Review Article

RECONSTRUCT, REMODEL AND REINCARNATE: AN ARCHEOLOGICAL APPROACH TOWARDS FACIAL RECONSTRUCTION

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ABSTRACT

Severally injured, decapitated, and/or mutilated skeletal structures lead to the difficulty in identification of mortal remains. Since the inception of forensic sciences and forensic odontology it has posed a greater challenge in identification of the deceased through the remains. Over the years, various techniques have been applied for the identification of deceased individuals. Out of these techniques, the commonly used are the comparison of ante-mortem and post-mortem data by using clinical records, radiographs, or DNA. Still the identification of severely mutilated bodies poses a challenge for the forensic team. The advent of the twentieth century brought a revolution in the field of facial reconstruction, as the computers could completely change the methods of reconstruction. Forensic facial reconstruction is art and science to recreate the antemortem appearance of an individual in order to recognize and identify the decedent. Over the years, many techniques of FFR and imaging modalities that provide the basic data for FFR have evolved. This poster depicts different methods of facial reconstruction and its pragmatic use in the field of forensic odontology.

Key Words: Mutilated, Facial Reconstruction, Two-Dimensional, Three-Dimensional, Anthropometrical , Anatomical, Computerized

INTRODUCTION:

Positive identification from the skeletal remains has always fascinated the medical experts in recreating and reconstructing the facial structures. With facial features playing a major role in identification of the human remains, the gross facial reconstruction augments and accelerates the process of identification. Skull is a rigid structure which can survive for centuries and the it proves to be an effective archaeological biofact. The bones of the skull form the basic framework to which soft tissues are attached[1]. Severally mutilated, burned, decomposed human remains are difficult to identity. The scientific art of creating appearance of an individual near to the original with the help of skull by reconstruction either through manual of digital methods is known as the forensic facial reconstruction[2]. However forensic facial reconstructions will not produce perfect replica of an individual face instead it gives a gross approximation which is an alternative in the identification when all the usual methods of identi,cation have failed. In archaeological investigations, facial reconstruction has been used to identify skeletal remains of famous people from the past[3]. This article reviews all the methods implied in the process of three-dimensional facial reconstruction and relives the history of a few famous cases sorted through the same process.

HISTORY

Unearthing of Tutankhamuns mummy and exploration of his mortal remains opened up new horizons for the forensic scientists in the field of reconstruction. The process which has been predominantly been used to identify the dead, to unveil the cause of death and recreate the facial structures, is now an important adjunct. Attempts at building the face on skull carried out since Neolithic period as a means of ancestor worship and preservation procedure. Anatomists were the first to become interested in the process of facial reconstruction. Anatomist Welcker and Tandler, were the ones who reconstructed the skulls of some historic ,gures and compared with portraits, sculptures and death masks[4]. The first three. dimensional (3D) facial reconstruction was tried by His (1895) and Kollman (1898). Kollman and Buchly (1899) reconstructed Stone-Age woman face with soft tissue thickness from women of that area which was considered to be the ,rst real scienti,c reconstruction[4]. United states of America became the first country to attempt facial reconstruction in 1916 by the initiatives of medicolegal experts. But , the first documented medicolegal identi,cation was done by Glaister and Brash (1937) by solving the mystery of missing Dr Ruxtons wife. Taking the lead, German physiologist

and anatomist Welcker devised a method of facial reconstruction by enumerating the varying tissue depths and named it as "Welcker's Facial Reconstruction Technique".

METHODS OF FACIAL RECONSTRUCTION

An array of methods has been tried and tested for the facial reconstruction over the ages. All those methods have eventually been cumulated into the two major modalities depending upon their procedural implication. These methods are: -

(1) The two-dimensional representation of the face drawn over a photograph of the skull.

(2) Three-dimensional facial reconstruction using a sculptural technique.

(3) Three-dimensional computerized facial reconstruction.

