Early utilization of medical implants dates back to ancient Egypt, with the use of bronze plates in skull repair. Since then, medical implants have been fashioned from a wide variety of materials: coconut shells, hem dressings, and the more recent stainless steel and cobalt chromium alloy of the early 1900s have all been utilized in implant construction, mostly for injury repair. In the modern age, however, biopolymers have replaced the crude materials of the past, allowing us to construct medical implants out of increasingly suitable components. A biopolymer is a synthetic material that is compatible with the body; this biocompatibility is defined as acceptance of an artificial implant by the surrounding tissues and body as a whole, with the degree of biocompatibility determining whether or not an implant is suitable for placement. In cases of soft tissue modification and reconstruction, silicone has emerged as the leading material of implant composition, because of its high degree of biocompatibility within the body. Silicone is a polymer composed of repeating units of dimethylsiloxane monomers, each of which contain the element silicon, which is chemically similar to carbon, as they are in the same periodic group. Elements within the same group share valence structure and the same type of electron orbitals, meaning that they can form similar compounds with other elements. This property renders silicone inert within the body and therefore makes it a very suitable material for implant construction. Whether in solid or gel form, these silicone implants have widespread applications in both cosmetic and reconstructive procedures in various areas of the body. Facial implants have been employed since 1956. Silicone gel-filled breast implants came into circulation around the same time, as Cronin and Gerow pioneered the “silastic gel prosthesis” in 1963. In the modern era, procedures such as reconstruction or augmentation of the cheek, chin, calves, pectorals, and joints have all heavily utilized silicone. Manufacturers of these implants offer a large variety of facial and body contouring pieces, each with varying dimensions that meet the patient’s individual needs. These premade implants are well suited to the task of cosmetic surgery, in which the surgeon formulates a desired template based on preoperative patient consultation and is then able to choose a matching style and dimension. Although there are many shapes and sizes from which to select, premade implants can be inadequate in certain situations, particularly those in which symmetrical reconstruction of a body part is required. In these special cases, custom-made pieces are necessary to provide the most accurate, realistic reconstruction. These custom-shaped implants can be designed to provide a precise mirror image of a body part, to give a more symmetrical and balanced result. An accurate custom implant can be constructed from plaster moulage. This technique involves a plaster artist forming a moulage cast of the patient’s defect and relying on the resulting mold to fabricate a specific silicone implant that fits the patient’s defect and matches the opposite side. Although

The Art of Custom Silicone Implants for Difficult Deformities

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Abstract
Patients who present for unilateral correction of anatomical deformities require development of a mirror image prosthesis. Moulage casting techniques offer a viable option for accurate design from which a custom implant can be fashioned, allowing surgeons to place a device that is unique to each patient’s needs. The authors discuss the advantages of working with an experienced artist to develop these castings and present two cases of successful implantation after moulage casting.

Keywords
plaster casting, moulage, silicone, pectoral implant, calf implant

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Figure 1. A negative impression taken of the chest of a patient with congenital ectodermal dysplasia. (This patient’s preoperative and postoperative photographs can be seen in Figure 4.)

Figure 2. A positive mold created from the negative plaster impression of a patient with asymmetrical calves resulting from polio. (This patient’s preoperative and postoperative photographs can be seen in Figure 5.)

Figure 3. (A) The custom calf implant formulated from the mold as described in Figure 2. (B) The custom implant is inserted into the patient’s calf.

The accuracy of moulage casting was documented in a study by Holberg et al in which an alginate moulage was taken of patients’ faces. The plaster casts and the patients’ faces were subsequently digitized using a three-dimensional laser scanner operating with structured light. The resulting point clouds were matched in a virtual environment to analyze the deviations between the cast and the facial surfaces. The deviations ranged from 0.95 to 3.55 mm.

**CASE STUDIES**

Utilizing moulage casting, we were able to provide accurate reconstruction in two specific cases, for a patient with Poland syndrome (resulting in underdeveloped pectoralis major muscles) and one with polio (resulting in atrophied muscles of the calf). Each moulage cast described was constructed from a non-sterile polymer modeling material. The polymer was packaged in two parts and required thorough mixing, after which a negative impression of the target body part was made by spreading Vaseline over the body part (for easier removal) and applying the casting material to the desired area (Figure 1). When partially dry, strips of gypsum plaster (plaster of Paris) were placed over the cast. Once the gypsum plaster and polymer/alginate material were completely set, the mold was eased away from the body part. Stone plaster was then...
poured into the negative mold and allowed to dry, after which the negative mold was peeled away to expose the positive impression (Figure 2). This molding was marked for any desired orientation lines or fenestrations and was then packaged and shipped to a manufacturer for fabrication of a matching silicone implant (Figure 3).
Figure 5. (A, C, E) A 15-year-old girl who presented with an atrophied calf resulting from polio in her younger childhood. (B, D, F) Two years after placement of a custom-made implant before left calf implant surgery. The patient’s gastrocnemius fascia was so atrophied that a submuscular pocket could not be dissected, so a subcutaneous pocket was dissected immediately over the gastrocnemius mediolateral heads and the soleus muscle for placement of the implant.
Implant Placement

All surgery was performed under dissociative anesthesia as described by other studies,5-7 with valium and ketamine.

Pectoral Implant

A 30-year-old man sought treatment for congenital ectodermal dysplasia.8 He demonstrated no development of the breast or pectoralis major muscle on his right side, and he also had a protrusion of fat and breast tissue on his left side. After consultation with the patient, we planned an operative course involving liposuction of the left breast to decrease the persistent gynecomastia there, followed after healing by a moulage casting and subsequent silicone implant to the right breast matching the left side (Figure 4).

Following implant manufacture, the second stage of the operative plan commenced. After sedation, the patient’s entire chest was infiltrated submuscularly with xylocaine and epinephrine. About 500 mL was infiltrated on each side with a blunt instrument, and an auxiliary incision measuring about 3.5 cm in length was made within the hair-bearing area. The dissection was carried beneath the pectoralis fascia, forming a pocket between the pectoralis major and the ribs. Bleeding was controlled with electrocautery. The implants were folded, inserted into the pocket, and carefully positioned with digital pressure. Cephalexin was flushed into each pocket after the addition of 15 mg of cyamethadrol on each side. The skin was closed with subcutaneous 5-0 Vicryl sutures, which were then reinforced with suture strips. The calf was then wrapped carefully in compression bandages, and a custom-made support stocking was applied.

In the two cases described here, complications were limited to those normally associated with implant surgery. Specifically, we have drained persistent recurring seromas from both patients every few months for four years.

CONCLUSIONS

The objective of reconstructive aesthetic surgery is to refashion and restore the wholeness of natural features that have been deformed by injury or other causes. It is generally performed to improve function but also to normalize the aesthetic appearance of an individual. In many cases, moulage castings provide a precise (and therefore valuable) template for reconstruction with custom-made implants. The implants formed from these molds are utilized to reshape the desired body part accurately and symmetrically.

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