Original Article - Comparative Study

High-Density Polyethylene Material versus Autogenous Grafts in Craniofacial Augmentation Procedures

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Abstract

Aim: The objective was to do a comparative study and to evaluate the outcome in overall acceptance for correction of residual facial deformity with autogenous graft versus porous polyethylene implants. **Materials and Methods:** A total of 16 patients in the age group of ≥15 years irrespective of sex, caste, religion, and socioeconomic status presenting with signs and symptoms of residual facial deformities and who were declared fit for surgery were included in the study. The study patients were further divided into two groups, of eight each. Deformity correction using autogenous grafts was performed in Group A and using high-density polyethylene (HDPE) alloplastic implants was performed in Group B. During the follow-up period, patients' and doctor rating of overall acceptance between autogenous and alloplastic (HDPE) bone grafts was recorded on 100-mm visual analog scale (VAS) on the 2nd day and 7th day and at 3, 6, and 12 weeks. **Results:** The unpaired *t*-test is used for evaluation. VAS score at all the follow-up periods above stated was significantly higher in alloplastic group than in the autogenous group for both in patients and doctor evaluation. **Conclusion:** From the present study, it can be concluded that porous HDPE implants are an effective alternative to autogenous grafts in accordance of overall acceptance for correction of residual facial deformity when proper case selection, exclusion of negative prognostic factors, and meticulous surgical procedure are followed.

Keywords: Autogenous graft, craniofacial augmentation, porous polyethylene implants, residual facial deformity

Introduction

Various materials have been used in facial augmentation including autografts, allografts, and alloplasts.[1-4] Autogenous grafts include the use of intraoral bone grafts, cranial grafts, rib grafts, iliac crest grafts, and tibial grafts. Although autogenous bone and cartilage offer the advantage of tissue compatibility, they are associated with donor-site morbidity, restricted availability, difficulty of shaping the graft, and unpredictability of remodeling and resorption. These problems were overcome with irradiated homografts (allografts), e.g., demineralized freeze-dried bone allograft. However, the fear of transmitted diseases, such as HIV, and studies showing unpredictable resorption and graft warpage, reduced the use of irradiated homologous tissue.[5] Dissatisfaction with autogenous implants and allografts catalyzed the development of and use of synthetic alloplastic materials. Various alloplastic materials of historic importance include silicone, gold, ivory inlays, paraffin, silver, Gore-Tex, or polytetrafluoroethylene 1–3. Porous high-density polyethylene (pHDPE) is an alloplastic material developed in the 1970s, comprised polyethylene resins as straight-chain aliphatic hydrocarbons. It is an inert material with very low tissue reactivity. It also causes minimal inflammatory foreign body reactions, forms no capsules, and yields no observable systemic or cytotoxic effects.[5] Hence, the present study is to do a comparison and evaluation of the outcome in overall acceptance for correction of residual facial deformity with autogenous graft versus porous polyethylene implants.

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Materials and Methods

A total of 16 patients in the age group of ≥15 years irrespective of sex, caste, religion, and socioeconomic status presenting with signs and symptoms of residual facial deformities and

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who were declared fit for surgery were included in the study. Informed written consent was obtained from all the patients. The study patients were further divided into two groups of eight each. Deformity correction using autogenous grafts was done in Group A and using HDPE alloplastic implants was done in Group B (Medpor Biomaterial; Biopore Surgical, Mumbai, Maharashtra, India). Patients present with the presence of any active acute infection and who refused their consent were excluded in the study.[6] Required laboratory investigations and radiographs were advised. The characterization of residual facial deformity sites for Group A is as follows: anterior maxilla – 2, zygomatic arch – 1, posterior mandible – 1, orbital wall – 2, and malar region – 2; and for Group – B chin – 3, orbital floor – 2, orbital wall – 2, and malar region – 1. During the follow-up period, patients' and doctor rating of overall acceptance between autogenous and alloplastic (HDPE) bone grafts were recorded on 100-mm visual analog scale (VAS) on the 2nd day and 7th day and at 3, 6, and 12 weeks. Unpaired *t*-test is used for evaluation.

