

Role of High Density Porous Polyethylene (H.D.P.E) Implants in Correction of Maxillofacial Defects and Deformity: A Review

Abstract

Facial defects and deformities present many reconstructive challenges in the field of maxillofacial surgery and a good surgical outcome is often elusive. As every surgical procedure has its own set of complications, reconstructive surgery using autogenous bone graft or any synthetic material including High Density Porous Polyethylene (H.D.P.E) implant placement is no exception. The use of porous polyethylene implant gained acceptance by maxillofacial surgeons because it integrates with tissue and becomes stable against bone.

Key Words

High Density Porous polyethylene Implant (H.D.P.E); reconstructive options; facial skeleton augmentation

Ravi Ranjan¹, Amit Kumar², Sujit Kumar³, Ravindra Kumar⁴, Bhumika Kamal Badiyani⁵, Kumari Preeti Ranjana⁶

¹MDS, Consultant Oral and Maxillofacial Surgeon, Advanced Oral and Maxillofacial Trauma Centre, Bihar Sharif, Bihar

²Senior Lecturer, Department of Public Health Dentistry, Sarjug Dental College and Hospital, Laheriasarai, Darbhanga, Bihar

³MD, Consultant Physician, Jeevan Jyoti Super Specialty Hospital, Bihar Sharif, Bihar

⁴BDS, Private Practitioner, Advanced Oral and Maxillofacial Trauma Centre, Bihar Sharif, Bihar

⁵Senior Lecturer, Department of Public Health Dentistry, Sarjug Dental College and Hospital, Laheriasarai, Darbhanga, Bihar

⁶MBBS, Junior Gynecologist, Jeevan Jyoti Super Speciality Hospital, Bihar Sharif, Bihar

INTRODUCTION

Most people today are well aware of reconstruction surgery. By definition, "reconstruction Surgery refers to any surgery that modifies or improves the appearance of a physical features, irregularity or defect." Facial defects and deformities present many reconstructive challenges in the field of maxillofacial surgery and a good surgical outcome is often elusive. The size and shape of the facial skeleton are fundamental determinants of the facial appearance. Small asymmetries in skeletal morphology can be noticeable and small changes through surgical intervention can be effective. The outcome of maxillofacial bone reconstruction is thought to be dependent on surgical skills, quality of adjacent soft tissues, size and location of the bone defect and choice of repair method. The methods include free and vascularised bone grafts, a variety of biomaterials and more recently the use of osteoinductive growth factors. Alloplastic materials may be used alone or in combination with bone transplants. The history of bone and skin allograft is replete with controversies due to the radical nature

of the procedure in earlier times. Understandably, the act of transferring bone or skin from one person to another invited much public contention on social, ethical and religious grounds. Furthermore, considering the dearth of knowledge on the subject in the past, failure of a study was as much an outcome as success. The First World War gambled as a unit of time and site, all the conditions of a meeting between surgeons coming from at the countries of the west world and a huge amount of various and serious facial traumatism. World War second resulted in large numbers of casualties. Losses of bone, fractures or burn wounds in victims of the War compelled surgeons of their time to come up with methods to repair these defects (bone-grafting and bone-transplantation). They constituted the basis of an independent maxillofacial surgery which is the origin of the aesthetic surgery even if at the same time the improvement of the anesthesiology gave rise to the general cosmetic surgery. Later the procedures involved in that cosmetic surgery took their part in the general reflexion of surgery and also in the 3D techniques



