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## 1. Learning Outcomes

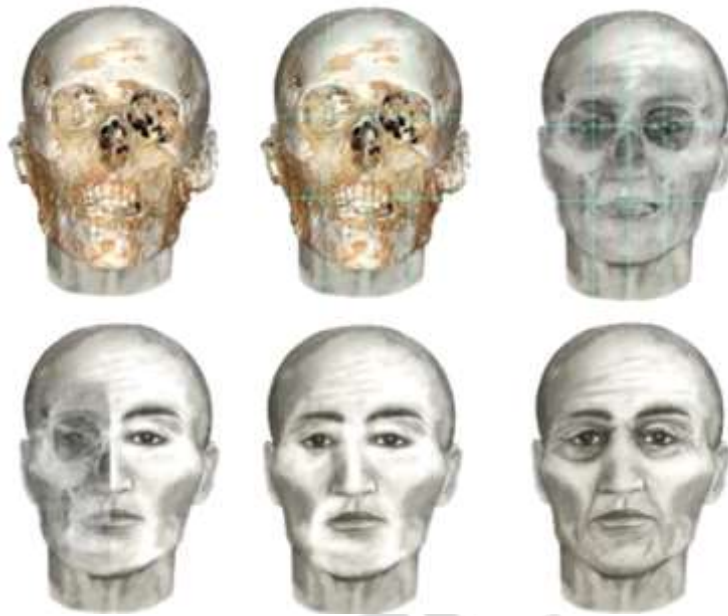
After studying this module, you will be able to know-

- About facial reconstruction
- About types of identification and reconstruction
- About various techniques of facial reconstruction and steps of facial reconstruction.
- About limitations of facial reconstruction

## 2. Introduction

Amalgamation of artistry with forensic science, osteology, anatomy and anthropology to recreate the face of an individual from its skeletal remains is known as Forensic Facial reconstruction. It is also known as forensic facial approximation. It recreates the individual's face from features of skull. It is used by anthropologists, forensic investigators and archaeologists to help in portraying historical faces, identification of victims of crime or illustrate the features of fossil human ancestors. Two and three dimensional approaches are available for facial reconstruction. In forensic science, it is one of the most controversial and subjective technique. This method is successfully used in spite of this controversy.

There are two types of methods of reconstruction which are used i.e. two dimensional reconstruction and three dimensional reconstruction. Sketching of facial features is involved in 2D reconstruction. This can be done by hand or by using a software. For rendering of soft tissues, the skull should be photographed with tissue depth markers attached. This 2-D technique is economical, fast and efficient. Minor adjustments in hair or face can be made rapidly and with ease. Skill of the artist, quality of original photograph and completeness of skull are the major factors that affect this method. Three dimensional techniques are also used for facial reconstruction. This is expensive and time consuming. Clay modelling and computer software both can be used for facial reconstruction using three dimensional techniques. In three dimensional method, the skull should be placed on a workable stand where tilting and turning of skull is possible in all directions. The skull must be positioned in the 'Frankfort Horizontal' position.



**Figure 1: Forensic Facial Reconstruction**

## 2.1 History

Reproduction of facial features from cranial remains was first done by Welcker (1883) and His (1895). According to the sources, His is acknowledged as the forerunner in advancing the technique. First data on facial tissue thickness was recorded by His. Later, additional data was collected and tables were compiled by Kollmann and Buchly (1898) which are still used in present day facial reconstruction. Origination of facial reconstruction took place in two of the four major subfields of anthropology i.e biological anthropology and archaeology. It was used to reconstruct the appearance of early hominid forms in biological anthropology whereas validation of remains of historic figures was done in archaeology. Estimation of appearance of ancient people using paleo-anthropological facial reconstruction was first attempted by Mikhail Gerasimov in 1964.

Gerasimov (1964) techniques were later used by his students to help in criminal investigations. Wilton M. Krogman popularized facial reconstruction in forensic field. In 1962, Krogman presented his method in detail in his book on facial reconstruction. Cherry (1977), Angel (1977), Gatliff (1984), Snow (1979), and Iscan (1986) also popularized 3-D facial reconstruction. First forensic facial reconstruction of about 2200 year old mummy was done by Canadian artist Christian Corbet using CT and laser scan. This was noted by Dr. Andrew Nelson of the University of Western Ontario, Department of Anthropology in 2004. This reconstruction is known as Sulman Mummy Project.

### 3. Types of Identification

Two types of identification in forensic anthropology are:

- Circumstantial identification
- Positive identification

#### 3.1 Circumstantial identification

A biological profile of the set of skeletal remains collected is established. When an individual fits the biological profile then it is termed under circumstantial identification. Identity of a person cannot be proved with this identification as more than one person can have same biological profile.

