Biomaterial Application

Craniofacial Reconstruction With High-Density Porous Polyethylene Implants

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Deformities of the facial skeleton may be reconstructed using autogenic or allogenic materials. Porous polyethylene is one of the few alloplastic materials currently in use having a well-documented history of reconstruction or augmentation in the maxillofacial region. High-density porous polyethylene, which is shown to be effective as a biomaterial, has additional advantages like tissue ingrowth, no capsule formation around it, and easy fixation. In this study, 83 implants in 71 patients were evaluated. Seven patients were in need of a second intervention. Three of the seven secondary interventions were for contour alignment, and four interventions were for extraction of the implants because of extrusion or infection. Placement of porous polyethylene implants directly under the skin without coverage of periosteum or another fascial envelope has an increased risk of early and especially late exposure. In cases like nasal dorsum or microtia reconstruction, we prefer autogenic grafts instead of allogenic materials.

Key Words: High-density porous polyethylene implants, craniofacial reconstruction, facial augmentation

Various autogenous and allogenic materials are used for augmentation and reconstruction of facial structures. Use of alloplastic implants in facial reconstruction is shown to be associated with low morbidity rates, but this is site and material dependent.[1] Porous polyethylene is one of the few alloplastic materials currently in use having a well-documented history of reconstruction or augmentation in the maxillofacial region.[2] High-density porous polyethylene (Medpor; Porex Surgical, Newnan, GA) is nonantigenic, nonallergenic, nonresorbable, highly stable, easy to fixate, and available in a wide variety of preformed shapes.[3] It has pores of 100 to 250 μm, and this unique pore size distinguishes it from other materials by facilitating the ingrowth of soft tissue, thereby firmly stabilizing this material in position. Tissue ingrowth into Medpor (Porex Surgical, Newnan, Georgia, USA) is demonstrated,[4] and its use as online graft is successfully demonstrated in experimental and clinical studies.[5] Porous polyethylene produces no capsule formation around it and is effectively used for reconstruction of nonweight-bearing areas.

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Materials and Methods

A total of 83 high-density porous polyethylene implants (Medpor Biomaterial; Porex Surgical, Newman, GA) were used in 71 (41 male and 30 female) patients between 1996 and 2003 in the Plastic and Reconstructive Surgery Department of Dokuz Eylul University by different surgeons. All patients underwent reconstruction or augmentation in the craniomaxillofacial region. More than one implant was used in some patients. Implants were placed subperiosteally when possible; fixation was obtained with nonabsorbable sutures or titanium miniscrews, and circulage was obtained with surgical steel. Rigid fixation could not be used in nasal or auricular areas. A customized carved Med-por block or sheets were used in zygomatic, orbital, nasal, and mandibular angulus regions, whereas fabricated implants were used for auricular, mental, and malar reconstructions as well as augmentations. Prophylactic antibiotherapy with first- and second-generation cephalosporins was administered. Patients were analyzed retrospectively according to complications and secondary interventions.

The cause of interventions using porous polyethylene was congenital in 16 cases (22%) and acquired in 55 cases (78%). Among the acquired cases, 34 were posttraumatic, 9 were secondary to tumor resection, 9 were for esthetic reasons, and 3 were caused by gun shot wounds (Table 1).

Table 1. Cause for Intervention

Cause for Intervention	*Number of Cases*
Acquired	
Posttraumatic	34
Secondary to tumor resection	9
Gunshot wounds	3
Esthetic	9
Congenital	16

Implants were placed in different parts of the craniomaxillofacial region. In the zygomatic region, 30 implants were used in 26 patients. Malar eminence and infraorbital rim augmentation or reconstructions were included in zygomatic interventions. All zygomatic interventions were done transcutaneously. The subciliary incision or exposure of the planned reconstruction area through an existing laceration was used. In the mandibular area, which enclosed the mentum, mandibular body, and angulus, 14 implants were administered in 9 patients. The transoral route was used in all patients. In the frontotemporal region, 13 implants were placed in 13 patients. All implants were secondary to trauma or surgical intervention; thus, existent scars were used for the reconstructive intervention. Seventeen implants were used in 15 patients for orbital wall reconstruction or total socket reconstruction. Three implants were used for auricular framework reconstruction in 3 hemifacial microsomic patients. Four implants were used in the nasal region for reconstruction of the nasal passage, augmentation of the nasal dorsum, and augmentation of paranasal areas. Another two implants were used in 2 patients for maxillary alveolar augmentation (Table 2).

