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International Journal of Current Research
Vol. 9, Issue, 12, pp.62433-62436, December, 2017

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

RADIOGRAPHIC APPRAISAL OF MAXILLO-MANDIBULAR OSTEOMETRICS – AN INDICATOR IN SEXUAL DIMORPHISM

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ARTICLE INFO

Article History:
Received 18th September, 2017
Received in revised form
11th October, 2017
Accepted 28th November, 2017
Published online 27th December, 2017

Key words:
Maxillo-mandibular osteometrics,
Sexual dimorphism,
Gender determination,
Maxillary and mandibular arches,
Digital occlusal radi.

ABSTRACT

Background: Human identification is the mainstay of civilization. Sex determination is the prime step in personal identification, which becomes difficult in mass disasters where corpse is dismembered beyond recognition. Research on sexual dimorphism using dental remains is a mining field, because no two mouths are alike and an individual tooth along with its arch dimensions is resistant to all post mortem insults.

Aim: To analyse the maxillary and mandibular dental arches by performing both linear and angular measurements in anterior, middle and posterior portions by using occlusal radiographs for possible gender determination.

Materials and methods: Metric analysis of dental arches was done on the maxillary and mandibular occlusal radiographs on a study sample of 30 with equal number of males and females of age above 18 years using software DIGORA. Statistical analysis was performed.

Results: Males were found to have greater Maxillary Inter Canine width and Maxillary Inter Molar arch width with p value less than 0.005, Males were also found to have greater maxillary left premolar incisor angle and no statistically significant differences were found among other angular measurements.

Conclusion: Maxillo-mandibular osteometrics can be used as a tool for gender determination but it is population specific.

Citation: Thumula Reshmi, Jyothirmai Koneru, Reddy Sudhakara Reddy *et al.* 2017. "Radiographic appraisal of maxillo-mandibular osteometrics – An indicator in sexual dimorphism", *International Journal of Current Research*, 9, (12), 62433-62436.

INTRODUCTION

"What a nightmare! Bodies– blackened; heads carbonised; shrunk and reduced to nothing, but only the teeth remained." (Ferrari*et al*., 2016)

- Dr. Oscar Amoedo (Father of Forensic Odontology).

Sticking on to this apothem, person identification with dental remains becomes the only option where everything else turn into ashes or lost as in cases of mass disasters. Personidentification, performed in either dead or alive for innumerable reasons takes account of gender determination as a strategicpacethat narrows down the search for identity by 50% and enhances the possibility of identification by 100%.Since ancient times, the traditional concepts for assigning sexin deceased were usinganthropometric measurements of skull and humerus, (Robinson andBidmos, 2009) pelvic girdle, (Ahmed *et al*., 2015) human sacrum, (Passalacqua, 2009) and other long bones which contribute us a pronounced qualitative and quantitativedata for gender determination. But in all the case scenarios the gold standard skeletal parameters for gender determination may not beavailable as parts of the skull or parts of jaws or teeth are the only remains of the deceased at most of the times. In such cases forensic odontologist plays an imperative role in determining the sexof a deceased by dental remains.There are many researches dealing with the importance of mandibular flexure (Badran *et al*., 2015), frontal sinus, nasal septal patterns (Reddy *et al*., 2014), and skull anthropometry (Vidya *et al*., 2012) in the sexual dimorphism. But what if only the parts of the jaw or only a few teeth are available for identification which poses an utmost challenge to the forensic odontologist.So, in such case we need a method that is simple, accurate and reliable concurrently.Althoughthere are many studies regarding odontometrics that are available till date but the maxillo-mandibular osteometrics isstill a mining field in sexual dimorphism.Withinthis context, we havedigital occlusal radiographs which offersentire information of the jaws and dentition in a single film on which the measurements can be performed easily, were used for gender determination. Researches in this aspect are very few and one study conducted by Leticia Ferreira dos Santos *et al*. in Brazilian population

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observed differences between males and females and found that Maxillomandiblarosteometrics can be used as an indicator for sex determination (Santos *et al*., 2015). With this background, the present study is an attempt to analyse the maxillary and mandibular dental arches by performing both linear and angular measurements in anterior, middle and posterior portions by using occlusal radiographs for possible gender determination.

