

## Original Article

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

Chong Sian Ng<sup>1</sup>, Seong Kin Foong<sup>1</sup>, Siow Ping Loong<sup>2</sup>, Cheng Ai Ong<sup>2</sup>,  
Noor Dina Hashim<sup>1</sup>

<sup>1</sup>Department of Otorhinolaryngology, National University of Malaysia, Jalan Yaacob Latif, Bandar Tun Razak, Kuala Lumpur, Malaysia

<sup>2</sup>Department of Otorhinolaryngology, Queen Elizabeth Hospital, Kota Kinabalu, Sabah, Malaysia

ORCID IDs of the authors: C.S.N. 0000-0003-2002-1303; S.K.F. 0000-0002-1846-5151; S.P.L. 0000-0001-5142-9737; C.A.O. 0000-0002-1277-0905; N.D.H. 0000-0002-1366-6202.

Cite this article as: Ng CS, Foong SK, Loong SP, Ong CA, Hashim ND. A novel use of modified tracheostomy tubes in preventing external auditory canal stenosis. *J Int Adv Otol.* 2021; 17(4): 301-305.

**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.<sup>1</sup> 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.<sup>2,3,4</sup> There are also reports where cost-effective dental impression materials (Aquasil Soft Putty) with a soft ventilation tube,<sup>5</sup> rubber tube,<sup>6</sup> composite Foley catheter,<sup>7</sup> and nasopharyngeal tube<sup>8</sup> 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.

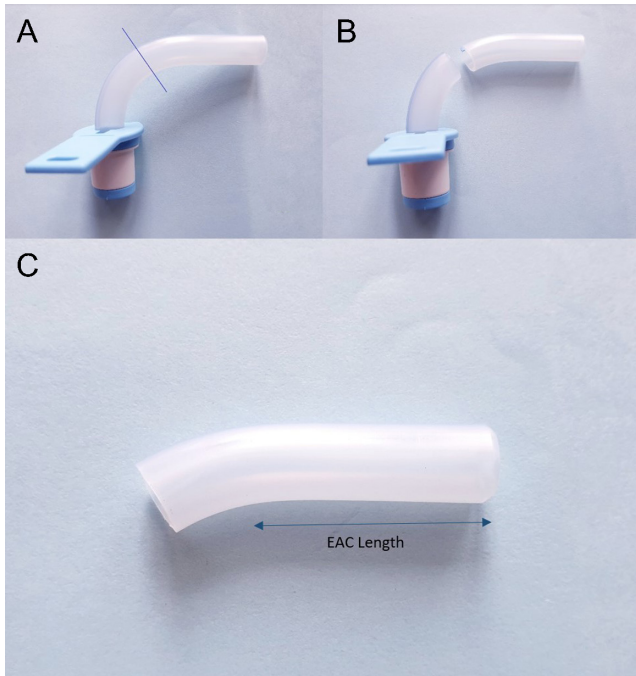
**Corresponding author:** Noor Dina Hashim, e-mail: dinahashim81@yahoo.com

**Received:** November 30, 2020 • **Accepted:** January 6, 2021

Available online at [www.advancedotology.org](http://www.advancedotology.org)

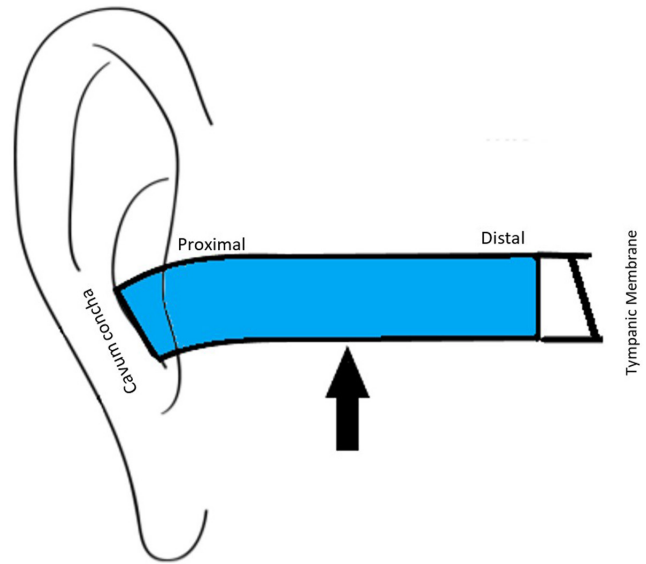


Content of this journal is licensed under a  
Creative Commons Attribution-NonCommercial  
4.0 International License.



