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Forensic Facial Reconstruction: Anatomical Art

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ABSTRACT-

Forensic Facial Reconstruction (FFR) is a forensic tool that involves the reconstruction of a skull found in mass disasters, earthquakes, terrorism, etc. It is an alternative process where no evidence is available, and the face of the unknown body is severely mutilated by animals, physical attacks, etc., to such an extent that even digital photography cannot establish the identity. Facial reconstruction techniques are based on the premise that a relationship exists between the underlying hard tissues with the overlying soft tissues of the skull. Facial reconstruction can be 2- dimensional or 3- dimensional. Software advancement has led to the development of computerized 3D-facial reconstruction systems to recreate characteristic facial morphology dependent on the skeletal features. The manual technique uses modeling material, such as plasticine, shellac biscuit, or clay, while the computer-aided technique provides for the reconstruction in a virtual environment based on the scanning of the skull, using specific editing and modeling software.

Keywords: Forensic Odontology, Forensic Facial Reconstruction, 2-D Facial Reconstruction, 3-D Facial Reconstruction.

Introduction

Forensic Facial Reconstruction (FFR) is a method that is frequently applied as a catalyst for human identification. It is a highly skilled procedure based on the sound scientific principles of osteology, physical anthropology, forensics, and art.[1]

It is the science as well as the art that fabricates the veil which beholds the identity of a person. Faces are fascinating, with intriguing histories which can be unraveled with the help of forensic advancements and be used to crack crimes and solve the distress caused by disasters.

Facial reconstruction aims at recovering the facial appearance of an individual from the sole datum of the underlying skull. Forensic science entails the identification of deceased people. When all the usual methods of identification have failed and the skeletal remains are the sole data available, facial reconstruction might be considered an enhancing tool for recognition. [3]

When it comes to the identification of an individual by means of facial reconstruction, two broad schools of thought exist. Some reviewers consider that forensic facial reconstruction is a method of approximation, i.e., different facial patterns can be established from the same skull. On the other hand, some researchers believe that each skull can produce only one face and hence lead to positive identification of the individual, and thereby called it "forensic reconstruction".[4]

The reconstruction techniques can be broadly divided into the 2- dimensional and the 3-dimensional techniques which are further analyzed manually or by specific software.

Historical Perspective

Historically, the use of facial reconstruction had been to

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build faces from archeological skulls of known individuals. One of the first recorded facial reconstructions is that of a famous composer Johann Sebastian Bach, by a German anatomist named Wilhelm His done in 1985, who applied average tissue depth thickness in the reconstruction process.[5]

At the turn of the 20th century and the next few decades, forensic reconstruction was mainly applied to archeological purposes. In the former Soviet Union, renowned archeologist and anthropologist Mikhail Gerasimov pioneered FFR (Forensic Facial Reconstruction) for research purposes and forensic identifications.[6]

The early scientists classified the face into four types of build: thin, very thin, well-nourished, and very well-nourished. Tissue thickness was then averaged accordingly and the maximum and minimum values were averaged for both sexes. Although carried out many years ago, some of the interpretations still have relevance today in the standards recommended for the reconstruction of Caucasian individuals.[8]

Methods Of Facial Reconstruction

The methods of facial reconstruction can be divided into two basic groups:

- 2- Dimensional
- 3- Dimensional

2-dimensional Facial Reconstruction-

This method was first developed by Karen Taylor.

The face is drawn and created on overlays that are later superimposed on the skull images or craniographs to produce frontal and lateral views. Facial features can be developed from visual or sketched images and with the advancements in technology they are blended digitally into the skull utilizing computer software.[8]

Several software programs are now being utilized for 2-dimensional craniofacial reconstruction. F.A.C.E. and C.A.R.E.S. are two such software systems. They work by capturing and digitizing radiographs, photographs, and images of skulls, and producing electronically altered versions of the image.[9]

CARES is an acronym for Computer Assisted Recovery Enhancement System and FACES stands for Forensic Anthropology Computer Enhancement System. These programs speed up the reconstruction process and produce more generic images.[10]

3- Dimensional Facial Reconstruction

Recently, various technologies have been built to produce facial reconstruction using computer software that improved versatility, performance, and speed. The first digital technique was developed by Moss for forensic purposes.

