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Clinical Experience with the Medpor Porous Polyethylene Implant

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Abstract. The Medpor porous polyethylene implant is a highly stable and somewhat flexible porous alloplast that has been shown to exhibit rapid tissue ingrowth into its pores. A total of 116 Medpor implants were placed in 70 patients over a four-year period. Implants were used for the chin, malar area, nasal reconstruction, ear reconstruction, orbital reconstruction, and the correction of craniofacial contour deformities. Many of these implants were placed in areas long considered problematic such as areas of thin soft tissue coverage, extensive scarring, and severe facial burns. Nine complications occurred including seven exposures, all of which occurred in areas of minimal soft tissue coverage. Because of the rapid vascularization of the implants, only two implants were removed, both from the columella. On the basis of our results, it is felt that the Medpor implant is an excellent alternative to existing implant materials. The implant is easy to shape; it is strong yet somewhat flexible; it is remarkably stable; and it exhibits tissue ingrowth into its pores.

Key words: Porous polyethylene—Medpor—Alloplasts—Implants—Craniofacial reconstruction

Facial harmony and balance are dictated by the facial skeleton that supports the overlying soft tissues [17]. Minor corrections to improve the facial relationships are easy achieved with the use of implants. It has been argued that autogenous tissue such as bone or cartilage is the optimal graft material to use for augmentation [26]. Problems with donor site morbidity, increased surgical complexity, difficulty in shaping the graft, and disappointing late results with warpage or resorption have led to the continued use of alloplasts. In recent years, attention has turned to the development of porous implants. The primary advantage of porous materials is that they allow for tissue ingrowth. At present, many of the available porous implants have had a number of limitations that preclude their utility. Implant materials have been difficult to use, excessively brittle, abrasive to surrounding tissues, or lacking structural integrity. The Medpor® (Porex Surgical, College Park, GA 30349, USA) porous polyethylene implant is a widely available alloplast that is an attractive alternative to other alloplasts and autogenous tissue.

The Medpor implant is made of a medical-grade, high-density polyethylene that is sintered to create a somewhat flexible framework of interconnecting pores. It has been shown to exhibit rapid tissue ingrowth into its pores with collagen deposition that ultimately forms a highly stable complex resistant to infection, exposure, and deformation by contractile forces [5, 13, 22]. The mechanical properties are such that the implant is easy to shape and is strong enough for use in non-load-bearing regions of the craniofacial skeleton. Medpor is available as a sterile implant in blocks, preformed anatomical shapes, and on a custom basis (Fig. 1).

Medpor has been available for clinical implantation since 1985. Since that time, its primary use has been for maxillofacial trauma reconstruction. Favorable results have been reported from hospitals affiliated with Johns Hopkins, Harvard, and the University of Southern California [18, 24, 27]. Our institutional experience with the implant consists of elective reconstructive surgery primarily for posttraumatic deformities and major facial burns. This experience should provide insight about the impor-

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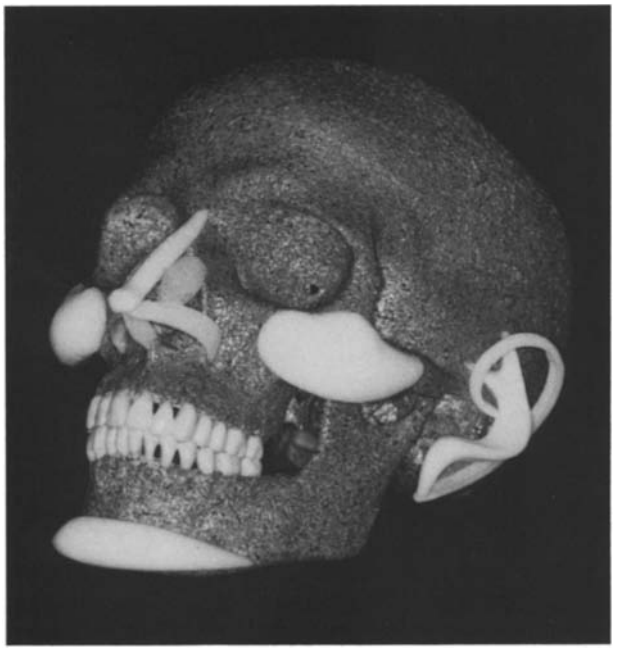

Fig. 1. The applications for the Medpor implant are demonstrated in the chin, malar, nasal areas, and as a framework for ear reconstruction

tance of this implant for reconstructive and aesthetic procedures.