**Figure 1.** (A) Tracheostomy tubes were modified by making a linear cut (blue line in the figure) at the distal part of the tube to exclude the tracheostomy flange as shown in (B). (C) The distal part of the tube is then modified by shortening the length of the tube to fit the measured length of the patient's auditory canal.

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 smoothed 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



**Figure 2.** Position of the stent in the external auditory canal with its distal end away from the tympanic ring and the proximal end (cut end) resting on the cavum concha.

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.

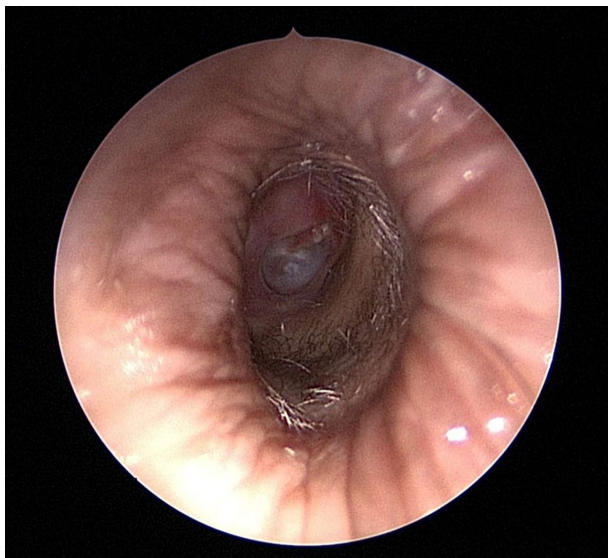
## RESULTS

### Case 1

A 53-year-old male presented with right EAC stenosis secondary to trauma sustained during a motor vehicle accident. An examination

## MAIN POINTS

- In our center, where stenting options are limited and cost is a debatable concern, we explored a novel method of using modified non-fenestrated uncuffed TT as postoperative stents after ear canal surgery.
- There were no significant major side effects and disadvantages noted throughout the treatment interval. All our patients were satisfied with the treatment and outcome.
- 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.
- The postoperative recovery times for both acquired and congenital EAC stenosis are similar.
- Insertion of a modified TT stent is easily applicable to all age groups, and can be performed in the outpatient setting.



**Figure 3.** Endoscopic image of the EAC post-stenting with a modified tracheostomy tube for a period of 12 months.

revealed a stenosis involving the meatus and a short segment of the cartilaginous canal, measuring 18 mm (as measured from the preoperative computed tomography (CT) images). He underwent canalplasty under general anesthesia and had a BIPP packing. Two weeks postoperatively, the canal was stented with a modified Portex TT size 6.0 with an outer diameter (OD) of 8.3 mm. The TT was kept for a month and subsequently, upsized to a TT size 6.5 (OD 8.7 mm) and 7.5 (OD 10.4 mm) during his subsequent reviews in the first and eighth months respectively. The TT was then kept for another 10 months. The frequency was reduced to every other day for the following 3 months, becoming less and less frequent months after. At 2 years after the surgery, the canal remains patent (Figure 3).