MATERIALS AND METHODS

A study sample of 30 was taken which included 15 females and 15 males above 18 years attending the Department of Radiology and who were advised occlusal radiographs for diagnosis and treatment.All 30 subjects who met with the below mentioned criteria I.e., fully erupted dentition and were never submitted to dental extractions (except for the third molar in any dental arch), periodontally healthy teeth to avoid possible changes in the anatomy ofmandibular and maxillary dental arches were included in the study. Patientswith developmental anomalies in the dental archesand gross destructions of tooth,Orthodontic problems and who are undergoing orthodontic treatment, Patientswho were not willing to participate in the study, were excluded from the study. After obtaining approval from the institutional research and ethical committee for the study, all the subjects were explained about the study. An informed written consent was obtained from the patient prior to their inclusion in the study. Digitalocclusal radiographsfor both the maxillary and mandibular arches were obtained by an investigator and after getting the radiographic images they were analysed by performing linear and angular measurements randomly for both the genders by another investigator.

The maxillary arch was denoted by capital letters and the mandibular arch bysmall letters and L indicating the left side and R indicating the right side. Linear measurements (Fig B) in the three proportions of dental arches i.e, by drawing linear line in between right and left canines named as (CC), right and the left first premolars (PP) and first molars (MM). Similarly linear measurements were performed on the mandibular arches which were named as (cc, pp, mm). Angular measurements (Fig C). Were performed by drawing a median line was drawn touching the vestibular portions of the projections of the maxillary central incisors and the point is named as I. From this point a linear line is drawn to the most vestibular portion of right canine and left canine and these points were named as C on either sides, a linear line from the point C to the midline is drawn and is named as A. now, the angle between the CIA on both the right and the left sides were measured. Similarly, PIB and MIC angles were measured taking most vestibular portions of buccal cusps of first premolar (P) and mesiobuccal cusps of first molars (M) on both right and left sides as reference points and linear lines drawn from these points towards midline were named as B, C.Obtained results were gender matched.

RESULTS

Obtained data was subjected to statistical analysis using SPSS software Version 20.0 software (IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp) Osteometric measurements of maxilla and mandible in three proportions i.e., Canine, Premolar and Molar region was analysed and compared in between males and females for possible gender determination. Statistical tests used in the present study were ANOVA Test for intragroup comparison and Unpaired T test for intergroup comparison in between males and females. Data was collected from 30 subjects above 18 years age of which 15 were males and 15 were females. Digital occlusal radiographs for both maxilla and mandible weretaken for each subject which ensued 60 occlusal radiographs on which the analysis was done. Table I shows the Mean, S.D of maxillary and mandibular linear measurements i.e., inter canine, inter premolar and inter molar width in

Table I. The Mean, S.D of maxillary and mandibular linear measurements

	GENDER	N	Mean	Std. Deviation	Unpaired t-test	P value
CC	Male	15	38.2420	1.57082	3.041	0.005
	Female	15	36.7140	1.14849		
PP	Male	15	52.6253	2.84232	2.006	0.055
	Female	15	50.7540	2.23093		
MM	Male	15	63.4560	2.11200	2.625	0.013
	Female	15	61.2207	2.48947		
cc	Male	15	28.3927	7.91781		
	Female	15	29.2180	1.00364	-.401	0.692
pp	Male	15	80.1607	128.99253	-1.030	0.312
	Female	15	45.8500	2.21119		
mm	Male	15	61.6080	2.11913	1.676	0.105
	Female	15	59.9033	3.32177		

Table II.The Mean, S.D of Maxillary angular measurements

	GENDER	N	Mean	Std. Deviation	Unpaired t test	P value
CIA R	Male	15	26.9867	3.15071	0.933	0.359
	Female	15	25.6220	4.71080		
CIA L	Male	15	27.4333	3.22594	1.586	0.124
	Female	15	25.2140	4.35539		
PIB R	Male	15	44.0467	3.79941	0.878	0.387
	Female	15	42.9733	2.82501		
PIB L	Male	15	45.7200	3.32914	2.592	0.15
	Female	15	42.7880	2.84838		
MIC R	Male	15	53.4267	2.61055	0.498	0.622
	Female	15	52.9807	2.28136		
MIC L	Male	15	54.1400	2.65701	0.501	0.620
	Female	15	53.6120	3.09318		

