

Mandibular Ramus Posterior Flexure: A Sex Indicator in *Homo sapiens* Fossil Hominids?

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ABSTRACT Accurate determination of sex in skeletal human samples is very important in anthropological and demographic studies. Recently, Loth and Henneberg have suggested that a new osteological criterion on the mandible, the mandibular ramus posterior flexure (MRPF) had a high sex discriminating effectiveness. A preliminary test applied to a few hominid mandibles (including Australopithecines, *Homo erectus*, Neanderthals and Upper palaeolithic hominids) apparently confirmed the high reliability of the MRPF as a sex indicator 'over time and through palaeospecies'.

As the pelvis is commonly considered as providing the most significant criteria that allows the establishment of skeletal sexual dimorphism of adults, the present paper evaluates this mandibular feature on a few additional palaeolithic hominids (i.e. Neanderthals and Early Modern Humans) for whom a gender estimation was known based upon the pelvis.

This analysis was conducted on the original material and its results appear in contradiction with those of the previous studies made by Loth and Henneberg. A reconsideration of the visual assessment of MRPF as a sex indicator in *Homo sapiens* fossil hominids is therefore suggested. Copyright © 2000 John Wiley & Sons, Ltd.

Key words: Early Modern Humans; mandible; Neanderthals; ramus; sex assessment

Introduction

If data collected from the skeletal morphology are relevant and fruitful in the study of past populations, all authors describing gender differences in the skeleton note that sexual dimorphism is better expressed among adult human skeletons.

In the last few years there have been new attempts to define single morphological traits that may contribute to a better understanding in the skeletal sexual dimorphism of adult individuals (e.g. Loth & Henneberg, 1996, 1997, 1998; Graw *et al.*, 1999). Loth & Henneberg (1996) were the first to define on the adult mandible a single morphological feature called the mandibular ramus posterior flexure (MRPF),

which they claimed to visually sex the bone with up to 99% accuracy in African blacks from the Dart collection (South Africa). This feature was tested on other samples (i.e. European and American whites, Amerinds and Afro-Americans) of known sex, and a result of 94.2% accuracy was observed from African and American samples combined (Loth & Henneberg, 1996).

The evident value of this neglected sex indicator in the mandible led these authors to suggest that 'preliminary investigations show that the trait is clearly evident in fossil hominids' (Loth & Henneberg, 1996). Consequently, they employed this mandibular feature to assess the sex estimation of 12 hominid mandibles, i.e. four Australopithecines, four *Homo erectus*, four Neanderthals and two specimens from the Czech Gravettian site of Predmosti (Loth &

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Henneberg, 1996, 1997). The conclusion of the study supports the high reliability of the MRPF as a sex indicator over time, from Plio-Pleistocene to Late Pleistocene hominids.

The material explored by the authors was mostly represented by casts and drawings, with the exception of the South African specimens. Moreover, for most of the individuals tested, the identification is not given and the data employed for the previous sex assessment remain unknown. Following Loth and Henneberg, the sex indicator defined on the mandibular ramus can be checked only if the three permanent molars are present or if the alveolar plane is still totally preserved. Therefore, mandibles exhibiting *ante mortem* tooth loss or not fully erupted dentition (i.e. adolescents) have to be excluded from the study.

The purpose of this paper is to report the results of an additional investigation applied to a few *Homo sapiens* hominids previously sexed on the basis of their pelvic morphology. While adult mandibles from Europe and southwestern Asia dated to oxygen-isotope stages 6–3 (ranging from 190 000–40 000 BP) are quite numerous ($N = 36$), those associated with a pelvis complete enough to assess the sex are scarce. Our study is based upon the examination of six original specimens kept in the collections of the Musée de l'Homme and the Sackler School of Medicine in the Tel Aviv University.

Material and method

Three Neanderthals and three anatomically modern humans are examined in the present study. Among the Neanderthal sample are Wadi Amud 1 and Kebara 2, both discovered in the northern part of Israel, and the most complete and least distorted skeleton ever discovered in Europe, that of La Ferrassie 1 from southwestern France. The two Levantine hominids were described as males and individual ages at death were thought to be quite identical for both fossils, i.e. between 25 and 30 years (Suzuki & Takai, 1970, p. 124; Rosenberg, 1986; Tillier *et al.*, 1989; Bar Yosef & Vandermeersch, 1991; Rak, 1991; Karasik *et al.*, 1998). The La Ferrassie 1 man had an age at death around 40 years

(Heim, 1976) and can be probably dated to the latter portion of early last glacial (early part of oxygen-isotope stage 3).

