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 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

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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

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.

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.

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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Photography for forensic odontologists & its impact on the judicial process

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ABSTRACT-

Forensic odontologists can play a crucial role in the judicial process of a criminal case. They collect valuable evidence during the investigation process and document the whole process. Documentation can be done in different ways and photography is one of the good methods to collect some pieces of evidence and document other valuable evidence. The outcomes of the criminal cases all depend upon the scientific and other shreds of evidence. Photography is now a very good way to document the crime scene and the various pieces of evidence present at the crime scene. Photographs are easy to show to the jury and magistrates and one photograph can easily explain the crime scene which is sometimes difficult to explain in many words. Forensic odontologists being part of the team, especially in mass disasters can utilize the knowledge and skills of photography and can be helpful to the investigation team. Digital cameras have revolutionized the use of forensic photography. Videography further adds value to photography. Drone photography and CCTV Photography can be of further help to the forensic odontologist in certain circumstances. Using alternate sources of light can further add value to photography. Intraoral cameras and selfies can also help in diverse medico legal situations. It is important to understand the importance of the background in photography and not to add the artefacts during photography. It is also important to know which format of the saved digital photography will be acceptable in the courts and know the limitations and advantages of photographic documentation.

Keywords: Forensic photography; odontologists, investigation, crime scene, bitemarks.

Introduction

Forensic photography is photography which helps in the delivery of justice by documenting photographically the details of the evidence utilizing the technical knowledge and skills of photography.

Photography is commonly used at the crime scene investigation to capture the evidence and photographic evidence has been accepted in the courts. With the onset of digital photography, it has become very convenient to record and store photographic evidence and show it to investigators and judges. The only issue is to know the legal requirements of forensic photography so that forensic photography is accepted in the courts.

To practice forensic photography basic equipment of photography is required e.g., a Digital Single Lens Reflex (DSLR) Camera, tripod stand, forensic rulers (ABFO 2 scale, coloured checker charts), compass, spirit level, flash guns with batteries, cross polarising filters and additional wide-angle lenses, telephoto lenses, fish-eyed lenses, macro lenses and extension tubes.

Flashes should be used where necessary as it helps to illuminate the area of photography, increases the depth of the field and helps to record the details of the crime scene.

The use of forensic Photography has been well-established in forensic odontology.[1]

When the dental charts are prepared during a postmortem examination for identification photographing the dentition definitely will be more acceptable in the courts.[2]

Proper training in forensic photography is a must before this can be applied in a good way to forensic odontology.[3]

Computerized photography will greatly help in these areas especially when the SOPs are followed. Whenever medicolegal photographs are stored these should be stored

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in password-protected folders [3]

Digital photography [4] and Full spectrum digital photography is the best method to collect and preserve evidence in cases of bite marks in forensic odontology.[5] when the bitemarks have healed then in those cases UV and IR photography can be of great help.[4]

Intraoral 3-dimensional scanners increase the accuracy of impressions in case of bite mark analysis and to increase its efficacy LASER and optical scanners are better.[4] Dental Print software will greatly help in the comparison of 3D prints with photographs or impressions of the bite marks.

Teeth fluorescence at different age groups can also help in age determination which can be recorded by photography.[5]

Photography can be very useful in the identification of the photographs of the teeth. Visible light photography as well as UV photography can help in this.[5]

Sometimes teeth are extracted so that identification may become difficult. In these situations, UV photography can be helpful when the tool marks can be detected on the teeth and alveolus.[5]

Selfies can also be used in identification and it can be of great help in the identification. In one of the surveys, 73.2% of participants' forensic odontologists considered that selfies can be useful for identification. Selfies can be supplementary antemortem dental evidence [6]

As digital forensics has created a revolution similarly digital photography is a revolution over the previous film-based photography.[4]

UV photography can help in the detection of composite resin material in the teeth and help in the identification.[7] It can also be possibly used in the future for age estimation.[7]

Material & Methods

Google Scholar is used to search the articles using keywords. Out of these articles relevant articles were studied further to incorporate the precise knowledge into this paper.

Discussion

Forensic photography is photographic evidence which can be utilized by investigators and prosecutors to build their case in front of the judges and by defence witnesses to establish their viewpoints.

