Three-Dimensional Imagery : A New Look at the Tautavel Man

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Abstract

In 1981 was shown an empirical reconstitution of the incomplete skull of a fossil man called the Tautavel Man. The recent advent of digital picture gave us a second opportunity to study the fragmentary remains (Arago 21 & 47) of the 'Oldest Frenchman' (450,000 years old). After researches on the original fossil records as well as on X-ray digital acquisitions, we made a 3D model by virtually replacing the fossils. A preliminary work was realized on solid cast then, in a second step, the considered placements were analyzed virtually. The correct middle face was mirrored, different deformations were balanced, the right parietal was placed differently. The lack of some bones was counterbalanced by a substitution with others more or less contemporary European skulls (Sima de los Huesos,…) digitalized as well. The different hypotheses can be tested directly, preventing a long and expensive work by means of cast reconstitution, which often proves difficult to handle. This work will allow us to better know the hominids of the Middle Pleistocene by resituating the Tautavel Man more accurately, while waiting for the discovery of the missing fragments during future excavations.

Introduction

In 1971, a human face was discovered in the "Caune de l'Arago", a cave in Tautavel, France, in layer "G" dated to 450,000 years BP (Lumley 1973, Yokoyama 1991). It was the 21st human remains found in this place, therefore called "Arago 21" (Fig.1). In 1980 was discovered an incomplete right parietal bone, "Arago 47", which could be joined with the face. Those two bones were baptized "Tautavel Man", a Homo heidelbergensis. Other discoveries were realized in the laboratory after studying isolated small bone fragments. We have two other parietal fragments corresponding to the right and left sides of the bregma area. They concern the same individual. At the moment other fragments are under consideration : one left parietal bone and two foramen magnum parts. A first reconstruction was realized in 1981; nowadays, with new technologies, we can improve this modelling.

Materials and Methods

[1] Specimens

We used 4 human remains : Arago 21, Arago 47 & 47A, Arago 3A. Arago 21 is a deformed face, due to a lateral pressure after depositing. This face is complete, including malar, maxillary, nose and frontal bones. There are many deformations, structural and superficial. The most distorted part is the left side of the face. The external surface of the right malar bone is deep, without internal deformations. The right parietal bone (Arago 47) is incomplete. The posterior and temporal parts are totally preserved with a large angular torus and a portion of the sagittal suture. We have 2 mm of coronal suture. It is the principal clue that allows us to say that it is the same individual. Arago 47A and 3A are two parietal bregma fragments fitting together with the frontal and permitting us to reconstruct the anterior part of the sagittal suture.

The first reconstruction, quite acceptable in those days, was achieved by M.-A. & H. de Lumley and R. David with an empirical method using those fragments and parts of mouldings of other skulls (Swanscombe for occipital, Sangiran 17 for temporal). Improving of this reconstruction was however necessary. In-

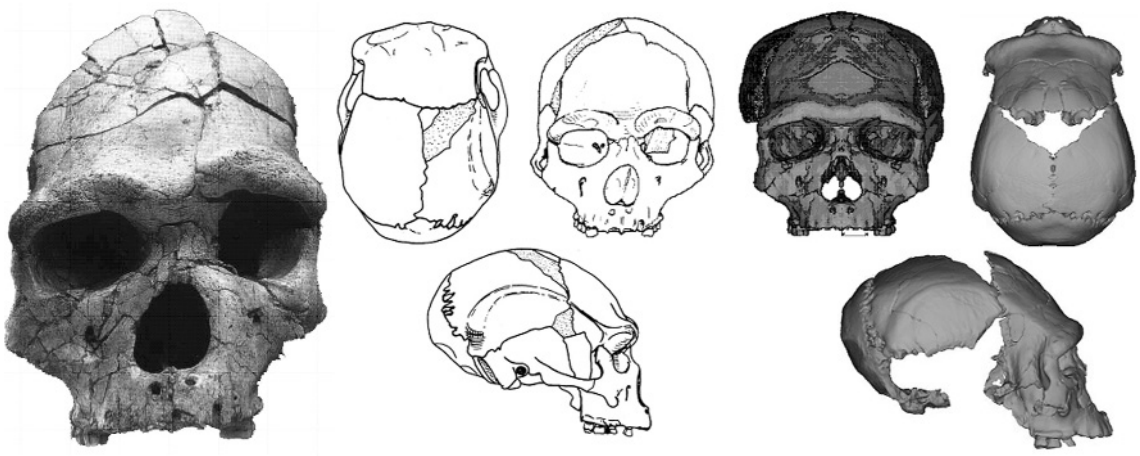

Figure 1 (left) Frontal view of Arago 21

Figure 2 (right) Different views of former (left) and newer reconstitutions (right) of the Tautavel Man. We can see the junction point between the face and the parietal