Fig. 1: Implant present in double peel pouch



Fig. 3: Implant can be fixed with screws

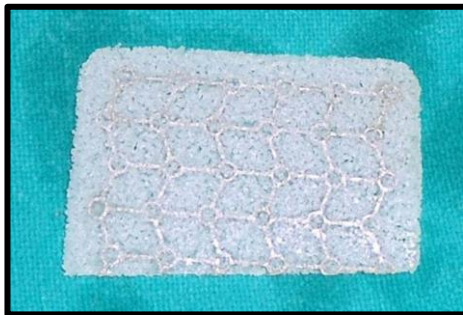


Fig. 5: Titanium embedded h.d.p.e implant

with the time dimension. At other times however, events served as impetus to the progress of allograft transplantation. Indeed, necessity is the mother of invention. Conceptually, autogenous bone would be the material of choice to restore the defects of the craniofacial skeleton because it has a potential to revascularize and further get incorporated into the facial skeleton, so much so that with time it would be biologically indistinguishable from the adjacent native skeleton. Practically, the use of autogenous bone is limited and the morbidity, increased intraoperative time and hospitalization costs associated with autogenous bone graft harvest can be significant. Furthermore, the inevitable resorption and the poor handling characteristics of autogenous bone grafts also limit the quality and predictability of the result. The need of remodeling the harvested bone into complex shapes may also complicate the surgery. In addition, significant bone resorption using free bone grafts along with morbidity and risks from harvesting bone grafts cannot be disregarded. Demineralized bone matrix

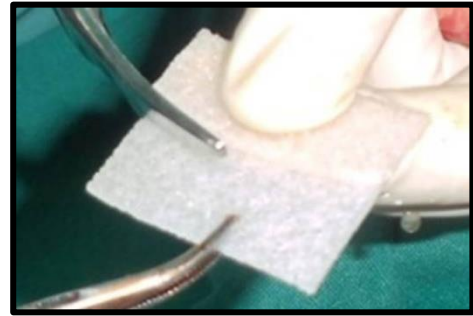


Fig. 1: Implant can be cut easily

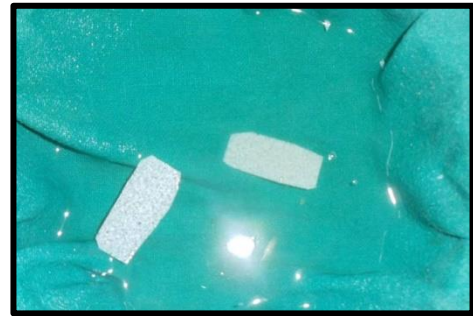


Fig. 4: After submerging the implant in a hot, sterile saline bath it can be moulded

(D.B.M) may overcome these problems, but it has no mechanical stability until bone has formed.^[1,2] Alloplastic implants are very useful in maxillofacial surgery to substitute missing bone parts or building up already existing ones. Guarda-Nardini *et al.*, present their experience with one of these alloplastic materials, high density porous polyethylene between (1992-1995); seventy one patients were treated with this material. The high density porous polyethylene was used in a variety of implant sites: orbit (sixteen), nose (three), zygomatic bone (five), mandible (seventeen), chin (eighteen), upper maxilla (ten), ear (seventeen), temporal (six) and frontal (one) regions, cranial vault (three). All the implants were obtained starting from blocks or sheets of High Density Porous Polyethylene (H.D.P.E) which had been opportunely modelled and shaped with a scalpel or a rotating burr. The implants were then anchored in the desired zone by screw, screw and plate or wire osteosynthesis. Rubin *et al.*,^[3] has reported an extensive thirty- two year experience with reconstructing the craniofacial skeleton. He noted that porous polyethylene was tolerated by the body. This observation is consistent with recent findings in which polyethylene was used as a reference standard for biocompatibility testing.

High Density Porous Polyethylene (H.D.P.E) implants

The use of porous polyethylene gained acceptance by maxillofacial surgeons because it integrates with tissue and becomes stable against bone. The high-