Table III. The Mean, S.D of Mandibular angular measurements

	GENDER	N	Mean	Std. Deviation	Unpaired t test	P value
cia R	Male	15	19.2887	3.96539	1.358	0.185
	Female	15	17.2707	4.17118		
cia L	Male	15	19.8400	4.00835	1.311	0.201
	Female	15	17.8027	4.49107		
pib R	Male	15	38.8000	2.66083	1.870	0.072
	Female	15	36.8053	3.16087		
pib L	Male	15	39.2573	3.18849	0.681	0.502
	Female	15	38.4140	3.58514		
mic R	Male	15	49.8067	1.97573	0.286	0.777
	Female	15	49.5840	2.27368		
mic L	Male	15	51.2047	3.33761	-0.407	0.687
	Female	15	51.7300	3.71950		

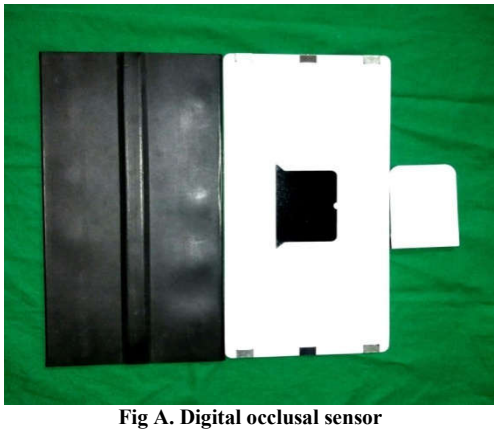

Fig A. Digital occlusal sensor

males and females group. Males were found to have greater Maxillary Inter Canine width and Maxillary Inter Second Molar arch with p value 0.005.Maxillary inter premolar and mandibular canine premolar and molar widths were also found to be greater for males than female but the difference was not statistically significant.

Table IIshows the Mean, S.D of Maxillary angular measurements CIA (Right and Left) PIB (Right and Left) and MIC (Right and Left) angles in males and females groups. All the maxillary angular measurements were greater in males when compared to females but statistically significant values were found for left premolar incisor angle with p value 0.15.

Table III shows the Mean, S.D of Mandibular angular measurements cia (Right and Left) pib (Right and Left) and mic (Right and Left) angles in males and females group. Although males were found to be having larger cia, pib, mic both right and left but the difference between the two groups were not statistically significant.

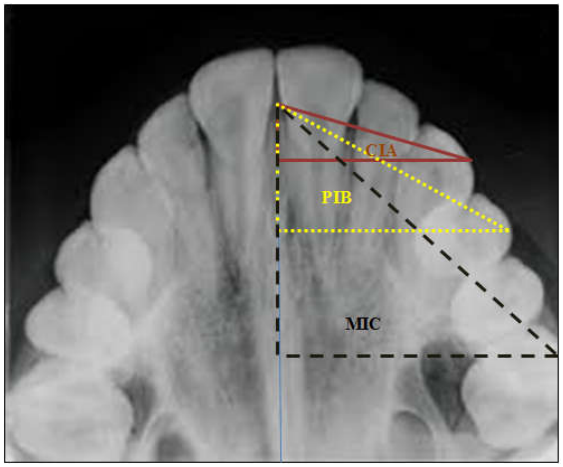

Fig B. Angular measurements

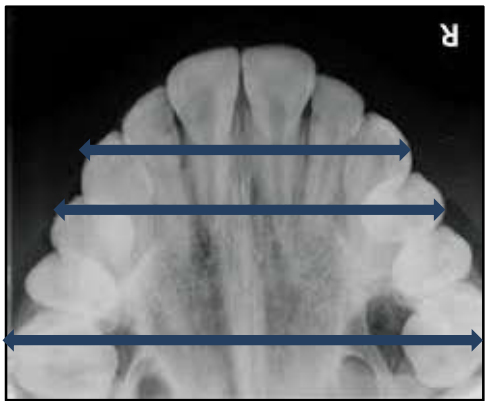

Fig C. Linear measurements on maxillary arches

DISCUSSION

"The beauty of the skin may ware out.., the muscle and fat may turn into ashes.., and the sparkle of the eyes may not hold the truth anymore.., But, the shine of the teeth withstand nature and will tell who I am?"

