First Endoscopic Transplantation of a Tympanic Allograft: A Case Report

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Introduction: Allograft tympanoplasty is a proven effective technique to restore eardrum and/or the ossicular chain. Before this manuscript, this technique always required a retroauricular incision. Ironically, the prelevation of the donor graft has been performed endoscopically for some years now. Here the authors present the first case of a successful endoscopic allograft tympanoplasty.

Aim: Reconstruction of a subtotal eardrum perforation with endaural endoscopic placement of a tympanic allograft.

Case Report: A 28 years old man of African origin presented with a central kidney-shaped subtotal perforation and moderate-severe conductive hearing loss (pure tone average: 62 decibels; air-bone gap: 42 decibels). For such large perforations Allograft Tympano-Ossicular System (ATOS) tympanoplasty can be applied. Because of the patient's African origin and dark skin type, an endoscopic endaural approach was chosen over a retroauricular approach to work less invasive and avoid keloid formation.

Results: During surgery, an endoscopic endaural placement of an ATOS was executed in the same manner as in cases with conventional retroauricular incisions. Follow-up care was identical to conventional cases. At his last visit, the perforated eardrum was closed with also an improved hearing (mild hearing loss; pure tone average: 23 decibels; air-bone gap: 8 decibels). After at least 3 months no severe adverse events were seen, and he was discharged from follow-up.

Conclusions: Endoscopic placement of an ATOS is an effective and minimally invasive technique to restore challenging eardrum perforations.

Key Words: Tympanoplasty, endoscopic ear surgery, Creutzfeldt-Jakob's disease, hearing loss, iatrogenic keloid

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Tympanoplasty is a routine ENT intervention performed on a daily basis, in which several techniques have evolved favorably over the years. From an overlay technique (first described by Zollner in 1955[1] and Wullstein in 1956[2]) with fascia- or skin-grafts toward a coincidental new technique discovery by Shea.[3] In 1960, during a stapedectomy, he used a remnant of the vein graft to close an eardrum perforation and placed it at the medial part of the tympanic membrane paving the way for the underlay technique. In current otological practice, perichondrium grafts, cartilage grafts, or fascia grafts[4] are often procured to restore the tympanic perforation through this underlay technique, all with their known advantages and disadvantages.[5]

In larger perforations (total or subtotal) where there is too little residual eardrum to stabilize the graft, this technique can be challenging. In those cases, allograft tympanoplasty can provide an effective alternative. The use of a donor eardrum requires a complete myringectomy which can also be an advantage in cholesteatoma cases to reduce the risk of residue.

The use of an Allograft Tympano-Ossicular System (ATOS) is a known successful technique.[6] ATOS is a total eardrum-with-chain graft (if desired including malleus, incus and stapes) which is procured from deceased donors (human) and finally transplanted to a living acceptor. In 1964, Challat[7] was the first to describe the use of a tympanic allograft. Despite the poor results (all 3 cases reperforated), he is considered the founding father of this technique. Jean Marquet recognized Challat's new technique and performed it in Belgium (Antwerp). In 1966, he described the first successful transplantation of a tympanic allograft.[8]

In 1988, Glasscock et al[9] advised against the use of a tympanic allograft because of the risk of transmission of prions causing Creutzfeldt-Jakob's (CJ) disease. In an earlier case, this lethal disease was already transmitted by corneal transplantation. Since the use of alcohol and formaldehyde (mostly used for preserving this grafts) proved ineffective in clearing these prions and the availability of plenty of autologous materials, this technique was no longer used in the United Kingdom.

In 1990, Tange et al[10] described a suspected transmission of these prions using a pericardial graft during myringoplasty. Four years after this procedure, CJ disease was detected in this patient, resulting in death after 1 month. The myringoplasty was indicated as the cause but prove was never delivered since the donor died after the heart surgery and CJ disease was never proven in the donor. Nevertheless, this technique was abandoned in the Netherlands because of this case and the choice was made to use autologous materials.