density, porous variety is used for facial implants because of its higher tensile strength. Ideally, their role in reconstructive procedures is not only simply replacing the missing bone part but also stimulate osteoconduction by acting as a scaffold for bone re-growth. Polyethylene, although chemically similar to Poly-Tetrafluoroethylene (PTFE), has a much firm consistency, resisting material compression, while still permitting some flexibility.^[3] Its firm consistency allows it to be easily fixed with screws and contoured with a scalpel or power equipment without fragmenting. Polyethylene is a simple carbon chain of ethylene monomer. Though a variety of alloplastic materials are available for maxillofacial reconstruction, implants made from Porous polyethylene biomaterial is currently available that meets the criteria for an effective implant material. Features includes :- 1) Implants are manufactured from linear high density porous polyethylene. 2) They are Biocompatible, 3) Pore size is engineered to range in size from 100 to 200 μm with more than 50% being larger than 150 μm . 4) Pores interconnect with each other which allows tissue ingrowth or fibro vascular ingrowth, 5) Structure of the implant is stable and rigid enough to maintain the porous framework under the conditions encountered at the implanted site permanently, 6) Is firm and flexible in nature, 7) Can be immobilized with sutures or with screws, 8) Biomaterial can be easily cut/ moulded/ reshaped during surgery. 9) The biomaterials are provided in sterile pack, packaged individually in double peel pouches, 10) The light weight property of biomaterial and ability to place the implant deep in the defect contribute to the overall popularity of this implant.^[4] Besides this features, few things must be kept in mind replacement in load bearing area inevitably leads to micromotion at the implant-bone interface, with bone erosion and subsequent implant extrusion. Implants that are chronically exposed to the sinuses are inevitably contaminated with bacteria and lost to infection. Portions of the cranial vault and internal orbit are the areas reliably replaced by alloplastic implants.

DISCUSSION

As every surgical procedure has its own set of complications, reconstructive surgery, using autogenous bone graft or any synthetic material including High Density Porous Polyethylene (H.D.P.E) implant placement is no exception. The rate of major complications reported by Edward Ellis III *et al.*,^[5] for harvesting iliac crest bone grafts

range from 0.7% to 25% and of minor complications which are more common ranges from 9.4% to 24%. Clinical experiences by Wahid Abdullah Salem Wajih^[6] have shown that calvarial grafts tend to resorb less than grafts taken from other donor sites, but calvarial bone can be difficult to shape and control during internal orbit reconstruction and have their inherent risk of neurological complications. H.D.P.E. implants for reconstruction to eliminate donor site complications and issues related to graft resorption. Thus they concluded that Orbital floor reconstruction using an autogenous graft or H.D.P.E Implant showed comparable results. The choice of orbital reconstruction must be primarily determined by the size and location of the orbital defect and the remaining structural support. Many different implant materials have been used with varying advantages and disadvantages. Complications and toxicities of implantable biomaterials used in craniofacial surgery have been reported in a review by Rubin and Yaremchuk in 1997.^[4] The aim was to compare different bone grafts and biomaterials for reconstruction of craniofacial bones. They included studies on the reconstruction of the skull, forehead, nose, zygoma and the orbit whereas reconstructions on load-bearing areas were omitted. In a study Comparison of genioplasty using H.D.P.E implant with osteotomy by measuring the amount of antero-posterior change in hard and soft tissue. Thirty-three patients who underwent mentum augmentation and who were followed-up for six months were included. Subjects were divided into two groups: (group A), with fourteen patients who underwent genioplasty using osteotomy and (group B), with nineteen patients who underwent genioplasty using H.D.P.E implant. Patients chose one of the treatments themselves. They concluded that the amount of the movement at the time of surgery when checked after surgery did not change in patients who underwent genioplasty using H.D.P.E implant compared with patients who underwent genioplasty which indicated that the patients treated using H.D.P.E implant had a smaller soft tissue relapse rate and the amount of change in the soft tissues was similar to that in the hard tissues. In addition, there were few postsurgical complications. Based on these results it was found that compared with the patients who underwent genioplasty with H.D.P.E implant the relapse rate of soft tissues was smaller. Some of the chief advantages of using H.D.P.E implant for genioplasty and augmentation

