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MORPHOMETRIC PARAMETERS OF KENYAN ADULT MANDIBLES

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ABSTRACT

Background: The mandible has a horizontal U-shaped body which is continuous at its posterior end with a pair of vertical rami forming the lower part of the facial skeleton. Knowledge of mandibular dimension is an important consideration during the selection of appropriate reconstruction techniques.

Objectives: To determine the morphometric parameters in Kenyan adult mandible and to relate them to those of a sample of reconstruction plate and screw.

Design: A descriptive cross-sectional study.

Setting: The National Museums of Kenya, Nairobi and the Department of Human Anatomy, University of Nairobi.

Subjects: Intact whole adult mandibles (n=82) were obtained from the National Museums of Kenya, Nairobi and the Department of Human Anatomy, University of Nairobi.

Results: The average length of the mandible in males for the right and left sides was 98.6 mm and 100.5 mm respectively while for the females this was 92.2 mm and 94.5 mm respectively. The average height of the ramus of the mandible in male for the right and left sides was 57.40 mm and 58.07 mm respectively while for female this was 51.81 and 52.20 mm respectively. Significant differences were noted among the curved length and heights of the mandible between male and females ($p < 0.05$). Significant difference between the right and left side of the mandible were noted ($p < 0.05$) as well as between the length of the mandible and the length of the reconstruction plate ($p < 0.05$).

There were no significant difference in the thickness of the mandible between males and females and; between the left and right sides of the mandible with averages of 13.94 mm at the symphysis, 11.00 mm at the canine 10.33 at the mental foramen 11.06 at the bifurcation of the first molar, 12.36 mm at the bifurcation of the second molar 8.62 mm at the level of the anterior ramus, 5.41 mm at gonion and 5.89 mm at the midpoint of the rams ($p > 0.05$) with strong positive correlations. Significant differences were, however noted between the thicknesses of the body and ramus of the mandible and the sizes of the screws ($p < 0.05$).

Conclusion: The baseline parameters of the mandibles for Kenyans can be used in the selection of appropriate reconstruction plates and screws.

INTRODUCTION

The mandible, the lower part of the facial skeleton, together with the calvarium collectively forms the skull. The mandible has a horizontal U-shaped which is continuous at its posterior end with a pair of vertical rami (1,2). Knowledge of mandibular dimensions is an important consideration during the selection of appropriate reconstruction techniques (3,4). The mandible may be involved in pathology or trauma leading to a breach in its continuity requiring reconstruction. Common indications include surgical

resection of mandibular tumours and trauma and infections affecting the oral cavity and oropharynx.

Population variations in mandibular and dental arch anatomic parameters have been shown in several studies (5-9). Didia and Daper (5) found that the mean values of the mandibular angle, body length and ramus height in Eastern Nigerians compared favourably with those of other Negroid populations, but was smaller than that for Caucasians, Mbajjorgnu *et al.* have suggested that the mandibular length, height and angles of black Zimbabweans could be a useful anthropological tool in a population group

identity (6). Puisoru *et al.* showed that there were significant differences in mandibular dimensions between various population groups (9). The objective of the present study was to determine baseline data on selected mandibular dimensions which in turn would be useful in the reconstructive procedures that may involve diverse types of plates and screws.

MATERIALS AND METHODS

Eighty two intact adult mandibles were used in the study including seven from the Department of Human Anatomy, University of Nairobi and 75 from the human osteological collection of the National Museums of Kenya in Nairobi, which were combined.

Approval was obtained from the Ethics, Research and Standards committee of the Kenyatta National Hospital and the University of Nairobi (Approval No. P77/4/2007). Permission was granted by the Director, National Museums of Kenya and the Department of Human Anatomy, University of Nairobi to use the mandibles. The local agent (Amiken) of SYNTHES^R gave permission to use the images and sizes of the reconstruction plates and screws.

The presence of the third molar was taken as an inclusion criterion for the mandibles. Mandibles

that were broken or incomplete and which were not labeled for gender were excluded.

The measurements were taken using a calibrated tape for the length and height of the mandible. The length of the mandible (a) was taken as the distance between the pogonion and gonion. The height of the mandible (b) was taken as the distance between the gonion and condyion (Figure1).

