Hyaluronic Acid Fat Graft Myringoplasty

An Office-Based Technique Adapted to Children

Issam Saliba, MD, FRCSC; Patrick Froehlich, MD

Objectives: To evaluate hyaluronic acid fat graft myringoplasty (HAFGM) for different tympanic membrane perforation (TMP) sizes and to compare its success rate with that of the underlay and overlay techniques.

Design: Prospective study.

Setting: Tertiary care pediatric center.

Patients: Two hundred eight children aged 4 to 16 years (mean age, 11.84 years) with TMPs.

Interventions: The HAFGM is a new technique for TMP repair in an outpatient pediatric population using local anesthesia. All the patients in groups 1 (underlay) and 2 (overlay) were operated on using general anesthesia, whereas group 3 (HAFGM) was operated on at the outpatient office using local anesthesia.

Main Outcome Measures: Postoperative status of the eardrum, hearing improvement, and incidence of complications.

Results: Patients with TMP were divided into 3 groups: group 1 had 75 patients; group 2, 65; and group 3, 73. The global success rate was 87% in group 3, with no difference with the remaining 2 groups. Successful closure of different TMP sizes was the same for the 3 groups. Postoperatively, air-bone gap improvement was better for group 3. No bone conduction threshold worsening was noted. The mean duration of the operative procedure was 65, 74, and 18 minutes for groups 1, 2, and 3, respectively (P= .02). Mean postoperative follow-up was 20.7, 17.5, and 14.6 months for groups 1, 2, and 3, respectively. Identification of the anterior perforation rim is mandatory to perform HAFGM.

Conclusions: The HAFGM did not require hospitalization for pediatric patients. It had the advantage of being feasible in children using local anesthesia. Its success rate was comparable with that of conventional techniques.

perforations (>30% of the membrane surface area), FGM and paper-patch myringoplasties have been found to be ineffective. 

Hyaluronic acid is a component of the extracellular matrix of many tissues in the body, making it highly biocompatible. Hyaluronic acid is frequently used in ophthalmologic surgery and in the treatment of lacermal drainage system diseases. Stenfors concluded that covering the defect of tympanic membrane (TM) with 1% HA repeated every second to third day has been shown to accelerate the closure of perforation size. However, Prior et al. concluded that repair of TMs with HA ester films alone is not recommended because the success rate for their first 5 patients was 0%. Their study, however, was aborted at this point.

Hyaluronic acid FGM (HAFGM) is an association of HA with FGM. The surgical technique was reported by one of us (L.S.) in 2008 in adults. It is a new technique for TM repair in an outpatient pediatric population performed using local anesthesia. In this study, we aimed to evaluate HAFGM in children with different TMF sizes to compare the success rate of HAFGM with that of the underlay and overlay techniques and to assess hearing improvement 1 year postoperatively.

METHODS

The following inclusion criteria were used in this prospective study conducted between January 1, 2007, and December 31, 2010, at a tertiary care pediatric center: children 4 to 18 years old (1) with perforations present for at least 6 months; (2) without evidence of active chronic otitis media, cholesteatoma, or retraction pocket formation; (3) without suspected ossicular abnormalities on microscopic examination; and (4) with functional hearing in the contralateral ear. Excluded were children with purulent discharge, suspected ossicu lar disease (ie, erosion, discontinuity, or fixation of the ossicular chain), suspected cholesteatoma, and an unidentified anterior rim of the perforation. The size of the perforation, the level of hearing loss were not considered exclusion criteria.

PATIENTS

The population was divided into 3 groups depending on the parent's choice of myringoplasty technique: underlay technique (group 1), overlay technique (group 2), and HAFGM technique (group 3). All the patients and parents received a full description (ie, surgical technique, risks, complications, and advantages) of the HAFGM procedure and of the underlay and overlay techniques. The parents discussed the procedure with the patient and signed the informed consent form. The temporals fascia or the tragal perichondrium was the graft used for the underlay and overlay techniques. All the patients in groups 1 and 2 were operated on while under general anesthesia, whereas group 3 (HAFGM) patients were operated on under local anesthesia in the outpatient setting. Patients in whom the anterior rim of the perforation was not identified and was hidden by the anterior wall bulging of the external auditory canal were excluded from the 3 groups to eliminate any bias because no drilling of this bulging was performed for the HAFGM group.

