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Determination of Sex and Estimation of Age by Mandibular Basal Bone Height

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Abstract

Aims and Objectives: To assess the age and sex determination through mandibular basal bone height

Materials and Methods: The study consists of 120 OPG samples, (60 males and 60 females) in the age group of 30 to 70 years, hereby the mandibular basal bone height measured as D1 and D2 on OPG's using planmeca romexis software. The distance measured between the lower border of mental foramen to the lower border of the mandible termed as D1. The distance between the lowest point of mandibular canal to the lower border of the mandible termed as D2. All these measurements were further subjected to statistical analysis like independent t-test, correlation and regression analysis to estimate age and to compare the differentiation between males and females.

Results: Overall the result shows the moderate level of significance, on multiple comparisons between age groups and sex among the population, it was observed that statistically **significant in male with relation to D1 among 61yrs to 70yrs** though other age groups show significant with less confidence interval. Female observations failed to show similar results neither with D1 nor with D2. Regression formula for age estimation and logistic regression for sex determination have been derived.

Conclusions: The present study highlighted that the male gender of the mandible can be determined by using D1 value as it gives significance, thus it can be used as an additional tool to establish the identity of a gender

Key words: *Mandibular basal bone height, mandibular canal, mental foramen orthopantomogram radiograph,*

Introduction

The mandible is a horseshoe shaped bone and the body of the mandible on either side has the basal bone component and the mandibular arch embedding teeth. Morphological changes of the mandible are thought to be influenced by the occlusal status and age [1]

The adult human mandible is a bone which exhibits a large degree of anatomical variability. This variation occurs not only between subjects or as a result of aging, but also between the right and left sides in an individual [2]

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During facial growth, the maxilla and mandible translate downward and forward. Although the forward displacement of the maxilla is less than that of the mandible, the inter-arch relationship of the teeth in the sagittal view during growth remains essentially unchanged [2]. Inter-digitation is thought to provide compensatory (tooth movement) mechanism for maintaining the pattern of occlusion during growth; the maxillary teeth move anteriorly relative to the maxillary basal bone while the mandibular teeth move posteriorly relative to the basal bone of the mandible (Marshall et al., 2011).

After growth has ceased, the single most important factor governing the gross morphological shape of the bone is related to the presence or absence of the teeth. After tooth extraction, there follows a phase of remodelling which may result in an extensive loss in the height of the jaws, particularly the mandible [3].

Mandibular body is divided into alveolar bone and basal bone. However, there is no distinct line separating basal bone from alveolar bone tissue. This is more of a physiologic than an anatomic difference [4]. Basal bone forms the dental skeletal structure, contains most of the muscle attachments, and begins to form in the foetus before the teeth develop. Classically, the mandibular basal bone is defined as that part of the mandible which is present inferior to the mandibular canal [5]. The mandibular canal and the mental foramen are the standard anatomic reference landmarks used to differentiate between the alveolar bone and the basal bone in the mandible [6].

Information is available that the aging skeleton retains a potential for growth. There is considerable evidence that continuous bone deposition takes place from adulthood to older-age and such changes have been reported on the skull and face [7]. There exists some amount of bone deposition along the lower border of the mandible as the age progresses [6]. Which contribute to increase in the height of mandibular basal bone. On the contrary, it is also proved that alveolar ridge resorption in edentulous mandibles, can extend into the base of the mandible [8], leading to decrease in the height of mandibular basal bone [9].

Panoramic radiography is the most commonly used tool in measuring the mandibular basal bone height [6, 10]. Various methods of gender determination have been established, in which the mandible plays an important role. The mandible is the strongest bone in the human body and persists in a well-preserved state longer than any other bone. Therefore, the use of morphological features of the mandible is a common approach used by anthropologists and forensic dentists in the determination of sex [11].

Aim and Objectives of the study:

1. To measure the mandibular basal bone height on OPG's

2. To compare the above measurements for age estimation and gender determination

Materials and Methods

This study consists of 120 Digital orthopantomogram radiographs, the samples were collected from the archive of Department of Oral Medicine and Radiology, JSS Dental College and Hospital, JSS Academy of Higher Education and research, Mysore, Karnataka, India. Which were taken with PROMAX digital Planmeca Machine, a total of 120 samples (60 males and 60 females) divided into 4 groups, each group consisted of 30 samples, with an equal number of gender distribution.

