2016

New evaluation of the Castel di Guido 'hyoid'

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Publication Details

Capasso, L., D'Anastasio, R., Mancini, L., Tuniz, C. & Frayer, D. W. (2016). New evaluation of the Castel di Guido 'hyoid'. Journal of Anthropological Sciences, 94 231-235.

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Abstract

Castel di Guido is located west of Rome and part of the Aurelian formation (Mariani-Constantini et al., 2001) along with other sites such as Torre in Petra and La Polledrara (Mussi, 2001). These localities are a mixture of surface collections and excavated sites, all associated with Acheulean tools and dated to MIS 9. At Castel di Guido material was collected from the surface and excavations in an erosional channel (Mariani-Constantini et al., 2001; Mussi, 2001). The Middle Pleistocene dates suggest an age of around 400 ka. Direct associations between the human bones and tools do not exist, but based on the size and degree of fossilization the human material is thought to be late Acheulean. The deposits overlie tuffs from the Sabatini volcanic eruptions, dated at 431 ka+/-40 ka - 438 ka +/- 40 ka. so cannot be older than this. Originally six fragmentary bones were recovered from the site (Alciati et al., 2005) but Capasso, Michetti & D'Anastasio (2008) found additional material based on their survey of the material for post-mortem modifications.

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doi 10.4436/jass.94021

JASs Correspondence & Notes

Journal of Anthropological Sciences

Vol. 94 (2016), pp. 231-235

New evaluation of the Castel di Guido 'hyoid'

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Introduction

Castel di Guido is located west of Rome and part of the Aurelian formation (Mariani-Constantini *et al.*, 2001) along with other sites such as Torre in Petra and La Polledrara (Mussi, 2001). These localities are a mixture of surface collections and excavated sites, all associated with Acheulean tools and dated to MIS 9. At Castel di Guido material was collected from the surface and excavations in an erosional channel (Mariani-Constantini *et al.*, 2001; Mussi, 2001). The Middle Pleistocene dates suggest an age of around 400 ka. Direct associations between the human bones and tools do not exist, but based on the size and degree of fossilization the human material is thought to be late Acheulean. The deposits overlie tuffs from the Sabatini volcanic eruptions, dated at 431 ka+/-40 ka - 438 ka +/- 40 ka. so cannot be older than this. Originally six fragmentary bones were recovered from the site (Alciati *et al.*, 2005) but Capasso, Michetti & D'Anastasio (2008) found additional material based on their survey of the material for post-mortem modifications.

Revised description

The specimen (CdG-1), is a tubular, not flattened, small bar of bone (Fig. 1a). As argued in the earlier paper, its morphology does not resemble that of hyoids of modern humans, the Neandertal from Kebara (Arensburg *et al.*, 1989) nor *Au. afarensis* from Dikika (Alemseged *et al.*, 2006). The hyoid of Dikika's child closely resembles that of an ape, as it is large and rounded, with a deep bulla. In Neandertals and modern human specimens, the corpus is flattened in an anterior-posterior dimension and rectangular in shape. A similar shape characterized the hyoids from Sima del los Huesos, which have been described as modern human-like (Martínez *et al.*, 2008). This material is earlier than Castel di Guido by more than 100 ka, so finding a non-modern-like hyoid at this site would have had important implications for the evolution of throat structures in hominins.

Anatomically, this small fossilized bone fragment more closely resembles a vertebral arch. The bone is too thick and short to be the body of human hyoid. Comparison with the Kebara hyoid (Arensburg *et al.*, 1989) shows