TWO DIMENSIONAL

Two-dimensional facial reconstructions method was first developed by Karen Taylor in Austin, Texas during the 1980's. Based on ante mortem photographs, and the skull[5] this method usually requires the collaboration of an artist and a forensic anthropologist. 2-D facial reconstruction is a technique recreats and remodels the facial appearance to that akin to the features of the person who was once alive. In the due process, photographs of skull are taken with all the relevant tissues

depth markers marked accordingly. This is further superimposed by the tracing paper or any other transparent paper. The artist then draws on the transparent paper carefully following the tissue depth markers and contours of the skull. It is very important to follow the markers and shapes in accordance to the skull, being extra vigilant to the features such as teeth, orbital shapes, nose bridges and nasal apertures. Computer assisted 2D reconstruction done by using various computer software programs like CARESTM or CARES (Computer Assisted Recovery Enhancement System) and FACES (Forensic Anthropology Computer Enhancement System) which capture and digitalize radiographs, photographs and images of skulls and gives an electronically altered version of the image.

THREE-DIMENSIONAL RECONSTRUCTION

This method also needs collaborative efforts from an artist and a forensic anthropologist. In manual methods, facial reconstruction is done by using various material like clay, plastic or wax on the skull to remodel the facial structure which further facilitates in identifying an individual. It is similar to two dimensional methods using tissue depth markers of specified lengths to represent different soft tissue depths at specific strategic points or

landmarks. In the computerized method, computer software is used to produce reconstruction by using photographs

Anthropometrical American Method/ Tissue Depth Method

American 3-D method was developed from the work of Krogman. In this method Krogman photographed a cadaver head before it was de' eshed. The sculptor, McCue, produced a facial reconstruction using tissue depth data on the same skull and recreated the facial structures matching it to the sex and racial origin of the individual. The results were promising as reconstruction had a good resemblance to the individual when compared to the photograph of the cadaver. In this technique soft tissue depth data obtained by the use of needles, X-rays or ultrasound is taken into consideration. Facial muscles are recorded in a proper anatomical manner, that requires highly trained personnel. Due to this technical working curve this technique is not preferred now a days. Previously, this method was commonly used for reconstruction by law enforcement agencies[6].

Anatomical Russian Method

This technique was given by the Russian anthropologist, Gerasimov (1971), who had attempted to recreate the appearance of deceased individuals. He developed an anatomical approach where modelling each facial muscle onto the skull layer by layer and then finally covering with a thin layer of clay to create the , nished face. This method is much slower than the American method and required greater degree of anatomical knowledge. This is used for reconstruction of fossilized skulls[7].

Combination Manchester Method/ British Method

Neave in 1977, developed a novel technique which became instantaneously famous and it is the commonly used method nowadays. This combination method incorporates both the Russian and American methods of anthropometrical and anatomical application. Neave worked with Manchester Mummy Team at the University of Manchester, which was responsible for the forensic investigation of numerous Egyptian mummies housed at the Manchester Museum. He used same sets of mean tissue depths as the American method, but followed Gerasimov's anatomical approach, using the tissue thickness points as guides when laying the skin layer over the musculature. This technique takes into account the use of both soft tissue thickness and facial muscles. Facial tissue markers representing the mean tissue depth which are determined by the age, gender, build are added on to the skull at anatomical point, either by placing

directly on the skull or by inserting them into the drilled holes of 3mm diameter. The muscles of mastication and facial expression are constructed on the skull based on their origin and insertion. The size and shape of reconstructed muscles is determined by the underlying hard structures. Muscles are usually modelled on the skull layer by layer with the help of clay. To represent skin and subcutaneous tissue a layer of clay is added over the musculature to create the finished face while maintaining the length of the pegs as a guide to the final tissue guides over the face.