Inclusion criteria: panoramic radiographs (OPG) with proper diagnostic property, Radiographs with properly visible mental foramen and lower border of mandibular canal

Exclusion criteria: Presence of any pathological lesions or deformities in the mandibular region

The methodology of recording the distances (D1 andD2) followed in this study was implemented from **Xie *et al*.** (1996) [6] **[Figure 1]**. A tangential line was drawn to the lower border of the mandible, on the left side and the Vertical lines were drawn from the lowest point of the mental foramen and the lowest point of the mandibular canal to the lower border of the mandible The distance measured between the lower border of mental foramen to the lower border of the mandible was termed as D1.The distance between the lowest point of mandibular canal to the lower border of the mandible was termed as D2. Similar measurements were carried out for all the radiographs in planmeca romexis viewer 2.9.2.R software, the measured values were compared and statistically analysed.

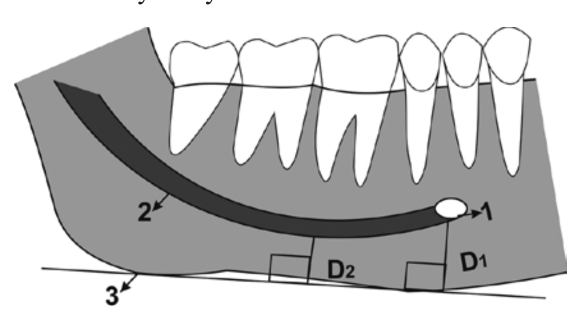

Figure 1: D1 = Distance between the lower border of the mental foramen and the lower border of the mandible, D2 = distance between the lowermost point

of the inferior alveolar canal and the lower border of the mandible, 1 = mental foramen, 2 = lower border of the inferior alveolar canal, 3 = tangential line drawn to the lower border of the mandible.

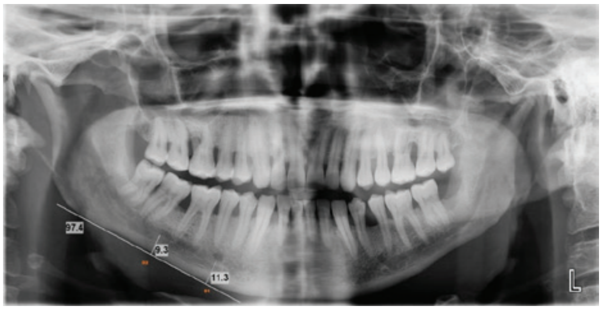

Figure 2: Measurements by planmeca romexis software

D1 and D2 measurements done on OPG in planmeca software

Results

In the present study, mandibular right side measurements were taken on OPG as D1 and D2 for all 120 samples. The statistical results are shown in the Tables 1 to 6. Further the difference of D1 and D2 values between males and females were noted and compared with other relevant studies.

In the present study, Parenthesis shows mean value,

There is significant difference between male and female in case of D1, showing the p value (0.016), There is significant difference in Male D2 as the p value shows (0.053)

Table: 1

Correlations					
SEX			AGE	D1	D2
MALE	AGE	Pearson Correlation	1	-.154	.361**
		Sig. (2-tailed)		.239	.005
		N	60	60	60
	D1	Pearson Correlation	-.154	1	.211
		Sig. (2-tailed)	.239		.106
		N	60	60	60
	D2	Pearson Correlation	.361**	.211	1
		Sig. (2-tailed)	.005	.106	
		N	60	60	60
FEMALE	AGE	Pearson Correlation	1	.341**	.020
		Sig. (2-tailed)		.008	.878
		N	60	60	60
	D1	Pearson Correlation	.341**	1	.300*
		Sig. (2-tailed)	.008		.020
		N	60	60	60
	D2	Pearson Correlation	.020	.300*	1
		Sig. (2-tailed)	.878	.020	
		N	60	60	60
**. Correlation is significant at the 0.01 level (2-tailed)., *. Correlation is significant at the 0.05 level (2-tailed).					

Observations:

(1) In case of Males there is positive correlation(r= 0.361 with p=0.005< 0.05) between age and D2

(2) In case of Females there is positive correlation (r=0.341 with p=0.008<0.05) between age and D1

(3) In case of Females there is positive correlation (r =0.300 with p=0.02<0.05) between D1 and D2.

Among **various age groups** ranging from 30ys to 70yrs of age it was observed that overall mean value of D2 (8.368) is found to be lesser than D1(14.285), suggesting **D1 has more predominant role in determining mandibular basal bone height**. On Inter observation among the age group, statistically significant was seen in higher with D1 and age groups of 61yrs to 70yrs. On correlation analysis between the age group and D1 it was found statistically significant (Pearson correlation <0.05) whereas **No significant correlation was observed with actual age and D2**. Independent t-Test according to different age groups shows statistical significance of 0.004 (<0.05) among age groups of **61yrs to 70yrs with D1 suggesting its reliability (Table: 1).**

Among the **gender population** of various age groups it was observed that overall mean value of **D1 is higher than D2 in both male and female** showing its correlation observation. With respect to gender between actual age and **D1 it was observed male** shows significant relation with respect to age groups and D1 (0.083) than females, similarly in relation to D2 (0.029) males in **the tests for normality,** but female observation failed to show any significant correlation statistically.

