Myringoplasty: Comparing Fresh Porcine Submucosa with Rice Paper Patch

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Abstract

Objective: To evaluate and compare the efficacy of freshly prepared porcine small intestine submucosa (SIS) with rice paper patch in the repair of large chronic tympanic membrane perforations.

Materials and methods: Chronic tympanic membrane perforations were bilaterally produced in five adult chinchillas using a 3mm aural speculum and a myringoplasty knife. Each chinchilla then was post-operatively monitored for up to 5 weeks to assess whether or not the perforation healed spontaneously. Only one gender was used, because the sex of the animal was not considered to be a factor.

Production of SIS graft: Fresh porcine small intestine was harvested and used in a total of seven perforations in seven chinchillas. A 6µm surgical blade was used to procure a strip of SIS graft which was approximately sized and stored into a sterile, chilled 0.9% saline solution until implantation.

Results

Operative technique: I myringotomy: Animals were fasted for no more than two hours prior to anesthesia with 1% to 3% isoflurane (per 1L oxygen) as not to disrupt the intestinal microflora. Body temperature was monitored closely with a rectal thermometer as adverse reactions to anesthesia such as hypothermia can develop in small mammals. The trans-canal approach to visualization of the TM through a 3mm otoscopic speculum was used in creating bilaterally TM perforations in each chinchilla. An incision was made with a myringoplasty knife, severing at least 70% of the pars tensa. Postoperatively, pain was controlled by buprenorphine (0.05 mg/kg) 30 minutes prior to emergence from anesthesia and enrofloxacine (20 mg/kg) once a day for five days. Each chinchilla was post-operatively monitored for five weeks. Changes in behavior such as reduced food and water intake, restlessness, vocalizations, and excessive rubbing or biting indicative of pain were managed with 2 ml/kg acetaminophen added to the drinking water and buprenorphine as needed. Furthermore, signs of infection were treated with antibiotic drops containing 10,000 U/mL polymyxin B sulfate, 10 mg/mL enrofloxacine, and 3.5 mg/mL dexamethasone. Despite these precautions, one chinchilla succumbed to an ear infection and was excluded from the study. Non-infected TM perforations that lacked signs of epithelial regeneration were declared chronic.

Operative technique: II myringoplasty: The remaining 4 chinchillas totaling 8 TM perforations underwent bilateral myringoplasty. After induction of anesthesia, the overlying epithelium was specifically removed and replaced with a glutaraldehyde-fixed fresh SIS graft and rice paper patch being placed in the right and left ears, respectively. SIS graft placement was facilitated by septically blotting the excess with 10% glutaraldehyde formalin saline solution. Rice paper patch was placed in the opposite ear by following the same general procedure. Freshly prepared porcine SIS and rice paper patch remained healed after 5 weeks.

Gross observations: Torens method of staining was used in which SIS appears pink, collagen blue-green, and mast cell granules deep blue. Two SIS repaired TMs, SIS fused with the TM (Fig. 2). As compared to their intact state, TMs are disorganized and appear to be undergoing modification. At 10µm magnification, SIS appears to be forming attachments to the TM. In the rest of the repairs, no inflammation is indicated at the site of infiltration of SIS and collagen. Lastly, one SIS-repaired TM demonstrated neovascularization in a collagen-dense region.

Discussion

Myringoplasty has limitations including the need for general anesthesia, costly equipment, surgical expertise, and donor site morbidity. With this in mind, rice paper patch was developed and successfully used on small perforations in order to reduce operating time and cost with a simple nonsurgical procedure. Rice paper patch acts as a scaffold that guides migrating epithelium from the borders of the perforation in order to produce healing without the limitations seen in myringoplasty. The economic benefits are substantial, especially for patients with time constraints that wish to avoid a surgical procedure.

Material and Methods

Animal model: The study was approved and monitored by the Philadelphia College of Osteopathic Medicine Institutional Animal Care and Utilization Committee. Five healthy adult female chinchillas each weighing 490 to 629g were purchased from Rancho's Chinchilla Ranch (LAFG 3, Ohio). Only one gender was used, because the sex of the animal was not considered to be a factor.

Production of SIS graft: Fresh porcine small intestine was obtained from a USDA approved vendor. The jejunum was sectioned and sliced longitudinally until a sufficient amount was harvested. The jejunum was then divided into segments approximately 10 cm long which were then sliced into 1 cm wide strips. The strips were washed, peeled of their serosa, and sliced into thin sheets. These sheets were then autoclaved and stored in 0.9NaCl saturated with antibiotic drops containing 10 U/mL polymyxin B sulfate, 10 mg/mL enrofloxacine, and 3.5 mg/mL dexamethasone, for up to 3 months.

Operative technique: I myringotomy: Animals were fasted for no more than two hours prior to anesthesia with 1% to 3% isoflurane (per 1L oxygen) as not to disrupt the intestinal microflora. Body temperature was monitored closely with a rectal thermometer as adverse reactions to anesthesia such as hypothermia can develop in small mammals. The trans-canal approach to visualization of the TM through a 3mm otoscopic speculum was used in creating bilaterally TM perforations in each chinchilla. An incision was made with a myringoplasty knife, severing at least 70% of the pars tensa. Postoperatively, pain was controlled by buprenorphine (0.05 mg/kg) 30 minutes prior to emergence from anesthesia and enrofloxacine (20 mg/kg) once a day for five days. Each chinchilla was post-operatively monitored for five weeks. Changes in behavior such as reduced food and water intake, restlessness, vocalizations, and excessive rubbing or biting indicative of pain were managed with 2 ml/kg acetaminophen added to the drinking water and buprenorphine as needed. Furthermore, signs of infection were treated with antibiotic drops containing 10,000 U/mL polymyxin B sulfate, 10 mg/mL enrofloxacine, and 3.5 mg/mL dexamethasone. Despite these precautions, one chinchilla succumbed to an ear infection and was excluded from the study. Non-infected TM perforations that lacked signs of epithelial regeneration were declared chronic.

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Results

Repairs with rice paper patch were fragile and proved difficult to harvest. On histological examination, only one of four ears (25%) showed epithelial tissue of a healed TM.

Conclusion

In this study, we examined the efficacy of freshly prepared porcine SIS xenografts to compare rice paper patch in the chinchilla animal model. Although rice paper patch can be effective in healing small TM perforations it isn’t without its downsides. As the size of the perforation increases, the efficacy of rice paper patch decreases clearly demonstrating an inverse relationship between size and success rate. The results of this study demonstrate freshly harvested porcine SIS as an effective graft for myringoplasty. SIS offers several advantages for TM repair, as it is readily available, affordable, and easy to harvest. Multiple applications for SIS in various animal models both in our laboratory and those of other investigators have previously demonstrated a high success rate using freshly prepared SIS grafts and the present study further extends its application to TM perforations. In under-resourced areas where other alternatives are not feasible, freshly prepared SIS could be a viable option in treating patients with chronic TM perforations.

References


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