Surgical Procedure

Achieving the appropriate implant shape is a crucial step for a successful augmentation [7]. With a little practice, Medpor is easy to shape. The implant can be cut with a pair of scissors or with a knife on a nylon block (Fig. 2). Bending is facilitated by heating the implant in boiling saline (Fig. 3). The heat permits configuration of the implant to a new shape that is maintained after cooling. Once the correct fit is established, fixation is performed using sutures, K-wires, or screws. It is important to feather the edges or to cover an irregular implant with a thin overlay, to obtain a smooth contour and to eliminate any potentially visible edges. As with any new implant, surgeons should familiarize themselves with the material and practice shaping the implant before surgery. Keys to success are to use as thin an implant as possible to optimize vascular ingrowth and to ensure that no undue pressure is exerted on the overlying skin.

Patient Population

This report includes all the Medpor implants placed by the author at the Rancho Los Amigos Medical Center. Surgeries were performed with a University of Southern California plastic surgery resident over a four-year period (May 1988 through May 1992).

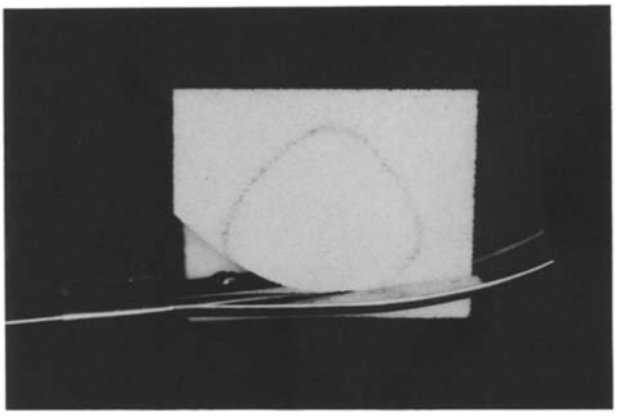

Fig. 2. Thin sheets of Medpor can be easily cut with a pair of scissors

Results

A total of 116 Medpor implants were placed in 70 patients. Implants were placed in the nose (27), in the chin (11), in the malar area (9), as an ear framework (41), in the orbit (15), and on the cranial vault (13). The etiologies of the deformities included trauma (36), burns (52), congenital anomalies (16), and aesthetic (12).

Nine complications occurred in this series, in each case when implants were placed in areas of thin soft tissue coverage. Two of the implants were removed. Five implant exposures occurred in ear reconstructions (3 for burn reconstruction, 2 for microtia reconstruction). These were managed without removal of the implant, and all went on to heal uneventfully. Two implant exposures occurred following nasal burn reconstruction; both exposures were managed by trimming the implant and closing the exposure. One was a columellar strut that was removed six months later because of a recurrence of the exposure. Two infections occurred in the nose; in one, a columellar implant that was thought to be the nidus of infection was removed. The two columellar implants that were removed supported implants placed on the nasal dorsum. After more than a year of followup, both of the nasal dorsal implants remain in place without complication.

No complications were associated with any of the implants placed in deep tissue pockets. One chin implant that was not fixed at the time of implantation was noted to be mobile two months after surgery, but was solidly fixed after six months.