Regression Analysis- stepwise

Table: 2: SEX = MALE

Coefficientsa,b						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	33.061	6.132		5.392	.000
	D2	2.065	.699	.361	2.953	.005
a. SEX = MALE						
b. Dependent Variable: AGE						

Using stepwise regression of Age on D1 and D2 we found in case of **Males**

Male Formula, Age=33.061 +2.065*D2.

This implies that Given D2 value one can predict their age (Table: 2). The P value for significance of the regression equation is 0.005< 0.05, which is significant and R^2 =0.131 (It is better if it is nearer to 1), Std. Error of the Estimate is 10.8 yrs.

Table: 3

SEX = FEMALE

Coefficientsa,b						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	24.006	9.449		2.541	.014
	D1	1.836	.665	.341	2.761	.008
a. SEX = FEMALE						
b. Dependent Variable: AGE						

Using stepwise regression of Age on D1 and D2 we found in case of **Females**

Female Formula, Age=24.006 +1.836*D1.

This implies that Given D1 value one can predict their age (Table: 3). The P value for significance of the regression equation is 0.008< 0.05, which is significant, Std. Error of the Estimate is 10.73950. Thus the age can be calculated from these regression formula according to the gender.

Table: 4: Logistic Regression to predict Sex

Variables in the Equation							
		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1a	D1	-.087	.091	.914	1	.339	.917
	D2	-.089	.112	.629	1	.428	.915
	Constant	1.985	1.421	1.950	1	.163	7.277
a. Variable(s) entered on step 1: D1, D2.							

The formula is based on above table:

The Logistic equation to predict SEX based on D1 and D2 is given by

Log [p / (1-p)] = 1.985+ (0.087*D1- 0.089*D2).

Where p is the probability of being Male. i.e.,if P<=0.05 predict it as a male otherwise as female (Table: 4). The accuracy of predicting the male correctly is 51.7% and female as53.3% and overall percentage is 52.5.

Discussion

The mandible is the strongest bone in the human body and persists in a well-preserved state longer than any other bone. Therefore, mandibular characteristics are extremely useful or determining sex [14].On comparing the results, males had higher D1 values, **D1 has more predominant role in determining mandibular basal bone height**. On Inter observation among the age group, statistically significant was seen in higher with D1 and age groups of 61yrs to 70yrs in males, this was similar with Xie *et al*., (1996), [6] who had achieved similar results. This can be explained on the basis of fact that sexual hormones such as androgens and oestrogen, contribute to the development of a morphologic difference in craniofacial skeletons between the genders and even to different velocity of growth in later adulthood. The speed of bone growth in adult women is lower than in mean, as observed by Enlow (1982),[4] who further stated that local factors such as masticatory muscles and bite force play an important role in craniofacial skeletal change. Tension is known to induce bone formation. Since the mandible functions as lever, contraction of jaw elevator muscles such as masseter and medial pterygoid muscle during normal chewing movements may cause a small amount of tension along lower border of mandible in the molar regions [4].

In general, men have stronger muscles and greater bite force than women, so more amount of bone deposition along the lower border of the mandible was observed in men compared to women. The sexual hormones and various strengths of force of masticatory muscles together explained the difference in height of mandibular basal bone between the genders. Further, women in postmenopausal age had accelerated rate of resorption of residual edentulous ridge due to osteoporosis, which was supported by von Wovern *et al*., (1980) [13]. In the present study both 30-40 years and 61-70 years of age group shows statistically significant mainly in the male genders, others are not significant but in contrast to Raviraj jayam study the age group of 41-50 years shows the significance.

Arati S. Panchbhai et al. (2013) conducted a study on Quantitative estimation of vertical heights of maxillary and mandibular jawbones in elderly dentate and edentulous subjects which stated that there were significant differences between elderly dentate and edentulous subjects in maxilla and mandible. The vertical measurements were significantly greater in men than in women in maxilla and the mandible. [15]

Conclusion

Human skeletal remains plays an important role in Forensic odontology and Medico-legal works to identify the individual, sometimes if a part of bone is also available, sex or age can be determined based upon different morphological and metrical parameters and this study can be applied for both living and deceased. The present study highlighted that the **male gender** of the mandible can be determined using **D1 value as it gives significance**, thus it can be used as an additional tool to establish the identity of a person, regression formulae for age estimation for male and female and logistic regression formula for sex determination have been done. Studies with larger samples may help to correlate gender determination using metric parameters.

Ethical Clearance- Taken from the JSSDCH, JSSAHER Ethical committee

Source of Funding- Self

Conflict of Interest - Nil

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