A Novel Use of Modified Tracheostomy Tubes in Preventing External Auditory Canal Stenosis

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BACKGROUND: Postoperative or post-traumatic canal restenosis in patients with external auditory canal (EAC) stenosis is a troublesome complication faced by many ear surgeons following canalplasty or meatoplasty. Many ear prostheses and surgical methods have been introduced to prevent the occurrence of such complication. Our aim in this study is to explore the feasibility of using modified non-fenestrated uncuffed tracheostomy tubes (TT) as postoperative stents after ear canal surgery.

METHODS: Canalplasty or meatoplasty was performed under general anesthesia via the posterior auricular transcanal approach. The EAC diameter and length were measured and a non-fenestrated uncuffed TT of suitable size was fitted into the ear canal. The TT was then modified during fitting, to fit onto the concha. Patients were advised on the importance of compliance. The adequacy of the size of the EAC after the surgery was assessed during follow-ups.

RESULTS: A total of 3 patients (4 ears) were included in our study. Various sizes of TTs were fitted into their EAC following canalplasty or meatoplasty. All of them showed excellent postoperative outcome on follow up 2 years after the surgery, with no evidence of postoperative EAC stenosis.

CONCLUSION: Modified TT stent after canalplasty or meatoplasty is proposed as an excellent alternative in preventing restenosis of EAC in centers with limited resources.

KEYWORDS: External auditory canal, tracheostomy, constriction, ear surgery, otology

BACKGROUND
External auditory canal (EAC) stenosis is a narrowing of the ear canal following various causes which can be either congenital or acquired. The narrowing can occur in isolation or involving both the bony and cartilaginous parts of the EAC. Meatoplasty or canalplasty with split skin graft is commonly performed in cases with matured stenosis.¹ EAC stents are almost always used postoperatively to prevent the risk of restenosis. The common stenting materials used may include ribbon gauze soaked with Bismuth Iodoform Paraffin Paste (BIPP) or Xeroform, expandable ear wicks, or absorbable gelatin sponges (Gelfoam). The other materials used and described in the literature are silicone for short-term or acrylic for long-term ear molds.²,³,⁴ There are also reports where cost-effective dental impression materials (Aquasil Soft Putty) with a soft ventilation tube,⁵ rubber tube,⁶ composite Foley catheter,⁷ and nasopharyngeal tube⁸ were used as a stent. In our center, we explored the feasibility of using a tracheostomy tube (TT) as a cost-saving and effective prosthesis to stent the canal postoperatively. Modified non-fenestrated uncuffed TTs of various sizes were used in a total of 3 patients (4 ears) with acquired and congenital ear canal stenosis. The stents were kept for 8 to 18 months, according to the severity of stenosis. The operated canals remain patent with good epithelization of skin, 2 years after surgery.