Computerized 3D Forensic Facial Reconstruction

Computer-assisted facial reconstruction was first introduced by Vanezis and his colleagues[8]. In this technique skull images scanned through laser scanner are transformed into the faces. Skull digitalized by using laser and fully shaded images are seen on the computer. Tissue markers are digitally placed on the garnered image at selected sites. A digital template from the previously scanned face of live subjects is masked over the skull facilitating it to specifically conform to the skull[11]. Technique by Quatrehomme et al. (1997), describes facial reconstructions based on deformable models. CT scan is used to obtain the

digitized 3-D models of two pairs of skulls along with their facial data. First pair is used as a reference and the other skull is used for the validation of the same. An applicable parametric algorithm is categorically used to convert the reference skull into the skull which has to be reconstructed. To compensate the lack of understanding of harmony between hard and soft tissue in the previously used techniques, Nelson and Michael introduced a new approach of reconstruction using the volume deformation. In this technique unknown skull and other reference skull are digitized. Then a set of control points are placed at specific anatomical positions on the heads and the skull. Out of them a single head is deformed by calculating and comparing the spatial distribution of the control points. Finally, the selected head deformed with the help of control points to the shape of the skull and further adjustments of addition of facial features, facial expressions and tissue depth variations done by manipulating the control points.

Till today, all computerized reconstruction techniques use CT scanners for obtaining the virtual copy of the unknown skull. In case of live subjects for the database, CT scanners allow both the skull and the face surface information to be obtained simultaneously and in the correct spatial relationship to each other. Due to

radiation hazards of CT scan a non-harmful alternative MRI is also being used. Off late, Cone-beam CT (CBCT) has also come into limelight to overcome certain disadvantages of CT. Studies are also being done to test the reproducibility of CBCT scanners by measuring the soft tissue thickness at different landmarks which revealed that thickness that can be measured with high reproducibility.

Computerized 3D is a fast, efficient and cost-effective computer-aided forensic facial reconstruction method. Models can be manipulated and edited easily at several angles to identify an individual within a short duration.

FEW CASES AT A GLANCE

Forensic art is a tool used in law enforcement in different capacities. The most popular form of forensic art that we have seen is the police sketch which had wonderful success in cases of missing persons. Now a days artists are turning towards computer softwares for drawings. Facial reconstruction is a method used in the forensic field when a crime involves unidentified remains. Over the past few years, it has been of much help in crime cases where there were no clues to track a person, or if a face has been damaged or the body decomposed. Recently few reported cases in India which were solved

by reconstructing, remodelling the facial tissues with the help of the skull only.

Sheena Bora murder case

On May 23rd 2012, Raigad police stumbled on a scorched body. Skull, bones, tissue and teeth were sampled. Records with dentist were enquired and corroborated. Forensics experts used digital superimposition photography and facial reconstruction for identification. They superimposed mugshots of the likely family members over the dead people to look for bone structure matches and finally the DNA test followed for confirmation. This is how with the help of 2D computerized technique Sheena Bora emerged from her bones.

The Nithari killings

In the famous Nithari case police faced the same problem of establishing the identity of skulls found in drainage. The investigating agency decided to go in for DNA test and facial reconstruction and facial super imposition of all skulls found. In 2006 Noida police sent 19 skulls and DNA samples for laboratory examination to forensic science laboratory. The forensic and DNA Experts using superimposition and 3D techniques identified 16 children.

Ambernath murder case

Police found decapitated body in the Ambernath hills with skin peeled. Police reached a team of forensic experts for the facial reconstruction. Forensic team used

anthropometry measurements to construct a face on the skull within 4 weeks. With the help of that police arrested victim's wife and her lover.

CONCLUSION

Forensic facial reconstruction is an evolving branch which plays role in the identification of severally injured, decapitated, mutilated and completely destroyed victims in homicides, genocides and/or mass causalities where identification of an individual becomes difficult. Even in the aspect of archeological surveys where skeletal remains are often found, one can rely on the facial reconstruction technique to establish the identity of the bygones. With time, techniques are changing gradually from artistic method to the scientific ones. All techniques have their own advantages and disadvantages. Latest 3D method using computer for facial reconstruction is widely used, but a computer system that interprets the muscle structure of the face which can be altered sculpturally would seems to be the most accurate way of developing facial reconstruction in the coming future. Thus, it can be said that the scope of improvement and scientific advancement go hand in hand when it comes to bringing back the dead.

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