A digital Vernier caliper was used for measuring the thicknesses of the five selected points on the body of the mandible (figure 2). The thicknesses of the body were taken at the symphysis (1), canine (2), mental foramen (3), first molar (4) and at the level of the anterior ramus (5) at a distance of one centimetre from the lower border.

The thickness of the ramus was taken at three points being at its midpoint (a), halfway between the condyion and the midpoint of the ramus (b); and at halfway between the midpoint of the ramus and gonion (c). The measurements for the thicknesses were taken at a distance of one centimetre from the posterior border for the ramus (figure 2).

All measurements were taken for both left and right sides of the mandible. They were carried out by the first author and another assistant to check for inter and intra-observer errors.

Figure 1

Curvilinear length (gonion-pogonion) and height (condyion-gonion) of the mandible

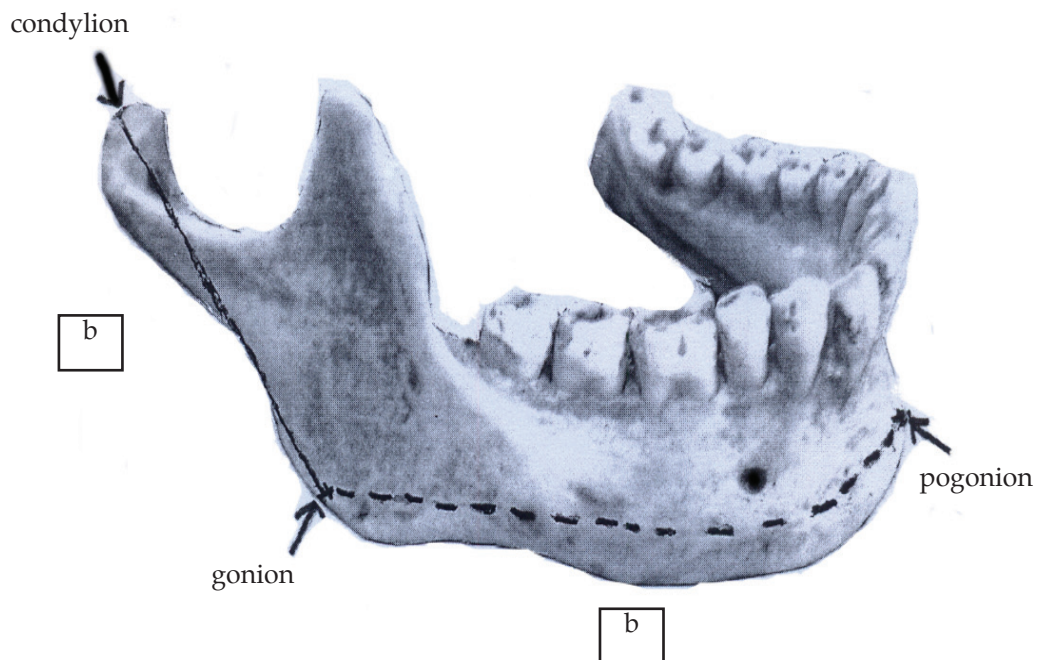
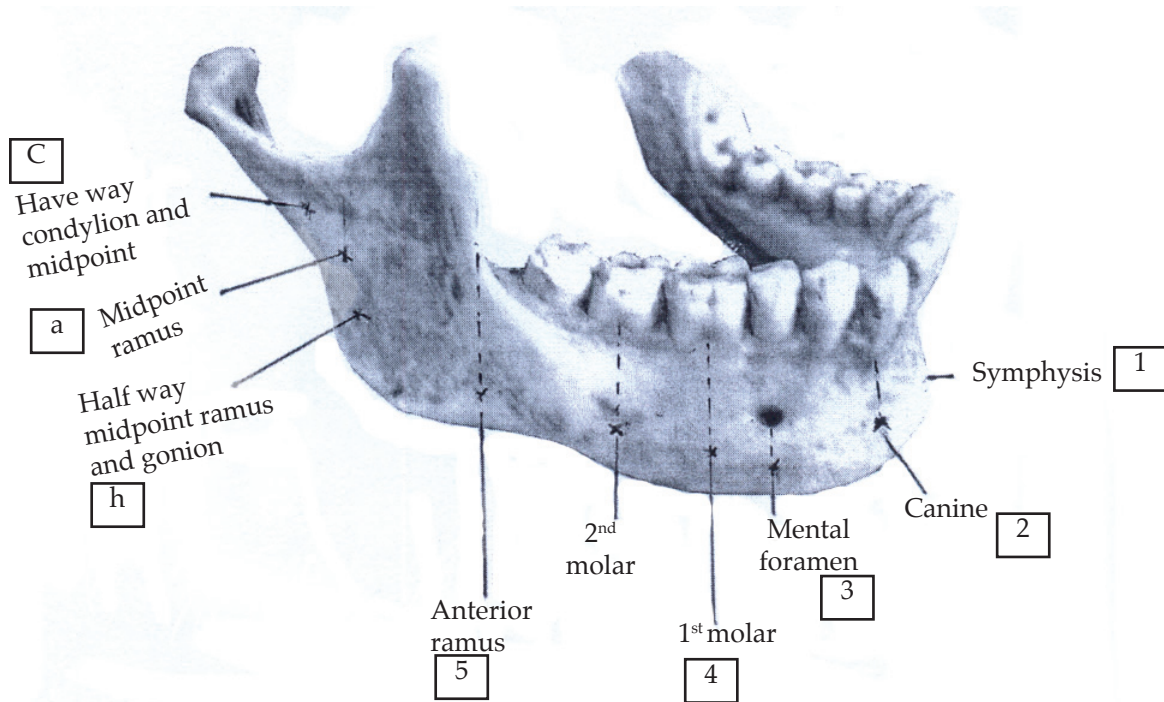


