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The Cervical Vertebrae, Mandible and Hyoid from the Kebara Mousterian Hominid 2 : Morphological and Behavioural Aspects

Les vertèbres cervicales, la mandibule et l'os hyoïde du squelette moustérien de Kebara 2 : aspects morphologiques et liés au comportement

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Abstract

The simultaneous presence on the Mousterian skeleton Kebara 2 (Mount Carmel, Israël) of three well preserved elements, the cervical column, the mandible and the hyoid bone for the first time permits us to suggest a reconstruction of the supralaryngeal region. This leads us to reconsider the question widely debated by English-speaking authors as to the speech aptitude of these Middle Palaeolithic populations, starting from different anatomical bases.

Résumé

La présence sur le squelette moustérien de Kebara 2 (Mont Carmel, Israël) de trois vestiges osseux bien conservés, la colonne cervicale, la mandibule et l'os hyoïde, permet, pour la première fois, de proposer une reconstitution de l'espace supralaryngien. Cette dernière conduit à reconsidérer la question largement débattue par les auteurs anglophones de l'aptitude à la parole de ces populations du Paléolithique moyen, en partant de ce fait de bases anatomiques différentes.

Key words : cervical column, mandible, hyoid bone, supralaryngeal region, speech aptitude.

Mots clés : vertèbres cervicales, mandibule, os hyoïde, espace supralaryngien, langage.

Introduction

The adult male hominid skeleton (KMH2) from the Kebara Cave, Israel - dated to ca. 60,000 BP (Valladas *et al.*, 1987; Schwarcz *et al.*, 1989)- preserves portions of the neck region that are either unknown or fragmentary in other Middle Palaeolithic specimens. These include a complete cervical vertebral column, a well-preserved mandible, and a virtually complete hyoid bone (Bar-Yosef *et al.*, 1986) (fig. 1). The latter find is of special importance because it is the first hyoid

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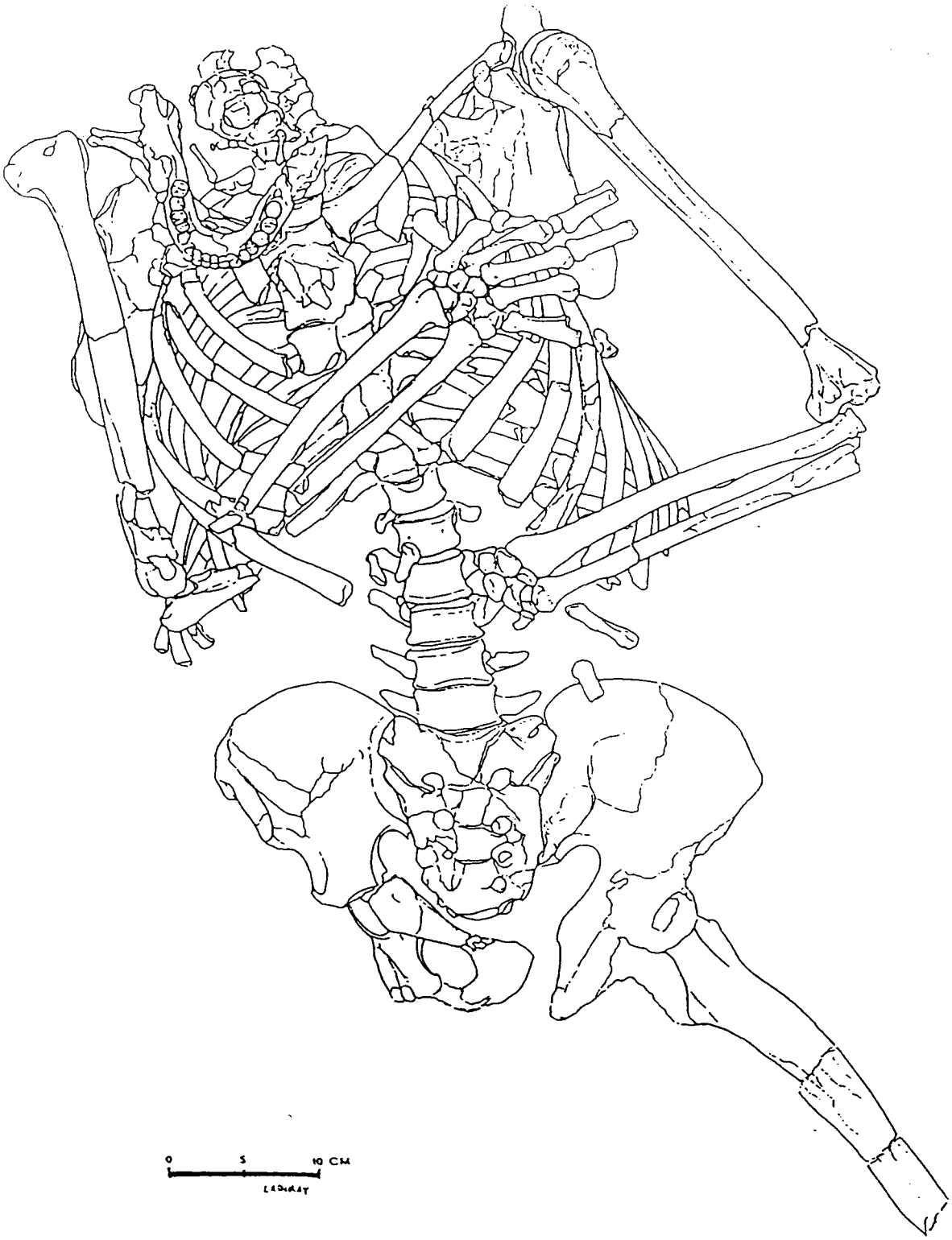

