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Forensic Anthropology Population Data

Tests of one Brazilian facial reconstruction method using three soft tissue depth sets and familiar assessors

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ABSTRACT

Facial reconstruction is a method that seeks to recreate a person's facial appearance from his/her skull. This technique can be the last resource used in a forensic investigation, when identification techniques such as DNA analysis, dental records, fingerprints and radiographic comparison cannot be used to identify a body or skeletal remains. To perform facial reconstruction, the data of facial soft tissue thickness are necessary. Scientific literature has described differences in the thickness of facial soft tissue between ethnic groups. There are different databases of soft tissue thickness published in the scientific literature. There are no literature records of facial reconstruction works carried out with data of soft tissues obtained from samples of Brazilian subjects. There are also no reports of digital forensic facial reconstruction performed in Brazil. There are two databases of soft tissue thickness published for the Brazilian population: one obtained from measurements performed in fresh cadavers (fresh cadavers' pattern), and another from measurements using magnetic resonance imaging (Magnetic Resonance pattern). This study aims to perform three different characterized digital forensic facial reconstructions (with hair, eyelashes and eyebrows) of a Brazilian subject (based on an international pattern and two Brazilian patterns for soft facial tissue thickness), and evaluate the digital forensic facial reconstructions comparing them to photos of the individual and other nine subjects. The DICOM data of the Computed Tomography (CT) donated by a volunteer were converted into stereolitography (STL) files and used for the creation of the digital facial reconstructions. Once the three reconstructions were performed, they were compared to photographs of the subject who had the face reconstructed and nine other subjects. Thirty examiners participated in this recognition process. The target subject was recognized by 26.67% of the examiners in the reconstruction performed with the Brazilian Magnetic Resonance Pattern, 23.33% in the reconstruction performed with the Brazilian Fresh Cadavers Pattern and 20.00% in the reconstruction performed with the International Pattern, in which the target–subject was the most recognized subject in the first two patterns. The rate of correct recognitions of the target subject indicate that the digital forensic facial reconstruction, conducted with parameters used in this study, may be a useful tool.

1. Introduction

Facial reconstruction is a method that seeks to recreate a person's facial appearance from his/her skull. This technique can be the last resource used in a forensic investigation, when identification techniques such as DNA analysis, dental records, fingerprints and radiographic comparison cannot be used to identify a body or skeletal remains [1–7].

The purpose of forensic facial reconstruction is to recreate, based on the skull, the face of the deceased at the time of his/her death, with sufficient likeness to the deceased to contribute to his/her recognition, hence leading to identifying the body. Facial reconstruction does not correspond to a photograph of the individual when alive, but can be considered successful if it is realistic enough to produce a good response from the public, leading to the identification of the subject. It is not an identification method, but rather a tool used for recognition. It is expected that publication of the reconstructed face will stimulate the family members or friends to recognize the face, thereby generating a

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shortlist of suspects, from which the individual may be identified through DNA analysis, dental records or other identification methods. Forensic facial reconstruction is an important forensic tool, which significantly increases the chances of identifying the dead [4,6–16]. Human recognition by three-dimensional craniofacial reconstruction can be very useful to identify unknown corpses [8], victims of violent crimes [17] and genocide [7].

Although there are many authors that recommend the use of facial reconstruction [4,6–16], its accuracy is controversial, and has been questioned by several authors [18–20]. Accurate facial reconstructions are those that should be easily recognized as the target individual (the person to whom the skull belongs) [18].

Stephan and Henneberg [19] built 16 facial reconstructions, which were judged by 37 assessors. Only one facial reconstruction was positively identified above chance. According to the authors, facial reconstruction should be used when all other methods of identification have failed and only to provide tentative identification.

Several researchers performed facial reconstructions and conducted studies to assess their resemblance with the target individual. For this, there are reports using the resemblance method and the recognition method [7,16,21–24]. The first one compares the created facial reconstruction to a photograph of the target individual and asks the examiners to determine levels of resemblance between them, using a scale where 1 = no, 2 = slight, 3 = approximate, 4 = close, 5 = strong resemblance [16]. The second one compares the performed facial reconstruction to the photograph of the target subject and of other subjects—the face pool (the number of other subjects has varied from 4 to 9), and asks the examiners to choose which of the photographs is more similar to the facial reconstruction, i.e., the examiners attempt to identify the target subject out of a number of presented faces [18]. Some studies, such as the works of Stephan and Arthur [22], Vanezis [21] and Stephan and Cicolini [23], consider the resemblance method imprecise, and recommend the use of the recognition method.

