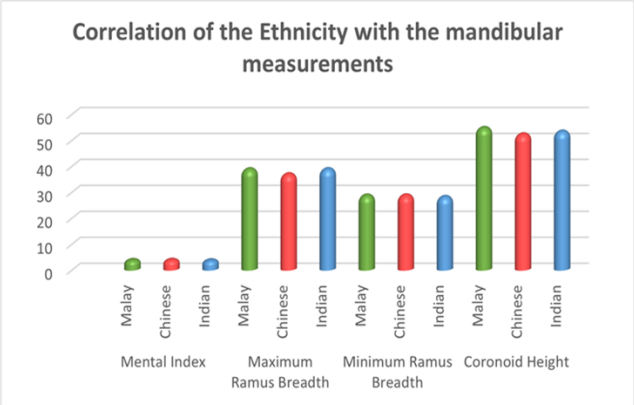

Figure 2. Correlation of the Ethnicity with the mandibular measurements.

The maximum ramus breadth has demonstrated greatest different in mean values which are lowest in Chinese, followed by Malay and Indian. The minimum ramus breadth

significantly correlated with age with p= 0.021 (Table 2, Figure 3).

		Mean	Std. Deviation	Std. Error	P Value
Mental Index	21-30 (A1)	3.879	.93	.11	0.669
	31-40 (A2)	4.064	.84	.12	
	41-50 (A3)	3.979	.97	.16	
	51-60 (A4)	4.069	.82	.14	
Maximum Ramus Breadth	21-30 (A1)	38.336	4.01	.49	0.373
	31-40 (A2)	37.451	3.08	.44	
	41-50 (A3)	37.100	4.44	.76	
	51-60 (A4)	37.319	3.89	.68	
Minimum Ramus Breadth Right	21-30 (A1)	29.776	3.59	.43	0.021
	31-40 (A2)	28.413	3.40	.49	
	41-50 (A3)	28.321	3.64	.62	
	51-60 (A4)	27.550	3.73	.65	
Coronoid Height	21-30 (A1)	54.300	9.47	1.15	0.634
	31-40 (A2)	54.060	6.61	.96	
	41-50 (A3)	52.753	6.74	1.15	
	51-60 (A4)	52.584	5.03	.89	

Table 2. Descriptive statistics for mandibular measurements age wise.

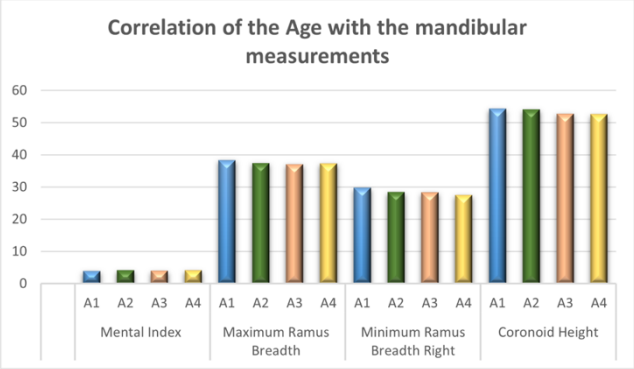

Figure 3. Correlation of the Age with the mandibular measurements.

	Gender	Mean	Std. Deviation	Std. Error Mean	P value
Mental Index	Male	3.997	.84	.09	.834
	Female	3.969	.93	.08	.831
Maximum Ramus Breadth	Male	39.521	3.65	.43	.002
	Female	37.662	4.01	.38	.002
Minimum Ramus Breadth	Male	28.967	3.62	.42	.516
	Female	28.605	3.67	.35	.515
Coronoid Height	Male	56.908	5.71	.67	.001
	Female	51.461	7.93	.76	.001

Table 3. Descriptive statistics for mandibular measurements based on Gender.

When comparing mean values between all the age groups, minimum ramus breadth shows mean values that gradually decreasing as the age increase. The height of coronoid and maximum ramus breadth in both right and left side between male and female of all age group showed a significant correlation with gender with p= 0.001 and p= 0.002, respectively, analyzed with student t-test (Table 3, Figure 4). When comparing mean values between both genders, height of coronoid and maximum ramus breadth expressing the greatest sexual dimorphism.

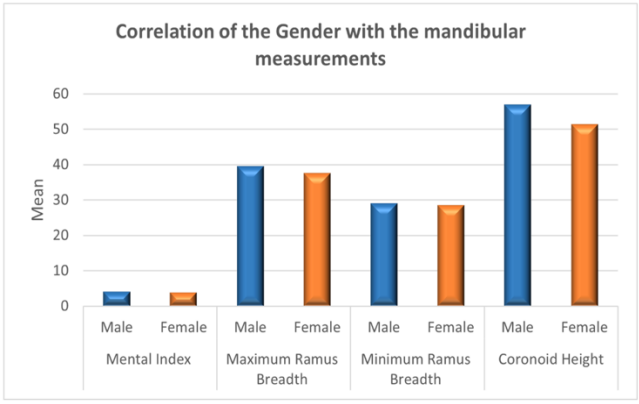

Figure 4. Correlation of the Gender with the mandibular measurements.

The results concluded that maximum ramus breadth can be used for ethnic determination in Malaysia whereas minimum ramus breadth can be used for age estimation. Maximum ramus breadth and coronoid height can be used effectively for gender determination. Mental index did not yield any significance for ethnic, age and gender determination in this study. The interobserver percentage agreement was 94% with kappa score of 0.84.