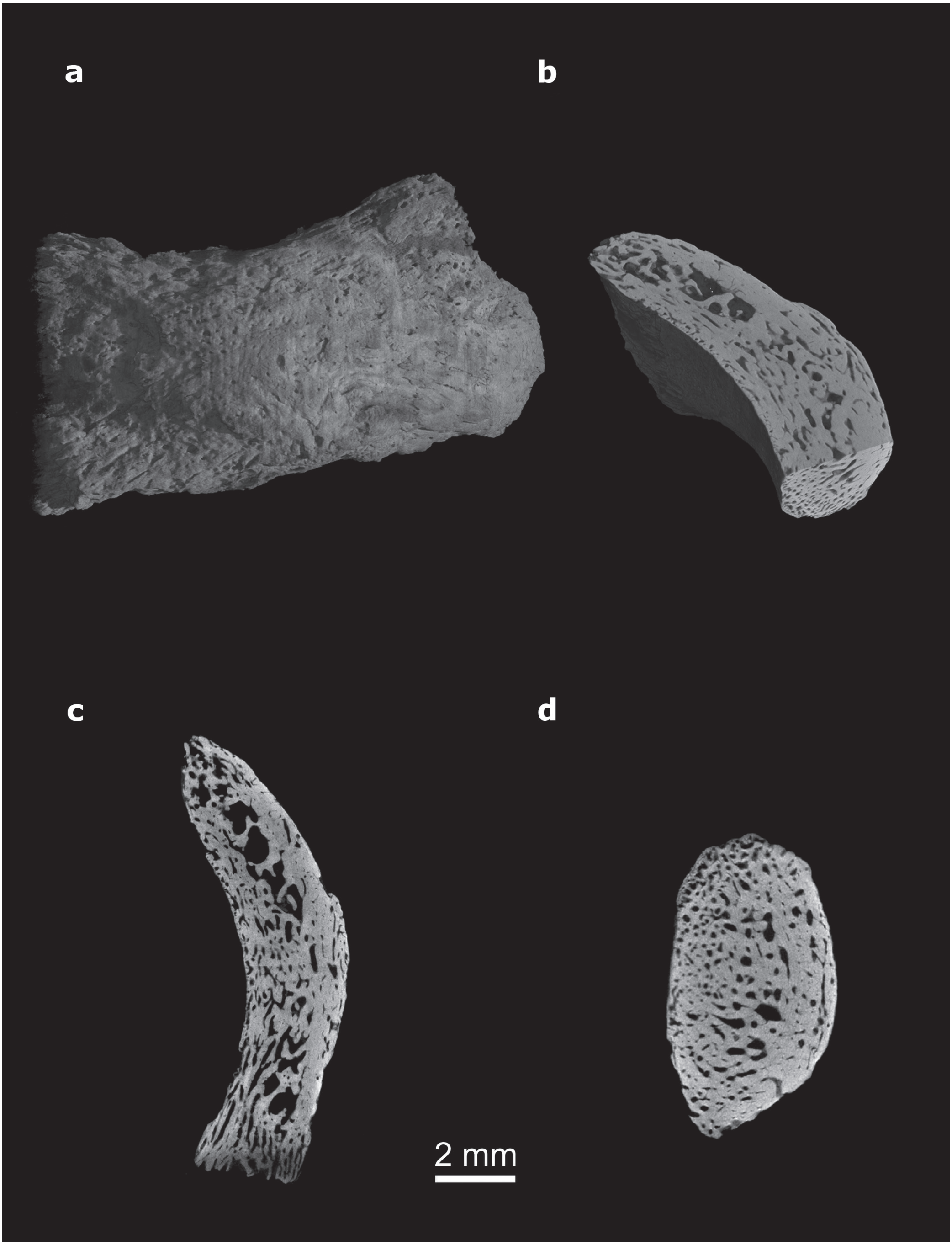

Fig. 1 - Castel di Guido sample (CdG-1, University Museum Chieti – Italy). Volume rendering (a); spongy bone structure (b); histological architecture: medial sagittal section (c) and medial transverse section (d).

