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Determining Gender and Age by Mandibular Anatomy Landmarks in Computed Tomography with Cone-Beam (CBCT)

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Abstract

Introduction: this study aimed at determining gender and age by mandibular anatomy landmarks in computed tomography with Cone-Beam (CBCT).

Methodology: this cross sectional study was performed on 147 CBCT images available in archive of radiology in the dentistry department of Ahvaz Jondi Shapoor medical science university. In this research, we assessed parameters including SMEF: Distance from mental foramen to the highest point of *alveolar crest* ridge, BIAC: distance from lowest point of IAC to the most anterior tangent point of buccal mandibular plate, LIAC: distance from the lowest IAC point to the most posterior tangent point o mandibular lingual plate, IMEF: distance from the lowest mental hole border to the lowest tangent point on inferior mandibular border, D2: distance from the lowest IAC canal border to the lowest tangent point on inferior mandibular border and gonial angle: junction of inferior mandibular border and posterior ramus border. Data were analysed by SPSS software 20th version and Spearman correlation coefficient tests, one-way variance analysis, Kruskal-Wallis, independent t, and Uman Withney.

Results: SMEF level was significantly different in groups and in 25-34 group it was significantly higher than under 25 group. In right side it was significantly higher than female. IMEF had no significant difference in age groups and in both side it was higher in male than female. BIAC in both sides had no significant difference. LIAC in both sides an in different ages had no significant difference in male and female. D2 had no significant difference in both sides. But in a group with patients older than 55 it was significantly higher than 45-54 group. In addition, in left side it was higher in male than female there was no significant difference in gonial angle in different groups in left side with in right side there was significant difference in different age groups. But there was no significant difference in gender.

Conclusion: evaluated indices in this research are not ry accurate to forecast age and gender and they cannot be used as accurate tools in estimating age and gender of people.

Keywords: Mandible, SMEF, BIAC, LIAC, IMEF, D2, Gonial Angle, Computed Tomography with Cone Beam, Sexual Dimorphism

1. Introduction

Determiningg the identity in forensic is identifying a person based on unique characteristics. Identifying remnants of human corpse becomes restricted due to changes in soft tissue. Thus, for identifying skeleton remnants, some methods are explored. Four main features of biologic identification that forensic anthropologists are care about include gender, age, ancestors and the race out of which gender is the most important one. Because accurate identification of gender limits population of the lost people to half and also subsequent methods for estimating age and height is mostly dependent upon the gender (Rathan, 2017).

When adult skeleton is entirely available for analysis, gender can be determined with 100 percent accuracy however in some cases that some parts of the body are available it is not easy to recognize the gender of the body and it becomes highly dependent upon founded organs. In alive people four methods including clinical, histological, chemical and analytical methods can use for determining the age. However, in dead person, changes after death such as decomposition, wound, or amputation may make the identification more struggling and even make it impossible (Shiva et al., 2015).

In this case, remodeling can help us. For example, remodeling in gonial angle, anti gonial, mental foramen, mandibular foramen and mandibular canal are changed by age and dental status. Out of different parts, skeletal, pelvis, skull and old indices are used for determining the gender. However, by many researches and progresses, face structures role becomes important (Singh et al., 2016).

CBCT imaging (Cone beam computed tomography) is an advanced imaging quality that provides unique visual manifestation from dental hard tissues and bone structures (White et al., 2014). Due to high speed of imaging and its low dosage, effective dosage with CBCT method is significantly lower than other imaging methods such as Computed Tomography.it high usage in dentistry is because of its low cost and dosage of its rays (Lascala et al., 2004). In addition, CBCT imaging system allows accurate screening in all mandible aspects in real size (Tozoğlu et al., 2014).

Some researchers have been performed on different facial indices by panoramic imaging method and CBCT in different populations. For instance, one study illusterated that gonial angle is not good predictor for determining the gender (Singh et al., 2016). In addition, in other study they concluded that gonial angle can be good for determining the gender (Bhardwaj et al., 2014; Shahabi et al., 2009).

In another research, BIAC (The Buccal Inferior Alveolar Canal) was the only indices that was significant in both genders. And AmaF (Note 1), PMaf (Note 2) (Note 3), SIAC, IIAC (Note 4) indices were not sigificnt statistically (de Oliveira Gamba, 2014). However, AmaF, Pmaf, SIAC, IIAC and BIAC can identify gender (Kimbel et al., 2017).

Since researchers showed different results and some of them are in contrast to others, in this study determining gender and age by mandibular anatomy landmarks in computed tomography with Cone-Beam (CBCT) was studied.

