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Facial Reconstruction: A Boon to forensic practice

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Abstract
When conventional methods are unsuccessful, forensic face reconstruction can be utilized to identify unidentified human remains. We want to evaluate the various techniques for face reconstruction described in the literature through this article. There are several methods for reconstructing the face, ranging from two-dimensional sketches to three-dimensional clay models. The degree of mistake previously experienced has been reduced because of the development of a quick, effective, and affordable computerized 3D forensic facial reconstruction approach made possible by advances in 3D technology. There are a number of hand-facial reconstruction techniques, but the combined Manchester method has been said to be the best and most precise technique for the successful identification of a person. The ability to recognize permits the participating government entities to compile a list of potential victims. The more traditional approach of forensic medicine can then be used to reduce this list and provide a positive identification. Facial reconstruction makes it easier and more certain for a person's relatives and friends to recognize them visually.

Keywords: Facial Reconstruction, forensic practice, archaeology, bone fragments, embalmed bodies

Introduction
If a skull is unintentionally found in a garden, woodland, etc., a certain identification is required. This is crucial for more than just legal reasons; it also helps the family get over their loss and find closure. In situations like these, established means of identification like radiography, DNA analysis, dental records inspection, etc., cannot be employed or have proven ineffectual because of issues like a lack of information, the state of the remains, expense, etc. A crucial forensic tool that can aid in face recognition of the skull and eventually result in a person's identification is forensic facial reconstruction [1, 2]. Scientific techniques and creative talent are used in forensic face reconstruction. In order to create a picture of a person for recognition and identification, the soft tissues of the skull can be recreated. According to some reviews, forensic facial reconstruction is a technique for approximating the face, meaning that several facial patterns may be generated from the same skull. The name "Facial Reconstruction" was coined by other researchers who believed that each skull could only generate one face, which would enable accurate identification of a person [3, 4].

Both forensic science and archaeology employ forensic facial reconstruction. This technique is used in forensic science to identify a person when more traditional methods of identification prove ineffective. It is used in archaeology to identify the faces of historical figures, bone fragments, embalmed bodies, etc. [1, 4].

The face plays a significant role in identifying and recognizing an individual since it has many distinctive traits that make it unique. A face shot is taken after a body that cannot be recognized is discovered. In certain cases, this image is digitally altered to make it fit for the witness to recognize or for the newspaper to print legally, which may eventually help identify the corpse [2, 5]. The only body part exposed for identification is the victim's face, which must be done by the victim's relatives, friends, or acquaintances. Sometimes a deceased corpse cannot be recognized because the face has been damaged by animals, physically attacked, or has decayed as a result of environmental causes. In cases when there is little to no other relevant evidence, forensic facial reconstruction is a different technique of identification [6].

The two types of reconstruction techniques are two-dimensional (2D) and three-dimensional (3D) procedures. They can be carried out and analyzed manually or by utilizing digital software. The Anatomical (Russian), Anthropo-metrical (American), and Combination Manchester (British) methods, created by Gerasimov, Krogman, and Neave, respectively, are the 3D manual techniques used in forensic facial reconstruction [2, 6].

Background

Wilheim His, a German anatomist, performed the first face reconstruction in 1895. Johann Sebastian Bach, a German composer, had his visage recreated [7]. German scientist and anatomist Welcker evaluated the depth of penetration of several anthropometric markers on the face using a short surgical blade before documenting the average tissue depth thickness from examining cadavers. The "Welcker Facial Reconstruction Technique" is what this is known as. Using the same method, Welcker recreated the faces of Schiller, Kant, and Dant. Wilheim further improved this method in the late 1880s and early 1890s by employing a narrow, sharp needle with a piece of rubber on the tip in place of a larger blade. As a result, there was less tissue deformation, which improved the findings [7-9]. Later in 1946, Wilton Maria Krogmann developed five fundamental principles—the relationship between the eyeball and orbit, the form of the nose tip, the position of the ears, the breadth of the mouth, and the length of the ears—to change the techniques for reconstructing the soft tissues of the face [10, 11].

Rapid, fast, and affordable computerized facial reconstruction software was created with the advancement of 3D technology. The facial reconstruction approach is replicated by the program. At London College University, where a cranial reconstruction technique was performed utilizing a laser-like scanner and video camera, computerized reconstruction was initially researched in the 1980s. A library of 'Living subject' facial surfaces was created using the data that was gathered [12, 13].

2-dimensional facial reconstruction

Soft tissue depth estimations are utilized in this to reconstruct a face from the skull. In the 1980s, Karen Taylor invented this technique in Austin, Texas. This technique is based on antemortem images and the skull that has to be recreated and involves collaboration between an artist and a forensic anthropologist for the reconstruction of the face. The deceased are also identified using skeletal remains using this procedure [13, 14].

These days, a variety of computer software applications, such as CARESTM or CARES (Computer Assisted Recovery Enhancement System) and FACES (Forensic Anthropology Computer Enhancement System), swiftly provide 2D reconstruction that may be modified and changed. They operate by photographing, digitizing, and creating an electronically changed versions of radiographs, pictures, and images of skulls. These tools expedite the reconstruction procedure and generate more standardized pictures [11, 14].

