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FACIAL RECONSTRUCTION- A REVIEW

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ABSTRACT

Facial reconstruction is used for many years to identify skeletal remains. It is a technique employed in a forensic investigation as a last resort to recreate an individual's facial appearance from his/her skull. It is also used in the image identification of criminals and victims as well as for post-mortem identification purposes. Facial reconstruction is a way to present visual information about an unknown individual in order to stimulate the general public into recognizing the person and lead to the discovery of new evidence.

In this paper an attempt has been made to review the different methods of facial reconstruction reported in the literature. There are several techniques of doing facial reconstruction, which vary from two dimensional drawings to three dimensional clay models. With the advancement in 3D technology, a rapid, efficient and cost effective computerized 3D forensic facial reconstruction method has been developed which has brought down the degree of error previously encountered.This paper will also discuss the historical developments of facial reconstruction leading to the various techniques employed today.

KEY WORDS: Reconstructing facial appearance, craniofacial reconstruction, history

Introduction

Facial reconstruction is used as an important forensic tool which may help in facial recognition of the skull and ultimately lead to positive identification of an individual [1].Forensic facial reconstruction is a combination of both scientific methods and artistic skill. It can be used to reconstruct the soft tissues onto the skull in order to obtain the image of an individual for his/her recognition and identification [2-4].

It is conducted to help with identification in forensic investigations [1–6] as a last resort when DNA analysis, fingerprint comparison, or radiographic and dental record examination have been unable to identify the skeletal remains [7].

Facial reconstruction is used in both forensic science and Archaeology. In forensic science, this method is used in the identification of an individual where the conventional\usual methods of identification are unsuccessful. In Archaeology, it is used to identify the faces of the people from the past, bone remains, embalmed bodies, etc.

The face of an individual has several different types of exclusive features and thus, is of great importance in identification and recognition of a person. When an unidentified body is found, a facial photograph is clicked. This photograph is sometimes digitally processed so that it becomes suitable for the witness to identify or for the newspaper to publish legal which may ultimately leads to identification of the corpse. The victim's family, friends/or acquaintance are required to visually identify the victim and the only body part uncovered for identification is the face. Sometimes, a dead body cannot be identified as its face cannot be recognized due to destruction by animals, physical attacks or decay caused by environmental factors. Forensic facial reconstruction is an alternative method in the identification process where there is little or no other evidence available.

Review Works

The purpose of forensic facial reconstruction is to produce an image from a skull which offers a sufficient likeness of the living individual that it will facilitate identification of skeletal remains when there are no other means available. Facial reconstruction is the process of recreating a face from the skull. It is conducted to help with identification in forensic investigations [1–6] as a last resort when DNA analysis, fingerprint comparison, or radiographic and dental record examination have beenunable to identify the skeletal remains [7].The skeletal structure and osteological analyses of the skull giveessential information about the facial morphology, but these arenot enough when used alone. Modeling soft tissue structures coveringthe skull is a significant part of the process of facial reconstruction[8].

The bones of the skull indicate a key determinant of facial appearance. Bones form the basic framework to which other tissues are attached, and how a person looks depends on all these factors together – skin, muscle, fat and bone. In human beings, the basic look is similar, but we are very sensitive to the small differences that can be used for identification purposes. Farkas et al describe how the variability of facial proportions ensures the individuality of the human face [9].

The first facial reconstruction was done by a German anatomist Wilheim His in 1895. He reconstructed the face of German composer Johann Sebastein Bach [9,10]. Welcker, a German physiologist and anatomist documented average tissue depth thickness from studying cadavers, he inserted a small surgical blade into various anthropometric landmarks on the face and then measured the depth of penetration. This is called as “Welcker Facial Reconstruction Technique”. Facial reconstruction of Schiller, Kant and Dant was done by Welcker by using the same technique. During the late 1880's and early 1890's, Wilheim further modified this technique by inserting a thin sharp needle which had a small piece of rubber on its tip instead of using wider blade. This reduced the amount of tissue distortion and lead to more accurate results. Later in 1946, Wilton Maria Krogmann defined five basic principles to modify the

methods of reconstruction of soft tissues of the face i.e. the relation of eyeball to orbit, the shape of nose tip, the ear location, the mouth width and the ear length [10].

Two-dimensional facial reconstructions are hand-drawn portraits based on radiographs, ante mortem photographs, and the skull. This method usually requires the collaboration of an artist and a forensic anthropologist. Recently developed, the F.A.C.E. and C.A.R.E.S. computer software programs quickly produce two-dimensional facial approximations that can be edited and manipulated with relative ease. These programs help speed the reconstruction process and allow subtle variations to be applied to the drawing.

Facial reconstruction rendering a two-dimensional (2D) view of a face can be accomplished by sketching on paper as well as on a computer. Facial tissue thickness can be marked at known landmarks and these marked dots can be connected with each other to make a general outline of the face. Forensic artists are able to draw the face from this image, if properly guided. Therefore they usually work under the supervision of a forensic anthropologist who has already analyzed the remains and its identifying skeletal characteristics, i.e. age, sex, race, body size, anomalies, trauma, pathological lesions, antemortem health status, and other unique features. The anthropologists should be able to describe where the eyes, ears, nose and mouth should be drawn in relation to the bony face. This requires a systematic understanding of human facial features. Based on these characteristics a face can be reconstructed, step by step. There are already several publications showing results of these studies. A similar attempt can be made using a lateral radiograph. Average soft tissue thicknesses are marked on the film or its copy and connected with each other.