2. Materials and Methods

This cross sectional and analytical-descriptive study was performed on 147 CBCT images available in archive of radiology in the dentistry department of Ahvaz Jondi Shapoor medical science university. Patients were included to the study if they were older than 14 without a specific systemic problem. edentulous and partial Edentulous patients, skeletal class II and class III patients (Al-Shamout et al., 2012), patients with long face and short face skeletal problem, and patients with Braxism and malocclusion and temporomandibular joint anomaly and broken tooth and patients after operation (Chole et al., 2013) and patients pathological problem in jaw and with systemic problems effective on jaw-facial skeleton and obvious radiographic errors and two branches mandibular canal and broken teeth and mandibular evolutionally disorders (Shiva et al., 2015) were eliminated from the study and replaced with other samples. In this study, patients were evaluated in 5 groups including younger than 25, 25-34, 35-44, 45-54, older than 54. Data were recorded in a check list by the researcher.

In this research, parameters that were assessed included

SMEF: Distance from mental foramen to the highest point of alveolar crest ridge,

BIAC: distance from lowest point of IAC to the most anterior tangent point of buccal mandibular plate,

LIAC: distance from the lowest IAC point to the most posterior tangent point o mandibular lingual plate,

IMEF: distance from the lowest mental holy border to the lowest tangent point on inferior mandibular border,

D2: distance from the lost IAC canal border to the lowest tangent point on inferior mandibular border and

Gonial angle: junction of inferior mandibular border and posterior ramus border (Gamba et al., 2015).

Images were provided by CBCT tool EWTOM VG model (from Quantitative Radiology Silvestrini Verona, Italy Company) via high resolution protocol. The voltage was 110 KVP and imaging lasted 5/4 seconds. In all images, NNT VIEWER software 5.6th version was used for drawing the lines. All images were screened on 19 inch Philips screen page with 1280×1024-pixel resolution and good color. For each patient, images were monitored separately by a jaw-facial radiology resident and then a ja-facial radiology professional with more than two years' experience randomly monitored images in order to make sure of the results.

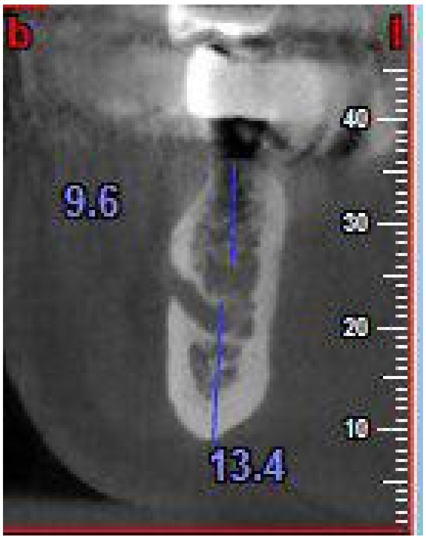

Figure 1. Distance from mental foramen to the highest point of alveolar crest ridge, and distance from the lowest mental hole border to the lowest tangent point on inferior mandibular border

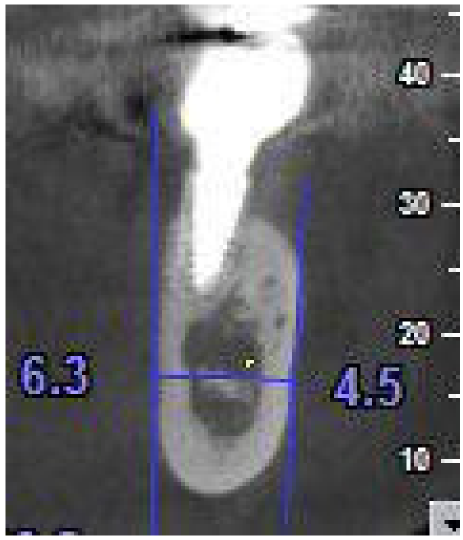

Figure 2. Distance from lowest point of IAC to the most anterior tangent point of buccal mandibular plate and distance from the lowest IAC point to the most posterior tangent point o mandibular lingual plate

