Cranioplasty with the Medpor porous polyethylene Flexblock implant

Technical note

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The authors describe the use of a porous polyethylene Flexblock implant for cosmetic cranioplasty. The implant may be used to cover any small- or medium-sized (<8 cm) cranial defect, offering similar cosmetic results to standard alloplast cranioplasty while decreasing operation time. The porous implant design permits ingrowth of soft tissue and bone to increase implant strength and decrease the risk of infection. The Flexblock alloplast has been utilized in 25 cases with excellent cosmetic results and no implant-related complications.

KEY WORDS • alloplast • cranioplasty • polyethylene • skull defect

Desirable properties of alloplastic materials for closure of skull defects include rigid fixation and cosmetically acceptable edge-to-edge contact and contour. Many techniques using alloplastic and autogenous materials have been championed for this purpose, including autogenous bone grafts, silicone, porous hydroxyapatite, and various metals either alone or in association with methyl methacrylate.3,7,10,13,15

Polyethylene is a highly inert material that has been used in the craniofacial skeleton, in some cases with follow-up periods of more than 30 years;12 it has long been used as a standard reference material for biocompatibility testing.4 The Medpor Surgical Implant is composed of high-density polyethylene microspheres sintered to create a framework of interconnected pores. This porous character permits ingrowth of vascularity, bone, and soft tissue to reduce the incidence of infection while increasing the strength of the implant.1,13,14 This highly stable and flexible alloplast has been approved for use in humans and is available in rectangular blocks or preformed anatomical shapes for specific craniofacial applications. Although experience with Medpor in craniofacial repair has been reported elsewhere,1,11,15 we have found this to be a superior material for standard neurosurgical cranioplasty for small and medium-sized defects, which has prompted the present report in which we describe our initial experience and implantation technique using the Medpor Flexblock implant.

Materials and Methods

The Medpor porous polyethylene Flexblock implant is designed with a smooth exterior surface and a series of conical projections on the undersurface (Fig. 1). The cost of the standard implant is directly comparable to a single-package methyl methacrylate cranioplasty kit.

Surgical Implant Technique

The Medpor surgical implant* may be used to cover any shape of cranial defect. It is fashioned as desired with Mayo scissors or a scalp. To ensure an adequate fit, a pattern of the defect is drawn on a paper template, then transferred to the smooth surface of the implant. The implant may be cut slightly larger than the template with a pair of large Mayo scissors. The cones on the undersurface of the implant enable the block to be flexed to any desired contour (Fig. 2A and B). To fit the edge of the implant to the craniotomy edge without a deformity, the underside of the implant is feathered with a scalpel to enable "lapping" of the implant to the surrounding bone edge (Fig. 2C). Alternatively, a shelf

* Medpor Surgical Implant manufactured by Porex Surgical, College Park, Georgia.
may be created at the edge of the craniotomy with a power burr to seat the edge of the implant into the surrounding bone (Fig. 2D). Fixation of the implant is performed by placing titanium screws directly through the implant into the bone (Fig. 3) or with the use of titanium miniplates together with the screws.

Although the implant is easy to bend without fracture, larger defects or sharp-contoured reconstructions may require additional molding, facilitated by heating the implant in warm normal saline. In such cases, the implant will retain its contour after cooling. For large defects (>8 cm) requiring increased strength, custom-made thicker implants are available and are recommended; however, Medpor is designed to offer coverage of small- and medium-sized defects and is not intended for use in areas requiring load-bearing structural support. Specific sizes and shapes of thicker implants are available for individual applications, and may be custom-ordered on an individual basis depending upon defect shapes derived from three-dimensionally reconstructed computerized tomography (CT) images.

Microscopic Appearance and Histology of the Chronic Implant

The high-density polyethylene microspheres are sintered to create a porous framework (Fig. 4 left). With chronic implantation, this porous network enables the ingrowth of fibrous tissue (Fig. 4 right) and bone at the implant interface.