#### 3.2 Positive identification

When particular and specific set of characteristics fits with individual's biological profile then it is termed under positive identification. Correspondence of skeletal remains with dental record, medical record, post mortem or ante mortem records, DNA records or DNA analysis etc. is also required.

In criminal cases, when identification of remains cannot be done using other means then facial reconstruction is used. Facial Reconstruction provide with strong leads that help in identification of remains.

### 4. Types of Reconstruction

There are two types of approaches of facial reconstruction during an investigation, two dimensional and three dimensional.

#### 4.1 Two Dimensional Reconstruction

On the basis of ante-mortem photographs and skull, two dimensional facial reconstruction is done. Since many cranial structures are invisible, they are not ideal for use. Forensic anthropologist and artist both have to work together for obtaining successful results of this method. This method was developed by Karen T. Taylor in 1980s. According to his method, at various anthropological landmarks on unidentified skull, tissue depth markers were adhered and then it was photographed. Lateral photographic prints are used as foundation for facial drawings done on transparent vellum.

There are two computer softwares which are used for facial reconstruction, F.A.C.E and C.A.R.E.S. They produce editable and manipulative 2-D facial approximations rapidly. They produce better images than hand drawn artwork and help speed up the reconstruction process.



**Figure 2: Two Dimensional Facial Reconstruction**

#### **4.2 Three-Dimensional Reconstructions**

There are two types of 3-D facial reconstructions: Sculptures made from modelling clay and other different materials and High dimensional 3-D computer images. The sculptures are made from casts of cranial remains. Three dimensional reconstructions also require a forensic anthropologist as well as an artist similar to two dimensional reconstructions. Manipulation of scanned photographs of unidentified remains, stock photographs of facial features and other reconstructions is carried out using computer programs. Reconstruction through these computer programs is very helpful in victim identification as it does not appear artificial.



**Figure 3: Sculptures made from modelling clay and other different materials.**

### **4.3 Superimposition**

It is one of the techniques that is included among methods of forensic facial reconstruction. For implementation of this technique the investigator must have some knowledge about identity of the remains. Superimposition can be applied if the identity of skeletal remains is completely unknown contrary to 2D and 3D reconstructions. An X-ray of skeletal remains is placed over the photograph of an individual suspected of belonging to the unidentified skeletal remains to carry out forensic superimpositions. In case of a match, alignment of the anatomical features of the face should be accurate.

## **5. Techniques for creating Facial Reconstruction**

### **Method for creation of three dimensional clay reconstruction**

Various methods and techniques are used while creating 3D facial reconstructions since a specific standard method has not been agreed worldwide. The method described is used after the assumption that sex, age and race of the remains have already been determined through other forensic anthropological techniques. To carry out facial reconstruction, skull is the most valuable remain. Sometimes, other remains available also prove to be valuable. Most of the time, the remains are covered with remnants of soft tissue. By close observation of these tissues thickness of the tissues can be estimated approximately by a forensic artist. Estimation of tissue thickness is one of the most important and difficult aspects of reconstruction. Other physical evidences found with the remains such as glasses, jewelry etc. are important in final stages of reconstruction as they can directly reflect the appearance of the individual whose remains are found.



**Figure 4: Skull with tissue depth markers**

## 6. Steps of Facial Reconstruction

Most commonly skull is found as remains which may or may not be covered with soft tissues. In case there is minimum or no soft tissue covering, thorough examination of skull should be done by forensic artists. Identification of any bony pathologies, ruggedness of muscle attachments, unusual landmarks, wear of the occlusal surfaces, profile of the mandible, symmetry of the nasal bones and dentition are the main features to be focused during examination but examination is not limited to these features only. Appearance of a person's face is affected by these features.

After complete examination, skull is cleaned and the broken or damaged areas are repaired with wax. Wax is used to reattach the mandible on the basis of alignment of teeth. In case of absence of teeth, approximate vertical dimensions between mandible and maxilla are measured and then mandible is reattached. Modeling clay is filled in nasal openings and artificial eyes are inserted into orbits between superior and inferior orbital rims. After this, plaster cast of skull is made. According to the reference data, colored plastics or colored ends of safety matches are attached at twenty one landmark areas after setting of cast. These landmarks represent the approximate thickness of facial tissue for persons of same sex, age and race as that of remains. After all these steps, modeling clay is used to add all the features.

