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SECTION 1 : THÉORIES ET MÉTHODES / THEORY AND METHOD

Colloque / Symposium 1.7

Three-Dimensional Imaging in Paleoanthropology and Prehistoric Archaeology

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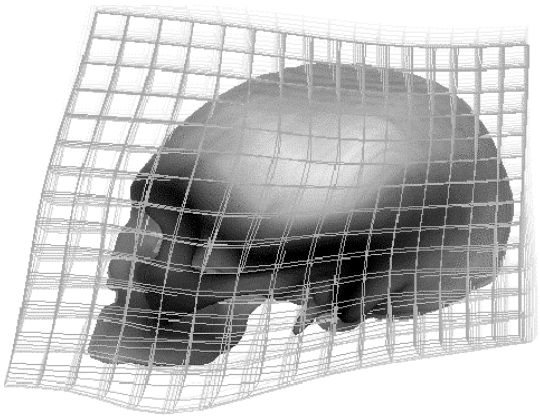

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COMPARISON OF A THREE-DIMENSIONAL AND A COMPUTERIZED-ASSISTED METHOD FOR CRANIO-FACIAL RECONSTRUCTION: APPLICATION TO TAUTAVEL MAN

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Résumé: Les auteurs ont tenté une reconstitution crânio-faciale de l'Homme de Tautavel, daté d'environ 450. 000 ans, découvert par H. de Lumley en 1971, à partir d'un moulage de la face et du pariétal de ce fossile, associés à des moulages, pour les os manquants, provenant d'Homo erectus découverts dans d'autres sites. Une reconstitution manuelle a été effectuée avec les méthodes utilisées en médecine légale pour l'identification des corps. Une méthode informatique tri-dimensionnelle a également été utilisée, en collaboration avec les chercheurs de l'INRIA (projet Epidaure, Sophia-Antipolis, France). Les résultats obtenus montrent que les proportions sont globalement respectées par les deux méthodes alors que la ressemblance entre les deux reconstitutions n'est pas parfaite. Les auteurs concluent à l'interêt d'utiliser conjointement ces méthodes pour obtenir une reconstitution des hommes préhistoriques.

Abstract: The authors report on the craniofacial reconstruction of the Tautavel Man 450.000 BP, discovered by H. de Lumley in 1971, based on an entire skull built with the front and the parietal bone of the Tautavel Man and fragments that were found at Homo erectus other sites. A three-dimensional manual craniofacial reconstruction has been set up for identification of missing persons in actual forensic cases. A three-dimensional computerized-assisted method was also settled in collaboration with, and by the INRIA team («Epidaure group», Nice Sophia-Antipolis, France). Both methods have been applied to the cranio-facial reconstruction of the Tautavel Man. The results show that global proportions are respected between both methods, whereas the resemblance between the non computerized- and the computerized-assisted method is not obvious. The conclusion is that both methods may be useful for obtaining a representation of prehistoric men.

Identification of human remains is a huge forensic issue. Identification records are often missing, as dental charts or DNA databases, and the last and ultimate approach may be craniofacial reconstruction, especially in difficult cases as decomposed or skeletonized remains. In turn facial reconstruction has emerged as an increasingly important tool in forensic pathology and forensic anthropology, generating a lead for positive comparative identification. These sophisticated techniques may be 2D or 3D, computerized-assisted or not.

In this work we will describe two techniques that we have settled for forensic practice (e.g. 3D-manual technique, and 3D-computer-assisted reconstruction), and we will indicate the results we have obtained with both techniques on the "Tautavel man" skull.

METHODS

Three Dimensional Manual Facial Reconstruction

The most traditional 3D approach is the manual build-up of the skull with a clay or clay-like material. This manual "plastic", or "sculptural" technique consists of applying a clay-like substance onto the skull, through the relationship between bone and soft tissues (Fedosyutkin et al, 1993). Skull morphology and metric features must be assessed before placing marks on precise anthropological points, where the average tissue depths are known according to the age, sex, and race of various populations. Then the space between these points are filled in with clay. Some areas such as ears, eyes, nose, mouth and lips are difficult to settle because they do not have clear bony indicators.

Three Dimensional Computerized Methods

The computerized 3D craniofacial reconstruction has been developed by only a few scientists (Evenhouse et al, 1992, Quatrehomme et al, 2000). We have used a method that was set up by a cooperation with the Epidaure group of the Inria team, in Sophia-Antipolis (France). The whole method is available in (Quatrehomme et al, 1997). We have used a first set, consisting of a skull model S1 and a facial model F1, which is the unknown face that we have to reconstruct, whereas the second set (Sr, Fr) is the reference head with a known skull and its known face. The method of reconstruction consists in deforming the surface of the skull, through a global parametric algorithm T, so that :

$$T (Sr) = S1$$

and this transformation is applied to the reference face Fr, with the issue of :

$$T(Fr) = F1?$$

This transformation is based only on some salient lines ("crest lines"), which correspond mathematically to lines of absolute maxima of the largest principal curvature.

RESULTS

3D manual- and 3D computerized methods had been developed for forensic practice. The validation of the manual

Figure 1 - Final result both methods

method has been achieved. Globally, out of 24 controlled cases, the results in terms of resemblance were considered as good results in 4 cases, middle results in 5 cases, and poor results in 15 cases (Quatrehomme, 2000). From a forensic point of view, it means that there is a hope for the family to recognize the missing person in nearly 40% of the cases. The validation of the computerized-assisted method is currently in process.

In the present work we have applied both methods on the Tautavel man (photography 1, 2), discovered by Henri de Lumley in 1971 and considered as dating back to 450 000 BP, on an entire skull cast built with the face and the parietal bone of the Tautavel Man and fragments that were found at Homo erectus other sites.

DISCUSSION

The 3D manual approach is very popular. Conversely, 3D computerized methods are sparsely described in the literature. Only a few of the computed facial reconstruction programs are true 3D.

But both methods suffer of a lack of scientific validation (Quatrehomme et al, 1994). This evaluation must deal with the relationship between the main anthropological points and the soft tissue depth at these locations, but also the relationship of various areas of the face between each others. But the validation must concern the issue of resemblance (which is the main issue in forensic practice) as well (Quatrehomme, 2000).

The 3D manual craniofacial reconstruction of the Tautavel man cannot be considered as a scientific one, because we do not know the average tissue thicknesses of the main anthropological points of the Tautavel man.

The 3D computerized method do not use this average of soft tissue depth. It is based on another approach which a 3D deformation of skull into another, and the application of this transformation to the reference face into the face to reconstruct (here the Tautavel man). Unfortunately we have no mean to check the results on ancient skulls. Furthermore we have observe that the resemblance between both methods is not obvious. Nevertheless, because it was the conclusion of our previous controlled study (Quatrehomme et al, 1997, Quatrehomme, 2000), we make the hypothesis that these methods preserve the relations between the bone and the face in various areas of the face, and preserve the balance between these areas. Even if the final result does not actually look like this peculiar and unique Tautavel man (in terms of precise resemblance), it is probably close to it, and this information is interesting in paleoanthropology. In conclusion we may assume that both methods are useful for obtaining a representation of prehistoric men.

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