The Reconstruction of Nasal Septal Perforation with High Density Porous Polyethylene Covered with Fascia Lata: An Experimental Study on Rabbit Model

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INTRODUCTION

Nasal septal perforation is an important problem for otolaryngology specialists and facial plastic surgeons. Several factors contribute to this problem as a surgical challenge. The surgical area in septal perforations has often been previously operated on, in which case fibrotic areas that have a limited tissue and impaired blood supply may be present (1). Nasal mucosa is almost always atrophic and is an unsuitable material for reconstruction. Even with open techniques, the surgical field is narrow (2), and the recommended techniques are not easy to perform without extensive experience (3). When this condition becomes symptomatic, it affects the patient’s quality of life. Sur-
Surgery is not recommended in cases of asymptomatic perforation, but even when symptomatic; it is often difficult to select the most suitable cases and the most appropriate techniques (2). This is why surgical outcomes are not always positive (4). Despite numerous surgical methods and many reconstructive materials, no single surgical procedure exists for septal perforation repair (5). Autogenous tissues, such as temporal fascia, septal and auricle cartilage, cranial periosteum, perichondrium, and ethmoidal and hip bone, have previously been used for the closure of septal perforations.

Biomaterials, such as Dacron, porous polyethylene, dolomite, and bioglass, can be used to produce grafts of adequate sizes and shapes. With their use, donor site morbidity can be avoided. The major disadvantages of biomaterials are infection which will result with failure of closure of the septal perforation.

The aim of our study was to evaluate the effect of a porous alloplastic implant, high-density porous polyethylene (HDPP: Medpor, Porex Surgical Products Group, Newnan, GA, USA), covered with fascia lata on nasal septal perforation in rabbits.

MATERIALS AND METHODS

Twenty (10 male, 10 female) healthy New Zealand albino rabbits were used. The study protocol was approved by the ethics committee of Istanbul University, Istanbul Medicine faculty in the DET AM department. The whole study, including the operations and post-operative care, was performed at Istanbul University in the Veterinary Medicine Anatomy department.

Room humidity was between 40% and 60%; room temperature was maintained at 21°C. The rabbits, when under general anaesthesia, were warmed by an electrical heater to maintain their normal body temperature. Oral temperatures of the animals were stabilised at 37.5-39°C. The rabbits’ weights were 3,700-4,400 g.

The animals were operated on under the general anaesthesia. The 20 rabbits were divided into study and control groups. For the study group, HDPP covered with fascia lata was implanted into the perforated area. For the control group, HDPP was implanted with no fascial covering. The rabbits were painlessly sacrificed after 4 months of observation and septal macroscopic and histological results were evaluated. The results were compared between the two groups.

Rabbits were operated on under 7.5-15 mg/kg xylazine and 40-60 mg/kg ketamine anaesthesia. A lateral incision was made from the lateral aspect of the left nares to the incisura nasomaxillaris. After exposure of the cavum nasi, the nasal perichondrium and mucosa were elevated bilaterally. A full-thickness 0.5 × 0.5-cm perforation was created. Bilateral mucosa, mucoperichondrium, and septal cartilage were removed. The perforation was created with a No. 11 surgical blade. In the study group, a fascia lata graft was obtained from the femoral region. The HDPP implant was cut to an appropriate size and covered with fascia lata. The material, which was wider than the perforation, was placed between the mucoperichondrial layers as an interposition graft (Figs. 1 and 2). No suture was used to stabilise the graft. The incision lines were sutured and the animals were allowed to wake up. For the control group, HDPP was implanted without fascial covering in the same manner. Methylprednisolone sodium succinate (0.5-2 mg/kg) was administered intramuscularly on the first post-operative day, and cefazolin sodium (10 mg/kg) was administered two times daily for 5 days. Butorphanol (0.1-0.5 mg/kg) was administered intravenously two times daily for post-operative pain. B-complex vitamins (1-2 mg/kg) were also administered in the post-operative period. Four months after the procedure, the first magnetic resonance imaging (MRI) scan was obtained to evaluate graft condition. The MRI slice thickness was 4.5 mm, and there was no gap between the slices (consecutive slices). The animals were then sacrificed with sodium pentothal in the ear vein under ketamine anaesthesia. The animals’
nasal septums were completely removed for macroscopic and histopathological examination. Sections of each septum were stained with haematoxylin and eosin and evaluated under ×100 magnification.