Following order is followed while layering the facial muscles on the cast:

1. Temporalis
2. Masseter
3. Buccinator



4. Occipito-frontals
5. Soft tissues of neck

After construction of these muscles, nose and lips are reconstructed. Width of lips is almost as wide as interpupillary distance. Age, sex, occlusion and race affect this distance significantly. Due to limited underlying bone, reconstruction of nose is the most difficult part of facial reconstruction. Probability of variation is high. Width of nasal spine and nasal aperture is measured while constructing nasal profile. To yield the approximate nose length, calculation is made of three times the length of the spine plus the depth of tissue marker number five. Examination of direction of nose spine (down, flat or up) determines the pitch of the nose. A block of clay that is the proper length is then placed on the nasal spine and the remaining nasal tissue is filled in using tissue markers two and three as a guide for the bridge of the nose. Below the bottom of nasal aperture alae is created. Alae are made as small egg shaped balls of clays which are five millimeters in diameter. This is done after completion of main part of the nose. Blending of alae with the nose is done to give it a proper round shape.

Next step is addition of soft tissues around the eyes and facial muscles. During this stage, further measurements are made in accordance to the race. After this, tissues are built up to within one millimeter of the tissue thickness markers and the ears are added. Reproduction of ears is a highly complicated task. After completion of all these steps, clay is added till the tissue thickness markers are covered and any other specific detail is added. This is known as 'fleshing' the face.

## 7. Limitation of Facial Reconstruction

Validity of facial approximation is not accepted by all researchers. Correlation between the bony features of the skull and the soft tissue of the face remains weak. Variability of facial muscles is high in both structure and presence whereas some muscles do not attach to the skull directly. Rebuilding of muscles from hard tissues is difficult. Final appearance of face is greatly impacted by subcutaneous fat in the face and there is no way to predict the level of this fat. Another issue with facial reconstruction is tissue depth. Average tissue depth is calculated according to the reference samples.

Facial reconstruction helps in providing new leads that may lead to a tentative identification. Through dramatic representations of the past, they may also encourage interest in new archaeological material and promote additional research. Methods of facial reconstructions should be used carefully for validation.

There are several limitations which are associated with forensic facial reconstruction.

Some of the limitations are:

**i. Insufficient tissue thickness data**

Sometimes due to unavailability of some parts of the bones, facial reconstruction is partially completed. For example, if mandible is missing then facial reconstruction has to be done without mandible resulting in partial reconstruction. Limited data is present on average facial tissue thickness in context of ages, sexes and body builds. Accuracy of reconstruction is majorly affected due to this disparity. Perfect and accurate reconstruction can be achieved only if the data is expanded.

**ii. Lack of methodological standardization**

Lack of methodological standardization in reconstruction of facial features is also one of the problems. Recognition of a single and official method of facial reconstruction is required. This also presents major setback in facial approximation because facial features like the eyes and nose and individuating characteristics like hairstyle - the features most likely to be recalled by witnesses - lack a standard way of being reconstructed. Current limitations can overcome by using computer assisted methods of facial reconstruction in contrast to the digital image processing and pattern recognition.

**iii. Subjectivity**

Only the type of face of the person can be revealed after reconstruction because of artistic subjectivity. Accuracy in position and general shape of the main facial features can be observed as these features are mainly determined by skull.

## 8. Summary

- Amalgamation of artistry with forensic science, osteology, anatomy and anthropology to recreate the face of an individual from its skeletal remains is known as Forensic Facial reconstruction.
- Reproduction of facial features from cranial remains was first done by Welcker and His. Later, additional data was collected and tables were compiled by Kollmann and Buchly which are still used in present day facial reconstruction.
- Estimation of appearance of ancient people using paleo-anthropological facial reconstruction was first attempted by Mikhail Gerasimov in 1964.
- First forensic facial reconstruction of about 2200 year old mummy was done by Canadian artist Christian Corbet using CT and laser scan.
- There are two types of identification in forensic anthropology: Circumstantial identification and Positive identification.
- On the basis of ante-mortem photographs and skull, two dimensional facial reconstruction is done.
- There are two types of 3-D facial reconstructions: Sculptures made from modelling clay and other different materials and High dimensional 3-D computer images
- Manipulation of scanned photographs of unidentified remains, stock photographs of facial features and other reconstructions is carried out using computer programs in 3-D reconstruction.
- An X-ray of skeletal remains is placed over the photograph of an individual suspected of belonging to the unidentified skeletal remains to carry out forensic superimpositions.
- By close observation of thickness of the soft tissues can be estimated approximately by a forensic artist while 3-D clay reconstruction.
- Identification of any bony pathologies, ruggedness of muscle attachments, unusual landmarks, wear of the occlusal surfaces, profile of the mandible, symmetry of the nasal bones and dentition are the main features to be focused during examination but examination is not limited to these features only. Appearance of a person's face is affected by these features.
- Clay is added till the tissue thickness markers are covered and any other specific detail is added. This is known as 'fleshing' the face.
- There are several limitations which are associated with forensic facial reconstruction. Some of the limitations are: Insufficient tissue thickness data, Lack of methodological standardization and subjectivity.