deed, the posterior curvature between the two parietals (original and reconstructed) did not correspond to an anatomical structure, creating an unusual protuberance. The face was distorted, not balanced, always asymmetric (different orbital cavities, slantwise nose,…). The sagittal suture was not in line with the lateral curvature. Also, the landmarks were not aligned. Finally, the asterion-lambda-asterion angle was too short for a Middle Pleistocene Hominid. It was more like that of the present Homo sapiens, with anatomical characteristics incompatible with Homo heidelbergensis (i.e: torus angularis, parietal thickness, supra-orbital torus, prognathism).

[2] Computer analysis

In collaboration with Initial Society and P. Corbex, we worked on computers with different software's (Mimics 2001, Magics 2001) and 0.5 mm thick CT scans of the original bones. We wanted to use virtual reconstruction because of the brittleness of the original fossil material and to prevent physical disassembly.

[3] Methodology

After researches on the original fossil records as well as on X-ray digital acquisitions and by taking into consideration the different points of view (Grimaud 1982, Spitery 1982, Vlcek 1986), we performed a computerized reconstruction of the skull. We used external anatomical features (parietal line, coronal suture) to position the bone fragments on the computer screen. The inferred effects of general deformation due to the compression of the face that occurred during fossilization were corrected by mirroring.

In the first place, we sought to obtain a more accurate version of face: we corrected the frontal bone (width, positioning of fragments, curvature), we modified the "nose" so as to have a less distorted nasal cavity and a smaller rise of the right malar bone (the external aspect of the left malar bone is correct, but not its location) and finally, we finished the face reconstruction by mirroring to preserve the right side, which is the less deformed. In the second place, we had to position the parietal bone (Arago 47): we used the portion of the coronal suture to connect the parietal and the frontal bones, like in the former reconstruction. Nevertheless we rose the parietal right posterior part, using measurements obtained by preliminary work on a moulding. It allowed us to test different arrangements. After that, we did a reconstruction of the midvault by mirroring the right parietal bone. Only for comparison (Fig.2), we adjusted on our rebuilding the occipital of Swanscombe, but not the two bregma fragments which were not scanned at that time.

Results

The consequences of the new bone arrangements are the following. We observe a growth of the missing pterion part and a reduction of the missing sagittal suture. The asterion-lambda-asterion angle is growing too. In the lateral and the sagittal view, we can see the connection of parietal and the frontal bone, with a continuity of the parietal line. There is no more break anymore between the face and the parietal in superior view (Fig.2, on the left). The sagittal suture is now straight, without curvature. The midvault is more rounded in frontal view.

The occipital bone and the midvault fit together without any modification. That was not the case with the former reconstruction which required an occipital adjustment by cutting off the occipital suture. It gave a value of 73° for asterion-lambda-asterion. The new value is 90,7°. For comparison, the average of Homo sapiens is 85° and, for Homo neanderthalensis, it varies between 70 and 99° and between 87 and 108° for Homo erectus (Spitery 1984). This new measurement corresponds more to an old hominid.

Table 1 indicates intermediate results, estimated and direct measurements taken from the newer and former reconstructions, 4 Homo neanderthalensis and 3 other European Hominids. These measurements were realized on mouldings.

	Max Midvault Width	As-As Width	La - G Line (M3)	La - Na Line	La - B line	B - G	B - Na	Min Frontal Width (M9)	Max Torus Width	Max Frontal Width (M10)
Ceprano	156	128	174	175	101	102	106	106	130	118
Arago 2003	**159**	**122**	**183**	**181**	**98**	**105**	**110**	**114**	**132**	**124**
Arago Swanscombe	142	112	181	175	100	103	105	103	125	107
Petralona	143	119	186	180	104	108	109	110	133	119
Sima de los Huesos 5	139	112	168	169	98	99	102	104	124	114
Neandertal	147	119	186	184	105	112	117	108	121	121
La Chapelle-aux-Saints	152	113	187	182	100	105	105	108	122	123
La Ferrassie	154	112	189	188	104	118	121	107	120	120
Monte Circeo	153	116	178	176	93	109	112	110	122	123

Table 1 Comparative table (Italicized numbers represent estimations. All the values are in mm.)