Statistical analyses were performed using NCSS 2007 and PASS 2008 (NCSS, Kaysville, UT, USA). Fisher’s exact test was used to compare the septal perforation rates between the study and control groups. The confidence interval was 95%, and a $P$-value of $<0.05$ was considered to indicate statistical significance.

**RESULTS**

All animals completed the study period at the end of 4 months. In the study group, one animal developed an upper respiratory infection with purulent nasal discharge. The infection was verified with MRI, which revealed that all graft materials were intact and had not resorbed (Fig. 3). Macroscopically, one of 10 perforations persisted, while the remaining nine perforations were closed. The perforated septum was in the rabbit that had the aforementioned upper respiratory tract infection. Histopathological examination of the remaining nine rabbits revealed that the continuity of cartilage was disturbed in the perforation areas. Granulation tissue was inverted in areas in which the cartilage continuity was disturbed (thick black arrow). The Medpore stayed intact at the edge of the perforation (white arrows).

In the control group, four of 10 perforations were closed. Six (60%) perforations remained. In animals in which the perforation remained, perforations were observed macroscopically and no further histopathological examination was performed. The fascia lata-covered HDPP implant had significantly higher perforation closure rates than those of HDPP implants alone ($P = 0.029$) (Table 1).

**DISCUSSION**

Nasal septal perforations are anatomical defects that may include...
Although HDPP is used in different parts of the body, its use in rhinologic procedures resulted in some degree of implant failure. A disadvantage of using synthetic material is such failure. Failure of the material is due primarily to infection and the direct contact of the material with an infected environment. Until integration and fibrous tissue ingrowth occur, the implants have no vascular supply. This is important in cases involving bacterial contamination because no immune entities or antibiotics will reach the implant area (10). To avoid bacterial contamination, especially in rhinologic procedures, it is necessary to preserve the mucosa and avoid mucosal tears. Such tears can lead to contamination, which will result in infection and removal of the implant (1). To decrease the potential for infection, in the study group, we covered the HDPP with autogenic material to protect it from the infected environment. Fascia was chosen for this purpose; fascia has very low metabolic requirements and allows for vascularisation and tissue growth on its surface (10). Although temporal fascia is readily obtained in humans, we choose fascia lata in our rabbits because it is difficult to obtain temporal fascia from rabbits. Covering autograft material was previously used in another study; Ribeiro and da Silva (13) used temporal fascia-covered auricular or septal cartilage to repair 258 perforations. The perforation sizes were 1.0-3.5 cm, and the graft was used with bilateral intranasal sub mucoperichondrial or sub-mucoperiosteal advancement flaps in closed rhinoplasty. The perforations closed in 257 of 258 subjects.

In our study, the HDPP piece was cut wider than the perforation and the fascia was laid onto the piece and sutured. The physical examination at 4 months and the MRI revealed that fascia lata-covered HDPP remained intact in nine of 10 animals; no remaining perforation was observed in these animals. The perforations were macroscopically closed in nine of 10 cases. Histopathological examination showed that the graft material remained on the edge of the perforation. In the control group, a high remaining perforation rate was observed (60%). This was due to direct contact of implant with the intranasal environment, as mentioned previously. The fascia lata-covered HDPP had significantly better septal perforation closure rates than did uncovered HDPP ($P=0.029$).

This study has some limitations. First, perforation and closure were performed in one stage. The graft was interposed immediately after the perforation was created. It would be better to assess the effectiveness of a graft in a long-lasting perforation instead of performing an immediate replacement. The nasal septum and mucosa is extremely thin in rabbits, and it would have been difficult to replace the material after a long period. Another limitation was the follow-up period. In a study by Godin et al. (14), the failure period of a different implant material, GoreteX, was prolonged to 44 months. Long-term results would have allowed for more accurate determination of long-term success rates and will be the topic of another study. However, we believe that a 4-month follow-up period is long enough to obtain experimental results in a study such as ours.
This paper focused on Medpore, its high implant failure rates, and a possible solution to avoid this failure. Thus, Medpore covered with fascia lata was only compared with uncovered Medpore. This is another limitation of this study, the absence of a control group to evaluate the usefulness of fascia alone. HDPP covered with fascia lata is an effective material for use in the repair of nasal septal perforations. It is easy to work with and avoids the increased operative time and morbidity associated with harvesting autografts.