MATERIALS AND METHODS
In our study, canalplasty is defined as a surgery to correct the stenosis of the cartilaginous EAC, while meatoplasty is the correction of stenotic ear meatus of 1-2 mm thickness.
Canalplasty or meatoplasty was performed under general anesthesia via a posterior auricular transcanal approach, depending on the severity of canal stenosis of each case, after informed consent was obtained from all our patients. The EAC was then packed with ribbon gauze soaked with BIPP and kept for 2 weeks. The diameter and length of the EAC were carefully measured after removal of the BIPP. A non-fenestrated uncuffed TT (Portex; Smiths Medical) which was cut according to the appropriate length from the tip (Figure 1) was then fitted into the ear canal. The TT was modified to be long enough to bypass the previous stenotic area, ensuring a safe distance from the tympanic membrane. The cut-end of the modified tracheostomy tube was smoothened to avoid trauma to the concha during fitting. The tube was lubricated with chloramphenicol ointment and then fitted into the EAC in such a way that the cut-end (proximal) of the tube rested on the cavum concha (Figure 2). It was kept in situ for a week and the ear was kept dry. The patient was then reviewed in the clinic after a week (third week postoperatively) to remove the modified TT (stent) for ear toileting. The stent was cleaned, dried, and reinserted into the EAC after ear toileting. Care was taken to avoid soft tissue prolapsing into the lumen of the EAC during toileting if the raw wound surface was big. Once the epithelization was adequate and there was no prolapse of soft tissue into the lumen, the patient was given another similar stent and taught to change it once a day. The used stent was cleaned and dried, then kept for the next change the following day. They were also advised against brushing the tube to avoid producing a rough surface on the TT, which may predispose to infection in the ear canal. The patients were advised on the importance of compliance in wearing it for 24 hours a day in the first 3 months after the surgery. During reviews, if the EAC was found to be healing well and had no sign of constriction, the frequency of usage was tapered down, initially for a few hours a day, then to an in–out application of the stent once a day, to ensure that the size of the EAC was still adequate. If there was no sign of constriction, the frequency of the usage (in–out application) was tapered down further to twice a week, then weekly. If there was a sign of constriction, then the duration of usage was prolonged. The size of the EAC stent was then adjusted accordingly during the initial reviews. Adequacy of EAC size after the surgery was assessed by comparing the size of operated EAC to the opposite normal side, and the ability to visualize the tympanic membrane via otoscopy. The interval between clinical reviews was then lengthened after the EAC had become epithelized, to assess the effectiveness and outcome of the stenting. In our series, the modified tracheostomy tube was used, with variable lengths of time per day or per week, for a duration of 8 to 18 months, depending on the severity of stenosis.

**RESULTS**

**Case 1**
A 53-year-old male presented with right EAC stenosis secondary to trauma sustained during a motor vehicle accident. An examination...
EAC was packed with BIPP and later kept patent with a modified TT size 7.0 (OD 10 mm) for 12 months (24 hours a day for the first 6 months, for a few hours a day for the next 3 months, and for a few times a week for the following 3 months). Unfortunately, the meatal size became smaller as the patient was non-compliant to stenting, requiring a longer duration of wearing a TT size 6.5 (OD 8.7 mm) for another few months. A follow-up 2 years later showed good patency of the EAC.

Two years later, after the surgery on the right ear, the meatal stenosis in the left ear worsened and led to canal cholesteatoma. Meatoplasty was performed again in the left ear and a 2 mm stenosis measured at the cartilaginous part of the EAC with canal cholesteatoma was observed medially. Postoperatively, BIPP was inserted into his right EAC followed by a modified TT size 5.5 (OD 7.5 mm) inserted into his neo-canal once the packing was removed, 14 days later. During the first 2 months of stenting, the stent was kept in situ for 24 hours with cleaning at regular intervals. After 6 months, the usage of the stent was gradually reduced to a few hours a day (3 months), followed by few times a week for the last 3 months. During his follow up 2 years later, there was no evidence of restenosis and the stent was no longer needed.

DISCUSSION

The causes of EAC stenosis or atresia are multifactorial. It could be a congenital anomaly or acquired from various causes such as trauma, infection, inflammatory changes, or tumors occurring in the EAC.\textsuperscript{5} Its management remains challenging as no standard guidelines are available, and there is a risk of postoperative restenosis. It is said that the risk of restenosis following canalplasty or meatoplasty is as high as 50%.\textsuperscript{10}

The aim of this case series is to introduce an alternative method for ear stenting after canalplasty or meatoplasty in patients with EAC stenosis. Our study is the first to use a modified TT as a stent in the EAC to reduce risk of restenosis in patients, after ear canal surgeries. The innovation of using a modified TT as an EAC stent came as an idea because there is a limitation in other stenting options in our center, mainly due to issues such as patients’ affordability and the logistics problem in this region of our country. TT is used as it is readily available at a majority of centers with otorhinolaryngology services and is cost-effective. It also has a series of sizes which can be easily modified to fit various sizes of ear canal after surgery. Due to its sturdy build, TT also provides a firmer support to the canal wall as compared to rubber stents, which subsequently proved to be an effective method to maintain the patency of the EAC postoperatively in all our cases. Besides that, the risk of adverse reactions compared to other devices are minimal as most of the TTs are made with medical-grade materials. Epithelization can also occur over the surface of the tube as the TT is smooth-surfaced. In all our patients wearing the stents with cleaning at regular intervals, there were no evidences of ear canal infections related to the stent throughout our follow-up.