Table 2. Summary of Interventions

Area of Intervention	*Number of Patients*	*Number of Implants*	*Placement Route*
Zygomatic (malar eminence and infraorbital rim)	26	30	Subciliary incision, existing scars
Mandibular (mandibular ramus, body, angulus, and mentum)	9	14	Intraoral, gingiva-labial incision
Temporal	5	5	Existing scar
Frontal	8	8	Existing scar
Orbital	15	17	Subciliary, transconjunctival
Orbital wall rec			
Total socket rec			
Auricular framework	3	3	
Maxillary alveolar augmentation	2	2	Transoral
Nasal	3	4	Intranasal anterior transoral
Rec of passage			
Dorsum augmentation			
Paranasal augmentation			

Rec = reconstruction.

Table 3. Zygomatic Implants

Zygomatic (malar eminence and infraorbital rim)	26 cases	30 implants	1 contour realignment

All patients were observed for at least 12

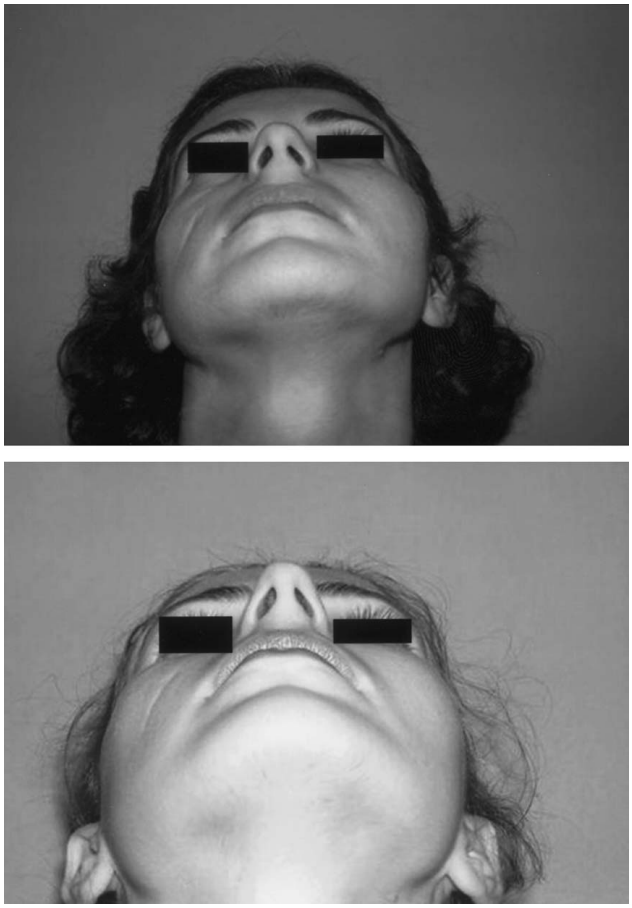

Fig 1 (Top) Female patient 6 months after an automobile accident with an untreated right zygoma fracture. (Bottom) Same patient after augmentation of the zygomatic area with customized Medpor implants.

Table 4. Mandibular Implants

Mandibular (mandibular ramus, body, angulus, and mentum)	9 cases	14 implants	1 implant infection

Table 5. Temporofrontal Implants

Temporofrontal	13 cases	13 implants	2 contour realignments

months. Extrusion of the implant was determined with inspection, and after implants were taken out, antibiotherapy was administered and infective status determined with microbiological studies. Hyperemia and an increase in temperature over the implant led to empirical antibiotherapy with cephalosporins or wide-spectrum antibiotics effective against oral flora in implants placed transorally.

Results

Eighty-three implants were used in 71 patients for craniomaxillofacial reconstruction. Implants were placed in different parts of the face.

Thirty implants were used in 26 patients for augmentation or reconstruction of the malar eminence and infraorbital rim. All implants were placed in subperiosteal pockets, and a wide pocket was created for implant placement. Only 1 patient was in need of a secondary intervention for contour alignment. No extrusion, no infection, and no implant displacement was noted (Table 3; Fig 1).

Fourteen implants were placed in nine patients in the mandibular region, including the mentum, mandibular body, and angulus. All implants were placed transorally into the subperiosteal plane. There were no complications regarding implant displacement or contour irregularities. Only one implant infection in the mandibular angulus was observed. The implant was taken out, and reconstruction with split costal graft was done after antibiotherapy (Table 4; Fig 2).

