A Precision Method for Contouring Bioresorbable Implants in Craniomaxillofacial Surgery

Mark D. DeLacure, M.D., F.A.C.S.^{1,2} and
M. Abraham Kuriakose, D.D.S., M.D., F.R.C.S.²

ABSTRACT

Bioresorbable implants (meshs and plates) are increasingly used in reconstructive craniofacial and skull base surgery. Usually these implants must be contoured to fit the complex craniofacial anatomy *ex vivo*; occasionally final contouring is performed *in vivo* and must be done without damaging surrounding structures (e.g., dura, brain). We report a precision method for *in vivo* contouring of bioresorbable implants using the Shaw hemostatic thermal scalpel.

KEYWORDS: Resorbable mesh, Shaw scalpel, craniomaxillofacial surgery

Bioresorbable mesh and plating systems for the osteosynthesis of craniofacial osteotomies represent a significant advance in surgical technology for selected patients and applications.^{1,2} All systems presently in use are composed of proprietary copolymers of polylactic and polyglycolic acid and require heat transfer for contouring. Commonly used methods include immersion in a water bath, wrapping in a dry heat pack, or placement near a heat convection device. Despite optimized temperatures and placement of heat sources near or even on (dry heat pack) the patient, we have found the 10- to 15-second contouring time to be inadequate and imprecise in many applications.

Although certain craniomaxillofacial applications are tolerant of minor errors in adaptation (e.g., cranial vault remodeling), others are less forgiving (e.g., osteotomy contouring for fibula free flap). Although the ability to reheat and recontour imperfectly fitting plates is an option, the rate-limiting step is usually the time required to transfer the plate from the heat source into the defect—a fairly fixed variable. Recommended techniques and instrumentation are proven adequate for relatively simple surface contour requirements, but these traditional methods have failed in more demanding constructs.

Heating plates and mesh *in vivo* has obvious limitations but may be performed using Bovie elec-

Skull Base, volume 12, number 2, 2002. Address for correspondence and reprint requests: Mark D. DeLacure, M.D., Department of Otolaryngology, New York University School of Medicine, 550 First Avenue, Suite 7-U, New York, NY 10016. E-mail: mark.delacure@med.nyu.edu. ¹Department of Surgery, Institute of Reconstructive Plastic Surgery and ²Division of Head and Neck Surgery, Department of Otolaryngology, New York University School of Medicine, New York, New York. Copyright © 2002 by Thieme Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA. Tel: +1(212) 584-4662. 1531-5010,p;2002,12,02,103,106,ftx,en; sbs00279x.

trocautery or a heated instrument. We have refined our technique and increased the precision of contouring by using the Shaw thermal scalpel (Smith & Nephew, Bartlett, TN), which has broad application in craniomaxillofacial and head and neck surgery. This technique has been used with plating systems from Synthes (Paoli, PA) and Lorenz-Biomet-Lactosorb® (Warsaw, IN) with excellent results. We also acquired clinical experience with systems from Macropore-Macrosorb® (San Diego, CA) before developing the contouring technique reported here.

TECHNIQUE

A heat pack consisting of a polyvinyl chloride bag containing calcium chloride is used in the Lactosorb® system. When injected with sterile water, an exothermic reaction occurs. The bag is folded over the implant, creating a heat pocket and temporarily rendering the material malleable. The heat packs cool rapidly and remain useful for only 15 to 20 minutes. A water bath preheated to 55° C is used to contour the plate in the Macrosorb® system. Complete pliability is noted after about 15 seconds. A battery-operated Power Pen™ is marketed to facilitate plate contouring.

The Synthes Resorbable Fixation System uses either a water bath or a hot air system for plate or mesh contouring. The hot air system may be used in the sterile field and provides interchangeable attachments for the direction of the airstream.