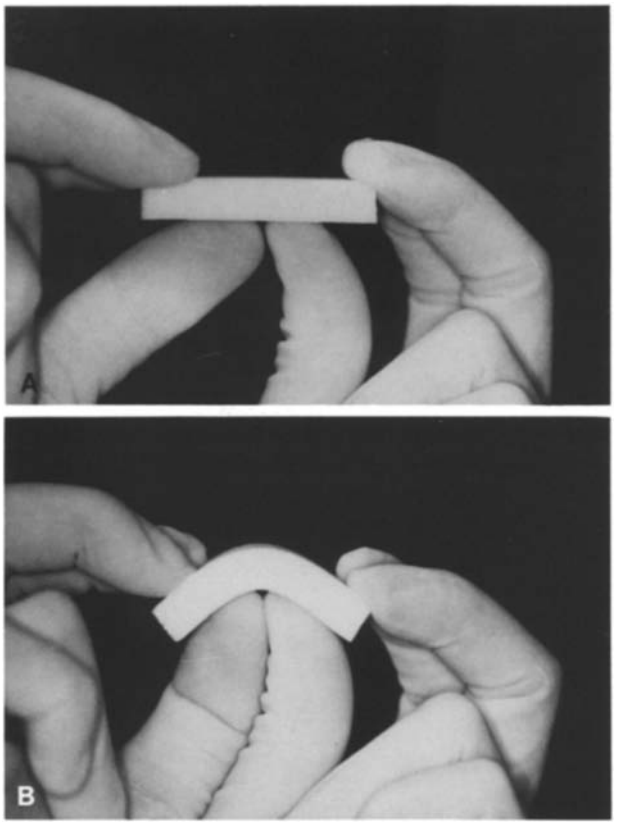

Fig. 3(A,B) When heated in boiling saline, Medpor can be bent into a desired shape. The implant will regain its structural properties upon cooling

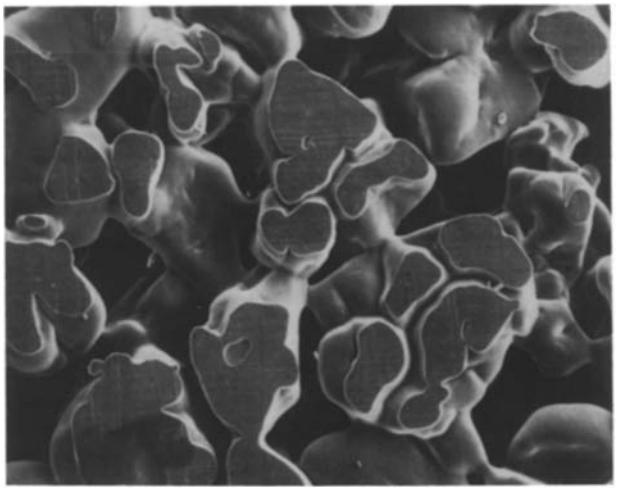

Fig. 4. Scanning electron micrograph (×20) of the Medpor implant demonstrating the contiguous, large-pore structure

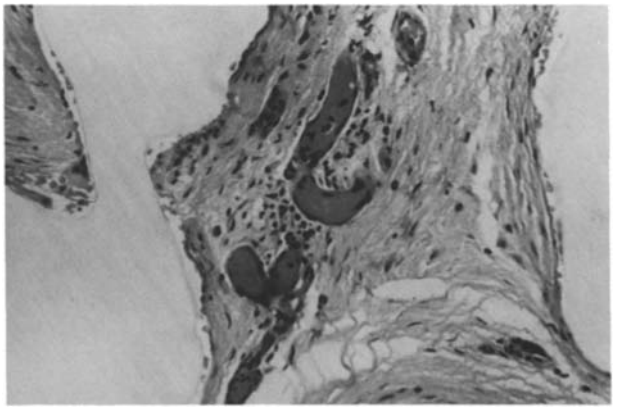

Fig. 5. A histologic section of Medpor is shown three months after implantation (H&E stain, ×150). The lucent areas are the unstained polyethylene. Mature blood vessels are seen coursing through the implant. Collagen is present throughout the interstices of the implant