Surgical technique

Preoperative antibiotics were given, and under strict aseptic conditions, the surgical site was prepared. After administering required anesthesia along with the local infiltration of the surgical site, an extraoral or intraoral incision was given depending on the type of deformity. Carrying blunt dissection, a subperiosteal pocket was created at the surgical defect.

pHDPE alloplastic surgical implant was dipped in gentamicin solution.[7] Gross contouring of an implant was done according to required dimensions after immersing implant in the hot saline bath at 80°C–100°C.[8] Then, the implant was tried in and final contouring was done. The implant was soaked in antibiotic solution (gentamicin) for 10 min before fixation [Figure 1a and b]. Finally, it was fixed with titanium screws of appropriate length. The layer-wise closure was done. Pressure dressing for 48 h was maintained along with postoperative oral antibiotics and analgesics for 5 days.[9] By following the same procedure, it is used for augmentation genioplasty, orbital floor reconstruction, and infraorbital rim reconstruction [Figure 2a-d].[10-13]

The autogenous bone graft was harvested and adapted to the defect [Figure 3a and b]. Anterior iliac crest allows the harvesting of cancellous bone, corticocancellous bone strips, or even tricortical bone, as appropriate. Palpate the widest part of the iliac crest forming the iliac tubercle. The incision is made 1 cm more laterally (inferiorly) or medially (superiorly) from the iliac crest to avoid a painful scar on the ridge of the iliac crest. Using the cutting diathermy, the fascia is split longitudinally to expose the iliac crest. The diathermy is then used to dissect the periosteum and muscle insertions to expose the bone surface. For cancellous bone graft, the crest was exposed and osteotome was used to make a trap door fenestration (two vertical cuts and one from the lateral aspect of the crest – the roof of the iliac blade is split and elevated hinging medially). Reflect the cortical bone to expose the cancellous bone. The closure was done in layers.[14]

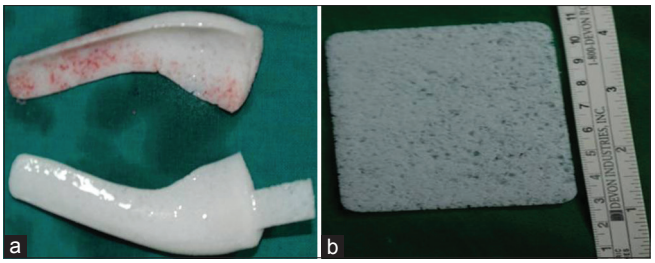


Figure 1: (a) High-density polyethylene chin implant. (b) High-density polyethylene sheet implant

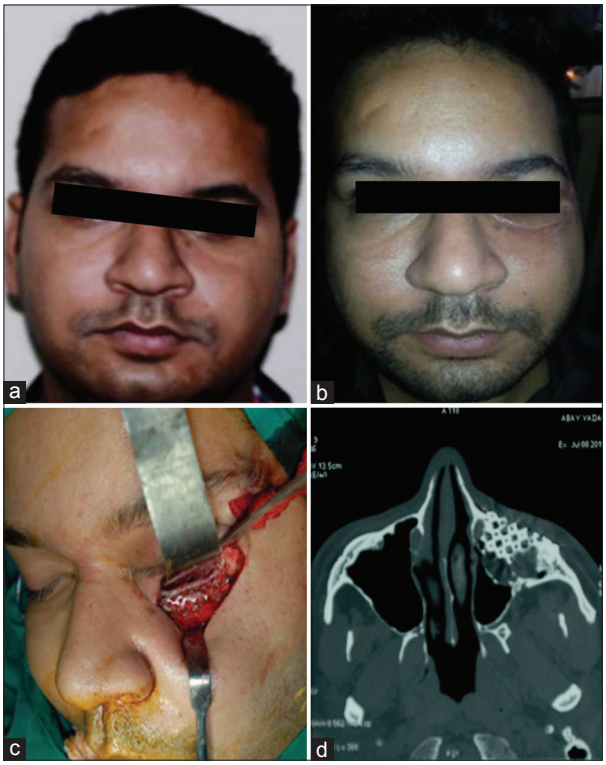


Figure 2: (a) Preoperative. (b) Postoperative. (c) Intraoperative use of porous high-density polyethylene. (d) Postoperative computed tomography scan

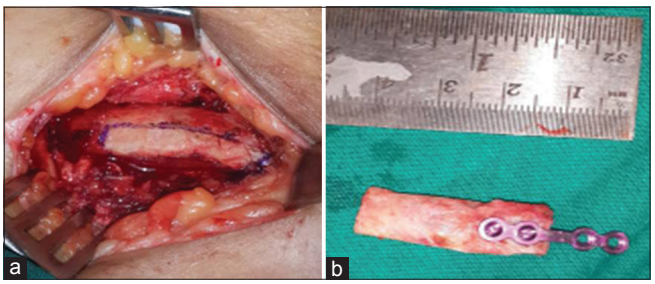


Figure 3: (a) Exposed iliac crest. (b) Plate fixed iliac crest

Observation and Results

This study included 75% male and 25% female patients. The patients belonged to 17–30 years of age with a mean age of 21.37 years.