Fig. 1 The Kebara 2 skeleton in situ with the hyoid bone between the two mandibular arches.

of any fossil hominid to be discovered. Although the cranium of Kebara 2 is missing, the presence of these other elements enables us to make some assessments about pathology, posture and the controversial question of speech capabilities.

The Cervical Vertebrae

Prior to the discovery of Kebara 2, the most informative examples of the cervical vertebrae from the Middle Palaeolithic were Spy (Fraipont and Lohest, 1887), Krapina (Gorjanovic-Kramberger, 1906), La Chapelle-aux-Saints (Boule, 1911-13), La Quina (Martin, 1923), Skhul and Tabun (McCown and Keith, 1939) and more recently Shanidar (Stewart, 1962; Trinkaus, 1983), Regourdou (Piveteau, 1966) and Qafzeh (Vandermeersch, 1981). Kebara 2 is the best preserved of all these individuals, as it is the only specimen with the complete series (C1-C7) represented (Arensburg, 1989). A detailed description and comparison of Kebara 2 vertebrae can be found in Arensburg (in press).

Boule's (1911-13) analysis of the La Chapelle-aux-Saints vertebral column reflected his view of the Neandertals as morphologically intermediate between chimpanzees and modern humans, representing the primitive "cousins" of modern humans. This view was echoed by McCown and Keith (1939, p. 93), who stated that "the Skhul and Neandertal cervical spines resemble each other and also those of the anthropoids". After such critical works as Arambourg (1955), Patte (1955), Toerien (1957), Straus and Cave (1957) and Piveteau (1966), it is not necessary to refute each of the old and largely discredited claims concerning the primitiveness of the Middle Palaeolithic cervical column.

The Kebara 2 cervical region displays no significant morphological differences from modern humans, and the individual ventral and dorsal heights of the vertebral bodies are within the range of both Middle Palaeolithic and modern human samples (Table 3 in Arensburg *et al.*, 1990). The Kebara 2 cervical column can be reconstructed to acertain its length and curvature. Comparative anatomical studies suggest that the vertebral discs comprise 22% of the total neck length (DePalma and Rothman, 1970), therefore the probable length of the Kebara 2 cervical column should be 106.5 mm (based on the combined heigths of C2-C7 (87.3 mm) plus 22%). This compares well with other Middle Palaeolithic specimens (Skhul V, 110.9 mm; Shanidar II, 132.2 mm) and modern humans, as Kebara 2 exceeds the mean value for European and American samples (Arensburg, in press). Thus the earlier picture of short-necked Middle Palaeolithic peoples is not supported by the Kebara 2 evidence. The curvature of the Kebara 2 cervical column also appears to be modern. Even without the discs, which are the main contributors to cervical curvature, the generally greater ventral body heights indicate the modern configuration of cervical lordosis.