The size of the perforation was estimated as a percentage and was graded using Saliba's TMP classification reported in 2008. grade I, small (for perforations <25% of the TM surface); grade II, medium (for perforations 25%-50% of the TM surface); grade III, large (for perforations >50%-75% of the TM surface); and grade IV, total (for perforations >75% of the TM surface).

HA OTOLOGIC LAMINA

We used the 8-mm-diameter disc of a transparent otologic lamina composed of HA ester (EpiDisc; Medtronic Xomed, Jacksonville, Florida). It has microperforations that allow permeability that facilitates drainage of exudates at the surgical site.

HAFGM TECHNIQUE

Fat was harvested for at least twice the size of the perforation through a 5-mm incision below the mastoid tip and behind the sternocleidomastoid muscle. After the perforation margins were deepithelialized circumferentially, absorbable gelatin pieces were placed into the middle ear through the perforation to support the fat graft. The fat graft was then inserted through the perforation as a hourglass-shaped plug. The lateral fat bulging should not be too high. Care should be taken to attain intimate contact between the transparent otologic lamina, the fat graft, and the TM remnant. The transparent otologic lamina should overlap the intact epithelium edge around the perforation. When the malleus handle was denuded by the perforation, it was carefully surrounded by the fat graft pieces. Depending on the TM perforation size, 1 or 2 HA transparent otologic lamina are placed over the fat graft. In the case of total perforation, the HA transparent otologic lamina cover the fat graft and the medial edge of the external auditory canal skin near the annulus. The HA is then covered with pieces of absorbable gelatin soaked with oxofloxacin to pack the ear canal. It is recommended to avoid excessive pressure on the HA transparent otologic lamina. No other ear dressing was required. Patients were discharged immediately after the procedure. The HAFGM surgical technique (Saliba's technique) was described in detail in a previous study.

OUTCOME MEASURES

The variables examined include patient age, sex, otologic symptoms, and previous surgery on the affected side; perforation side, location, and size; and the duration of surgery. In addition, the collected data include postoperative complications, time of follow-up, and hearing test results. Patient hearing was measured before and after repair of the eardrum perforations. Any bone conduction decrement of 10 dB or greater would be considered a significant sensorineural hearing loss and reported in the results. The mean values of the preoperative and postoperative air conduction and bone conduction thresholds at the frequencies 200, 1000, 2000, and 4000 Hz served to calculate the pure-tone average and the air-bone gap (ABG) closure. A photoendoscopic image of each TMP was taken immediately before the procedure and at postoperative months 2, 4, 6, and 12. This allowed us to study the evolution of TM healing. Successful closure and graft failure rates were based on the status of the TM at the most recent visit, a minimum of 12 months postoperatively. Hearing improvement was assessed using the audiogram results obtained and 12 months postoperatively. The first postoperative appointment was scheduled at 2 months, or sooner if there was a complication. Follow-up was conducted 4 to 6 months and 12 months after the procedure and then yearly.

STATISTICAL ANALYSIS

A variance analysis with repeated measures and χ² tests was performed for statistical analysis. A P < .05 was considered statistically significant.
This prospective study included 208 children. Only 5 patients, all from group 3, had a bilateral perforation. Group 1 included 75 TMPs; group 2, 65; and group 3, 73. Age (range, 4-16 years), sex, and side of TMP were not statistically significantly different among the 3 groups (Table 1). We assessed age as a categorical variable; patients were grouped as follows: younger than 11 years and 11 to 18 years old. No statistically significant difference was found between the 2 age categories in each group or among the 3 groups (Table 2).

Otolologic symptoms in the preoperative period were not statistically significantly different among the 3 groups. Patients reported hearing loss, otorrhea, otalgia, ear fullness, and tinnitus. Numerous previous surgical procedures in the affected ear were reported: transmyringoplasty, myringoplasty, canal wall up mastoidectomy, and ossicular chain reconstruction. No difference among the 3 groups was noted (P=.87).