In our literature review, many types of stenting material have been used by surgeons around the world to prevent EAC stenosis postoperatively. These include silicone and acrylic ear molds, cost-effective dental impression materials (Aquasil Soft Putty; Dentsply) with a soft ventilation tube, rubber tubes, composite Foley catheters, and nasopharyngeal tubes.
Table 1. Summary of Cases with their Cause, Site, and Length, Surgical Approach, Tracheostomy Tube Size Used, Duration of Maintaining Stent Insertion, and Post-Stenting Outcomes

| Case | Cause of Stenosis | Site and Length of Stenosis | Surgical Approach | Tracheostomy Tube Size | Stent Duration | Outcome (after 2 years) |
|------|-------------------|-----------------------------|-------------------|-----------------------|----------------|------------------------|
| 1    | Acquired          | Cartilaginous part of right EAC, 18 mm | Postauricular, canalplasty | 6.0-7.5 | 18 months | No restenosis, No infection |
| 2    | Congenital        | Cartilaginous part of right EAC, 10 mm | Postauricular, meatoplasty | 5.0-6.5 | 10 months | No restenosis, No infection |
| 3    | Acquired          | Left ear meatus, 2 mm | Transcanal, meatoplasty | 6.5-7.0 | 12 months | No restenosis, No infection |
| 4    | Acquired          | Right ear meatus, 2 mm | Transcanal, meatoplasty | 5.5 | 8 months | No restenosis, No infection |

Stent materials or devices with personalized impression such as acrylic and silicone molds as reported by Savion et al.2 and Moon et al.,3 offer good compliance of the stent size to the width of the EAC as impressions are done immediately in the operating theatre intraoperatively. However, the lack of hollow channels in these prostheses prevent ventilation and drainage from the ear, which may be a cause for infection. This will also cause difficulty in administration of ear drops in the postoperative period. To overcome the problem, it was suggested that one can drill a tunnel throughout the length of the mold; however, its effectiveness is not mentioned.

Soft stenting materials such as rubber tubes and Foley catheters are inexpensive, readily available, and offer good channel for ventilation and drainage of the EAC. However, Kuo et al.4 mentioned that inflammation may be triggered by the stent if epithelialization of the EAC is inadequate. Therefore, resurfacing of the newly made EAC is mandatory to avoid postoperative contracture caused by the stent placement to the exposed epithelialized bone. With an integrated skin layer followed by long-term Foley catheter placement, the result is good.5

Throughout our experiences in using TT as a form of stent to prevent EAC stenosis, there have been no significant or major side effects or disadvantages noted throughout the treatment interval. The change of tube was demonstrated and explained to the patients during clinical reviews. Once they had gained confidence, patients were allowed to self-change the tube accordingly. There was no tympanic membrane perforation, or any other sign of injury over the EAC throughout follow-up. All our patients were satisfied with the treatment and outcome. In our cases, where modified radical mastoidectomy was done, there was also no evidence of cholesteatoma recurrence with the tube in situ, and the mastoid cavity was dry with no evidence of infection throughout the treatment duration. We think that the lumen of the TT provided good aeration to the middle ear. All our patients were healthy without any significant comorbidities, therefore there were no major differences in postoperative recovery time for both acquired and congenital EAC stenosis, under our observation. This method worked well in both children and adults. Children, however, must be advised comprehensively and should be able to cooperate in taking care of the stent. From our experience, the self-cleaning mechanism of the EAC also appeared to be still intact. Nevertheless, this successful method is reported only for a small number of patients. Therefore, a larger cohort observing the outcome of this method for an extended duration should be conducted to provide beneficial information on the cost effectiveness.

CONCLUSION

Modified tracheostomy tube stent after canalplasty or meatoplasty offers an excellent alternative in preventing restenosis of EAC in centers with limited resources. This method is easily applicable in outpatient settings and has no documented complications.

Ethics Committee Approval: N/A.

Informed Consent: Written informed consent was obtained from all participants who participated in this study.

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