The form of the spinal processes merits special attention as it is crucial for an understanding of head and trunk posture. Spinous process shape corresponds to very important functional adaptations : in modern humans with the balance of the head directly over the vertebral column, the ligamentum nuchae is substantially reduced and bilateral movement is augmented with concommitant increases of the attachment surfaces (i.e. bifurcation) for the rotator and extensor muscles (e.g. trapezius, semispinalis capitis, multifidus, interspinalis, etc.) (von Eggeling, 1922; Allbrook, 1955; Fielding *et al.*, 1976). Boule (1911-13) focused on the length, inclination and bifurcation of the spinous processes in La Chapelle-aux-Saints, using this morphology as the basis for his pithecoid assessment. The spinous processes are somewhat horizontal for the last two vertebrae (C6 and C7) of Kebara 2, but they are not bifid, falling within the range of modern human variation. However, examination of the total configuration of the Kebara 2 and other Middle Palaeolithic individuals' spinous processes does not suggest any significant difference in posture and head balance from modern humans (Arensburg, in press).

Straus and Cave (1957) introduced the notion that pathology was an important component of Neandertal morphology when they

argued that oesteoarthritis affected the general form and inclination of the La Chappelle-aux-Saints spine. Kebara 2 also exhibits some pathology, but it is limited to the first three cervical vertebrae, affecting the atlanto-odontoid and C2-C3 articulations (Duday and Arensburg, in press). This pathology appears to be the result of degenerative changes from normal usage, and was not likely to have restricted movement or altered posture.

The Mandible

The state of preservation of the Kebara 2 mandible is excellent (fig. 2). The body and ascending rami are almost complete, showing some damage to the left coronoid process and mandibular notch. The left condylar process is missing but the right is complete. All muscular attachment areas are clearly defined (Tillier *et al.*, 1989). For example, the mylohyoid ridge can easily be followed along the internal surface, and exhibits the anteriorly descending course found in modern humans. The dental arcade is complete and the occlusal relations are evident. Attrition in this individual is slight, indicating Kebara 2 was a young adult.

The Kebara 2 mandible shows a combination of gracile and robust features. Serveral measures exceed those of modern humans as well as other Middle Palaeolithic specimens (Tillier *et al.*, 1989). The corpus is extremely robust and tall, especially in the symphyseal region, but decreases in height posteriorly as in more gracile individuals. In profile, the symphysis shows a vertical rather than a receding orientation, as might be expected in very robust Middle Palaeolithic individuals. The pathology is minor (enamel hypoplasia, hypercementosis, alveolar resorption) and did not affect the condylar portion of the temporomandibular joint.

The Hyoid

The Kebara 2 hyoid is nearly complete ; the body and the two greater horns are preserved. The latter are not fused to the body of the bone and the lesser horns are missing, a common condition in modern human hyoids. Indeed, synostosis between the various elements of the hyoid is not always achieved, and the lesser horns may remain cartilaginous throughout an individual's lifetime.

The ventral surface of the body presents two deep superior fossae separated by a median crest for the attachment of the geniohyoid muscles, and two less marked lateral inferior fossae for the omohyoid muscles. The right greater horn is complete and preserves the distal attachment surface for the thyrohyoid ligament.

Kebara 2 is comparable to modern humans on two levels : morphologically and metrically. In all repects, the morphology of Kebara 2 hyoid is within the range of modern human variation (Arensburg *et al.*, 1989). Most importantly, the attachment areas for those infrahyoid muscles on the ventral surface of the body (omohyoid, sternohyoid and thyrohyoid) are identical to those of modern humans, as are the attachments for the hyoglossus muscles on the greater horns.

