Fabrication procedure for cranial prostheses

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A procedure for duplication of cranial bone flaps used in cranioplasty is described. This procedure overcomes the difficulties inherent in direct duplication of irregular-shaped bone flaps through primary replication of the flap in wax. The wax pattern is used to fabricate the definitive prosthesis. (J Prosthet Dent 1998;79:229-31.)

Cranial defects may result from trauma, disease, and congenital malformations. Repair of cranial defects is indicated to protect underlying brain tissue, provide pain relief at the defect site, improve cosmesis, and minimize patient anxiety.[1-3] Cranioplasty is accomplished either with osteoplastic reconstruction or restoration with alloplastic implants. Cranial alloplastic implant materials used include metal,[4,5] acrylic resin,[2,6,7] polyethylene,[8] and silicone.[9]

Acrylic resins have been advocated because of their ease of use, availability, and tissue compatibility. Local tissue reaction has been reported with the use of acrylic resin,[10] but these effects have been transient.[11] Autopolymerizing acrylic resin may be applied and adapted directly into a cranial defect, using saline irrigation to reduce heat from polymerization.[7] However, presurgical fabrication of cranial prostheses is more desirable because reproduction of contour is more easily controlled and use of heat-processed resin is possible, resulting in a stronger prosthesis.[1]

Several methods exist for presurgical fabrication of acrylic resin cranial prostheses. Impression of the defect may be made and a wax pattern fabricated on the cast, restoring anatomic contours.[3,12,13] A computer-generated model of the defect may be developed and used to fabricate a wax pattern.[1,14] Alternatively, if the cranial bone flap is available, the bone flap may be invested, flasked, and duplicated directly.[15] The bone flap possesses the proper contours required of the prosthesis and its duplication for use in cranioplasty is therefore ideal. However, bone flaps with irregular shapes may be difficult to invest and retrieve from a stone mold.

Fig. 1. Cranial bone flap with trephine holes.

Fig. 2. Trephine holes and border irregularities restored with wax.

This article describes a procedure that overcomes problems associated with investing and retrieving complex structures from a rigid mold.

PROCEDURE

1. Prepare the bone flap for duplication with wax to restore trephine holes and border irregularities (Figs. 1 and 2).

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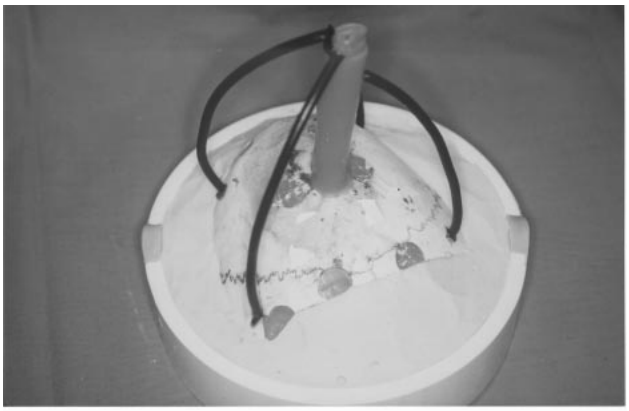

Fig. 3. Bone flap is invested in irreversible hydrocolloid impression material. Wax sprue and vents are attached to convex surface of flap.

Fig. 4. Second layer of impression material is applied. Paper clips are partially embedded for retention of stone cap.

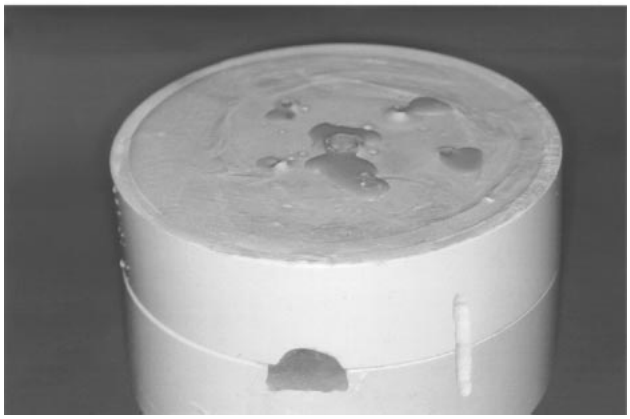

Fig. 5. Molten wax poured into sprue until excess wax escapes through vents.

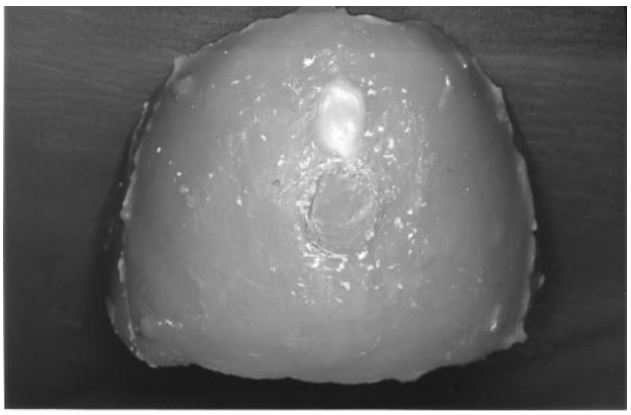

Fig. 6. Wax duplicate of cranial bone flap.