Figure 2
Landmarks for the thickness of the mandible



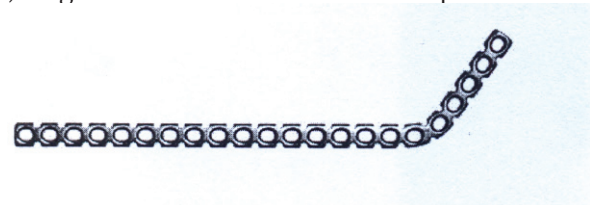
Analysis: The mandibles was carried out for the combined samples from the National Museums of Kenya and the Department of Human Anatomy. Data were analysed for male and female mandibles and the right and left sides using the SPSS (version 12.0).

Descriptive statistics included measures of central tendency (mean) and measures of dispersion (standard deviation). Statistical tests, t-test were done to determine significant differences between male and female mandibles; and the right and left sides of the mandibles. Kappa co-efficient for inter-examiner variability in mandibular parameter measurements was also determined. The mandibular parameters were compared with the sizes of reconstruction plates and screws shown in Figure 3 and 4. The Kenyan mandibular parameters were compared with those obtained from the literature for other population groups.

Length of plate (mm) 40 48 64 80 96 112 128 144 160 116 192

Average length 112.72mm

(b) Angled mandibular reconstruction plate



Average length 136mm

Average height 40mm

No. of holes 4+16 5+11 6+18

Length of plate (mm) 32+128 40+136 48+144

(c) Reconstruction plate with condylar head.

