

## HORIZONTAL ANGLE OF INCLINATION OF THE MANDIBULAR CONDYLE IN A KENYAN POPULATION

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### SUMMARY

The horizontal angle of inclination, is important in maintaining the function of the temporomandibular joint. It should be maintained in the manufacture of condylar prostheses since deviation may lead to disk displacement and degeneration of the articular fossa. While inter-population variations exist in mandibular morphometry, published information on the horizontal angle of inclination in the African population is not available. This study therefore aimed to determine the normal range of the horizontal angle of inclination amongst Kenyans. Sixty three mandibles of African origin were used. The horizontal angle of inclination was measured as the angle between the medio-lateral axis and the coronal plane. Data collected were analyzed using SPSS v.17 for means and variance, and represented using tables, charts and photographs. The horizontal angle of inclination was larger on the right ( $22.55^\circ$ ) than on the left ( $20.01^\circ$ ) ( $p = 0.002$ ). The mean angle was larger on the right ( $24.76^\circ$  vs.  $21.75^\circ$  in males) but smaller on the left in females ( $17.80^\circ$  vs.  $20.37^\circ$  in males), but the difference was not statistically significant. The difference between right and left angles was larger in females ( $6.96^\circ$ ,  $p < 0.05$ ) than in males ( $1.38^\circ$ ,  $p > 0.05$ ). It differed significantly between the left and the right. This difference was more pronounced in females than in males for unknown reasons. The horizontal angle of inclination in Kenyans was different from those reported in general literature, and manufacturers of condylar prostheses need to factor these variations during fabrication to avoid post-operative morbidity.

**Key words:** Mandibular condyle, angle of inclination

### INTRODUCTION

The shape and morphometry of the mandibular condyle (MC) can affect the functional properties of the temporomandibular joint (TMJ); for instance, the congruency of the MC to the articular fossa has been shown to affect occlusal properties of the mandible (Kurusu et al., 2009). The HAI of the mandibular condyle (HAI) is also important as far as mandibular function is concerned. Westesson et al., (1991) noted an association between a moderate increase in HAI ( $29.7^\circ - 33.5^\circ$ ) and disk displacement, and another between a large increase ( $36.5^\circ$ ) in the angle and degenerative disease of the MC. It was not clear whether the increase was the cause or the effect of the pathology. It was suggested that an increased angle would cause tension on the lateral ligament,

an increase in the angle. It is also possible that incongruence between the MC and the articular fossa could lead to mechanical wear of the MC (Westesson et al., 1991). It therefore follows that, in the manufacture of condylar prostheses, the HAI of the prosthesis has to mirror that of a normal mandible so as to return the function of the TMJ to as close to normal as possible. Condylar prostheses commonly used to correct traumatic injury or in procedures requiring resection with disarticulation, such as tumours, trauma and degenerative diseases (Patel and Maisel, 2001). In one study, the majority (63%) of facial tumours occurred in the mandible, and ameloblastomas comprised 34% of these (Parkins et al., 2007). Ameloblastomas are benign odontogenic tumours that develop primarily

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In a recent Kenyan study, 59.3% of ameloblastoma cases required resection with disarticulation of the TMJ due to extension of the tumour into the condylar process (Butt et al., 2011). The aim of condylar replacement in such instances is to maintain function (i.e., height, mandibular occlusion and jaw mobility), as well as facial aesthetics. Since mandibular morphometry differs

significantly between populations (Hinton, 1983), condylar prostheses manufactured to foreign specifications might be of poor fit in African populations, and would therefore result in post-operative morbidity. The aim of this study was to determine the normal HAI range for the Kenyan mandibular condyle.

## MATERIALS AND METHODS

Data from 63 mandibles (126 condyles) were collected. Of these, 12 were female, 30 were male and 21 were of unknown gender. The sexed mandibles were sourced from the National Museums of Kenya. Those of unknown gender were obtained from the Human Anatomy

Department, University of Nairobi. Mandibles with the second or third molar erupted were included. Fractured or edentulous mandibles, including those with chipped condyles were not included in the study.