Results

The Medpor implant has been used in 25 cases requiring cranioplasty (Table 1). These included a variety of cranial defects of small to medium size, most commonly temporal craniectomy defects. Excellent cosmetic results were obtained in all cases, including three in which the implant was utilized to reconstruct the lat-
Porosity eral..nioplasty, materials. sinus be time" the has acrylate and reconstruction 15 months, Flexblock Prior these operation time is...limits have been reported. Follow-up periods ranged from 6 to 15 months, with a median of 9.4 months. This cranioplasty material and technique appear to produce cosmetic results comparable to standard cranioplasty materials. In comparison to methyl methacrylate cranioplasty, operation time is shortened with the use of the Flexblock implant by avoiding obligatory "cure time" prior to closure.

Discussion

A variety of cranioplasty materials and implantation techniques have been reported in the literature. While autogenous materials for skull and craniofacial reconstruction possess optimum biocompatibility characteristics, complications arising from the donor site and increased operation time limit their widespread use. For these reasons alloplastic materials continue to be popular, the most widely used being methyl methacrylate alone or in combination with titanium or wire mesh. However, the use of methyl methacrylate may be associated with potential complications, including an exothermic reaction produced during the curing process which may result in local tissue damage, release of a toxic monomer that has been implicated in local and systemic reactions, fracture of the brittle implant, and a significant rate of infection.

Polyethylene is a highly inert material that exhibits a consistently benign clinical response and has been proven stable over many years of use in humans. Medpor is a form of high-density polyethylene that contains a system of interconnecting pores of approximately 150 μm in diameter. This porous architecture enables the ingrowth of vascularity and soft tissue within a period of 3 to 4 weeks to form a stable interface that anchors the implant. Over longer periods, it permits the incorporation of bone at the implant-bone interface.

Maas, et al., compared various porous materials (Proplast, Silastic, Supramid, and Medpor) for facial bone augmentation in dogs, and found the greatest implant stability with Medpor. Moreover, Merritt, et al., demonstrated that, after healing, dense ceramic implants were more susceptible to infection than porous polyethylene; they suggested that the vascular ingrowth may protect the implant from infection. In this regard, in a recent series reported by Romano, et al., the implant was used in 140 cases of open facial fractures with no infectious complications. Similarly, an orbital blow-out fracture model in rabbits, ingrowth of vascularized soft tissue occurred with Medpor implanted adjacent to the contaminated maxillary sinus, eventually resulting in normal mucosal covering of the implant. In contrast, Proplast implants in the same model produced only fibrous reaction that failed to develop vascular, bone, or mucosal ingrowth.

In the present series of patients, the implant has been used for coverage of small- and medium-sized (< 8 cm) cranial defects in various locations. This experience suggests that the Medpor Flexblock implant offers a safe, cosmetically equivalent alternative to standard methyl methacrylate cranioplasty while ease of im-

### TABLE 1

<table>
<thead>
<tr>
<th>Location &amp; Size</th>
<th>No. of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>temporal</td>
<td></td>
</tr>
<tr>
<td>small</td>
<td>11</td>
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<tr>
<td>medium</td>
<td>4</td>
</tr>
<tr>
<td>frontotemporal, medium</td>
<td>5</td>
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<tr>
<td>parietal</td>
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<tr>
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<td>1</td>
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<tr>
<td>medium</td>
<td>2</td>
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<tr>
<td>occipital, medium</td>
<td>1</td>
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<tr>
<td>suboccipital, medium</td>
<td>1</td>
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* Small: < 4 cm; medium: 4 to 8 cm.
planted shortens operation time. It is not designed to function as a structural support material; as such it is recommended only for non-load-bearing small and medium-sized defects, and may in fact prove to be particularly useful for implantation adjacent to nasal sinuses in skull base and craniofacial reconstruction.1,11

One potential liability with the use of Medpor for cranioplasty is that the ingrowth of soft tissue may render secondary removal difficult in cases that demand later reoperation, although as yet we have no experience with this.

Disclosure

The authors have entered into no consultation agreement with the manufacturer, and no outside funding or materials were provided for this work.

References


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