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Digital reconstruction of the LB1 *H. floresiensis* cranium

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It is well known that interpretation of the human fossil record is complicated by variation in fossil preservation, particularly when those fossils are fragmented and/or distorted. Although qualitative morphological information can sometimes be gathered from a distorted fossil, morphometric and/or biomechanical analyses [1, 2] can be compromised because the integrity of the fossil is often an essential prerequisite. The logical consequence is that fragmented and/or distorted fossils are excluded from advanced morphometric and/or biomechanical analyses, thus reducing the fossil sample size and, ultimately, our knowledge of human evolution. In this contribution we present a virtual reconstruction of the H. floresiensis holotype (LB1) cranium using state of-the-art three-dimensional (3D) digital modelling and GM methods [3]. The LB1 cranium, along with the post-cranium, was recovered in September 2003 during archaeological excavation at Liang Bua, a limestone cave on Flores in eastern Indonesia 14 km north of Ruteng (the provincial capital of Manggarai Province). The age of LB1 ranges between 60.000 years ago (kyr) and 100.000 kyr [4]. As far as the skull is concerned, while the mandible is almost complete (apart the left condyle), the bregmatic region, right frontal, supraorbital, nasal and sub-nasal regions were discovered damaged [5]. Moreover, LB1 shows cranial asymmetry, which has been considered by some authors to be similar to that observed in non-pathological African ape and fossil hominin crania, but by others as positional deformational plagiocephaly, a condition that results from plastic deformation of the skull during infancy. Overall, even though the LB1 skull is mostly preserved, the fragmented and missing regions of the cranium coupled with the alleged physiological cranial asymmetry (post-depositional deformation cannot be entirely dismissed), a digital reconstruction is required in order to use the specimen for morphometric and biomechanical analysis. 3D digital models of the external cranial surface, endocranium, mandible, and upper and lower teeth were obtained from the CT image data acquired by Brown and colleagues in April 2004. The first step entailed the reconstruction of the right zygomatic arch, left supraorbital bone and left mandibular condyle by mirror imaging the preserved side, that is using morphological information of the original specimen. Then, the remaining missing parts (i.e., bregmatic, nasal and sub-nasal regions) were virtually restored by warping a reference cranium, i.e. KNM-ER 1813 (H. habilis) using thin plate spline interpolation. Finally, a symmetric version of LB1 cranium was obtained using reflected relabelling. This new reconstruction provides the opportunity to adjust and/or integrate previous cranial measurements and is suitable for further quantitative studies, such as assessing cranial morphological variation using GM methods or testing hypothesis of feeding behaviour by means of finite element analysis.

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