Table 1: Comparison of visual analog scale scores for patient's evaluation between autogenous and alloplastic (high-density polyethylene) bone graft groups at different time intervals

Time intervals	Bone graft groups	VAS scores for patient's evaluation		Unpaired *t*-test
		Mean±SD	Min-Max	
Pre-operative	Autogenous	30.00±9.26	25.00-45.00	*t*=-1.590, *P*=0.134 (>0.05), Not significant
	Alloplastic (HDPE)	36.50±6.93	25.00-45.00	
2nd day	Autogenous	60.88±3.00	55.00-65.00	*t*=- 2.237, *P*=0.042 (<0.05), Significant
	Alloplastic (HDPE)	69.00±9.83	60.00-85.00	
7th day	Autogenous	62.38±3.20	56.00-66.00	*t*=-2.584, *P*=0.022 (<0.05), Significant
	Alloplastic (HDPE)	71.88±9.89	62.00-87.00	
3rd week	Autogenous	64.13±3.56	57.00-67.00	*t*=-2.834, *P*=0.013 (<0.05), Significant
	Alloplastic (HDPE)	74.63±9.86	65.00-90.00	
6th week	Autogenous	65.63±3.70	58.00-68.00	*t*=-2.990, *P*=0.010 (<0.05), Significant
	Alloplastic (HDPE)	76.63±9.72	68.00-92.00	
3rd month	Autogenous	68.75±5.18	60.00-75.00	*t*=-3.144, *P*=0.007 (<0.01), Highly Significant
	Alloplastic (HDPE)	80.38±9.09	70.00-95.00	

Table 2: Comparison of visual analog scale scores for doctor's evaluation between autogenous and alloplastic (high-density polyethylene) bone graft groups at different time intervals

Time intervals	Bone graft groups	VAS scores for doctor's evaluation		Unpaired *t*-test
		Mean±SD	Min-Max	
Pre-operative	Autogenous	31.25±2.32	30.00-35.00	*t*=-1.017, *P*=0.434 (>0.05), Not significant
	Alloplastic (HDPE)	35.38±2.88	30.00-40.00	
2nd day	Autogenous	61.88±3.31	57.00-68.00	*t*=-2.270, *P*=0.040 (<0.05), Significant
	Alloplastic (HDPE)	67.38±6.00	57.00-76.00	
7th day	Autogenous	64.00±3.89	59.00-71.00	*t*=-2.461, *P*=0.027 (<0.05), Significant
	Alloplastic (HDPE)	70.88±6.88	59.00-79.00	
3rd weeks	Autogenous	65.50±3.86	61.00-72.00	*t*=-2.992, *P*=0.010 (<0.05), Significant
	Alloplastic (HDPE)	74.00±7.05	61.00-82.00	
6th weeks	Autogenous	67.50±3.38	63.00-74.00	*t*=-3.487, *P*=0.004 (<0.01), Significant
	Alloplastic (HDPE)	76.88±6.81	66.00-86.00	
3rd month	Autogenous	69.38±3.20	65.00-75.00	*t*=-4.970, *P*=0.000 (<0.001), Very high significant
	Alloplastic (HDPE)	80.75±5.63	70.00-90.00	

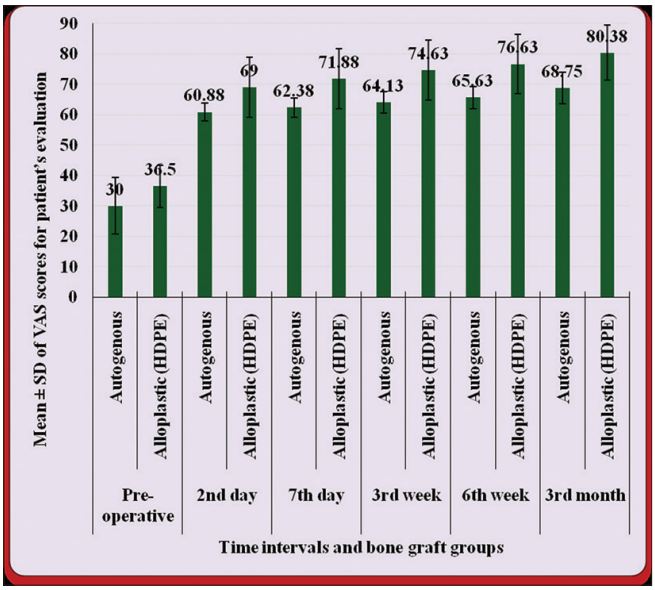
Table 1 and Graph 1 show the comparison of VAS scores for patient's evaluation between autogenous and alloplastic (HDPE) bone graft groups at different time intervals – 2nd day: (t = −2.237), 7th day: (t = −2.584), 3rd week: (t = −2.834), 6th week: (t = −2.990), and 3rd month: (t = −3.144).