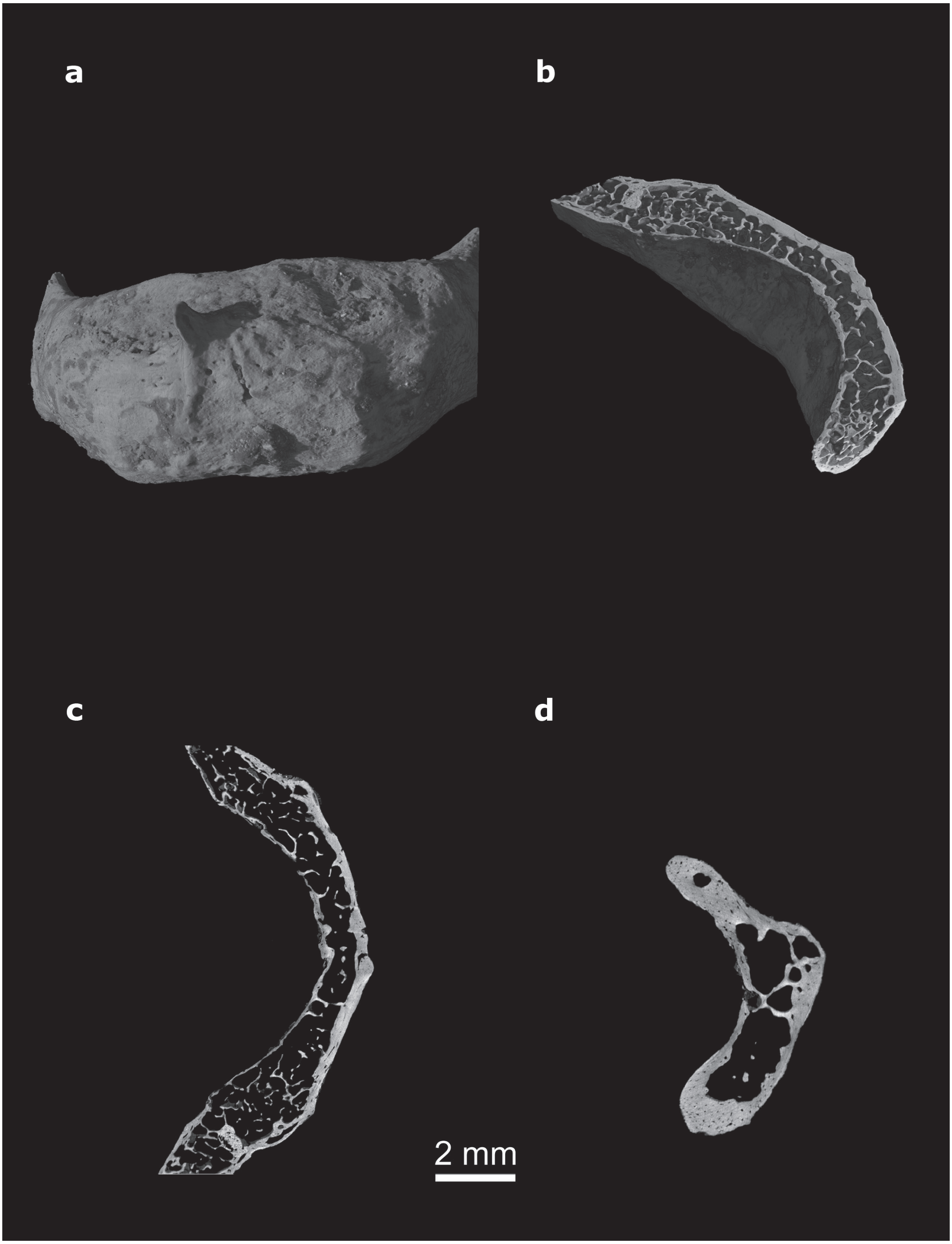

Fig. 2 - **Homo sapiens** ***hyoid (Canne della Battaglia T58, University Museum Chieti - Italy). Volume rendering (a); spongy bone structure (b); histological architecture: medial sagittal section (c) and medial transverse section (d).***

Tab. 1 - X-ray computed microtomography set-up.