3-dimensional facial reconstruction

A forensic anthropologist and an artist are also required for this procedure. By applying clay, plastic, or wax directly to the victim's skull, or more frequently, a copy of the victim's skull that must be recognized, face reconstruction is carried out manually. Since this approach similarly uses tissue depth markers of predetermined lengths to indicate various soft tissue depths, it is comparable to two-dimensional systems. At particular key locations or landmarks, the markers are put into tiny holes on the cast of the skull. Using scanned and stock photos, computer software creates reconstruction in the computerized approach [15].

Different methods of manual 3D facial reconstruction

Anthropometric American Method/ Tissue Depth Method

Krogman came up with this technique in 1946. Soft tissue depth information is taken into account using this strategy. Police departments frequently employed this technique for rebuilding. X-rays, ultrasonography, and needles were used to take precise measurements. This approach is no longer favoured since it takes highly skilled workers to capture face muscles in an anatomically correct fashion [15, 17].

Anatomical Russian Method

Gerasimov developed this technique in 1971. Here, soft tissue depth information was not taken into account, but anatomically correct face muscles were utilised. This technique involved layer-by-layer moulding of the muscles, glands, and cartilage onto the cranium. These days, this method is not frequently employed. This approach requires more anatomical understanding and is significantly slower than the American method. Using this technique, fossilized skull reconstructions have been made [18-20].

Combination Manchester Method/British Method

The most widely used technique for face reconstruction today was created by Neave in 1977. This method takes into account the thickness of the soft tissues as well as the facial muscles. Facial tissue pegs or markers are added to the skull after the cranium and mandible have been articulated and the skull has been mounted on an adjustable stand in the Frankfort Horizontal plane, either by placing them directly on the skull or by inserting them into previously drilled holes on the cast at 90 degrees using a 3mm drill bit [5, 9, 20]. The mean tissue depth at the anatomical site is represented by the length of each peg. The depth of the facial tissue depends on the person's age, gender, build, etc. The modelling material is used to build the face and chewing muscles, which are then positioned according to where they start and end on the skull. Based on the underlying hard tissues, different muscles have different shapes and sizes. The orbits are filled with 25mm-diameter plaster or plastic prosthetic eyeballs. The prosthetic eyeballs are positioned in the orbit so that the iris is touched by a line drawn from the middle of the supraorbital to the middle of the infraorbital margins. The outer canthus is positioned 4mm medial to the malar tubercle, while the inner canthus is positioned 2mm laterally to the lacrimal crest. The outer canthus is positioned 10 mm below the frontozygomatic suture and 5-7 mm from the orbital edge when the malar tubercles are missing [21]. The bony nasal aperture measures three-fifths of the total width of the soft nose at its broadest point, which yields the maximum width of the nose. The nasal aperture determines the nasal profile, as well as the size, shape, and number of alae [22]. The maxillary canine and first premolar are situated close to the corners of the mouth, and there are six anterior teeth for every inch of the mouth's breadth. The upper and lower anterior teeth control lip thickness. The

external auditory meatus serves as a reference point to determine the location of the ear canal and the length of the ear is anticipated by the length of the nose. The face's muscles are typically modelled one by one on the skull, which is to be recreated in clay. Next, a layer of clay is added over the musculature to represent the skin, and strips of clay are then rolled, shaped, and added over the muscle/fat structure to create the finished face while maintaining the length of the pegs as a guide to the final tissue guides over the face [19, 20].

Computerized 3D Forensic Facial Reconstruction

A quick, effective, and affordable computer-aided forensic facial reconstruction method was created because of the development of 3D technology. In this approach, the operator created 3D computer models by hand with clay models. While some computerized systems employed virtual sculpting systems with haptic feedback (Phantom DesktopTM Haptic Device; Sensable Technologies), some computerized systems used 3D animation software (Free Form Modelling PlusTM; Sensable Technologies, Wilmington MA) to model the face onto the skull. When doing an analysis, haptic feedback systems have the capacity to feel the surface of the skull. They may also give crucial skeletal information for facial reconstruction, such as the strength of muscle attachments, the location of the eye, the position of the malar tubercle, etc.[22] However, this method necessitates knowledge in both anthropology and computer modelling. It lessens the subjectivity and expertise of the practitioner. Additionally, this technique swiftly and effectively produces several photographs of the same face [19, 22].

Conclusion

Forensic facial reconstruction is a quick, non-invasive, and effective technique that may be performed whenever necessary. This method is utilized for archaeological study as well as for the identification of people from skeletal remains. Thus, visual identification by the person's relatives and friends is made simple and clearer. The Combination Manchester approach has been determined to be the best and most accurate approach for the positive identification of an individual while using the traditional manual methodology. However, manual procedures need a lot of labour. The manual process of facial reconstruction can be replicated by forensic facial reconstruction software. The manual approach is far more difficult than the computerized method, which also requires less training for the practitioner.

Conflict of Interest

Not available

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