SEXUAL DIMORPHISM IN THE MANDIBLES OF A HOMOGENIUS BLACK POPULATION OF TANZANIA

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ABSTRACT

Mandibles of known age and gender from cadavers of Tanzanian Bantu population were studied to determine if the human mandible could be sexually dimorphic in a homogenous population. All mandibles were measured using electronic two-digit millimeter veneer caliper. All of the male (100%) and 96% of the female mandibles were positively sexed. The present study indicates that the mandible of the Tanzanian Bantu population possesses metric parameters that make it sexually dimorphic. More studies, involving other Tanzanian groups, might reveal racial or ethnic differences based on mandibular morphometrics.

INTRODUCTION

Several studies have documented that skeletal characteristics vary with sex, age and populations (Weisl 1954, Singh & Potturi 1978, Jit & Gadhi 1966, Steyn & Iscan 1998, Loth & Henneberg 1998, Ferrario *et al.* 1999, Iscan & Steyn 1999). Accuracy in sexing increases with the number of component bones available and with combination of different parameters in different bones. Studies on the mandible have indicated features that could be used in sexing and age estimation (Mbajiorgu *et al.* 1996, Loth & Henneberg 1998, Fabian & Mpembeni 2002). Some studies have also indicated that mandibular features vary with ethnicity (Nummikoskim *et al.* 1988, Ferrario *et al.* 1999, Iscam & Steyn 1999). However a number of mandibular parameters still pose controversies and therefore no single parameter has been generally accepted with reliability and significance in distinguishing

gender and ethnicity (Mbajiorgu *et al.* 1996, Donnelly *et al.* 1998, Sawyer *et al.* 1998). Sexual dimorphism in mandibular morphology has been shown in very young mandibles from ages 0 to 7 with accuracy decreasing to teen age (Loth & Henneberg 2001). However there are contradictory results regarding reliability in morphological features (Donnelly *et al.* 1998). Other studies have shown difficulties in predicting sex based on morphological features in very young mandibles, even though prediction was possible in the older group (Chen *et al.* 2000). Metric parameters would therefore add a quantitative element and reliability in sexing using the mandible.

If different parameters are tested within populations, both qualitative and quantitative criteria could be identified within population groups and used in combination to distinguish sex, age and possibly ethnicity. By simple observation of the mandibles clear differences in size, height, thickness and/or width and rounding, and muscular attachments markings can be observed. Other features, that show clear differences by simple observation, include bicondylar distance and bulkiness of the mandible. Very few studies have been done on the mandible of Tanzanian populations in trying to identify any morphological features that could show either sexual or ethnical dimorphism. Most other studies on the mandible have been based on single or limited specific features (Donnelly *et al.* 1998, Loth & Henneberg 1998). In our earlier study we looked into few features including the angle of the mandible, the rounding of the ramus and muscular attachment markings and width of the body of the mandible (Fabian & Mpembeni 2002). Using those few features the mandible showed sexual dimorphism in the adult Bantu population. The present study attempted to identify metric parameters of the mandible of the Tanzanian Bantu population, which, when coupled with morphological features, could be used in sexing using the mandible. The parameters studied were bicondylar distance, ramus and sympheseal heights, height of the basal bone (from the base of the mandible to the mental foramen) and the alveolar process (from the mental foramen to the upper border). Total mandibular height, length and width of the condylar process were also measured.

METHODS

Fifty mandibles of known gender, 25 females and 25 males, were obtained from remains of dissected cadavers in the Department of Anatomy of the Muhimbili University College of Health Sciences and two other private medical schools in Tanzania. All cadavers were adults between 20 and 50

years based on the mortuary records. All the mandibles included in this study had good dentition with tooth loss ranging from 0-3 in each jaw. There were three edentulous male mandibles that we excluded from the main study and were only used as controls for heights of the basal bone and the alveolar process. Mandibles were cleaned of all soft tissues without destroying the periostium, using forceps and surgical blade. They were then immersed in a solution of 10% Sodium hypochlorite mixed with 10% Formaldehyde and some glycerin for 7 days to clear all remaining soft tissues. They were subsequently allowed to dry under room temperature before measurements were taken. The mandible measurements were taken using an electronic two-digit millimeter veneer caliper. Heights were measured at the level of the mental foramen and sympheseal height at the symphysis menti. Bicondylar distance was measured between the left and the right condyles with the most medial points taken as the points of reference. The height of the ramus was measured from the lower border of the ramus to the deepest point between the head and the coronid process (coronoid notch). To measure width and length of the condylar process, the greatest anteroposterir (width) and mediolateral (length) distances of both condyles were measured The data was then entered into a computer and analyzed using the EPI INFO program (Dean *et al.* 2000).

RESULTS

In all the parameters, male mandibles were found to have higher values compared to female mandibles. Also the range was much higher among the male mandibles than it was for female mandibles (Table 1). The mean height of the ramus of the mandible was higher in male mandibles than in the females, and the difference was statistically significant ($P< 0.000007$). Overall mean for bichondylar width was found to be 79.78 mm. The mean for males, 80.56 mm, was higher compared to that of females (76.95mm) but the difference was not statistically significant ($p>0.05$). The mean height of the basal bone was found to be 13.81 mm. Male mandibles had higher values with a mean height of 14.7 mm compared to that of female mandibles that had the mean height of 11.73 mm. The difference in mean heights between males and females was found to be statistically significant ($p<0.0001$). The alveolar process had the overall mean height of 15.31 mm. Males were found to have a higher mean of 15.62 mm compared to the females with a mean of 14.64 mm but the difference was not statistically significant ($P> 0.32$). When the dentate mandibles and the edentulous mandibles were compared, it was found that there were no differences in the values for the basal bone.