Thirteen implants were used in 13 patients in the temporofrontal region. There was a postsurgical reason for reconstruction (e.g., donor area augmentation of temporal muscle flap, defect after frontal craniotomy and surgical ablation) in 5 patients and a posttraumatic reason in 8 patients. Existing incisions were used for secondary reconstruction, and all implants were placed subperiosteally. There were two secondary interventions for contour alignment in early cases. After these cases, borders of the defects were deepened with burr holes and edges of the implant were smoothed out to the extent possible. Fixation was achieved with miniscrews and nonabsorbable sutures for the most part. Sutures were tied to bone or to small holes produced at the border of the defects (Table 5; Figs 3 and 4).

Four implants were used in three patients in the nasal region. Two implants were used in the same patient for paranasal augmentation after Le Fort I

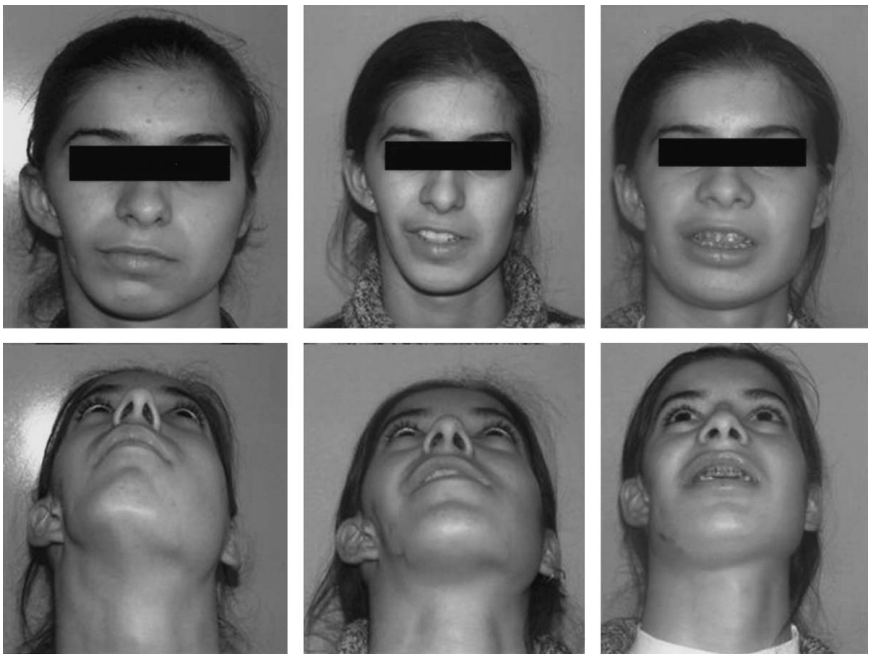

Fig 2 Female patient with right hemifacial microsomia. (Right) Preoperative anterior and submental images of the patient. (Middle) Same patient after unilateral mandibular distraction and Le Fort I maxillary osteotomy. (Left) After right mandibular angulus augmentation with customized Medpor implant.

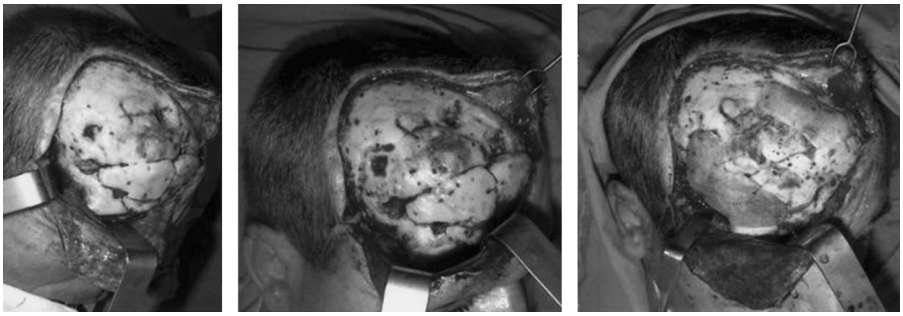

Fig 3 Operative sequence in frontotemporal region. (Right) Exploration of the defective area. (Middle) Determination of the defect and deepening of the edges. (Left) Insertion of the implant after smoothing out the edges and fixation of the implant to the osseous vault with surgical steel and nonabsorbable sutures.

maxillary advancement osteotomy. One implant was used for nasal dorsum augmentation, which became exposed after 14 days. One implant was used in a patient with a total midface reconstruction done with a free rectus abdominus musculocutaneous flap for reconstruction of a nasal passage. Although the implant showed no infection, not enough vascular ingrowth could be demonstrated and it was taken out (Table 6).