Table 2 and Graph 2 shows comparison of VAS scores for doctor's evaluation between autogenous and alloplastic (HDPE) bone graft groups at different time intervals – 2nd day: (t = −2.270), 7th day: (t = −2.461), 3rd week: (t = −2.992), 6th week: (t = −3.487), and 3rd month: (t = −4.970).

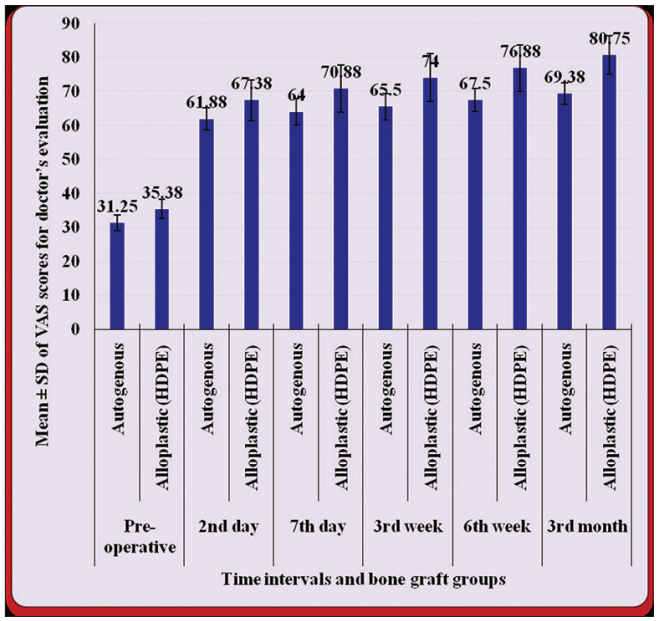
The VAS score at all the follow-up periods stated above was significantly higher in alloplastic group than autogenous group for both in patients' and doctor's evaluation (P < 0.05).

Discussion

No material has matched all the criteria for an ideal implant, but pHDPE comes quite close to it. pHDPE has several advantages, namely, shorter operating time, as it does not involve harvesting of autologous bone or cartilaginous graft, no donor-site morbidity, and no requirement of general anesthesia. In addition, autologous graft procedures have an unpredictable resorption rate, with consequent relapse and risk of warping which is not a problem with pHDPE.[15-17] In theory, pHDPE implant seems to be a good implant, but it is not without its limitations. It has the theoretical greater risk of infection as compared to autogenous grafts and has increased the incidence of implant mobility and extrusion as compared to autogenous grafts. It is difficult to remove if subsequent surgery is required. It is relatively noncompressible, is somewhat flexible, and can be carved easily with a sharp instrument and applied directly onto the facial skeleton as an onlay implant owing to its excellent biocompatibility. Pieces can be sutured or screwed together when necessary. HDPE is similar in hardness to the cancellous bone at room temperature, but it demonstrates excellent thermoplastic abilities and can be bent and molded easily after being submerged in hot sterile saline (80°C–1000°C) for several minutes with permanent results.



Graph 1: Comparison of visual analog scale scores for patient's evaluation between autogenous and alloplastic (porous high-density polyethylene) bone graft groups at different time intervals



Graph 2: Comparison of visual analog scale scores for doctor's evaluation between autogenous and alloplastic (high-density polyethylene) bone graft groups at different time intervals

The material is biologically inert and characterized by large pores averaging 200 nm in diameter. This property allows for significant tissue ingrowth, excellent implant fixation, very low resorption, and low likelihood of infection or exposure. HDPE implants achieve optimal fixation through tissue ingrowth to the underlying bone when implanted in a subperiosteal pocket. It can be sculptured before surgery, or fabricated implants are also easily obtainable in the market. Increased tissue ingrowth also increases its resistance to infections. pHDPE is effectively used in facial skeletal reconstructions and in different reconstructive interventions such as augmentation of malar, paranasal, and mandibular contours and orbital floor reconstruction.

Conclusion

Hence, after assessing both the autogenous graft and alloplastic material, it is seen that none of the grafts have completely matched the overall criteria of an ideal graft. Both grafts having some advantages and its counter disadvantages but based on the observations made and duly discussed, it can be concluded that Biopore (pHDPE) implants are an effective alternative to autogenous grafts in accordance with overall acceptance for correction of facial deformity when proper case selection, exclusion of negative prognostic factors, and meticulous surgical procedure are followed.[18] Selection criteria and cost factor in a developing country like India limits the number of patients. Due to small sample size and short duration of the study, the long-term success rate cannot be concluded, and for which long-term study and bigger sample size are warranted.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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