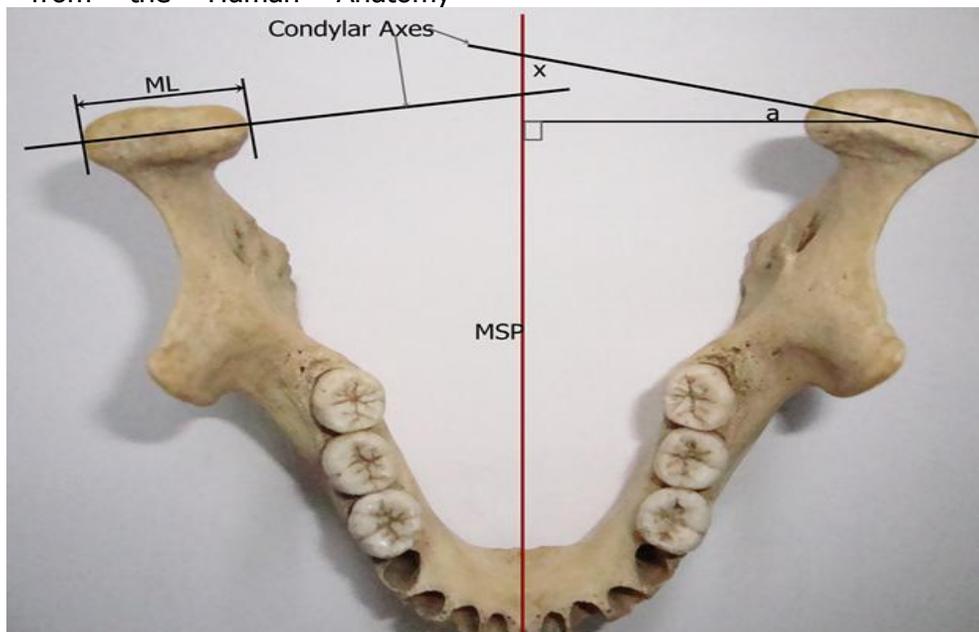


Figure 1: The horizontal angle of inclination was measured as the angle  $a$  ( $= 90 - x$ ) Mandible, superior view. ML – Medio-lateral diameter, MSP – Midsagittal plane

The sagittal plane was defined as a plane passing through the menton and between the genial tubercles. A sketch such as the one in **Figure 1** was made for all mandibles, photographed using a digital camera at a resolution of above 3MP and the angles analyzed using ImageJ™ software, v.1.43u (National Institutes of Health, USA). Data were

collected and analyzed using SPSS v.17 and Microsoft Excel 2007. Means and standard deviations were calculated. Statistical significance was inferred from the data using paired  $t$ -test for side differences, and independent  $t$ -test for gender differences.  $p$ -values of  $<0.05$  were considered statistically significant.

## RESULTS

The mean angle of inclination was  $22.55 \pm 5.43^\circ$  on the right and  $20.01 \pm 6.22^\circ$  on the left (paired  $t$ -test:  $p = 0.002$ ). On the right, the mean angle was  $21.75 \pm 4.22^\circ$  in males and  $24.76 \pm 5.58^\circ$  in females; on the left, the mean angle was  $20.37 \pm 5.95^\circ$  in males and  $17.80 \pm 5.85^\circ$  in females. The differences in angle between the sexes were not statistically significant on either side (independent  $t$

– tests:  $p = 0.066$  on the right and  $p = 0.212$  on the left). In females, the right angle was  $6.96^\circ$  larger than the left angle, a significant difference (paired  $t$ -test:  $p=0.004$ ). In males the difference in angles was much smaller ( $1.38^\circ$ ) and the difference was not statistically significant (paired  $t$ -test:  $p = 0.118$ ). These data are summarized in Table 1.

Table 1: Summary of measurements of horizontal angle of inclination

Horizontal angle of inclination				
	Overall (n=63)	Male (n=30)	Female (n=12)	P value
Right ramus	$22.55 \pm 5.43^\circ$	$21.75 \pm 4.22^\circ$	$24.76 \pm 5.58^\circ$	0.112
Left ramus	$20.01 \pm 6.22^\circ$	$20.37 \pm 5.95^\circ$	$17.80 \pm 5.85^\circ$	0.216
P value	*0.002	0.118	*0.004	

\*Statistically significant at 95% level

## DISCUSSION

In a study on a Brazilian population by Crusoe-Rebello et al., (2003), males showed no statistically significant side differences in the angle of inclination. This was similar to the findings in the

current study. However, female right and left angles of inclination showed a large and statistically significant difference.

Table 2: Comparison of horizontal angle of inclination

Study	Male		Female	
	Right	Left	Right	Left
Richards, 1987 <sup>1**</sup>	15.00 °		16.70 °	
Richards, 1987 <sup>2**</sup>	16.30 °		14.90 °	
Westesson, 1991***	21.20°			
Crusoe-Rebello et al., 2003	22.09 °	21.47 °	-	-
Kurita et al., 2003***	18.30 °			
Current study (2011)	21.75 °	20.37 °	24.76 °*	17.80 °*

\* $P < 0.05$ , \*\*No side data, \*\*\*No side, sex data, <sup>1, 2</sup> Narrinyeri and Kurna Aboriginal tribes (separate samples)

On average, the angle of inclination in Kenyans was similar to that in the Brazilian population (Crusoe-Rebello et al., 2003). However, there were vast differences between the angles in the Kenyan population and the 2 Aboriginal populations (Richards, 1987), as well as with an Asian population (Kurita et al., 2003) (Table 2). This could be due to racial differences as well as differences in eating habits, but no firm conclusion can be made as the diets of neither population were studied. Further, it was not clear why right

and left angles in females in the current study differed so greatly. Further investigation into this is recommended.

In conclusion, the angle of inclination differed significantly between the left and the right. This difference was more pronounced in females than in males for unknown reasons. The HAI in Kenyans was different from those observed in general literature, which implies that condylar prostheses should be customized for the local population to avoid post-operative morbidity.

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