Discussion

The Medpor porous polyethylene implant has a unique combination of properties that gives it a significant advance over other available alloplasts: The implant is easy to shape; it is strong yet somewhat flexible; it is remarkably stable; and it exhibits tissue ingrowth into its pores. Polyethylene is a highly inert material that has a long history of use in the craniofacial skeleton; more than 30 years of patient followup are reported [19]. High-density polyethylene has a consistently benign response. Used commonly in orthopedic appliances, it has been a standard reference material for biocompatibility testing [12]. Medpor is a porous form of high-density polyethylene that is strong enough to resist deformation of the pores that are critical to vascularization of the implant and tissue ingrowth. The contiguous, large-pore structure of the Medpor implant enables tissue fluid to circulate throughout the implant (Fig. 4). Rapid vascularization of the implant accompanies soft tissue ingrowth (Fig. 5). The pore size of Medpor is controlled so that more than 50% of the pores are larger than 150 μm. If the need arises to remove the implant, our experience has been that elevating the tissue from the implant is much like elevating periosteum from a bony surface.

Other porous alloplasts have been used for implantation in the maxillofacial area. Porous hydroxyapatite has generated significant interest because its composition is similar to human bone and because of the degree of bone ingrowth into the implant [10]. Hydroxyapatite, however, can be difficult to use. Its brittle nature has led some surgeons to caution against its use in areas likely to sustain trauma [22]; others have warned about fracture during attempts at fixation [20]. Although there may be a significant amount of tissue ingrowth into an extremely rigid implant, the structure of the implant may become abrasive because of shear forces at the tissue inter-

face. Observations that hydroxyapatite exhibits a variable degree of resorption after implantation are also of concern [11]. Granular forms of hydroxyapatite rely on a cohesive admixture for the structural integrity of the implant. Their primary drawback is difficulty in maintaining the appropriate form before tissue ingrowth occurs.

Proplast, a less brittle porous material, is very different from Medpor. Proplast does not provide the necessary structural integrity for consistent tissue ingrowth; its pores do not readily interconnect; and they tend to collapse with the application of pressure. Proplast has been found to be unstable when implanted into tissue; when tissue ingrowth does occur, fragmentation of the Proplast implant has been observed [2, 3, 22].

Chin Implants

Medpor has a variety of applications in the facial skeleton. Chin implantation is one of the most common uses for a facial implant. The procedure is easy to perform, the results are good, and the complication rate remains low. The most commonly used material continues to be silicone. Complications observed with use of a smooth-surfaced implant are bone resorption, shifting of the implant, and ptosis of the overlying soft tissue. Silicone chin implants are known to cause resorption of the underlying bone, an effect believed to be caused by mechanical pressure and by the active capsule that forms around all silicones [8, 14]. Osteointegration of an alloplast is a key principle in stabilizing orthopedic implants, and to date there have been no reports of bone resorption under Medpor implants [3]. One of the major advantages of an implant that allows for tissue ingrowth is the fixation of the overlying chin pad to the implant. Following the placement of a silicone chin implant, ptosis of the implant and the chin pad can exacerbate a so-called "witches chin" deformity. Such silicone-associated deformities can be corrected with a structurally stable porous implant. If a small incision is contemplated, it is often easier to insert the implant after cutting the implant into two pieces, inserting each piece individually, and then reconnecting the pieces. The cut should be made so that the two pieces fit in a tongue-and-groove fashion. Fixation with a suture, screw, or a K-wire until tissue ingrowth has occurred is recommended.