Under microscopic vision, TM was virtually divided into 4 quadrants—posterosuperior, posteroinferior, anterosuperior, and anteroinferior—to facilitate localization of the TMP site (Table 3). The size distribution was not statistically significant among the 3 groups (Table 3). The number of large and total perforations was relatively lower than the number of small and medium perforations in the 3 groups, without any significant difference among them.

The global success rate of TMP closure was not statistically significant comparing the underlay (85.7%),...
HAFGM indicates hyaluronic acid fat graft myringoplasty.

Comparing perforation grades, no significant difference in the success rate was observed among the 3 techniques performed on the small, medium, large, or extra-large perforations, and no difference in success exists among the 4 TMP grades in each group (\(P > .05\)) (Figure 1). In addition, the previous ear operations did not affect the success rate of myringoplasty in any of the 3 techniques. Furthermore, no significant differences in success rates were observed when posterior perforations were compared with either anterior or anteroposterior perforations in each group, and between groups (\(P > .05\)).

Failure cases occurred mainly in the first 4 postoperative months in the 3 groups (\(P < .05\)). No causes of failure were identified except for the case of infection in each of groups 1 and 3. Complications were more frequent in the underlay (86.5%), and HAFGM (87.0%) techniques. Comparing perforation grades, no significant difference in the success rate was observed among the 3 techniques performed on the small, medium, large, or extra-large perforations (\(P > .05\)), and no difference in success exists among the 4 TMP grades in each group (\(P < .05\)) (Figure 1). In addition, the previous ear operations did not affect the success rate of myringoplasty in any of the 3 techniques. Furthermore, no significant differences in success rates were observed when posterior perforations were compared with either anterior or anteroposterior perforations in each group, and between groups (\(P > .05\)).

Failure cases occurred mainly in the first 4 postoperative months in the 3 groups (\(P < .05\)). No causes of failure were identified except for the case of infection in each of groups 1 and 3. Complications were more frequent in group 1 (\(P < .03\)). Whereas TM cholesteatoma pearls arise more frequently after an overlay technique, we found only 1 case of cholesteatoma in group 2 and 2 cases in group 1. This white spot on the TM should raise suspicion for cholesteatoma. Early diagnosis and treatment are imperative to allow easy removal and to avoid middle ear involvement. Surgery was performed in all 3 of these patients with a transcanal approach using local anesthesia and a tympanomeatal flap, and the cholesteatoma pearl was peeled from the TM. After removal, the medial layer of the TM was intact, and no further action was taken. Histopathologic analysis confirmed a cholesteatoma. On follow-up, otoscopic examination results were normal, with no signs of recurrence. In addition, 4 cases of TM retraction developed after the underlay technique. There were no graft lateralizations or blunting.

Hearing results 12 months postoperatively are given in Table 4. The ABG was significantly improved after surgery in the 3 groups. However, the postoperative ABG and pure-tone average were significantly better after HAFGM than after the underlay (\(P < .02\)) or overlay (\(P < .03\)) technique. The postoperative ABG improvement by frequency is represented in Figure 2. No difference was found postoperatively among groups 1 (96.6%), 2 (96.0%), and 3 (98.3%) for the speech discrimination score or for the bone conduction threshold. Thus, no sensorineural hearing loss was found in any patients. Surgical procedures were followed up for more than 12 months in the 3 groups. The mean postoperative follow-up was 20.7 months for group 1, 17.5 months for group 2, and 14.6 months for group 3. The mean duration of the operative procedure was 65 minutes for group 1, 74 minutes for group 2, and 18 minutes for group 3 (\(P < .02\)).

Three main interests lie in the HAFGM: its success rate, its feasibility using local anesthesia, and its safety. In addition to the high success rate comparable with
that of the underlay and overlay techniques, HAFGM in Sainte-Justine University Hospital Center, Montreal, Quebec, Canada, is processed using local anesthesia in a mean of 18 minutes at the outpatient clinic department. There is no need for sedation. Although the fat graft fills the middle ear and slightly bulges through the TM, it progressively disappears until postoperative month 12. The TMP closure is stable after month 4, as is the hearing test with a maximum follow-up of 48 months.