Especially in cases of large perforations, it is difficult to obtain wide, flat, and thin grafts. HDPP is an option for septal perforation closure in humans. However, like other synthetic materials, HDPP has some degree of failure. Covering HDPP with fascia lata decreased the remained perforation rate by protecting the implant from the contaminated environment. Additional studies are needed to demonstrate the safety of this material, and long-term follow-up is needed to clarify the long-term success rates.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

REFERENCES

1. Seyhan T, Kircelli BH, Caglar B. Correction of septal and midface hypoplasia in maxillonasal dysplasia (Binder’s syndrome) using high-density porous polyethylene. Aesthetic Plast Surg. 2009 Jul;33(4):661-5.
2. Re M, Paolucci L, Romeo R, Mallardi V. Surgical treatment of nasal septal perforations: our experience. Acta Otorhinolaryngol Ital. 2006 Apr;26(2):102-9.
3. Pedroza F, Patrociniio LG, Arevalo O. A review of 25-year experience of nasal septal perforation repair. Arch Facial Plast Surg. 2007 Jan-Feb;9(1):12-8.
4. Dosen LK, Haye R. Nasal septal perforation 1981-2005: changes in etiology, gender and size. BMC Ear Nose throat Disord. 2007 Mar 7;7:1.
5. Kogan L, Gilbey P, Samet A, Talmion Y. Nasal septal perforation repair using oral mucosal flaps. Isr Med Assoc J. 2007 May;9(5):373-5.
6. Goh AY, Hussain SS. Different surgical treatments for nasal septal perforation and their outcomes. J Laryngol Otol. 2007 May;121(5):419-26.
7. Ambro BT, Zimmerman J, Rosenthal M, Pribitkin EA. Nasal septal perforation repair with porcine small intestinal submucosa. Arch Facial Plast Surg. 2003 Nov-Dec;5(6):528-9.
8. Ceylan A, Ileri F, Celenk F, Yilmaz M, Ushu S. Upper lateral cartilage inner mucoperichondrial flap technique for the repair of nasal septal perforation. ORL J Otorhinolaryngol Relat Spec. 2007;69(4):245-50.
9. Baj A, Spotti S, Marelli S, Beltramini GA, Gianni AB. Use of porous polyethylene for correcting defects of temporal region following transposition of temporalis myofascial flap. Acta Otorhinolaryngol Ital. 2009 Oct;29(5):265-9.
10. Keefe MS, Keefe MA. An evaluation of the effectiveness of different techniques for intraoperative infiltration of antibiotics into alloplastic implants for use in facial reconstruction. Arch Facial Plast Surg. 2009 Jul-Aug;11(4):246-51.
11. Oliveira RV, de Souza Nunes LS, Filho HN, de Andrade Holgado L, Ribeiro DA, Matsumoto MA. Fibrovascularization and osteogenesis in high-density porous polyethylene implants. J Craniofac Surg. 2009 Jul;20(4):1120-4.
12. Yildirim G, Haliloglu T, Sacpi T, Kahvecioglu O, Onar V, Savci N, et al. Tracheal reconstruction with porous high-density polyethylene tracheal prosthesis. Ann Otol Rhinol Laryngol. 2000 Oct;109(10 Pt 1):981-7.
13. Ribeiro JS, da Silva GS. Technical advances in the correction of septal perforation associated with closed rhinoplasty. Arch Facial Plast Surg. 2007 Sep-Oct;9(5):321-7.
14. Godin MS, Waldman SR, Johnson CM Jr. Nasal augmentation using Gore-Tex: a 10-year experience. Arch Facial Plast Surg. 1999 Apr-Jun;1(2):118-21.