2. Use an appropriately sized PVC pipe as a custom flask.[16] Make indexing keys between the cope and drag of the flask for proper alignment and orientation. Place undercuts for retention of stone and impression material on the internal aspect of the flask.
3. Fill the bottom third of the drag with dental stone and partially embed paper clips in the stone. Invest the bone flap, concave surface down, with a thin mix of irreversible hydrocolloid impression material. (Impression material may be applied to the concave surface of the flap before placement in the flask to avoid air entrapment. The flap is invested concave surface down to facilitate flow of molten wax.)
4. Soften baseplate wax by heat, roll into a cylinder approximately 1 to 1.5 cm in diameter, and attach as a sprue to the center of the invested flap (Fig. 3). Attach three or more wax vents (6 gauge) near the periphery of the invested flap. (The number of vents will depend on the shape and size of the flap. The vents and sprue should be long enough to extend above the top of the cope.) Apply a thin coat of petroleum jelly to the bone flap, sprue, and vents to facilitate subsequent separation of the flask and retrieval of these structures.
5. Place the cope, pour a thin mix of irreversible hydrocolloid impression material and partially embed paper clips (Fig. 4), then pour dental stone over the impression material.
6. After the stone has set, separate the flask and remove the bone flap. Pull out the wax sprue and vents to create channels for pouring and escape of molten wax. Reassemble the flask and pour molten baseplate wax into the sprue until wax escapes through the vents (Fig. 5).
7. After wax solidification, separate the flask and retrieve the wax duplicate of the bone flap (Fig. 6). (The margins of the wax duplicate may then be modified according to the design desired by the surgeon. An inlay, onlay, or combination inlay-onlay design may be used.[1,3,12,13,15])
8. Flask the modified wax duplicate and invest in dental stone (Fig. 7).
9. Pack and process the invested wax duplicate in heat-polymerizing clear acrylic resin. (Split packing may be performed to facilitate addition of an internal

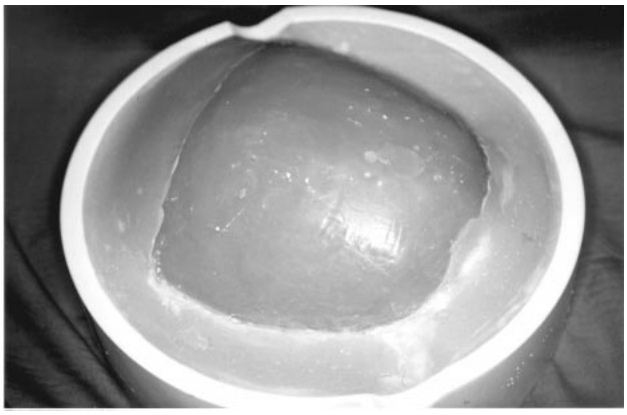

Fig. 7. Wax duplicate invested in dental stone.

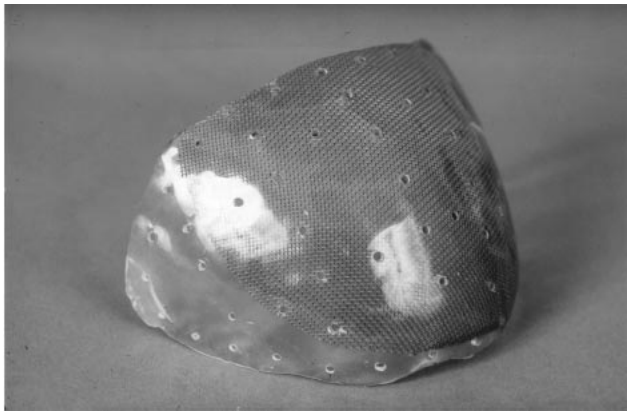

Fig. 8. Completed prosthesis show perforations and internal titanium mesh.

titanium mesh, if requested by the surgeon.) After processing, finish and polish the cranial prosthesis. Place perforations on the cranial prosthesis with a No. 8 round bur and bevel the edges of the perforations with a slightly larger bur (Fig. 8). (Perforations permit fluid exchange and connective tissue ingrowth, and provide a means for securing the prosthesis to adjacent bone.)

10. Sterilize the prosthesis with ethylene oxide, followed by adequate aeration.

SUMMARY

This article describes a procedure that allows duplication of cranial bone flaps with irregular shapes for use in cranioplasty. An intermediate step of bone flap duplication in wax, using irreversible hydrocolloid impression material, overcomes the difficulties inherent in direct duplication of bone flaps.

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