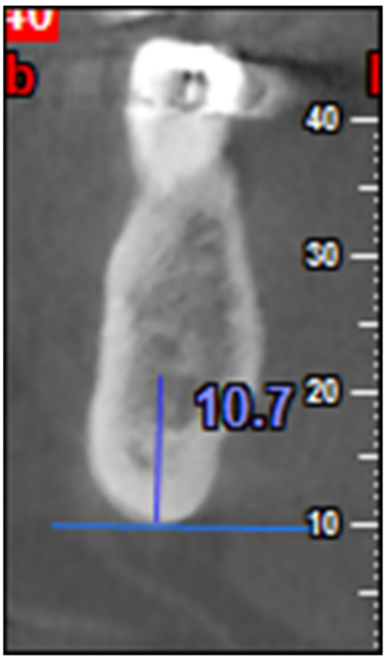

Figure 3. Distance from the lowest IAC canal border to the lowest tangent point on inferior mandibular border

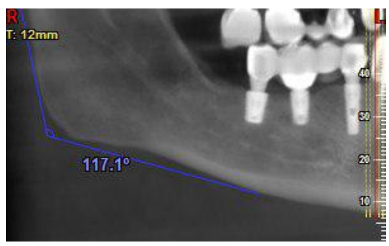

Figure 4. Gonial angle

Data were analysed by SPSS software 20th version. Kolmogorov-Smirnov Test was used for assessing data distribution. For analyzing data Spearman correlation coefficient tests, one-way variance analysis, Kruskal-Wallis, independent t, and Uman Withney were applied. Level of significance was $p<0.05$.

3. Results

Out of 147 images, 73 images (49.7%) were for females and 74 images (50.3%) were for males. Age mean was 46.45 with the minimum age of 14 and maximum of 78. Maximum frequency was related to 35-44 years old group: 82 patients (27.9%), 64 patients older than 55 (26.5%), 64 patients were 45-54 years old (21.8%), 52 patients were

25-34 years old (17.7%) and 18 cases were under 25 years old (6.1%).

Generally, based on Kolmogorov-Smirnov test distribution of age is not normal (p=0.033). SMEF, D2 and gonial angle had normal distribution (p>0.05) and IMEF, BIAC and LIAC had abnormal distribution (p<0.05). In left side, age has abnormal distribution (p=0.05) and other variables had normal distribution (p>0.05). Descriptive statistic of variables is mentioned in Table 1.

Table 1. Descriptive statistic of evaluated variables

Standard deviation	**Mean**	**Number**		
3.190	13.644	134	Right	
3.263	13.730	134	Left	**SMEF**
3.221	13.687	268	Total	
2.300	12.429	137	Right	
2.142	12.603	136	Left	**IMEF**
2.220	12.516	273	Total	
1.316	4.782	139	Right	
1.297	4.619	137	Left	**BIAC**
1.307	4.701	276	Total	
1.953	4.384	139	Right	
1.830	4.375	138	Left	**LIAC**
1.889	4.380	277	Total	
1.909	7.554	137	Right	
1.836	7.583	136	Left	**D2**
1.870	7.568	273	Total	
8.252	120.631	35	Right	
11.968	124.700	12	Left	**gonial angle (degree)**
9.370	121.670	47	Total	

3.1 Age

There was no significant relationship between SMEF with age (r=0.111, p=0.07) in right side (r-0.111, -=0.202) and left side (r=0.110, p=0.207). There was no significant difference between SMEF and different age groups (p=0.009) however in right side (p=0.270) and left side (p=0.060). According to Tukey comparison, SMEF mean in 25-34 group (14.88±2.47) was significantly higher than under 25 years old group (11.92±3.89) (p=0.016). Other comparisons were not significant.

Generally, there was significant difference between IMEF and age (r=0.125, p=0.04) and in left side (p=0.03, r=0.179). There was no significant difference between IMEF with age in right side (p=0.410, r=0.071) (p>0.05). In addition, there was no significant difference between IMEF and age groups in right and left side (p>0.05).

There was no significant difference between BIAC and age (r=0.019, p=0.753) and in right side (p=0.569, r=0.049). There was no significant difference between BIAC with age in right and left side (p>0.05).

Generally, there was no significant difference between LIAC and age groups (r=0.069, p=0.689) in right side (r=0.034, p=0.689) and left side (r=0.90, p=0.293). There was no significant difference between LIAC with age in right and left side (p>0.05).

Generally, there was direct and significant difference between D2 and age groups (r=0.164, p=0.011). But there was no significant relationship between D2 in right side (r=0.136, p=0.112) and left side (r=0.167, p=0.052). There was no significant difference between D2 and age groups in tight and left side. According to Tukey comparison, d2 mean in group older than 55 (8.176±1.865) was significantly higher than 45-54 years old group (7.180±3.89) (p=0.016). Other comparisons were not significant.