include easy manipulation, easy fixation of implants with metal screws and availability in diverse shapes and sizes. However similar to other foreign materials, it is readily infected and should be handled carefully. They also concluded that it should not be used in weight-bearing areas, such as the temporomandibular joint. It is also contraindicated if any of the following conditions are present: 1) Inadequate tissue coverage, 2) Patients with systemic diseases that result in poor healing, 3) Areas that have been irradiated for the treatment of cancer and/or 4) Areas that are exposed to the external environment.^[7] Another study twenty-six patients with fractures of the orbital floor were included and their main aim was to evaluate the long-term results after reconstruction of the orbital floor with porous polyethylene implants. The main cause of fractures was road traffic accidents. All the fractures were reconstructed with thin and ultra-thin porous polyethylene sheets. No implants extruded and there were no signs of inflammatory reaction against the porous polyethylene. The symptoms were treated in fourteen patients with enophthalmos, eighteen with diplopia, and sixteen with limited extrinsic ocular motility, fourteen with impairment of the infraorbital nerve and eight with hypoglobus. Postoperative infections in four patients were treated with systemic antibiotics. Persistent ectropion was present in two patients. They concluded that High-Density porous Polyethylene (H.D.P.E) sheets are reliable, safe and effective implants and may be used for reconstruction of the orbital floor fracture with no donor site morbidity or need to fix implant.^[8] They did a prospective study on thirty - four patients with a variety of facial skeletal deformities and subcutaneous defects to determine use of High-Density porous Polyethylene (H.D.P.E) for their corrections. Types of deformity treated included orbital defects (seven), temporal defects (eight), Fronto cranial defects (eight), maxillary and malar defects (four), calvarial bone graft donor site defects (seven) and chin deficiency (two), total of forty sites. The patients were in the age range of twenty to seventy four years. The authors found that all implants were fixed to the surrounding tissues at three months only one case required removal of implant due to infection. The authors concluded that H.D.P.E implants offer an excellent alternative to autogenous and other alloplastic materials with advantages in terms of its versatility and relative ideal pore size allows for excellent soft tissue

ingrowth and coverage.^[9] Indications for facial skeleton augmentation Patients with normal, deficient and surgically altered or traumatically deformed anatomy may all benefit from implant augmentation of their craniofacial skeleton. Most often, facial augmentation is done to enhance facial appearance in patients whose skeleton relationships are considered within normal range. They want more definition and angularity of their appearance, other patient desire to balance their facial dimensions. Craniofacial deformities that are disfiguring and are of functional consequence to vision, usually require skeletal osteotomies and rearrangement as treatment. Less severe midface and mandibular hypoplasia are common facial skeletal variants.

CONCLUSION

Thus, we can say that High Density Porous Polyethylene (H.D.P.E) implants is a versatile and an exciting material with ever increasing range of application in maxillofacial, orbital and neurosurgical surgeries.

REFERENCES

1. Sevin K, Askar I, Sarey A. Exposure of high-density porous polyethylene used for contour restoration and treatment. *British Journal of Oral and Maxillofacial Surgery* 2000;38:44-9.
2. Klinge B, Isaksson S, Jonsson J. Osseous Response to Implanted Natural Bone Mineral and Synthetic Hydroxyapatite Ceramic in the Repair of Experimental Skull Bone Defects. *Journal of Oral Maxillofacial Surgery* 1992;50:241-9.
3. Rubin JP. Complications and toxicities of implantable biomaterials used in facial reconstructive and aesthetic surgery: a comprehensive review of the literature. *Plastic Reconstructive Surgery* 1997;100:1336-53.
4. Yaremchuk MJ. Facial skeletal reconstruction using porous polyethylene implants. *Plastic Reconstruction Surgery* 2003;111:1818-27.
5. Ellis E, Messo E. Use of non resorbable alloplastic implants for internal orbital reconstruction. *Journal of Oral Maxillofacial Surgery* 2004;62:873-81.
6. Wajih WAS, Shaharuddin B, Razak NA. Hospital Universiti Sains Malaysia Experience in Orbital Floor Reconstruction: Autogenous Graft versus H.D.P.E Implant. *American Association of Oral and Maxillofacial Surgeons. Journal of Oral and Maxillofacial Surgery* 2011;69:1740-4.

7. Park JY, Kim SG, Baik SM. Comparison of genioplasty using H.D.P.E and osteotomy. *Oral Surgery Oral Med Oral Pathology Oral Radiology Endod* 2010;109:26-30.
8. Yilmaz M, Vatvada H, Aydin E. Repair of fractures of the orbital floor with porous polyethylene Implants. *British Journal of Maxillofacial Surgery* 2007.
9. Fodel JL, Lee S. The Use of High-Density Polyethylene Implants in Facial Deformities. *Arch otolaryngol head and neck surgery* 1998;124.