SAMPLE	T58	CdG-1
VOLTAGE	80 kV	100 kV
CURRENT	100 µA	80 µA
NUMBER OF PROJECTIONS	2400	2400
EXPOSURE TIME / PROJECTION	5.5 sec	2.8 sec
FILTER	1 mm Al	1 mm Al
CUBIC VOXEL WITH SIDE	10.7 micron	10.0 micron

that it is approximately three times thicker at the base and shorter in height by more than one-third. Comparisons to a modern human hyoid (Fig. 2) reveal similar results, with the modern hyoid thinner in the anterior-posterior view. CdG-1 is a stocky bone, unlike the Kebara and modern human hyoids, which are long and thin. Part of the reason it was identified as a hyoid corpus is the presence of a prominent crest on the anterior face (Capasso *et al.*, 2008). In fact the whole face is swollen into a tubercle, which is positioned lower than in the Kebara or modern human hyoids. The anterior face lacks the depressions lateral to the tubercle, typical of modern human and Kebara hyoids. On the anterior face of Kebara's hyoid the fossae for the geniohyoid muscles are deep and pronounced. Nothing similar appears in Castel di Guido bone. Unlike Kebara, the superior margin does not form a shelf, but has a rounded margin. Even young individuals have a superior border, which forms a shelf that extends back a few millimeters and definitely makes a break with the anterior face. In Castel di Guido the bone surface does not angle posteriorly in the superior-most aspect, but forms a margin of a few millimeters, then it drops vertically and inferiorly. Viewed superiorly one can look down the anterior and posterior face and follow bone surfaces. In the Kebara and modern human hyoids (including young individuals) the interior face is obscured by the superior shelf.

The overall morphology best matches the posterior arch of the atlas and the tubercle is the attachment for *ligamentum nuchae*. The bone fragment does not appear to be the anterior rim, since its internal surface lacks the dens articular facet. Corroboration of this new assessment comes from microtomographic sections, which show CdG1 to be very different in basic details from a modern hyoid bone.

A modern human hyoid of an adult male from Canne della Battaglia (T58) and the CdG-1 bone (both stored in the University Museum of Chieti, Italy) were analysed by X-ray computed microtomography (Tab. 1) at the TomoLab station of the Elettra Synchrotron Light Laboratory in Trieste (Italy). The TomoLab station is based on a microfocus source which guarantees a minimum focal spot size of 5 microns, in an energy range from 40-130 kV and a maximum current of 300 µA. A set of 2D slices was reconstructed by using the commercial software COBRA (Exxim) from tomographic projections acquired by the detector (a water-cooled, 12bit, 4008x2672 pixels CCD camera with a pixel size of 12.5×12.5 mm²) during a full sample rotation (360 degrees). Volume renderings of the samples were obtained by the commercial software VGStudio MAX 2.0©.

Scanned images of the CdG-1 show that it is mostly composed of cancellous bone with a moderate cortical cover. This is very different from the modern human hyoid body, that is primarily a thin plate of cortical bone with very thin cancellous bone and well developed inter-trabecular spaces (Figs. 2b-d). Besides, the body of the modern human hyoid presents many thin trabeculae that form a complicated net, more evident in the lateral regions of the hyoid's body. The Castel di Guido bone has a thick cancellous bone and covered with cortical bone, narrow inter-trabecular spaces and an irregular orientation of the bony trabeculae (Figs. 1b-d). So, it is a thick bone, metrically different from hyoid bones of modern humans, Kebara Neanderthal or Sima de los Huesos hominins (Arensburg *et al.*, 1989; Capasso *et al.*, 2008; Martínez *et al.*, 2008).

Conclusions

The Castel di Guido specimen has an external and micro-structural anatomy that is very different from extant and fossil hyoid bones. It is better identified as the posterior rim of the first cervical vertebra.

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Editor, Giovanni Destro Bisol