The digital reconstruction techniques can further be divided into automated and modeling systems.[8]

Regardless of the method used, forensic facial reconstruction procedures can be divided into three basic schools of thought:

1. The Anthropometric American method/Tissue depth method, developed by Krogman uses average tissue thickness at various points on the skull.
2. Anatomical Russian method developed by Gerasimov, by carving muscles, glands, and cartilage layer by layer onto the skull.
3. Combination Manchester method/ British method developed by Neave, by taking into account both the thickness of the soft tissue and the facial muscles.[11]

The Manchester method is the technique of choice in most forensic institutions because it uses common techniques from the other two schools.

The various modalities, their advantages and disadvantages have been enlisted in the table below.

Table 1- Methods Of Forensic Facial Reconstruction

NAME OF THE METHOD	DEVELOPED BY	DESCRIPTION	ADVANTAGES	DISADVANTAGES
Anthropometric American Method/ Tissue Depth Method	Krogman in 1946	Use of soft tissue depth data.	Needles, x-rays and ultrasound gave accurate measurements. Facial muscles are recorded in a proper anatomical manner.	Requires highly trained personnel and hence, not preferred nowadays.
Anatomic Russian Method	Gerasimov in 1971	Shaping muscles, glands, and cartilage onto the skull.	Recreate prehistoric skulls.	Slower method. A greater degree of anatomical knowledge is required.
Combination Manchester Method/ British Method	Neave in 1977	Both, soft tissue thickness and facial muscles are taken into consideration.	More accurate and anatomically correct.	Requires expertise.
Computerized 3-D forensic facial reconstruction	Software- Free Form Modelling Plus, Sensable Technologies, Wilmington MA)	Computer-aided reconstruction using computerized 3-D models.	Fast, efficient, and cost-effective.	Requires both anthropological and computer operating skills.

Uses Of Forensic Facial Reconstruction

The main purpose of facial reconstruction is to elicit the recognition of a deceased individual leading to identification. These methods are beneficial when-

- Unidentified human remains are discovered
- In cases of mass mortality owing to disasters
- Wherein, traditional methods of identification have proven to be ineffective
- In archeology- to reconstruct faces of people from the past, embalmed bodies, etc.

Advancements In FFR:

Owing to rapid advancements in technology, the field of forensic reconstruction has reached new heights. Various new tools and software are being studied to evaluate, compare and conclude more efficacious modalities that eventually lead to positive identification.

Wuyang Shui et al; presented a pipeline for computerized CFR (Craniofacial Reconstruction) based on a statistical shape model (SSM) which integrates tasks such as skull digitization, calculation of geometric measurements, sex classification, computerized CFR, and facial shape editing.[12]

Maya De Buhan et al; proposed a new numerical method for facial reconstruction wherein they combined the classical features with mathematical and computational skills in 3D geometric modeling. In this method, first, a method for generating a closed surface mesh model of the skull template is introduced. Second, the elastic shape-matching method used to link skulls with each other is used and lastly, the shape-matching tool is combined with soft tissue deformation techniques from computational surgery for transporting the face templates onto the unknown skull.[13]

Yang Wen et al; suggested a new craniofacial reconstruction method based on a region fusion strategy. In this method, the skull and face are divided into five local regions and mapped and finally region fusion model is applied to reconstruct the face.[14]

Discussion

Forensic facial reconstruction is a rapid and efficient method used for the identification of individuals from skeletal remains, as well as for archeological purposes. This field has evolved greatly over the years. What began as the time-consuming process of construction of 3-D models using clay, has evolved to a stage where tools like CBCT and CT show a promising future in the said field.

A case report by Rosane Perez Baldasso et al highlights that forensic facial approximation can be satisfactorily applied in the forensic field for individual recognition purposes.[11]

Maya de Buhan et al presented a numerical method for facial reconstruction where the skull is considered as a whole surface and not restricted to some anatomical landmarks, allowing a dense description of the skull/face relationship.[13]

Further, the use of 3D computerized systems has allowed more efficient procedures for forensic facial reconstruction. Won- Joon Lee et al, carried out a study to demonstrate the capability of 3D modeling methods in producing reliable facial reconstructions with acceptable levels of resemblance employing the combination method and the imaged scanned from CBCT.[6]

Conclusion

Forensic facial reconstruction is a reliable and efficient method for the identification of individuals. With advancements in technology, new and more modern methods are constantly evolving. It offers a valuable recognition method in law enforcement, archeological research, and for others in the science community committed to the analysis and representation of the human face.

Thus, this field that serves as a blend of art and science has evolved greatly over the years and shows a promise to reach higher horizons.

Conflicts Of Interest

None.

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