Malar Implants

The use of a structurally stable implant with a high degree of tissue ingrowth is especially important in the malar region (Fig. 6). With an improved understanding of the significance of soft tissue attachments in facial rejuvenation and trauma reconstruction, the less than optimal effect of placing a smooth implant in the malar region is becoming apparent [9, 15, 16]. In order to insert a malar implant, the soft tissue envelope is elevated off one of the main areas that suspends the midface. Placing a smooth implant into the pocket may interfere with the reattachment of the face, and the eventual ptosis of the soft tissue envelope may explain the drawn appearance of patients many years after malar augmentation. The capsular contracture that develops over a smooth-surfaced implant may further compound that effect. Although technically more demanding, the advantage of using an implant that allows for tissue ingrowth becomes clear. The Medpor implant eventually becomes fixed to the facial skeleton, and the ingrowth of the overlying soft tissue supports the soft tissue envelope of the face.

Nasal Implants

In the nose, Medpor has a number of useful applications. Augmentation of the nasal dorsum has a higher complication rate than implants placed in areas with greater soft tissue coverage. The soft tissue envelope of the nose is relatively thin, and the graft is subject to a variety of external forces. Keys to success include using an implant that is appropriately shaped and one that fits into the pocket. A common pitfall with using a poor fitting silicone implant and compressing it into a tissue envelope is that, with time, the compressed portion of the implant will cause tissue erosion. The properties of Medpor make it a good choice as a dorsal onlay for reconstructive and aesthetic purposes. Available nasal shapes are easily modified for that purpose. Thin onlays of Medpor, 0.85 mm in thickness, are particularly useful for areas that traditionally have been augmented with autogenous tissue. Thin pieces can be used to augment or replace alar cartilages and prevent nasal airway collapse. In burn patients, thin pieces of Medpor have been used with success under mature skin grafts [24]. The rapid vascularization of the implant helps ensure its stability. Collagen ingrowth into the implant gives it added strength and a smooth surface, masking small contour irregularities and rendering the implant almost invisible under the skin. Medpor should be used with caution in the columella [4, 24]. The shear forces exerted on the implant by normal motion of the nose disrupt tissue ingrowth into the implant and predispose the implant to exposure.

Ear Reconstruction

Medpor has been shown to have an important application in ear reconstruction [23]. The development