After the defect is prepared and the appropriate implant is selected, the material is heated according to the manufacturer's recommendations and precontoured to the requirements of the defect. In situ contouring is performed by direct contact of the Shaw scalpel with the plate. The average temperature used is 70 to 160° C. As with any heat source, the amount of contact time between the blade and the material is an important factor in addition to the absolute temperature setting. Deformation of screw holes, mesh interstices, or both

Figure 1 A full-thickness cranial vault defect. The bioreabsorbable mesh is being contoured to form a base for the hydroxyapatite cement cranioplasty.

have been noted, but their presence has not made it more difficult to obtain fixation via holes in the perimeter of a sheet so contoured. Additionally, this phenomenon has not resulted in clinically detectable weakness in or failure of the implant.³ This technique has been particularly useful in creating 90-degree bends at the cut margins of bone in full-thickness cranioplasty defects where the bioresorbable mesh serves as a foundation to dampen the effects of brain pulsation on overlying hydroxyapatite cement (Fig. 1).

This instrument also has been used to "weld" together sheets of resorbable mesh when a need for a large surface area either outstripped the inventory on hand or exceeded the readily available sizes as chosen by the manufacturer. This welding is accomplished by placing resorbable screws in the perimeter of overlapping sheets and then creating a pop rivet-type fixation by flattening the screw head and tip against the plate, thereby fixing the two (or more) together (Fig. 2).

Finally, the thermal scalpel has been used to weld protruding screw heads down to the plate or mesh, lowering the overall profile of the hardware in critical areas where they would be visible, palpable (e.g., periorbital region), or risk attenuation of overlying soft tissue (Fig. 3). A similar technique using a wire loop has been reported by Habal.⁴

Figure 2 Hydroxyapatite cement cranioplasty over bioresorbable mesh.

Figure 3 A thermal scalpel is being used to weld two sheets of bioresorbable mesh.

A precontouring step remains essential because the contact thermal scalpel is ineffective beyond the area of direct contact (no. 10 blade) and because of the hole deformation properties of the technique when one attempts to contour a large planar surface area.

RESULTS

The clinical summary of patients who underwent contouring of bioresorbable implants with a thermal scalpel is shown in Table 1. The patients were followed for 6 to 26 months. There has been no

Table 1 Clinical Summary of Clinical Application of Shaw Scalpel for Contouring Bioresorbable Implants in Nine Patients

No.	Surgical Procedure	Type of Implants	Number of Implants	Method of Implant Contouring		Immediate Implant Failure	Late Implant Failure
				Hot Bath	Shaw-Scalpel		
1	Cranioplasty with bone cement and mesh	Mesh	1	X	X	No	No
2	Cranioplasty with bone cement and mesh	Mesh	1	X	X	No	No
3	Cranioplasty with bone cement and mesh	Mesh	1	X	X	No	No
4	Fibula free flap	Plate	2	X		No	Yes
		Mesh	1	X	X	No	No
5	Fibula free flap	Plate	2	X	X	No	No
6	Fibula free flap	Plate	2	X	X	No	No
		Mesh	1	X	X		
7	Access mandibulotomy	Plate	3	X	X	No	Yes
8	Access mandibulotomy	Plate	2	X	X	No	Yes
9	Orbital floor reconstruction	Mesh	1	X	X	No	No

evidence of hardware failure attributable to this contouring technique. Implants, however, failed in cases in which the thermal scalpel was not used to contour the implants. The failures were likely due to the biomechanical features of the site or the context requiring the implant (e.g., mandibular osteotomy fixation, fibula free flap osteotomy sites).

DISCUSSION

The Shaw hemostatic thermal scalpel is an instrument familiar to most surgeons who operate in the head and neck region. It consists of a hand-held controller and composite Teflon™-coated scalpel blades containing microprocessors and sensors to control temperature precisely. It has proven to be a superior hemostatic cutting and dissecting instrument in selected applications and has been in broad clinical use since the early 1980s. Consequently, it is often already available in the operative field or

readily available during such procedures. The precision of final contouring of bioresorbable implants has been improved through the application of this instrument in selected contexts. The ability to contour the implants in vivo, without damaging surrounding structures (e.g., dura, brain), is particularly useful in this region.

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