

Skull Replication using Silicon Impression Material for Forensic Facial Reconstruction Procedure

Arjun Kundu^{1*}, Astha Pandey², Mohak A. Thakor³

¹School of Doctoral Studies and Research, National Forensic Sciences University, Gandhinagar, Gujarat, India.

²School of Forensic Science, National Forensic Sciences University, Gandhinagar, Gujarat, India.

³Dr. M K Shah Medical College, Chandkheda, Ahmedabad, Gujarat, India.

ABSTRACT

Skull replication or obtaining a skull replica is an important step during forensic facial reconstruction or any other investigative procedure. When working on the original skull, there is a possibility of fracture of the delicate bones or damage to other structures. Replicating a skull allows us to preserve the original, study the skull during the entire investigative procedure, and leave a record of the specimen. The duplication of the skull can be done with impression materials like alginate, silicon and molding with gypsum or plaster of Paris. With the advancement of technology, CT scan, CBCT, 3D scanning, and 3D printing can aid in a better and more accurate replica of the skull and also without touching or tampering with the skull. But in cases where such a facility is not available, replication is made manually with impression materials. In this study, the skull duplication process is systematically prepared in a few phases using silicon impression material.

Keywords: Skull duplication, Skull replica, Three-dimensional reconstruction, Forensic facial reconstruction, Forensic science.

Int J Eth Trauma Victimology (2022). DOI: 10.18099/ijetv.v8i02.04

INTRODUCTION

Facial reconstruction is used as an important forensic tool that may help in refabricating the appearance of the skull that best resembles the original face of the deceased for personal identification.^{1,2} When working on the original skull, there is a possibility of fracture of the delicate bones or damage to other structures. Replicating a skull before starting a facial reconstruction process or any other investigative procedure offers important advantages. Replicating a skull allows us to preserve the original, study the skull during the entire investigative procedure, and leave a record of the specimen. Usually, the bones of the skull are fragile, most of the time they are damaged or missing, leading to difficulty in processing and preserving while working on it. The duplication of a skull is a complicated and time-consuming practice. However, it requires training and experience to duplicate the skull without damaging it.³ With the advancement of technology, easy skull replication methods are introduced. 3D scanning and 3D printing can aid in a better and more accurate replica of the skull and also without touching or tampering with the skull.⁴ But in cases where such a facility is not available, replication is made manually with silicon or alginate impression materials. In this study, the process of duplicating the skull is systematically prepared in a few phases. Each phase has been explained in detail and supported with illustrations to make it easier to understand.

MATERIALS AND METHOD

The skull and mandible used for duplication in this study are obtained from the archives of the Laboratory of

Corresponding Author: Arjun Kundu, School of Doctoral Studies and Research, National Forensic Sciences University, Gandhinagar, Gujarat, India, e-mail: arjun.kundu77@gmail.com

How to cite this article: Kundu A, Pandey A, Thakor MA. Skull Replication Using Silicon Impression Material for Forensic Facial Reconstruction Procedure. *Int J Eth Trauma Victimology*. 2022;8(2):12-14.

Source of support: Nil

Conflict of interest: None

Received: 11/12/2022;

Received in revised form: 25/12/2022;

Accepted: 28/12/2022;

Published: 30/12/2022;

Forensic Odontology, National Forensic Sciences University, Gandhinagar. The silicon impression material used in this study is “SILOCZEST”. Other tools used are a mixing spatula, masking tape, scissors, BP blade, rubber bowl, cotton, oil-based clay, plaster of Paris, and dental stone.

Skull Handling

Careful handling of the skull should be done. Stabilizing the skull should be done with clay, cork ring, or a sandbag. Avoid picking up the skull with your fingers in the orbit, or nasal aperture; instead, both hands should be used to handle the skull, or a thumb should be placed in the foramen magnum with the palm of your hand supporting the base of the skull.^{3,5,6}

Skull Preparation

The first step is to prepare the skull for duplication. The openings, foramina, and gaps should be masked so that they are not filled and damaged by the silicon impression material. Openings of more than 2 to 3 millimeters should be masked



Figure 1: Masking of foramen and cavities



Figure 2: Forming the base for the maxilla and mandible

with tape. Larger foramen like foremen magnum is also masked with tape (Figure 1). Keep the vomer bone and nasal spine fully exposed, as these landmarks are important to determine the structure of the nose. Keep a small amount of cotton or gauge inside the nasal aperture and seal it with tape. Fill the orbit partially with cotton, and then mask it with a small piece of tape, or a light application of clay. Be careful during handling the delicate bones inside the nasal aperture and eye socket.^{3,5-7}

Mold Preparation

The skull morphology consists of multiple irregularities, foramina, concavities, and convexities. Care should be taken so that the silicon impression material won't stuck under the concavities and break the skull bones. The silicon mold is to be formed in two parts for duplication of the skull. A line is drawn along the lower border of the zygomatic bone, going through the superior margin of the teeth and extending up to the superior border of the external auditory meatus. The space between the zygomatic bone and the temporal bone should be filled. The mold should also be formed in two halves for the mandible, placing the line between the mental foramen and the inferior margin of the teeth going completely around the mandible.^{6,8} The base is made along these lines with clay (Figure 2).