After the publication of these articles, the use of allografts in otological surgery came to a decline. Today, some countries and colleagues still avoid this technique because of fear for transmission. Minatogawa and Kumoi[11] published an article in 1999 to temper these fears. After more than 10,000 cases worldwide involving allogeneic material transplantation (tympanic membranes and ossicles), transmission of CJ prions has never been described. Nevertheless, they advised to screen potential donors profoundly and exclude donors with probable or definite dementia and Alzheimer disease.

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The whole process and the different procurement techniques of these allogeneic tympanic membranes and ossicles were extensively investigated and discussed by the group of Caremans et al,[6] Van Rompaey et al,[12] and Caremans et al.[13] Their research mainly focused on the possible procurement techniques of this ATOS (Schuknecht bone plug technique[14] vs. endoscopic procurement) and which technique was the most efficient. Since endoscopic procurement was more time-efficient, less invasive, presented less risk of prion transmission (because of the extracranial approach) and was esthetically invisible (transmeatal approach), this technique is nowadays more often used compared with the Schuknecht technique for procurement of this graft. The results of transplantation, from these allografts obtained by a different method, are equivalent. The take-rate and hence success rate of this procedure was 97% in this study.[6]

The overall take-rate of this allograft was previously described by Schilder et al,[15] in which 7% of the grafts reperforated. It is important to mention that the population of this study consisted only of pediatric cholesteatoma cases, so decreased function of middle ear ventilation could bias these results. Furthermore 12% of the population developed an unsafe retracted eardrum which needed revision surgery.

Since the emergence of endoscopic ear surgery and the proven efficiency and effectiveness of this technique by Marchioni et al,[16] it appeared an opportune idea to also try endoscopic placement of this graft in a living acceptor. This because of the minimally invasive aspect of this procedure and more esthetically pleasing result (no retroauricular incision, reducing the likelihood of keloid formation).

CASE PRESENTATION

Preoperative

A 28-year-old man of African origin who presents with complaints of hearing loss. He has been known to have recurrent ear infections in his childhood, which were always treated effectively with topical treatments. At the time of this writing, the patient complains of reduced hearing and tinnitus in the left ear; he describes this as a murmur rather than a high-frequency beep. On enquiry, there are no complaints of vertigo, nor a feeling of pressure in the ear. He has not had any otological intervention before.

Micro-otoscopy on the right shows an intact, limited retractile transparent eardrum.

The left tympanic membrane shows a central kidney-shaped large perforation (nearly subtotal) with a mild moist aspect of the middle ear mucosa that can be inspected through the perforation.

The preoperative audiometry is shown in Figures 1A, B demonstrating a mild, mixed hearing loss on the right over all frequencies [Pure Tone Average (PTA): 30 decibels (dB) Hearing Loss (HL) with an Air-Bone-Gap (ABG) of 7 dB]. On the left mainly moderate to severe conductive hearing loss over all frequencies with a PTA of 62 dB HL and an ABG of 42 dB.

Tympanometry shows a curve type A according to Jerger on the right and a type B according to Jerger with large volume on the left.

Preoperative audiometry and the legend demonstrating moderate to severe hearing loss in the left ear (Figs 1A, C).

Preoperative audiometry demonstrating mild hearing loss in the right ear (Fig 1B).

The patient was counseled for allograft tympanoplasty on the left ear. As the patient's skin can be classified as a Fitzpatrick skin type VI, a risk of keloid formation was discussed. Together with the patient's consent an endoscopic approach was opted.