Three Med-por implants were used for auricular framework reconstruction in microtia patients. One of the implants was wrapped and prefabricated with temporal fascia, and the other two were directly placed into the postauricular pocket. No rigid fixation was used. One implant showed extrusion after 6 months and was replaced with a costal cartilage framework.

Two implants were used for maxillary alveolus (nasal sill) augmentation in two patients with an operated cleft lip, and no complications were observed (Table 7; Fig 5).

Discussion

The face is the most important esthetic unit of the human body, and deformities of the facial soft tissues and skeletal structure are highly displeasing for the patients. Deformities of the facial skeleton may be

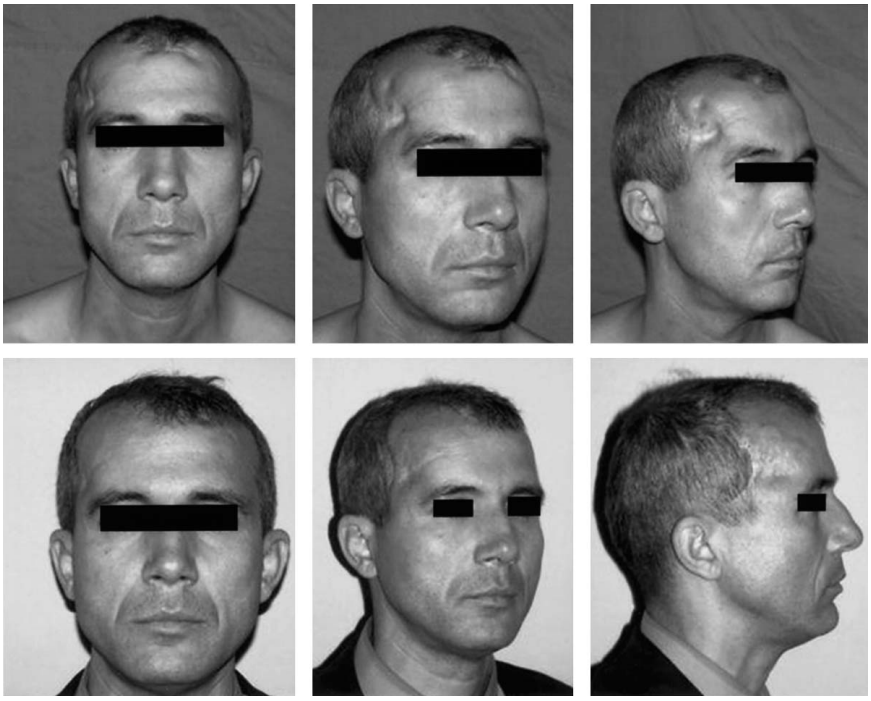

Fig 4 Male patient after gun shot wound in the frontotemporal area and after frontal craniotomy. (Top) Preoperative appearance of the patient. (Bottom) Patient after frontotemporal augmentation with Med-Por implant.

Table 6. Nasal Implants

Nasal	3 cases	4 implants	2 extrusions
Dorsal augmentation			
Paranasal augmentation			
Passage reconstruction			

reconstructed using autogenic or allogenic materials. Although allogenic materials possess disadvantages like rejection, capsule formation, displacement, and decreased resistance to infections, they also have advantages like no donor site morbidity, easy obtainability, possibility of preoperative shaping and fabricated implants, and no problems concerning absorption and fade-off. These advantages make them useful in facial skeletal reconstruction.

High-density porous polyethylene, which is shown to be effective as a biomaterial, has additional advantages like tissue ingrowth, no capsule formation around it, and easy fixation. It can be sculptured before surgery, or fabricated implants are also easy obtainable on the market. Increased tissue ingrowth also increases its resistance to infections.[6] Med-por is effectively used in facial skeletal reconstructions and in different reconstructive interventions like nasal dorsal augmentation[7,8]; augmentation of malar, paranasal, and mandibular contours[9]; microtia reconstruction[10]; and orbital floor and socket reconstruction.[11,12] At our clinic, we placed 83 implants in 71 different patients. Seven patients were in need of a second intervention. Three of the seven secondary interventions were for contour alignment, and four interventions were for extraction of the implants because of extrusion or infection. Absence or a decreased amount of subcutaneous fat in temporal and frontal areas makes small contour irregularities of less then 1 mm remarkable with palpation and inspection. We decided to deepen the contours of the defects with a burr hole; after placement of the implant, the edges are again smoothed out. This again demonstrated the importance of in-place contouring of the implant.[9] Other secondary interventions were for exposed implants in nasal dorsal augmentation and microtia reconstruction and for extraction of infected implants in the mandibular angulus region. Exposed implants in the nasal and auricular regions showed no signs of infection, and no microorganisms were encountered. Exposure occurred in 1 patient 2 weeks after surgery, but the other cases showed exposition after 6 months of placement of the implant. Reason for these exposures may be overlying thin soft tissue, local ischemia of this soft tissue, or its decreased resistance against trauma. These late complications discouraged us from using alloplastic implants in nasal dorsum and microtia reconstruction. Similar conclusions were also reached by Frodel and Lee,[13] Sevin et al,[14] and Carboni et al.[2] We prefer autogenic tissue in cases in which subperiosteal placement or placement under a second facial structure is not possible.