Generally, there was indirect and significant difference between gonial angle and age groups (r=0.416, p=0.004). But there was no significant relationship between gonial angle in left side (r=0.081, p=0.803). There was no significant difference between gonial angle and age groups in left (p>0.05).

3.2 Gender

SMEF mean (standard deviation) was (p=0.001) and in right side (p=0.005) was significantly higher in male than female. However, in left side there was no significant relationship between female and male (P>0.05).

IMEF mean in right side had no significant difference between female and male. However, generally (p=0.003) and in left side (p=0.02) this distance was significantly higher in male than female.

LIAC mean and gonial angle generally and in left side and right side there was no significant difference between male and female (p>0.05).

D2 mean generally (p=0.006) and in left side (p=0.02) was significantly higher in male and female. This distance in right side had no significant difference in male and female (p>0.05).

Table 2. Comparison of variables evaluated basis of gender

P value	Z	t	Standard deviation	Mean	Number	Gender		
0.005*	-	2.872	3.351	14.414	67	Male	Right	
			2.840	12.873	67	Female		
0.085*	-	1.738	3.218	14.239	64	Male	Left	SMEF
			3.257	13.265	70	Female		
0.001*	-	3.245	3.275	14.329	131	Male	Total	
			3.055	13.073	137	Female		
<0.001**	-3.557	-	2.545	12.964	68	Male	Right	
			1.905	11.901	69	Female		
<0.001*	-	4.192	2.300	12.429	137	Male	Left	IMEF
			2.000	13.363	65	Female		
<0.001**	-5.155	-	2.040	11.908	71	Male	Total	
			2.142	12.603	136	Female		
0.062**	-1.863	-	1.237	5.018	70	Male	Right	
			1.360	4.542	69	Female		
0.020*	-	2.364	1.316	4.782	139	Male	Left	BIAC
			1.339	4.886	66	Female		
0.003**	-2.959	-	1.214	4.370	71	Male	Total	
			1.297	4.619	137	Female		
0.614*	-	-0.506	1.835	4.3014	70	Male	Right	
			2.075	4.469	69	Female		
0.400*	-	-0.844	1.733	4.237	66	Male	Left	LIAC
			1.918	4.501	72	Female		
0.407**	-0.829	-	1.780	4.270	136	Male	Total	
			1.989	4.485	141	Female		
0.092*	-	1.696	2.142	7.830	68	Male	Right	
			1.618	7.281	69	Female		
0.027*	-	2.238	1.982	7.946	65	Male	Left	D2
			1.636	7.250	71	Female		
0.006*	-	2.761	2.058	7.887	133	Male	Total	
			1.622	7.265	140	Female		
0.500*	-	-0.682	8.845	119.384	13	Male	Right	
			8.001	121.368	22	Female		
-	-	-	0	0	0	Male	Left	gonial angle
			11.968	124.700	12	Female		
0.306*	-	-1.035	8.845	119.384	13	Male	Total	
			9.544	122.544	34	Female		

4. Discussion

Dentistry jurisprudence has been one of the method for assessing sexual dimorphism and identification of lost people through skeleton residual. These estimations can be performed by anthropometric assessments in jaw by callipers. In human being, mandible is the strongest and the most durable bone of the skull that has the most characters related to dimorphic sexual characters (14). This study aimed at determining gender and age by mandibular anatomy landmarks in computed tomography with Cone-Beam (CBCT).

In this research, there was no significant difference between mental foramen distances to the highest point of alveolar crest ridge with different age groups. Distance from mental foramen distance to the highest point of alveolar crest ridge in 25-34 years old was significantly higher than under 25 years old group (p=0.016).

In this study, distance from mental foramen distances to the highest point of alveolar crest ridge in general was (p=0.001) and right side (p=0.005) was significantly higher in male than female. Similar to this study, Uppal et all (2017) reported that SMEF in male was higher than female; however, this different was significant (Uppal et al., 2018).

Generally, (r=0.125, p=0.04) and in left side (r=0.179, p=0.03) there was direct and significant relationship between distance from the lowest mental hole border to the lowest tangent point on inferior mandibular border (IMEF) in right and left sided and was generally higher in male than female (p<0.001). Similar to this study, Uppal et al. (2017) reported that IMEF was higher in male than female however this difference was not significant (Uppal et al., 2018).