Metrically, the Kebara 2 hyoid is also very similar to modern humans. Only the transverse diameter appears to be significantly larger, but the exact position of the greater horns relative to the body is somewhat difficult to assess because of the missing articular cartilages. However, a good measure of overall dimensions is the transverse /sagittal ratio (Papadopoulos *et al.*, 1989) which for Kebara 2 falls well within the modern human range (Arensburg *et al.*, 1990). Any consideration of metrics is meaningless unless morphology, function and anatomical relations are taken into account. Without this, one might be misled in comparing Kebara 2 (or any fossil hominid) with totally inappropriate samples (c.f. Laitman *et al.*, 1990).

Anatomical Relations

The hyoid is often described as a free-floating bone as it lacks direct articulation with

other skeletal elements. However, this description is misleading because the hyoid is connected through a set of muscular and ligamentous relationships to the mandible, cranial base, larynx, pharynx, sternum and scapula. Its position relative to the vertebral column is also known.

The position of the hyoid bone and the underlying larynx in hominid fossils may be assessed fairly accurately if the mandible and its muscle markings and contacts with the cranium are recovered. Some workers suggest that the hyoid and larynx in Middle Palaeolithic hominids were placed much higher than in modern humans (i.e., closer to the cranial base). This is the condition in apes and human newborns, and acts to limit their supralaryngeal space and speech capabilities (Liebermann and Crelin, 1971; Liebermann *et al.*, 1972; Laitman *et al.*, 1979; Liebermann, 1984; Crelin, 1987). In contrast, we argue that the Kebara 2 hyoid should be positioned at the same level as modern humans for the following reasons :

1) muscular marking on the mandible and hyoid follow the pattern seen in modern humans, suggesting a similar suite of muscular relations;
2) the position of the hyoid relative to the cranial base is contingent on head and neck posture. With a modern curvature of the cervical vertebrae (i.e. cervical lordosis), the hyoid must be positioned low relative to the cranial base;
3) the hyoid has a relatively fixed position with regard to the mandible, lying roughly at or below the inferior border (Falk, 1975). This relationship is independent of head positioning or cervical lordosis;
4) the Kebara hyoid is of modern human proportions and morphology.

When the Kebara 2 hyoid is positioned according to these observations, there is no apparent reduction of the supralaryngeal space. This very important point is best illustrated by a reconstruction of the anatomical relations between the hyoid, mandible and cervical vertebrae of Kebara 2 (fig. 3).