Discussion and Conclusion

The work on the Tautavel remains will be finished within a few months with the addition of the two bregma fragments. We will be able to correct definitively and precisely the curvature of the superior part of the frontal bone and the coronal suture. Our work will consist in levelling out the small excrescences created by frontal deformation. After that, we will have the sagittal outline from the rhinion and the nasion to the bregma, 2 cm of sagittal suture, a small gap (2 cm) and the rest of the sagittal suture to the lambda.

Anatomical characters look more archaic than later Middle Pleistocene Homo erectus and Homo heidelbergensis. Comparison with the skulls of other fossil men allows us to place this reconstitution closer to an older skull, the one from Ceprano, Homo cepranensis (Mallegni et al. 2003). Our reconstruction shows many similarities with this skull: a broad nasal bone, a torsion of the supraorbital torus, a bilate-

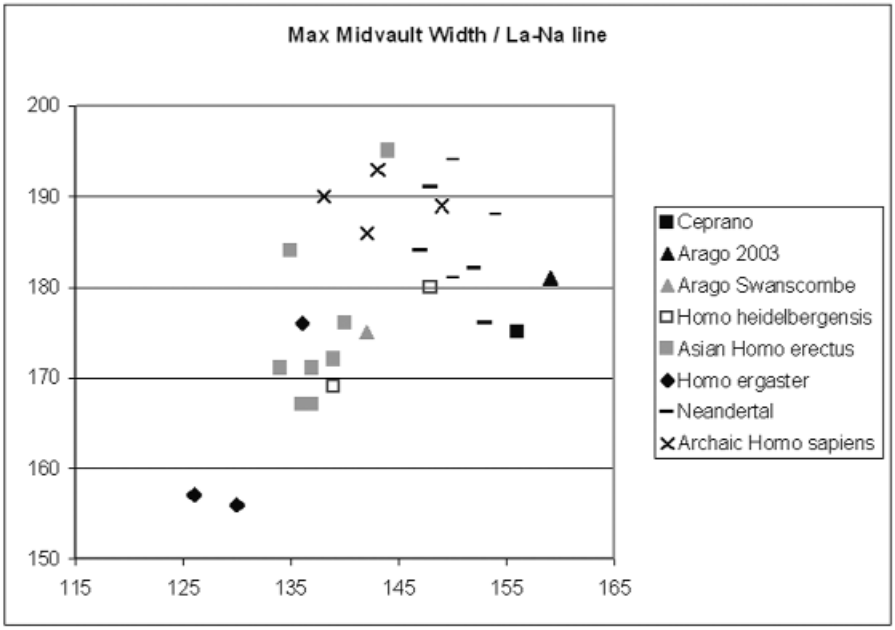

Figure 3 Comparison of different Hominid populations with the newer reconstruction of Arago

ral discontinuity of the supratoral sulcus, a pronounced postorbital constriction, a frontal keel, a flattened parietal, a maximum breadth across a prominent angular torus, and a low cranial vault. Anatomically, the Ceprano Man shares many features with our reconstruction and the dimensions of his temporal bone correspond to the gap in the Tautavel Man. Figure 3 illustrates the closeness between them. A comparison with this man who died 900,000 or 800,000 years ago (Mallegni et al. 2003) points out the archaic characteristics of Arago 21-47. The dating back to 450,000 years BP is an estimation, but we could imagine that this man is even older. We will develop this question when this work is totally finished.

We will continue our reconstruction by assembling this one with the two bregma parietal fragments and by filling the missing parietal anterior parts. Another part of the work will consist in finding similar skulls in order to reconstruct the missing parts. After scanning those skulls, we will "carve" them to take the interesting fragments (temporal, sphenoid and occipital bones). Presently, the most interesting skull is Ceprano. Once this stage has been achieved, we will be able to make resin models by stereolithography (Zollikofer 1998, 2002).

With digital technology, we will suggest a new reconstitution after we have directly tested different hypotheses, preventing a long and expensive work, by means difficult to handle cast reconstitutions. This work will allow us to have a new vision on the Hominids of the Middle Pleistocene by better situating the Tautavel Man, pending further discoveries of the missing fragments during future excavations.

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