Discussion

Procedures for estimating age, gender, stature, and ethnic background are critical in determining the biological profile of the remains. In the absence of entire skull, mandible is being used for identification purposes, as it is considered as the strongest and most durable bone.[5] A recent study conducted in Indonesia have concluded that the mandibular cortical width can be used as the significant indicator in the age estimation.[6] Other researchers proved that many parts of mandible show variation in identification parameters. Measurements of the mandibular ramus tend to show higher sexual dimorphism, and differences between the sexes are generally more marked in the mandibular ramus than in the mandibular body. Gonial angle and antegonial region are important landmarks in the mandible, which were influenced by sex, age, and dental status.[7] Mandibular ramus also showed strong evidence that it can be used for sex determination in forensic analysis.

Panoramic imaging is commonly used in the clinics as the screening tool. The accuracy of panoramic radiography in providing anatomic measurements has been recognized. This conventional imaging modality has gained the popularity because of the relatively low radiation dose, decreased exposure time, image reproducibility and coverage of both the jaws in one image.[8] But the magnification and distortion of the images in some cases may limit the use of the OPGs but the vertical dimensions are found to be less altered as compared to horizontal measurements.[4] In our study, this limitation did not affect our results since all images were uniformly magnified. In forensic anthropology, comparison of antemortem and postmortem radiographs is one of the cornerstones of positive identification of human remains. Antemortem orthopantomograms may be of great value in the identification of human remains.[9]

During the course of our research work, we have come across several studies investigating the gender dimorphism of mandible. In one of the Malaysian studies, the location of the mental foramen was used as the predictor for ethnicities using 600 OPGs. But no statistically significant correlation was found between the location of mental foramen and various ethnicities in Malaysia.[10]

In another similar Malaysian study, mental foramen was found to be a useful predictor in the age, gender, and ethnicity in the targeted population. A significant decreasing trend was noticed in relation to the mandibular body height as age advances in both females and males.[11]

In another Malaysian study, the relationship of the impacted mandibular third molars with age, gender and ethnicity were determined and concluded a positive association among them.[12]

In the current study, the maximum ramus breadth has shown the statistically significant difference between the three Malaysian ethnicities with p= 0.008. The Indian community was found to have the larger and Chinese with the smaller maximum ramus breadths, in the targeted sample size.

An Indian-based study has proven that each parameter of the mandibular ramus (Maximum ramus breadth, minimum ramus breadth, condylar height, projective height of ramus and coronoid height) can be utilized for sex identification and forensic analysis.[13]

An author in his study concluded that the mandibular condyle and the ramus are the most sexually dimorphic sites associated with bone remodeling process during the growth of an individual.[7]

In one of the Brazilian study, various morphometric measurements on the dried skull were used in the forensic age estimation, although they couldn't find any promising results.[14] Another study evaluated the role of the mental index (MI), the maximum and the minimum ramus breadth and the height of coronoid process in digital dental panoramic radiograph for the purpose of determining the age and gender of the study subjects. Results have shown that coronoid height and MI were reliable indicator for age and gender. However, the mandibular ramus breadth can only be useful for sex discrimination in elder age population.[15]

A radiographic research conducted on Saudi population in 2017 concluded that except the gonial angle and minimum width of the ramus, all the variables (maximum/minimum ramus width, maximum height of coronoid process, maximum condylar height and maximum ramus height, body height in the premolar and molar region, gonial angle and bigonial width) were shown to be reliably different between gender.[16]

In an Egyptian radiographic study, the condylar and coronoid ramus heights were the most significant in identifying the gender and age respectively. There was a statistically significant direct correlation between age and ramus linear measurements i.e. an increase in age is associated with an increase in these measurements and vice versa.[17] The contradictory results in our study could be because of the varied geographical distribution affecting the skeletal growth of the participants.

A recent study was conducted in Egypt, using the CBCT for determining age and gender using the mandibular measurements. They found a significant difference between males and females for the mean length of the mandible ramus in the age range of 17–58 years. This study concluded the fact that the mandibular ramus length is more valuable in age estimation as compared to sex determination. They also stated that the CBCT can provide more precise information about the mandibular measurements for forensic analysis.[18]

In a systematic review, authors reviewed 16 radiographic studies and 20 morphometric

studies of dry mandibles. They reinforced that the mandible can be used significantly in age and gender prediction when combined with the other data.[19]

To the best of our knowledge, the present study was the first of its kind by using height of coronoid process and ramus breadth for ethnicity determination amongst Malaysian population. Our study showed some of the similar results with other studies indicating the coronoid height and maximum ramus breadth as the significant gender predictors with p value of 0.001 and 0.002, respectively. Coronoid height and the maximum ramus breadth were significantly higher in males as compared to females. Minimum ramus breadth significantly correlated with the age determination, with decrease in the breadth with the advancing age (p = 0.02). However, we could not find any significant correlation with mental index and age and gender determination, with p value of 0.669 and 0.834, respectively.

We have found that there is a noticeable trend for most of the mandibular measurements (maximum/minimum ramus breath, height of coronoid process and mental index) as they were relatively higher among male participants.

Conclusions

Based on the results obtained in the current study, it may be concluded that the mandible is a reliable tool in determining age, gender and ethnicity among the targeted population. In the view of these findings, further studies can be conducted with increased sample size, aiming at diverse population and with the use of advanced imaging modalities like CBCT to evaluate the usefulness of mandible as a forensic tool.

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Declaration of Interest

The authors report no conflict of interest.

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