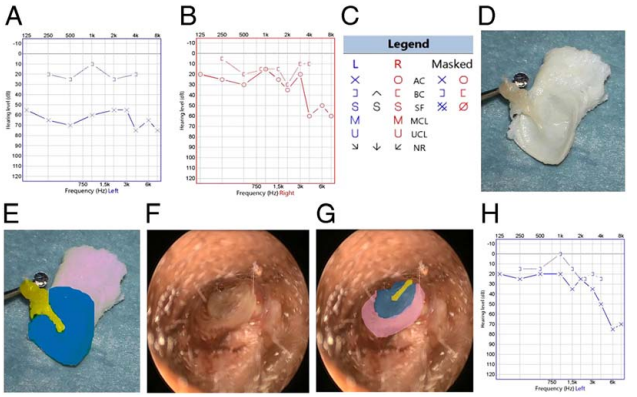

FIGURE 1. (A) Preoperative audiometry demonstrating moderate to severe hearing loss in the left ear. (B) Preoperative audiometry demonstrating mild hearing loss in the right ear. (C) Legend of audiometry. (D) Image of an ATOS. (E) Image of an ATOS, malleus colored in yellow, tympanic membrane in blue and skin cuff in pink. (F) Postoperative image of the patient's ear canal and transplanted ATOS. (G) Postoperative image, malleus colored in yellow, tympanic membrane in blue and skin cuff in pink. (H) Postoperative audiometry result of the left ear demonstrating a mild mixed hearing loss.

The following risks related to the surgery were discussed with the patient: recurrent perforation, rejection of the graft, hearing loss, postoperative infection, and hemorrhage.

Surgery

A 0° otoendoscope (rigid—Storz Hopkins 2.7 mm), a light source, HD3-CCD camera (Storz H3-Z-TH-100), and video screen were used.

The intervention consisted of the following steps:

1. Rosen incision, 5 mm lateral to the fibrous annulus.
2. The tympanomeatal flap is detached lateral to the annulus. Lifting out this annulus and detaching circumferentially the eardrum with the remaining meatal flap from the bony ear canal.
3. Disconnect eardrum from manubrium mallei and umbo.
4. Removal of eardrum and attached meatal flap (total myringectomy). A long meatal skin flap remains laterally. The chorda tympani was identified and was resected and removed due to fibroadhesive scar tissue in connection to the eardrum remnants.
5. Inspection of the middle ear demonstrated a normal movement of the ossicular chain. The round window reflex was intact.
6. Placement of an ATOS, which was provided by the tissue bank of the Universitary Hospital of Antwerp. The graft is adapted to the patient's needs and thus the donor malleus is removed. Transcanal placement of the graft. The cuff is just large enough and fits molded into the external bony ear canal.
7. The graft is fixated with Tisseel glue (Baxter, Deerfield, IL) to the bony ear canal.
8. Folding back the patient's skin of the ear canal over the cuff of the graft.
9. Placement of transmeatal packing (2 blue silastic sheets, soluble foam blocks and gauze) soaked in hydrocortisone-oxytetracycline ear suspension.

The operation time was 77 minutes and went without complications.

Postoperative

The patient remained 1 night in hospital and paracetamol was administered when the patient complained of pain. A conventional ear pack was placed, and a dressing was applied over the pinna. Ten days after surgery the ear pack was removed at our outpatient clinic. The allograft was in its correct position and there were no signs of graft rejection.

Three weeks postoperatively, the patient returned to our outpatient clinic. Subjectively, his hearing was much better. The tinnitus was still present, and the patient could not determine whether it was less intense. Otherwise, no complaints of pressure sensation in the ear, nor vertigo complaints were present.

Micro-otoscopy on the left demonstrated a normal ear canal and a graft which remained nicely in its transplanted position. Anterior to the manubrium mallei, a small fold in the graft was noticed. There were no signs of infection, nor effusion.

The audiometry demonstrated nearly closure of the air-bone gap. PTA of 23 dB HL and a residual air-bone gap of 8 dB. A tympanometry was no longer performed due to otoscopic confirmation of a closed eardrum.

The patient consulted 3 more times in the context of single otorrhea of the left ear. On reexamination, we observed granulation tissue around the allograft. This was treated topically with a gauze soaked in hydrocortisone-oxytetracycline ear suspension. After 3 days, this gauze was removed, and the patient was asked to continue applying with the same suspension for 10 more days. At the last visit, we observed again a normal ear canal and the ATOS was still intact. The last audiogram was as good as before, performed 10 weeks postoperatively.