The mold consists of two parts- the flexible one and the hard supporting mold. The flexible mold is formed by silicon



Figure 3: Silicone pouring layer by layer on the skull and mandible

and the supporting mold can be made from plaster of Paris or dental stone.

Silicon Impression Material and Material Handling

Silicon impression materials are dimensionally stable, have suitable working time and setting time, and will not leave a residue or harm the bone. Silicon impression material used in the procedure, "SILOCZEST", consists of two parts, resin, and catalyst. It is milky white, fast curing, cures at room temperature within 1–3 hours, operating time 5–15 minute at 25°C, and mixing ratio 100: 3–5. Alginate could be used in the same way, although the mold will not be permanent. Measure the materials using a volume or weight standard per the manufacturer's directions. You will have about 5 to 10 minutes before the silicon gets too stiff to use, so mixing is to be done in small batches so that it is easy to use. It is convenient and time-saving to pre-measure several batches before beginning the process. Sulfur is a common element in latex gloves and a few oil-based clays. Avoid wearing latex gloves or use sulfur clay as the silicon will not be set up if in contact with sulfur.⁶

Applying the Silicon

Start pouring the silicon over the cranium; care should be taken to keep the thickness of the silicon as uniform as possible (Figure 3). Care should be taken while working around the orbits and nasal aperture. To fill in the orbits and nasal aperture, you should tilt the skull accordingly. Apply the silicon layer by layer. Don't apply a new layer until the previous one has been set up. This will result in damage to the surface of the silicon underneath. Fill up any leftover spaces in the silicon from previous layers using multiple coats over the entire skull. For the openings in the orbits, small bits of cotton are placed inside. These are placed only after the first layers of silicon have been set. The cotton collapse when the mold is removed, keeping intact the delicate bones of the orbits. Make sure to keep an adequate thickness of material at the top of the cranium to maintain structural rigidity. Any excess silicon around the cranium and the mandible is trimmed.



Figure 4: Forming the hard supporting mold for the skull and mandible



Figure 5: Opening the molds of the skull and mandible



Figure 6: Replica of cranium and mandible

Hard Supporting Mold

We have to make a hard shell to support the flexible mold, or else the rubber will not be able to hold its shape during pouring. This can be made from a variety of materials, such as plaster of Paris or dental stone. The cranium is round, and there will be a natural undercut on both sides, so it is better to make the mold in two halves. After the first side is completed, apply petroleum jelly on the edges, so the second side does not bond with the first. The hard supporting mold for the mandible is made by the same procedure. (Figure 4)

Opening the Molds

The molds are ready to be opened when the plaster has been set up and is hard. Insert a small wax knife into the separating line and twist slowly and gently to move the pieces apart. It is better to remove the mother mold or rigid portion first and then peel the silicon away slowly, so the bones don't get damaged. Clean up any debris or bits of clay. (Figure 5)

Cleaning up the skull

The skull is cleaned and restored to its original condition. Any little bits of silicon that are stuck in the tooth sockets or any foramina can be pulled out with the help of tweezers.

Assemble and Pour the Skull

First, fill the molds with a small amount of material and rotate the mold to evenly coat the insides. Pouring should be done in several layers. You may pour the skull solid, but this will result in a heavy skull and also may cause some shrinkage in the casting. To overcome this problem, you can add light sponge material during pouring the cranial cavity. After the material is set, remove the rigid mold and then peel the silicon away slowly. Thus, the replica of cranium and mandible is ready. (Figure 6)

CONCLUSION

This study describes the manual method of duplication of the skull and mandible. This results in an exact copy of the skull and mandible in the laboratory environment which will be helpful in forensic facial reconstruction cases as well as for other anthropological studies. The replication of the skull and mandible is a complicated and time-consuming practice and it requires training and experience to duplicate without damage. Further studies are required for measuring the accuracy of the replica against the original one.

DECLARATION OF CONFLICTING INTEREST

The author(s) declared no potential conflicts of interest concerning this article's research, authorship, and/or publication.

FUNDING

The author(s) received no financial support for the research, authorship, and/or publication of this article.

ACKNOWLEDGMENT

I thank Dr. Abraham Johnson and Dr. Gargi Jani for their support in the study.

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