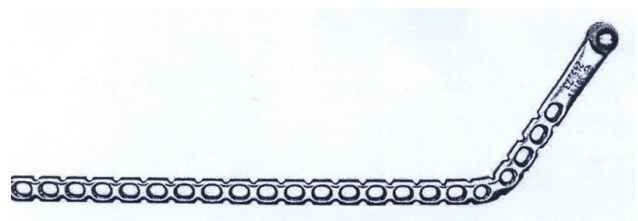


Figure 3

Reconstructive plates of various sizes

(a) Straight mandibular reconstruction plate



No. of holes 5 6 8 10 12 14 16 18 20 22 24

Average length 144mm

Average height 55mm

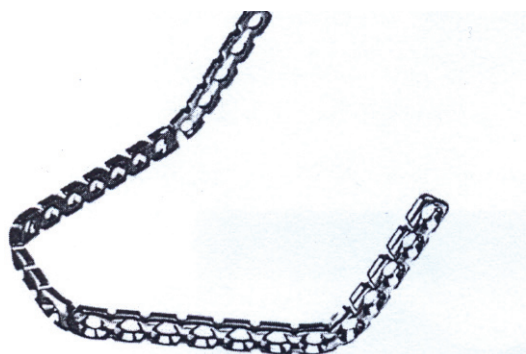
Holes 16+3 18+4 20+5

Length (mm) 128+50 144+55 160+60

Figure 4

Shows a full mandibular reconstruction plate and screw

(a) Full mandibular reconstruction plate



Holes 26 28 32
 Dimensions (total length in mm) small (208) Medium (224) Large (256)
 Average length 229.3mm

(b) A representative mandibular cortical screw



Total length sizes (mm): 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40

RESULTS

The sample of 82 mandibles consisted of 48 males and 34 females. The mean value of the length of the

right mandible in males was 98.6 mm while that of the left was 100.5 mm. The mean length of the right and left mandibles in females was 92.2 mm and 94.5 mm respectively (Table 1). There was a significant difference in the length between males and females and right and left sides ($t=7.013, P<0.05$), with a strong positive correlation of 0.902 and 0.964 respectively. Kappa co-efficient of 0.269 was obtained from the inter-observe values indicating fair agreement.

The mean height of the right and left mandibles in males was 51.4 and 58.1 mm respectively; and that in females was 51.8 and 52.2mm respectively (Table 2). The mean height of male and female mandibles and right and left sides showed significant differences ($t=5.399, p<0.05$); with a strong correlation of 0.825 and 0.881 respectively. Kappa co-efficient for inter-observer variability was 0.616 indicating

The average length of the straight plate (112.12mm), the length (136mm and height (401mm) of the angled plate and length (144mm and height (55mm) of the of the plate with condylar head showed a significant difference with the average length and height of the mandible ($p<0.05$).

The thickness of the body and ramus of the mandible were taken at selected points (Tables 3,4 and 5). There was no significant difference in the thicknesses of the mandible at the selected points in the body and the ramus between males and female ($p>0.05$). There was a strong positive correlation. Significant differences were noted between the right and left sides of the mandible ($p<0.05$). Notably, there was significant difference between the thickness of the mandible and the screw sizes ($p<0.005$)

Table 1

The length of the body of the mandible according to sex, right and left sides

		Length of the mandible (mm)	
		R	L
Male (n=48)	Maximum	109.0	111.0
	Minimum	90.0	94.0
	Mean	98.6	100.9
	S.D	4.39	3.99
Female (n=34)	Maximum	100.0	105.0
	Minimum	84.0	83.0
	Mean	92.2	94.5
	S.D	3.63	4.69

Mean length (mm) for both genders = 96.5 ± 5.19

Table 2*The height of the ramus of the mandible according to sex, right and left sides*

Height of the ramus (mm)			R	L
Male (n=48)		Maximum	70.80	69.30
		Minimum	45.60	48.90
		Mean	57.40	58.07
		S.D	4.86	7.56
Female (n=34)		Maximum	62.42	59.70
		Minimum	42.40	42.70
		Mean	51.81	52.20
		S.D	4.25	4.28

Mean height (mm) of the mandible for both genders = 54.8 ± 5.27

Table 3*The thickness of the body of the mandible at the symphysis and canine*

		Body thickness at symphysis		Body thickness at canine	
		Right	Left	Right	Left
Male (n=48)	Mean	14.49	14.42	11.29	
	S.D	1.56	1.69	1.23	1.28
Female (n=34)	Mean	13.73	13.73	10.62	10.84
	S.D	1.43	1.43	1.23	1.41

Combined mean at the symphysis 14.12 ± 1.63 , at canine 10.91 ± 1.25

Table 4*Thickness of the mandible at the bifurcation of the second molar and at the level of the anterior ramus.*

		Thickness at bifurcation		Thickness at anterior ramus	
		Right	Left	Right	Left
Male (n=48)	Mean	11.99	12.29	8.28	8.87
	S.D	1.39	1.33	1.39	1.63
Female (n=34)	Mean	12.38	12.77	8.42	8.91
	S.D	1.46	1.43	1.57	1.73

Combined mean of the thickness at the second molar = 12.15 ± 1.39 , at the anterior ramus = 8.38 ± 1.44 .