Stephan [18] developed research using the resemblance method, and concluded that it is not possible from resemblance ratings to determine the accuracy and/or quality of a facial reconstruction since a non-target individual may receive a resemblance rating equal to, or higher than, the target individual. Stephan and Henneberg [24] believe that face pool comparison may be a more reliable method of assessing a facial reconstruction's accuracy than resemblance ratings, which measure the similarity between the facial reconstruction and the target subject and not the ability for the target subject to be recognized from a group of faces.

When the recognition method is used, all the photographs of the subjects to be recognized can be presented simultaneously to the examiners in the recognition process or presented sequentially. Researchers such as Stephan and Arthur [22], Stephan and Henneberg [24] and Vanezis [21] suggest the use of sequential presentation, rather than the simultaneous one.

Evaluations of facial reconstructions under laboratory conditions are usually performed by people unfamiliar with the target individual [20]. This is not representative of real identification scenarios, when individuals who are familiar with the target subject usually make the identification [18,20]. Stephan et al. [20] tested 2D facial reconstructions for their "recognizability" in familiar and unfamiliar scenarios. The authors observed that the identification rates in both familiar and unfamiliar trials followed similar trends, but the magnitude of the relative responses was different. The same "FA5" person was correctly recognized by 86% of the familiar assessors (total sample size 7) and by 56% of the unfamiliar assessors (total sample size 86). The person "FA1" was correctly recognized by 40% of the familiar assessors (total sample size 5) and by 44% of the unfamiliar ones (total sample size 43). The person "FA4" was not recognized by familiar assessors (total sample size 4) and was correctly recognized by 28% of the unfamiliar ones (total sample size 43). In this research, average recognition rates between both scenarios were 42% for familiar and 43% for unfamiliar assessors.

Facial reconstruction enables the restoration of the contours of the soft tissues over the skull, producing a face and increasing the probability of facial recognition. The reliability of this technique depends on analyzing the values of soft tissue thickness observed in a given population [18]. To produce facial reconstruction, information on the thickness of the soft tissues that cover the bony structures of skull and face are vital [6,21,26–28].

Scientific literature has described differences in the thickness of facial soft tissue between ethnic groups. There are different databases containing information on what has been published in the scientific literature. These relate to certain populations such as North American Blacks, Whites and Hispanics [29], South Africans [30], African Zulus [31], Egyptians [32], Europeans [13], Australians [26,33], Portuguese [34], Japanese [35], Caucasians [12], White Americans [36], and Black Americans [37]. The most commonly used data on the thickness of facial soft tissues are those collected by Rhine and Campbell [37] and Rhine and Moore [36], according to Kähler et al. [38] and De Greef et al. [39].

There are also works comparing the thickness of facial soft tissues between different ethnic groups. The soft tissue thickness measures of Portuguese are different from that of the Spanish people, supporting that geographic proximity does not necessarily mean similar facial soft tissue thickness [34]. The facial soft tissue thickness of Saudi individuals is significantly different from Caucasians [40]; measures of Egyptians are different from Zulus, Black and White Americans, Japanese and mixed South Africans [31]. The measures of people from Northwest India are different from American Blacks, American Whites and Japanese [41].

With the aim of verifying how important the correct ethnic group depths are to facial reconstruction, Wilkinson et al. [42] carried out a research in which six facial reconstructions were built over copies of the same skull, using six different sets of tissue depth data: White European, Black American, Korean, Japanese, Mixed Race and Southwestern Indian. The skull was a stereolithographic copy produced from Computed Tomography data of a White European living man. The authors performed a resemblance study; the White European and the Mixed Race facial reconstructions were rated as the closest resemblance to the target individual by 36.8% of the 247 examiners. The Southwestern Indian, the Japanese, the Black American and the Korean heads were rated as the closest resemblance to the target subject by, respectively, 23.9%, 16.2%, 12.6% and 8.9% of the examiners. The authors believe that the correct tissue depth data, with regard to ethnic group, is important for facial reconstruction. Nevertheless, a reasonable resemblance should be performed even using the incorrect racial origin data.

Stephan and Simpson [43] made an analytical review of the published adult data concerning facial soft tissue depths. Their findings suggest that race effects on soft tissue depth data are not strong since studies display broad but similar soft tissue depths ranges and central tendencies irrespective of race. The authors believe that it seems justifiable to consider the effects of race on soft tissue depths as minimal.

There is not a clear racial demarcation in Brazil, due to the considerable miscegenation of its people. The anthropological types have been classified by comparing the skin pigmentation using a chromatographic scale, and by morphological characteristics. They are classified in four groups: leucoderma, faioderm, xantoderm and melanoderm [25].

Until 2008, there were no data on the facial soft tissue thickness of the Brazilian population. In 2008, a dissertation defended at the