DISCUSSION

Endoscopic ear surgery (EES) is gaining more popularity in otological surgery. This for both procedures of the external ear and middle ear, but also for approaching the inner ear, middle, and posterior cranial fossa.[17] It is also an important topic among otological surgeons in training, with early efforts being made to learn this technique (through courses and skills-lab moments) to work less invasive.

Although it appears a recent feature, this technique was first described by Thomassin et al[18] in 1990 during cholesteatoma surgery where the endoscope was used as an adjuvant tool to work on the epitympanic recess. In 1993, McKennan[19] published an article describing how he uses the endoscope in his "second-look mastoidoscopy" to rule out residual cholesteatoma. And in 1994, the well-known term "looking around the corner" was described for the first time by Magnan et al.[20]

In the article by Nogueira et al[17] and Tarabichi and Arsiwala,[21] the history and evolution of this technique, as well as the different possible materials that can be used for this purpose, are discussed in more detail. When comparing the endoscopic approach to the microscopic approach, there are several advantages and disadvantages. The main advantages using the endoscope are better and wider visualization which allows easier teaching and orientation for the less trained. Furthermore, greater amplification can be obtained and "hidden areas" can be inspected which are not possible using the microscope. One can also significantly reduce the operation time and avoid unnecessary incisions (less invasive), reducing postoperative morbidity. The main disadvantage is that it requires 1 hand to hold the endoscope making "one-handed surgery" necessary. It is not the intention to debate more thoroughly on this matter of what is best. Otological schools have opted that surgeons have to choose personally the technique which is the most effective and comfortable in his or her hands. By this vision, younger surgeons appear to be eager to learn both techniques. Sometimes it is also determined by what is best available in the hospital.

Instead the key focus point here is that surgery should be adapted to the individual needs of the patient. The main reason for choosing an endoscopic approach in this patient was the patient's skin type (Fitzpatrick skin type VI). Because this skin type is known to have a higher risk of developing keloid postoperatively, which was also the surgeon's former experience. Keloid scarring is a benign fibroproliferative disorder of the skin, mainly triggered by the disturbance of the skin by any wound (surgical or traumatic).[22] The mechanism behind this is still not well-known enough due to the lack of animal models (keloid formation is unique to humans).[23] It is suspected that keloid formation follows the same pathway as normal wound healing, but that this pathway perishes chronically after wound closure. A probable dysfunction at the cellular level. Besides the esthetic component, which can have a social and psychological impact on the patient, pruritus or pain complaints are often linked to it. The current treatments (steroid injections, interferon therapy, 5-flurouracil therapy, Imiquimuod therapy, surgical excision, cryotherapy, radiotherapy, etc.) are often ineffective, expensive, painful, cause several side effects or complications and require long-term patient compliance. Also, recurrence is a serious issue, in 45% to 100% of the cases described by Alster and Tanzi[24] there was a recurrence of keloid formation after surgical excision (used as monotherapy). Prevention is and remains the gold standard and nonessential cosmetic surgery should not be performed on known keloid formers according to Kelly.[25]

In the popularization of endoscopic ear surgery, the minimal invasiveness of this approach is emphasized. However, most classically trained ear surgeons would refer to the retroauricular incision as a very friendly one that gives little morbidity and usually heals very well. The Black skin though may be associated with keloid formation that could provoke other problems after the initial problem was taken care of. Due to the shift in general surgery to less invasive approaches, it is furthermore an opportune idea to use this technique even for cases with low risk of keloid formation.

CONCLUSION

Allograft tympanoplasty can successfully be performed endaurallly with an endoscope. In this way, a skin incision can be avoided to work less invasive. This approach may be of greater importance to skin types that are more prone to keloid formation.

NOTES ON PATIENT CONSENT

The patient's participation consent was obtained through an informing document, which he signed. The patient agreed to use all information in his file, as well as pictures taken during surgery and during visits to the outpatient clinic.

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