Ringenberg studied the properties of fat tissue in otology. He compared 3 sites of swab—abdomen, buttock, and earlobe—and concluded that the earlobe allows better epithelial and mucosal tympanic growth because it is more dense. Ear lobe fat is not enough to fill the perforation hole of grade II or greater. We used fat in the region below the mastoid tip and behind the sternocleidomastoid muscle through a 5-mm incision, with special care to harvest a sufficient sample of fat that was at least twice the size of the perforation. If temporalis muscle fascia is an inert support for the tympanic closure, the fat graft presents a big revascularization activity confirmed by the serial otoscopic photograph we took postoperatively. This early revascularization is probably the physiologic explanation for the tympanic growth. Studies about vascularization of the fatty tissue showed that angiogenesis precedes adipogenesis. Moreover, this adipose tissue promotes cicatrization and revascularization of nonvascularized areas. These properties are intimately due to the secretory activity of adipose cells, producing a lot of metabolites.

As reported in the literature, age was not found to be a prognostic factor for the HAFGM success rate or for the underlay and overlay techniques. The site and the size of the TMP do not affect the success rate of HAFGM. However, patients with anterior wall bulging of the external auditory canal were excluded to eliminate bias because no drilling was performed in the HAFGM group. The HAFGM technique is limited by this inconvenience because it is performed in the office of the outpatient department. Underlay and overlay cases were performed in the operating room under general anesthesia.

The TM vibrates at the same frequency as the incoming sound and, in turn, causes the ossicular chain to vibrate at that same frequency. Postoperative hearing improvement is statistically significant in the 3 performed techniques. However, we noticed a significantly higher ABG gain in the HAFGM group at 0.5-, 1-, 2-, and 4-kHz frequencies. Laser interferometry to compare the vibration characteristics of repaired TM by the HAFGM, underlay, and overlay techniques could explain this phenomenon. At the first postoperative year, the operated TM does not show new sclerotic areas but rather a normal TM appearance with a small, thin, fatty

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Hyaluronic acid is a nonototoxic material. Sensoneural hearing loss reported in patients who had undergone tympanoplasty procedures has not been noticed in any study on FGM, including the present study. Absorbable gelatin inserted into the middle ear to support the fat graft does not seem to affect the result of conductive hearing loss at the fourth postoperative month. Hearing tests at 1 year postoperatively were similar to those performed at 4 months. These pieces of absorbable gelatin are important to prevent medialization of the fat graft and to prevent adherence development between the medial side of the TM and the promontory. The HAFGM does not need any support at the level of the anterior annulus, where the graft may lose TM contact with traditional underlay tympanoplasty, or an epithelial dissection on the anterior TM remnant as in the overlay myringoplasty. All these factors leave HAFGM with minimal complications: TM medialization, lateralization, blunting, and cholesteatoma pearls did not occur in any patient in this HAFGM pediatric series.

Because this population was divided into 3 groups depending on the parent's choice of myringoplasty technique, this study was not a randomized controlled trial, and, therefore, a selection bias may play a role.

In conclusion, HAFGM is a cost-effective alternative in TMPs of all sizes in all quadrants if complete visualization of the margin is possible, including revision cases. It provides the basic requirements for TM grafting, with its own favorable characteristics.

Because of its substantial operational advantages, HAFGM can be suggested as a first choice for the reconstruction of a dry TMP in a pediatric population. It is performed under local anesthesia as an outpatient office procedure; there is no need for sedation, and it also yields a high success rate, better than that of FGM alone or HA alone. Results are comparable with those of the underlay and overlay myringoplasty techniques.

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Correspondence: Issam Saliba, MD, FRCS(C), Department of Otolaryngology, Sainte-Justine University Hospital Center, 3175, Cote Sainte-Catherine, Montreal, QC H3T 1C5, Canada (issam.saliba@umontreal.ca).

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