There was no significant difference between distance from lowest point of IAC to the most anterior tangent point of buccal mandibular plate (BIAC) with age generally (r=0.019, p=0.753) and in right side (r=0.049, p=0.569) and in left side (r=0.005, p=0.949). Standard deviation of (mean) distance from lowest point of IAC to the most anterior tangent point of buccal mandibular plate (BIAC) generally in right side and left side was significantly higher in male than female. Similar to this study, Uppal et al. (2017) reported that BIAC was higher in men than women but this difference was not significant (Uppal et al., 2018).

There was no significant difference between distances from the lowest IAC point to the most posterior tangent point o mandibular lingual plate (LIAC) with age groups generally and in left and right side. In this research, distance from the lowest IAC point to the most posterior tangent point o mandibular lingual plate (LIAC) in age groups generally and in left and right side was higher in female than male. In contrast to our study, Uppal et al. (2017) reported that LIAC was higher in men than women but this difference was not significant (Uppal et al., 2018).

Bone growth in adulthood can be controlled by some factors. Sexual hormones such as estrogen and progesterone can influence on fastness of bone growth and creates difference in craniofacial morphology between genders. Bone growth speed in male is higher and it causes craniofacial aspects to be 5-9% bigger in compare to women. In addition, muscle tension is considered factor of bone formation and in mandible, contraction of elevator muscles during chewing motion creates tension in ramus. Generally, men have stronger chewing muscle than female (Uppal et al., 2018).

In this research, there was direct and significant relationship between distance from the most inferior border of IAC canal to the most inferior tangent point on inferior border of mandible with age (r=0.154, p=0.011). There was no significant difference between the distance from the most inferior border of IAC canal to the most inferior tangent point on mandible inferior border with age groups in right and left side. However, this distance generally in older than 55 age group was significantly higher than 45-54 age groups (p=0.016) probably because height of basal mandible bone with age increase because bone sediment happens along with mandible inferior border in adulthood (Jayam et al., 2015).

Results of this study showed that distance from the most inferior border of IAC canal to the most inferior tangent point on inferior border of mandible generally (p=0.006) and in left side (p=0.02) in male is significantly higher than female. This distance in right side has no difference in men and women. Similar to this study, Jayam et al. (2015) reported that this distance is higher in male and female (Jayam et al., 2015).

Generally, mean (standard deviation) of gonial angle in men was 119.384(8.845) degree and in women was 122.544 (9.544) and their difference was not significant which can be due to low number of samples. Along with this study, Bhardwaj et al. (2014) reported that this angle in men was 117.66 (6.54) and in women was 122.10 (6.04) (7). Sairam et al. (2018), Joo et al. (2013), Bhuyan et al. (2018) and Gohsh et al. (2009) (Ghosh et al., 2009) reported that gonial angle in female in bigger than male.

In contrast to this study, Tafakhori et al. (2017) and Gamba Td et al. (2016) (14) showed that this angle in male is smaller than female. These differences can be due to type of the tool for assessing, accuracy of radiologist, sample of the study and population under study considering the race and age.

Casey and Emrich (1988) reported that gonial angle is 3-5 degree in female is bigger than male probably because people who have higher strength in chewing have smaller gonial angle and generally male are stronger in chewing (Casey; 1988) this study was compatible with other studies (Joo et al., 2013).

Results of the study showed that there is weak reverse and significant relationship between gonial angle and age genrally (r=-0.416, p=0.004) and in right side (r=-0.489, p=0.003) while by age increase this angle is reduced. In contrast to our study, Tafakhori et al. (2017) reported that gonial angle is increased by getting older (Tafakhori et al., 2017).

Lo number of samples in some indices was limitation of the study. Since in this study, image archive with various fov were used. All 6 variables were not able to be studied.

5. Conclusion

SMEF in various age groups had significant difference and in 25-34 age group was lower than under 25 group. In addition, in right side it was significantly higher than female. IMEF in different age group had no significant difference while in males in both sides was significantly higher than females. BIAC in both side and in different age group had no significant difference. However, in male in left side was significantly higher than females. LIAC in both side and in different age and in both female and male had no significant difference. D2 in both side had no significant difference. However, in older than 55 group it was significantly higher than 45-54 years old group. Moreover, in left side it was higher in male than female. There was no significant difference between gonial angles in different age groups in left side however there was significant difference in right side in different age groups. But it was no difference in both genders. Evaluated indices in this study had no high accuracy in forecasting age and gender and they cannot be applied as an accurate tool in estimating age and gender of people.

Conflict of interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

Notes

Note 1. The Anterior Mandibular Foramen.

Note 2. The Posterior Mandibular Foramen.

Note 3. The Superior Inferior Alveolar Canal.

Note 4. The Inferior Alveolar Canal.

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