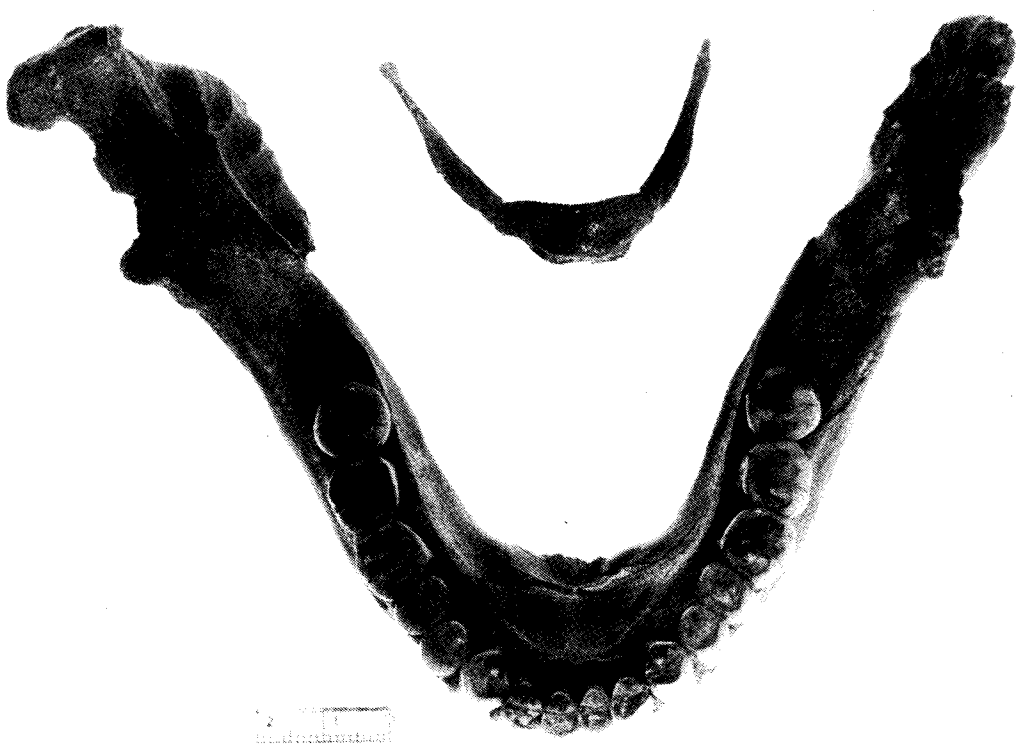

Fig. 2 The Kebara mandible and the Kebara hyoid in superior view.

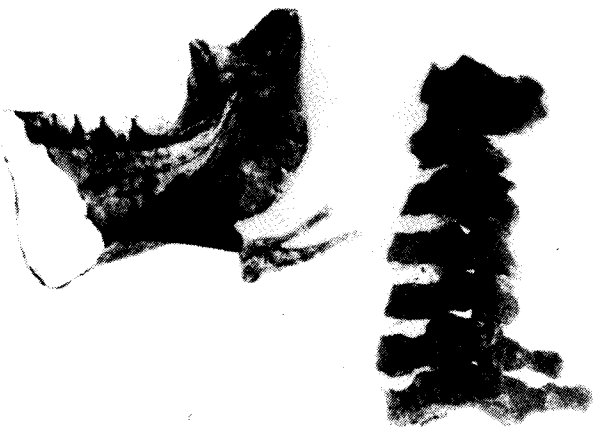

Fig. 3 Lateral view of the reconstructed Kebara cervical column, hyoid and hemimandible. The black portion represents the mylohyoid muscle. Placement of the vertebral column relative to the hyoid and mandible is approximative.

The Kebara 2 cervical column length is determined using our estimate for the combined height of the bodies and discs, and the curvature is based on articulation of the transverse processes. There is slight distortion of a few articular surfaces (Arensburg, in press), but the general form of the column is not affected. The mandible is oriented with the inferior symphyseal margin at the level of the fourth cervical vertebra, maintaining a horizontal occlusal plane. Finally, the position of the hyoid bone is determined by reconstructing the mylohyoid muscle from its origin along the mylohyoid line of the mandible to its insertion on the ventral surface of the hyoid body. The hyoid body is positioned at the level of the fourth cervical vertebra, in line with the inferior symphyseal margin and just below the gonial angle of the mandible.

This reconstruction shows the available room for the supralaryngeal tract of Kebara 2. This space is not reduced by the robusticity of the mandible, the dimensions of the hyoid, or by the placement of the hyoid relative to the cranial base (determined here as roughly equivalent to the temporomandibular joint).

Conclusions

The new data from the Kebara 2 specimen strongly suggest that Middle Palaeolithic people shared structural relationships with modern humans in terms of their vocal tract. They appear to be equally capable of speech when hyoid positioning and supralaryngeal space are the criteria considered.

Kebara 2 does not necessarily tell us about the origin of speech. Nevertheless, the fossil provides important biological evidence pertaining to the speech capability of hominids preceding modern humans. Biological evidence pointing to similar speech capabilities and brain morphology in Middle Palaeolithic hominids (especially Neandertals) and modern humans is generally rejected because of the view that these features are the structural basis for unique modern human behaviours (Davidson and Noble, 1989; Dibble, 1989). In fact, speech limitations are often proposed as a key factor determining the Neandertal demise (Cavalli-Sforza *et al.*, 1988; A.E. Wilson, quoted in Brown 1990). Some workers, while accepting the biological evidence, still interpret it as a situation where structure evolves before function (c.f. Noble and Davidson, 1989). However, all the cultural evidence for complex behaviour at Kebara, (mortuary practices, lithic complexity, and organization of site activity areas) (Arensburg *et al.*, 1985; Meignen and Bar-Yosef, 1988; Tillier *et al.* 1988; Bar -Yosef and Vandermeersch, eds, in press) would imply that the Middle Palaeolithic inhabitants were probably making good use of their anatomical capability for speech.

Acknowledgments

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