However the values for the alveolar process were very different, with edentulous mandibles having very low values. In the present study, the number of the edentulous mandibles was too small for any meaningful statistical comparisons. Mean symphesial height was also significantly higher in the male mandible than in the female mandible ($p<0.0001$). The mean condylar width (antero-posterior distance) was found to be 8.46 mm. The mean value for males was 8.6 mm and was higher than that of females, which was 8.0 mm, but the difference was not significant ($p>0.05$). Similar findings were observed with the condylar length (mediolateral distance). Males had a larger mean value of 21.1 mm compared to that of females, 20.33 mm but the difference was not statistically significant ($p>0.05$).

Table1: Results of measurements for different mandible parameters with range, mean, standard deviation, and statistical significance (P values). Measurement taken from cadavers at the hospital in Tanzania

PARAMETERS	MALE		FEMALE		(P values)
	Range (mm)	Mean±SD (mm)	Range (mm)	Mean±SD (mm)	
Bicondylar width	73.9-87.23	80.557±3.82	72.69-80.35	76.95±3.9	0.171
Height of ramus	44.07 - 54.88	49.942±2.65	42.1-48.5	44.185±1.71	0.000007
Height of basal bone	13-18	14.72±1.4	10-15	11. 73±1.55	0.00025
Height of alveolar process	6-22	15.625±3.02	11-18	14.636	0.321
Height body of the mandible (total)	18.62-33.89	27.857±3.18	22.56-32.06	25.392±	0.031615
Sympheseal height	10.87-17.33	15.524±1.49	8.56-15.51	11.28±2.2	0.000006
Condylar width	8.00-9.00	8.6±0.15	6.0-9.0	8.0±1.73	0.320
Condylar length	18.0-24.0	21.1±2.08	19-22	20.33±1.53	0.575

DISCUSSION

In general, sexual and age differences can be observed in different components of the human skeleton including the pelvic bone, the skull and the mandible (Jit & Gadhi 1966, Singh & Patturi 1978). Morphological features and metric parameters of the human mandible are useful in diagnosis and treatment of dentofacial conditions and could also be used in identification of human remain (Eisenburger *et al.* 1999, Ohm & Silness 1999, Ogawa *et al.* 2000). Features of the mandible have been shown to vary from one ethnic group to the other with significant intra-subject variation for shape but not for size (Ferrario *et al.* 1997, Humphrey *et al.* 1999).

Morphological features alone could therefore have deficiencies in accurate sexing. Since other studies have also shown that there is inter-racial and gender differences in the size of the mandible (Ferrario *et al.* 1999), metric parameters will put more weight in sexing and identification of ethnicity.

In the present study, male mandibles had generally higher values in all dimensions. Total mandibular heights were also found to be higher in the male mandibles than in female ones, but the difference was not statistically significant. This contradicts other studies that found higher values for mandibular height in females than in males (Mbajiorgu *et al.* 1996). This could be explained by differences in ethnicity since there are indications for differences in values of the mandibular angle among different black African populations (Mbajiorgu *et al.* 1996).

The height of the basal bone was found to be higher in male mandibles and the difference was statistically significant. The basal bone height did not change with tooth loss since mean values were not different between the edentulous and dentate mandibles, and could therefore be used in bone identification instead of total mandibular height. There was no significant difference in height of the alveolar process between male and female mandibles. This dimension was found to be lower in the edentulous mandibles, possibly caused by resorption of the alveolar process that takes place after tooth extraction (Xie *et al.* 1996, Narhi *et al.* 1997, Hobson 1998). However, statistical analysis could not be done because of the small number of edentulous mandibles available. Elsewhere, it has been shown that alveolar bone atrophy in edentulous elderly people is higher in females than in males (Soikkonen *et al.* 1996, Narhi *et al.* 1997).

Both mean values for condylar width (antero-posterior distance) and for condylar length (mediolateral distance) were found to be higher in male mandibles than in females but in both cases the differences were not statistically significant ($p>0.05$). Other studies have found significant gender differences in greatest medial-lateral condylar dimensions (Celic *et al.* 1998). Bicondylar distance was found to be higher in the male than the female mandible, the difference was statistically significant. Data regarding bicondylar distance has not been shown in previous studies. Mean values for height of the ramus of the mandible was found to be higher in male mandibles than in the females and the difference was statistically significant. Data regarding the height of the ramus of the mandible is also

lacking. Both bicondylar distance and the ramus of the mandible can be used as indicators of the size of the mandible, and in this case therefore their higher values attribute to the larger size in male mandibles in the studied population.

We conclude that the mandible of the Tanzanian Bantu population possesses metric parameters that make it sexually dimorphic and therefore metric parameters could be combined with morphological features in sexing of human remains. More studies involving other Tanzanian groups could be done to assist in identification of racial or ethnic differences using the mandible.

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