Among the anatomically modern humans, two specimens from the Skhul and Qafzeh Middle Palaeolithic layers in northern Israel are concerned. Skhul V was described by McCown & Keith (1939) as a male with an age-at-death of between 30 and 40 years. A younger age was given for Qafzeh 9, i.e. between 16 and 21 years, and several aspects of the pelvis suggested a female sex assessment for the specimen (Vandermeersch, 1981; Bruzek & Vandermeersch, 1997). The Ohalo II H2 specimen, recently found in the northern Jordan Valley and dated to ca. 19 000 BP was added to the study. Morphological characteristics indicate that Ohalo II H2 was a male and an estimated age-at-death of 35–40 years was proposed (Hershkovitz *et al.*, 1995).

According to Loth & Henneberg (1996), adult human males exhibit an angulation of the posterior border of the mandibular ramus at the level of the occlusal surface, whereas females display generally a straight posterior border of the ramus. When a flexure is present on female mandibles, the feature is never at the same level as in males: the flexure is nearby the condylar process or close above the gonial angle. A score of +1 is assigned if the flexure is visible at the occlusal level and –1 in other cases. If the trait is badly expressed, a score of 0 is assigned. For each mandible, the scores for the left and right ramus are added and mandibles with score of 0–+2 are identified as males, and mandibles with scores of –1 or –2 are identified as females.

The results of the test application for the six palaeolithic hominids are presented in Table 1.

Discussion

Five of the palaeolithic hominids examined (Figure 1) are young adults or adults. For them, sex assessment based on mandibular criteria appears quite consistent (the exception is represented by Ohalo II H2) in total contradiction with the previous prediction using the pelvic characteristics.

Table 1. Scores for MRPF and sex estimation of the palaeolithic hominids

	MRPF side scores		Sex estimation	
	Left	Right	MRPF	Pelvis
Kebara 2		-1	Female	Male ^{a,f}
Amud 1	-1	-1	Female	Male ^{b,e}
Qafzeh 9		+1	Male	Female ^d
Skhul V	-1	0	Female	Male ^a
Ohalo II H2	+1	+1	Male	Male ^g
La Ferrassie 1	-1	-1	Female	Male ^c

^aMcCown & Keith (1939); ^bSuzuki & Takai (1970); ^cHeim (1976); ^dVandermeersch (1981), Bruzek & Vandermeersch (1997); ^eRosenberg (1986); ^fRak (1991); ^gHershkovitz *et al.* (1995).

The last specimen under investigation, Qafzeh 9, exhibits the root apex of the third molar still opened and seems to be aged between late adolescence and adulthood. Interestingly, two gender determinations were proposed from the pelvic study. While a female sex assessment was first suggested by Vandermeersch (1981), based on two pelvic characteristics, i.e. the ischio-pubic index and the sciatic notch morphology, a male determination was later proposed by Rosenberg (1986) using the Phenice's method. Such an assertion was later retained by Rak (1990). However, it should be reminded that the method of Phenice (1969, p. 300) 'has only been tested on adult material'. Additional analyses conducted by Bruzek (1991) and White & Folkens (1991, p. 325) have confirmed that this method should be restricted to fully adult skeletons, and its application provided erroneous results particularly for young females. Recently, a multivariate statistical analysis was applied to the Qafzeh 9 pelvis by Bruzek & Vandermeersch (1997), which confirmed the previous female determination.

Interestingly, the unique positive result represented by the Ohalo II H2 Upper Palaeolithic individual and this seems to be in agreement with the previous observations made by Loth and Henneberg on the Predmosti III and IV Gravettian mandibles.

Among the palaeolithic hominid sample examined in this paper, the discrepancy shown in Table 1 between sex estimations based upon either the pelvis or the MRPF can be interpreted

in different ways: (1) the expression of mandibular sexual dimorphism might differ between fossil (i.e. Neanderthals and Early Modern Humans) and recent *Homo sapiens*, (2) the accuracy of the mandibular criterion as a sex indicator may be related to the age at death of the individuals, (3) this accuracy might depend upon the sample tested.

Concluding remarks

In conclusion, a visual assessment of MRPF as a sex indicator in six palaeolithic hominids did not bring evidence of a high value of this discriminant factor among fossil *Homo sapiens*.

Our results contrast with those published by Loth & Henneberg (1996, 1997) for other fossil specimens. However, they are in agreement with the conclusions reached by several scholars (Coqueugniot & Bruzek, 1997; Donnelly *et al.*, 1998; Hill, 1999), who questioned the accuracy of the MRPF from the examination of recent samples originated from other collections than those previously employed to establish the validity of the feature.

It can be suggested that scoring the MRPF macroscopically may not suffice to establish the accuracy of this feature and that the low reliability of MRPF obtained on some recent samples may be interpreted as an illustration of inter-populational variabilities.