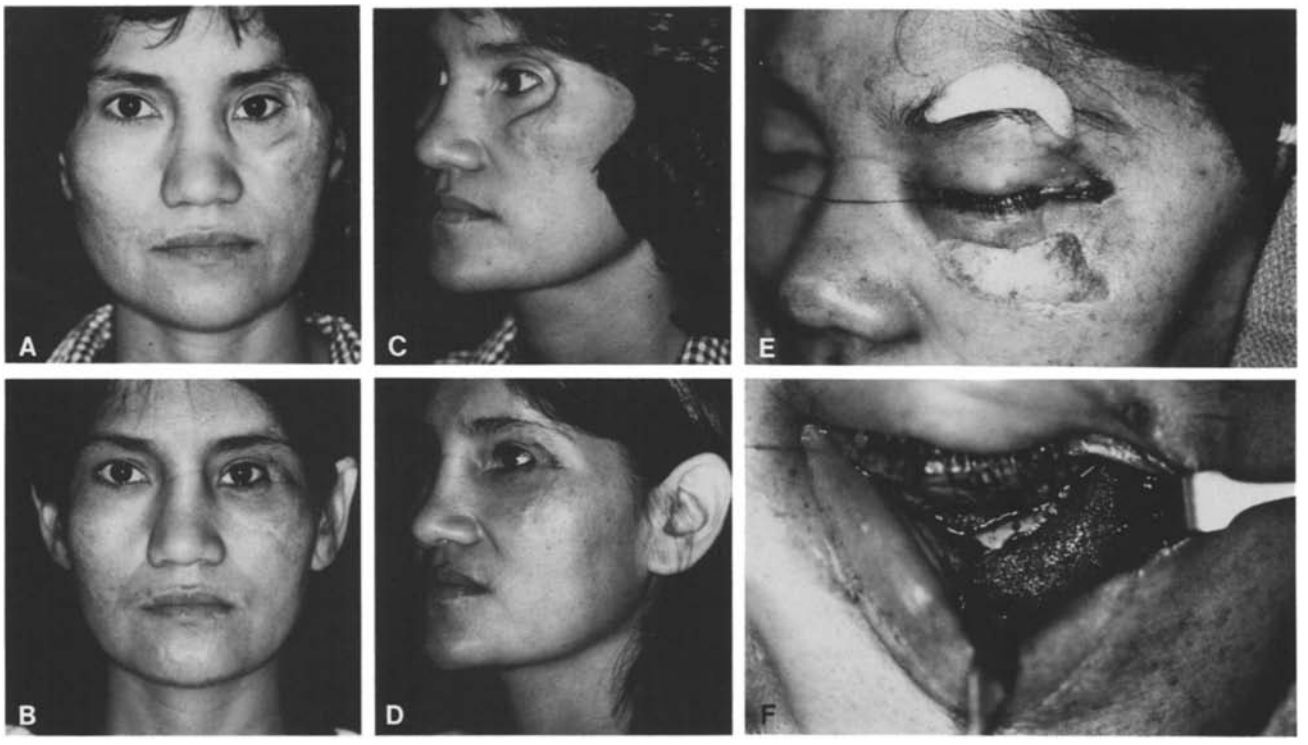

Fig. 6(A,C) Before and **(B,D)** after photographs of a patient with periorbital trauma and a previous reconstructive effort, who underwent **(E,F)** Medpor onlay augmentations with grafts fixed with microscrews. The orbital floor defect and the position of her globe were corrected with thin implants stacked within the orbit

of the "pivoting helix" design that can fold against the head in event of externally applied pressure has changed the scope of alloplastic ear reconstruction. Keys to success include ensuring an adequate vascular supply by using a temporoparietal fascial flap and by anchoring ends of the implant that may otherwise act as a spring and become exposed.

Orbital Reconstruction

Orbital floor reconstruction remains one of the most common applications for Medpor. The orbital floor can be rebuilt using thin or ultrathin sheets. The implant can also be stacked to effect volumetric changes. Stacking the implant anteriorly in the orbit tends to elevate the globe and correct vertical dystopia. Volumetric augmentation in the posterior aspect of the orbit tends to move the globe forward and correct for enophthalmos. The low incidence of Medpor-related complications in the orbit is noteworthy given the number of implants that have been placed in contact with open, contaminated facial sinuses [18]. In an animal study, Medpor implants exposed to the maxillary sinus showed rapid tissue ingrowth and incomplete mucosalization of the exposed implant within 3 to 4 weeks [5]. This is also consistent with both a previous case report and an animal study in privates in which exposed implants remained fixed and well vascularized [1, 21]. Eriksson suggests that the large negative surface charge of polyethylene may contribute to those findings [6].

Cranial Applications

Cranial onlay applications with Medpor are similar to chin and malar applications, and the advantages center on the ease of use of the material, tissue ingrowth, and stability of the implant. Complex shapes such as the supraorbital rim often can be reproduced using the flexblock implant. Flexblock, which was designed as an onlay for calvarial bone graft donor sites, has a smooth exterior surface and a series of conical ridges on its undersurface that enables easy bending, good contour adaptability, and suitable strength [25]. Cranial onlays are usually fixed with a suitable microscrew system. Final contouring can be performed *in situ,* and an ultrathin sheet of Medpor may be used as an overlay to eliminate any minor irregularities or potentially visible implant edges. When a primary indication for a cranioplasty is the protection of the brain, or when there is a large cranial defect, flexblock alone does not provide adequate strength. For those situations, a custom-fabricated Medpor implant may be more appropriate. Implant thickness can be specified, and the implant can be matched to fit a given defect

using computerized axial tomography or magnetic resonance imaging data.

Summary

On the basis of our results, it is felt that the Medpor implant is an excellent alternative to existing materials used for facial contour correction. The implant material is easy to shape; it is strong yet somewhat flexible; it is remarkably stable; and it exhibits tissue ingrowth into its pores.

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