Tooth morphometry and arch dimensions are not fixed, they are unique and are population specific, and it varies in both the genders whichoutlines their significance in sex determination. (Santos *et al*., 2015) These approaches have been proved to be very useful individually yet incur a higher accuracyrate when used in a combination as they complement each other.The size and shape of the arches is influenced byvarious factors such as, thesutural expansion in the maxilla, interarch relationships of the teeth, contractile properties of supracrestal fibers, growth of the bone, eruption and angulation of the teeth and Ethnic background. Hence, variability in the shape of dental arches is may be the result of the impact of any of the above factors. Many studies stated that arches increases in width up to the age of 13 years i.e. in the transitional dentition period, with a very little significant growth after this period where a functional dentition is achieved (Santos *et al*., 2015). Forensic anthropology becomes difficult to deal with the cases where entirely charred and putrefied skeleton are the only remains available for identification and identifying the skeleton in a corpse almost always necessitates opening of the body causing emotional distress to the deceased ones' families, their existent beliefs. Radiographs in this regard provide a more precise, easier and accurate method for examining the corpse without opening the body (virtual anthropology which makes use of highly specialized imaging and investigatory modalities for the better identification of the corpse). Also, these methods facilitate the examination of the infectiously or toxically contaminated corpses (Dedouit *et al*., 2014). Hence, radiographs are preferred for analysis to diagnostic casts which are unattainable in above mentioned scenarios. Radiographs have added benefits over conventional autopsy and traditional

anthropology by enabling the transport of the data to the specialist for further exploration (Williams and Bradshaw, 2015). Few studies were reported in the literature regarding the forensic applicationof jaw osteometrics and their variations in different races and some researches done on Brazilian and Punjab population (Santos *et al*., 2015; Bunger and Jindal, 2013) were supportive of its role in gender determination, but those which were done in Australian, Indonesian population were contradictory in regard to the use of these parameters (Dalidjan *et al*., 1995; Merz *et al*., 1991). All these researches were done on the study models, but the present study highlighted the use of digital occlusal radiographs in simulating the arch dimensions. In the present study, we have calculated both the linear and angular measurements and among all the linear measurements (both maxillary and mandibular) maxillary inter canine and inter molar width have showed statistically significant results with higher‘t’values i.e., greater in males than females which goes in accordance with the results obtained insimilar type of studies conducted in Punjabpopulation (Bunger and Jindal, 2013), Puducherry (Daniel *et al*., 2014) and in Brazilian population (Santos *et al*., 2015). Some clinicians have speculated some reasons behind could be the women have smaller bony ridges and alveolar processes and the less average weakness of musculature when compared to males, which have pronounced effects on measurements of facial breadth and dental arch height and width, and the later growth period (Daniel *et al*., 2014). For the forensic identification of an unknown, the sensitivity and specificity of any identifying method should be high to avoid inaccurate identification and prosecution of the innocent individuals. The use of inter-canine and inter- molar arch widths in determining the gender has a high sensitivity value i.e., 92% for both with a satisfactory specificity 76% and 64% respectively according to a study conducted in Puducherry population (Daniel *et al*., 2014). In the present study, although all the angular measurements of both maxillary and mandibular are found to be greater for males than females, only the maxillary PIB L values have showed statistically significant results with the remaining parameters showing low significance values which virtually agrees with the results obtained in the study conducted in Brazilian population (Santos *et al*., 2015). The population in India is of ethnic diversity. Based on the data observed from a study among all the races (Altherr *et al*., 2007), Caucasian women usually have smaller teeth and African descent males have the biggest teeth in the dental arches, and so relationship between arch size can vary among gender and ethnical group, indicating bigger sizes in males, as seen in the present study of linear measures. Thus, Maxilla-mandibular osteometricscan be used as an adjunct to osteometrics of long bones.

Conclusion

India is a subcontinent with amalgamation of various cultures, traditions and ethnicity. It is possible that the craniofacial and dental characteristics could be influenced by these diverse ethnic patterns.Hence, further more researches are yet to be conducted among various populations highlightingthe use of these dental characteristics in person identification and gender binary system. The present studyemphasised the significance of the use of some dental parameters like maxillary and mandibular intercanine and intermolar width which were found to be larger in case of males in comparison with the females in gender determination.

Finally, Digital occlusal radiography on the other hand is a rapid, handy, and an accurate technique simultaneously that can be easily performed with minimal equipment for analysing the dental arches for possible gender determination in case of mass disasters.

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