Forensic photography is a very good way of recording the evidence at the crime scene and this holds for forensic odontologists too. The only issue is that forensic odontologists should know the basics of photography and the legal requirements of forensic photography so that there are no questions raised about the authenticity of the photograph being used by forensic odontologists.

In dentistry, an intraoral camera is quite useful for recording the details of teeth which can be useful in identification. Intraoral scanners can be very useful for recording minute details and making casts of the accused from which transparencies can be made to exclude the innocents from the list of accused in case of bite marks.

Different lighting techniques can be used under different circumstances to have good photographs. Oblique lighting especially is very useful in certain situations while brightfield and darkfield illumination may be useful in other circumstances. Transillumination or backfield illumination and coaxial illumination may be useful in other circumstances. Choosing the right lighting techniques will help to get a good photograph.

Alternate light sources can be useful in certain situations. Cross-polarized lights and alternate fluorescent light sources make a difference in certain circumstances. Fuzi UV and IR cameras are useful for recording in UV and IR light sources and can be useful to record old bite marks when these may not be visible to the naked eye.

Videography, CCTV photography, selfie photography and SLR Cameras have their utilities and constraints as far as their utility in forensic odontology. Similarly panoramic and 3600 photography have their utilities.

DSLR cameras can record injuries in and around the mouth. While recording the injuries it should be taken care that the injuries are properly lit, and their orientation to other facial parts is preserved; these should never be bigger than life-size and forensic rulers should be in the field and there should be no shadows. The right aperture and right speed should be used.

Flash should be used to avoid shadows even during sunlight. During rain a lens hood or umbrella may be used. In fog, flash should be used at an angle of less than 450. If there is excessive wind speed the shutter speed should be increased. A sturdy tripod stand will also be of great help in such circumstances.

3D photography can help to reconstruct the crime scene beautifully which can be very useful to the investigators as well as the judiciary but this has the limitation that it requires costly equipment and expertise.

In videography along with the recording of the crime scene investigator can record the narration which can be very useful later on. Videography cannot be a replacement for

still photography and both can be complementary to each other.

CCTV recording is very useful for the identification of the accused persons and now CCTV is also coming with facial recognition features which will further help in the identification.

Selfies can help in identification in mass disasters as the front teeth are usually visible which can help in identification. Even now apps are available which can help in the identification of selfies.

Peripheral cameras are good for photography on curved surfaces and bitemarks on the curved surfaces can be recorded in a good manner by peripheral cameras.

While photography is being done crime scenes should not be disturbed and contaminated. The date and time of photography along with compass direction should be documented along with weather and lighting conditions. Make and Focal length of the camera should also be documented along with the name of the photographer.

The background should be plain and non-reflective and photography should not be done against the source of light. Consent for the photography should be taken and it will be better if the same gender photographer is there. In the case of violent subjects, the presence of the investigator will be useful to avoid physical attacks on the photographers.

Photographers should protect themselves from infections and if needed personal protective Equipment should be used. If he has contaminated the scene accidentally should inform the investigator and give his fingerprints and shoe prints to the investigator.

The RAW format must be preserved for the courts as this is acceptable in the courts. If stored in computers folders must be password protected and passwords should be strong.

Forensic photography is good for recording the crime scene and injuries. It is also good for recording the dying declaration and recording the statements of witnesses and suspects. Forensic odontology is good for the recording of bitemarks, recording of facial and dental injuries, and recording of the condition of teeth in mass disasters along with charting of postmortem dentition.

Conclusion

Forensic odontologists can use photography at various crime scenes for recording the evidence. This can be of particular help in bite mark cases both fresh and old cases. It can be used in mass disasters to record postmortem dental evidence along with charting. Selfies too can help in identification. It can be of help to record and find out the tool marks when teeth are removed to obscure the identification. It can help in age estimation by studying the teeth' fluorescence. All this will be possible if forensic odontologists know the basics of photography to capture good photographs and the legal requirements associated with using forensic photography. Well-presented photographic evidence will have an impact on the outcome of the judicial processes. Forensic photography is good as it is easily understood by the common man, investigators, prosecutors, defenders, and judges.

Conflict of Interest: None

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