The MRPF, as well as all morphological features used individually, cannot reach the same level of accuracy than that brought by a combination of non-correlated traits. Obviously a reliable sex identification in skeletal series should derive from a combination of skeletal features not correlated (Sjøvold, 1988) and cranial traits give less performance than that of the pelvis. Indeed, a recent report by Königsberg & Hens (1998) shows that the combination of five morphological skull provides an accuracy of 81% in sex determination while the accuracy on the basis of the pelvic criteria may overpass 95% (e.g. Ferembach *et al.*, 1979; Krogman & Iscan, 1986; Bruzek, 1991).

Ancient DNA research applied to fossil hominids has just started and the main objective has been to document genetic relationships

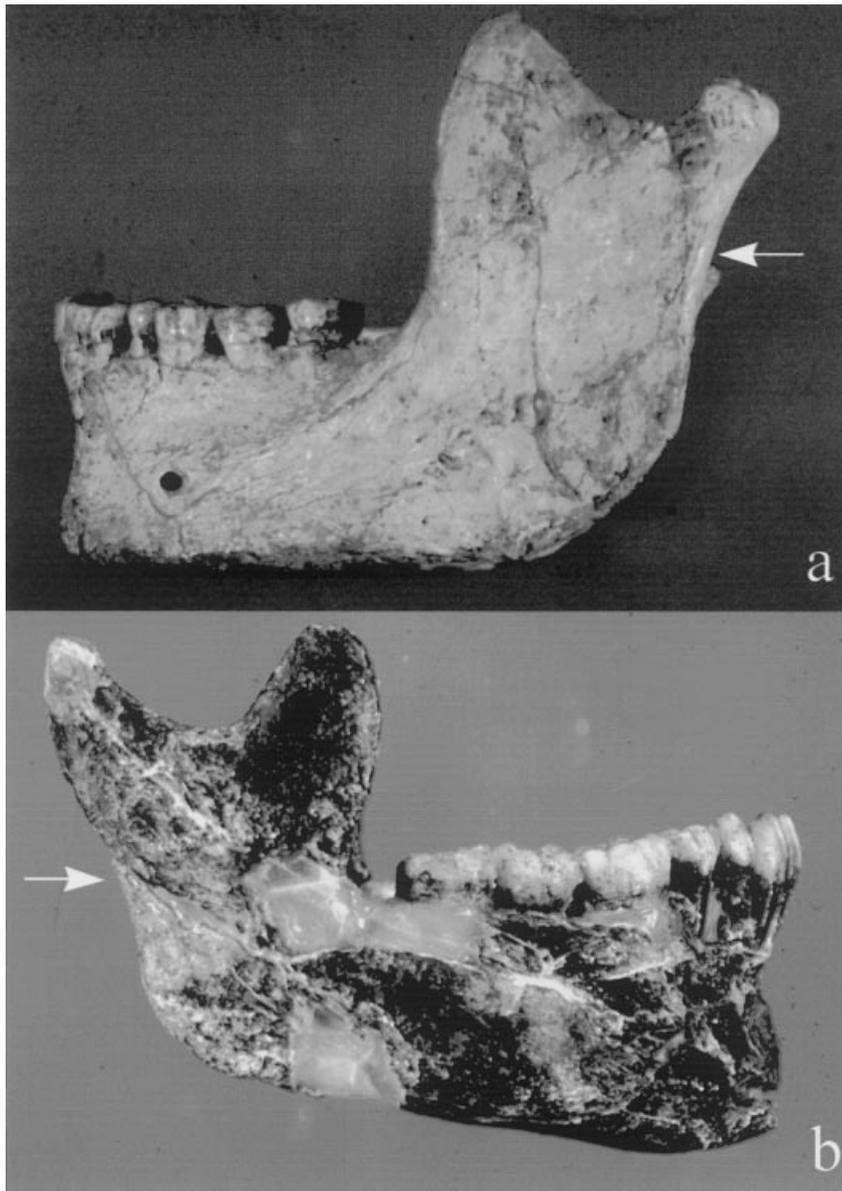


Figure 1. Lateral views of two Levantine Middle Palaeolithic mandibles. (a) The Amud 1 mandible (left side); (b) the Qafzeh 9 mandible (right side). The white arrows indicate the level of the maximum flexure.

between groups (e.g. Cooper *et al.*, 1997; Krings *et al.*, 1997). Consequently, the identification of sexual dimorphism still relies almost exclusively upon skeletal morphological features. We think that MRPF must be considered for anthropological and forensic purposes as one additional feature among the many parameters used in sex assessment of skeletal series. However, the potential usefulness of the MRPF in the sex estima-

tion of fossil hominids seems to have been overestimated.

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