Secondary intervention in a mandibular angulus augmentation demonstrated an infected implant, which was colonized with oral flora. The implant

Table 7.

Auricular framework	3 cases	3 implants	1 extrusion
Maxillary alveolar augmentation	2 cases	2 implants	

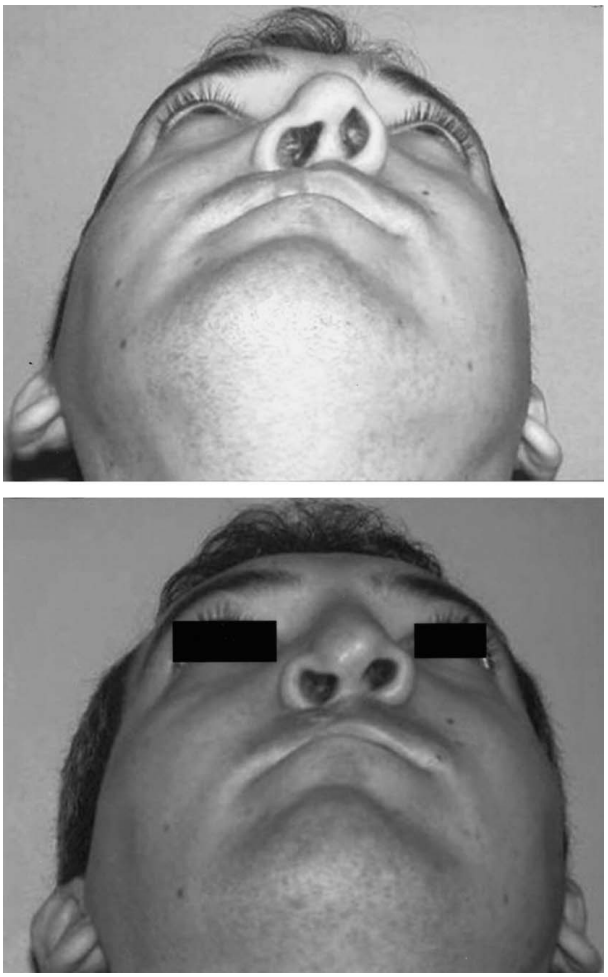

Fig 5 Operated cleft-lip patient with depressed maxillary alveolus. (Top) Patient with depressed maxillary alveolus. (Bottom) After augmentation of maxillary alveolus with Medpor implant.

was placed through the intraoral route. In other studies comparing postoperative complications in craniofacial reconstructive interventions, the rate of infection in porous polyethylene implants placed through intraoral route was also shown to be correlated with an increased rate of postoperative infections.[15] We may speculate that the porous structure of porous polyethylene implants may promote bacterial adherence and colonization when contaminated with oral flora when using the transoral route. Use of porous polyethylene implants in orbital floor reconstruction is a safe and effective method, because no complications were observed in this study.

A customized carved Med-por block or sheets were used in zygomatic, orbital, nasal, and mandibular angulus regions, whereas fabricated implants were used for auricular, mental, and malar reconstructions as well as augmentations. Prefabricated implants without any modifications were mostly used for esthetic purposes. For most reconstructive purposes, however, customized implants carved out of blocks or sheets were used.

Use of porous polyethylene implants in craniofacial surgery for reconstruction or augmentation of facial structures is an easy, effective, and safe way, which has low morbidity. Morbidity is site dependent. Placement of porous polyethylene implants directly under the skin without coverage of periosteum or another fascial envelope has an increased risk of early and especially late exposure. In cases like nasal dorsum or microtia reconstruction, we prefer autogenic grafts instead of allogenic material.

Morbidity is also dependent on the route chosen for implant placement. The transoral route for mandibular angulus reconstruction demonstrated infective complications, which can lead to extraction of the implant. Although we are still using the transoral route for interventions in the mandibular areas, meticulous surgical technique and bacterial prophylaxis should be undertaken.

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