Obviously certain aspects of the face must be modified, based on sex, race and age. The nose, for example, changes throughout life. Other features, such as the shape of the mouth and thickness of the lips, also change with age and their relationship with the facial skeleton. The 2D technique (sketches) has been used by some anthropologists to save time and reduce the cost of an artist.

Three-dimensional facial reconstructions are either: 1) sculptures (made from casts of cranial remains) created with modeling clay and other materials or 2) high-resolution, three-dimensional computer images. Like two-dimensional reconstructions, three-dimensional reconstructions usually require both an artist and a forensic anthropologist. Computer programs create three-dimensional reconstructions by manipulating scanned photographs of the unidentified cranial remains, stock photographs of facial features, and other available reconstructions. These computer approximations are usually most effective in victim identification because they do not appear too picturesque or too artificial.
Techniques for attaining facial information for 3D reconstruction are broadly categorized into three, namely, pure image-based techniques, hybrid image-based techniques and 3D scanning techniques. The pure image-based techniques perform the reconstruction using only 2D images without estimating the real 3D structure. In hybrid image based techniques both approximations and the data gained from images are used in the reconstruction process. The 3D scanning techniques have the capability to capture the complete 3D structure since scanned images provide both geometry and texture information of the face

There are many approaches for reconstructing 3D faces but the choice of approach may vary according to the application for which the reconstruction is used. The most successful approach up-to-date is analysis by synthesis in which the parameters of the 3D statistical model are adjusted to increase the accuracy between the reconstructed face and the 2D face image. The errors in this approach are caused by 3D-2D alignment, shape differences, illumination differences and the quality of the dense correspondence among the 3D surfaces [11].

Superimposition is a technique that is sometimes included among the methods of forensic facial reconstruction. It is only sometimes included as a technique because investigators must already have some kind of knowledge about the identity of the skeletal remains with which they are dealing (as opposed to 2D and 3D reconstructions, when the identity of the skeletal remains are generally completely unknown). Forensic superimpositions are created by superimposing a photograph of an individual suspected of belonging to the unidentified skeletal remains with an X-ray of the unidentified skull. If the skull and the photograph are of the same individual, then the anatomical features of the face should align accurately.

The skull is the basis of facial reconstruction; however, other physical remains that are sometimes available often prove to be valuable. Occasionally, remnants of soft tissue are found on a set of remains. Through close inspection, the forensic artist can easily approximate the thickness of the soft tissue over the remaining areas of the skull based on the presence of these tissues. This eliminates one of the most difficult aspects of reconstruction, the estimation of tissue thickness. Additionally, any other bodily or physical evidence found in association with remains (e.g. jewelry, hair, glasses, etc) are vital to the final stages of reconstruction because they directly reflect the appearance of the individual in question.
Most commonly, however, only the bony skull and minimal or no other soft tissues are present on the remains presented to forensic artists. In this case, a thorough examination of the skull is completed. This examination focuses on, but is not limited to, the identification of any bony pathologies or unusual landmarks, ruggedness of muscle attachments, profile of the mandible, symmetry of the nasal bones, dentition, and wear of the occlusal surfaces. All of these features have an effect on the appearance of an individual's face.

Once the examination is complete, the skull is cleaned and any damaged or fragmented areas are repaired with wax. The mandible is then reattached, again with wax, according to the alignment of teeth, or, if no teeth are present, by averaging the vertical dimensions between the mandible and maxilla. Undercuts (like the nasal openings) are filled in with modeling clay and prosthetic eyes are inserted into the orbits centered between the superior and inferior orbital rims. At this point, a plaster cast of the skull is prepared. Extensive detail of the preparation of such a cast is presented in the article from which these methods are presented.

After the cast is set, colored plastics or the colored ends of safety matches are attached at twenty-one specific “landmark” areas that correspond to the reference data. These sites represent the average facial tissue thickness for persons of the same sex, race, and age as that of the remains. From this point on, all features are added using modeling clay.

First, the facial muscles are layered onto the cast in the following order: temporalis, masseter, buccinator and occipito-frontals, and finally the soft tissues of the neck. Next, the nose and lips are reconstructed before any of the other muscles are formed. The lips are approximately as wide as the interpupillary distance. However, this distance varies significantly with age, sex, race, and occlusion. The nose is one of the most difficult facial features to reconstruct because the underlying bone is limited and the possibility of variation is expansive. The nasal profile is arbitrarily determined by projecting two lines from the midline of the skull unless any obvious bony asymmetry is present, in which case accommodating adjustments to the possible projection are made.
The muscles of facial expression and the soft tissue around the eyes are added next. Additional arbitrary measurements are made according to race (especially for those with eye folds characteristic of Asian descent) during this stage. Next, tissues are built up to within one millimeter of the tissue thickness markers and the ears (noted as being extremely complicated to reproduce) are added. Finally, the face is “fleshed,” meaning clay is added until the tissue

thickness markers are covered, and any specific characterization is added (for example, hair, wrinkles in the skin, noted racial traits, glasses, etc.).

Conclusions

Forensic facial reconstruction is a rapid, non-invasive and efficient method where reconstruction can be repeated at any time if required. This technique is not only used for identification of individuals from skeletal remains but is also used for archaeological research purposes. Visual identification by the individual's family and associates thus becomes easy and more defined. In this paper we discuss the history of facial reconstruction in the deceased, starting from the skull.

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