Table 5*Thickness of the ramus of the mandible*

		At mid-point ramus		Half-way between condyion and midpoint ramus		Half-way between gonion and mid-point ramus	
		Right	Left	Right	Left	Right	Left
Male (n=48)	Mean	5.96	5.81	6.66	7.00	5.81	5.76
	S.D	1.04	.96	1.06	1.02	1.22	1.36
Female (n=34)	Mean	6.05	5.75	6.32	6.37	5.92	5.53
	S.D	1.00	.99	1.03	.88	1.01	1.15

Combined mean at the midpoint of the ramus = 5.99 ± 0.98 , at halfway between condyion and midpoint of the ramus = 6.25 ± 1.05 and halfway between gonion and midpoint of the ramus = 5.87 ± 1.10 .

Table 6

The comparative aspects of the mandibular parameters of length and height in Kenyans with those of other population groups showing the t-values. The combined mean of male and female mandibular parameters was significantly different with other population groups as shown by the t-values

Population group	Mandibular length (mm)	t- value	Ramus height (mm)	t- value	Author
Zimbabweans	84.9 ±0.23	20.42	60.1±0.27	-9.64	Mbajiorgu <i>et al.</i> (6)
Japanese	81.2 ± 5.99	11.09	63.5±6.87	-7.69	Usta <i>et al.</i> (14)
Nigerians	92.7 ±0.65	6.58	55.8±0.56	-1.72	Didia and Daper (5)
South Africans	89.7 ±0.3	11.9	-	-	Iscan and Steyn (13)
Romanians	91.0 ± 3.55	4.61	53.0±0.83	3.05	puisoru <i>et al.</i> (9)
Kenyans (present study)	96.5 ± 5.19			54.8±5.27	

DISCUSSION

The present study provides baseline data for mandibular parameters obtained by direct measurements on the bone. The data obtained radiologically have been found to be unreliable (18-23). Measurements made from panoramic radiographs involve methodological error because of the magnification factor due to the position of the object between the X-ray source and the film. In addition there are varied types of panoramic X-ray machines with different ranges of magnification (18,21-23). However, accurate mandibular measurements can be taken using 3-dimensional (3-D) CT -scans as shown by Nasel *et al.* (19) and Hanazawa *et al.* (20).

The sizes of Kenyan mandibles in the present study were not comparable with the average sizes of a sample of reconstruction plates. The full mandibular plates were shown to have been smaller than the average total length of the mandible. The parameters of the Kenyan mandibles are significantly different from other population groups, thus the need for selection of plates and screws applicable to the specific population.

Appropriate selection can be made from the range supplied in sets. Due to financial constraints, in our set-up, patients are usually advised to obtain individual units of plates when reconstruction is indicated. Thus, average mandibular dimensions would be useful in prescribing the stated plates. The average thickness of the mandible at specific regions would guide in obtaining appropriate screws that support the plates. This has been supported by different studies. Mehta and Descher (24) whose analysis of different techniques of mandibular reconstruction emphasised on the objectivity of assessing the size of the mandibular defect in selecting any particular reconstructive technique. Ari *et al.* (25) in a review of the long-term results of reconstruction plates for mandibular defects also showed that the larger the defect the stronger the plate needed reconstruction and the

more the number of screws needed to support the plate. This is in addition to the type of bone graft needed to augment the defect, with long span de' needing vascularised grafts while small defects requiring less elaborate non-vascularised graft or even just bone substitutes.

Further emphasis of the mandibular dimensions in the selection of appropriate reconstruction has also been shown by Dimitroulis in his review on mandibular reconstruction after tumour surgery (4) Okura *et al.* have also shown that the size of the defect influences the long-term outcome of mandibular reconstruction using plates (26).

In conclusion, the present study provides baseline parameters of mandibles of Kenyans which is of prime importance in reconstruction surgery. It also shows variations with other Population groups in respect to mandibular parameters.

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