#### Case 2

A 20-year-old male presented with right congenital canal atresia following multiple presentations of recurrent mastoid abscess. The high-resolution CT-temporal was consistent with canal cholesteatoma. A modified radical mastoidectomy with meatoplasty was performed. A 10 mm length of complete stenosis of the cartilaginous EAC with canal cholesteatoma extending into antrum and mastoid air cells was found intraoperatively. The stenotic segment was excised after removal of the cholesteatoma, and followed by meatoplasty. BIPP ear packing was inserted followed by a modified TT size 5.0 (OD 7.0 mm) after removal of BIPP. Two weeks later, a larger TT size 6.5 (OD 8.7 mm) was used and kept for the next 6 months. The patient was instructed to wear the stent for 24 hours a day for the first month, and only at night for the subsequent 4 months. The tube was finally removed after 5 months of regular stenting. However, during his follow-up 1 month after removal of the stent, we noticed a mild constriction of the EAC. He was then advised to wear the stent (TT size 6.5) at night for an additional 5 months. After 2 years, the EAC was well epithelized and patent.

#### Case 3

A 13-year-old male with bilateral acquired meatal stenosis presented to us with canal cholesteatoma. On examination, his left ear meatus was found to have a pinhole stenosis measuring 2 mm from the cartilaginous part of the EAC. Meatoplasty was performed, and the

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.<sup>9</sup> 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%.<sup>10</sup>

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
3	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<sup>2</sup> and Moon et al,<sup>3</sup> offer good compliance of the stent size to the width of the EAC as impressions are done immediately in the operating theatre intra-operatively. 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<sup>4</sup>; 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.<sup>7</sup> 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.<sup>7</sup>

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.

**Peer Review:** Externally peer-reviewed.

**Author Contributions:** Concept – C.A.O.; Design - C.S.N.; C.A.O.; Supervision - N.D.H.; S.P.L.; Resource - C.A.O.; S.K.F.; Materials - C.A.O.; Data Collection and/or Processing - C.A.O.; S.K.F.; Analysis and/or Interpretation - C.S.N.; C.A.O.; N.D.H.; Literature Search - C.S.N.; S.K.F.; Writing - C.S.N.; C.A.O.; N.D.H.; Critical Reviews - N.D.H.; C.A.O.; S.P.L.

**Acknowledgments:** The authors have no conflict of interest to declare.

**Conflict of Interest:** The authors declared that this study has received no financial support.

**Financial Disclosure:** The authors declared that this study has received no financial support.

## REFERENCES

- McCary WS, Kryzer TC, Lambert PR. Application of split-thickness skin grafts for acquired diseases of the external auditory canal. *Am J Otol.* 1995;16(6):801-805.
- Savion I, Good J, Sharon-Buller A. An acrylic resin conformer for the prevention of external auditory meatus stenosis. *Laryngoscope.* 2005;115(11):2006-2009. [\[CrossRef\]](#)
- Moon IJ, Cho YS, Park J et al. Long-term stent use can prevent postoperative canal stenosis in patients with congenital aural atresia. *Otolaryngol Head Neck Surg.* 2012;146(4):614-620. [\[CrossRef\]](#)
- Sela M., Feinmesser R, Gapany B, Taicher S. Prosthetic repair of meatal stenosis. *J Prosthet Dent.* 1986;56(2):214-216. [\[CrossRef\]](#)
- Bast F, Chadha P, Shelly J, Collier JM. Prevention of postoperative ear canal stenosis using stents made of dental impression material: a rapid, cost-effective solution. *Clin Otolaryngol.* 2017;42(4):954-956. [\[CrossRef\]](#)
- Soliman T, Fatt-Hi A, Abdel Kadir MA. A simplified technique for the management of acquired stenosis of the external auditory canal. *J Laryngol Otol.* 1980;94(5):549-552. [\[CrossRef\]](#)



7. Kuo CY, Chen HC, Shih CP, Wang CH. A composite Foley catheter stent used to successfully manage recurrent canal stenosis caused by fibrous dysplasia of the temporal bone. *Int Adv Otol.* 2014;10(2):194-196. [\[CrossRef\]](#)
8. Tsou YA, Than KY, Li TS. Using nasopharyngeal tube to stent external auditory canal in atresia repair. *J Plast Reconstr Aesthet Surg.* 2014;67(5):e144-e145. [\[CrossRef\]](#)
9. Luong A, Roland PS. Acquired external auditory canal stenosis: assessment and management. *Curr Opin Otolaryngol Head Neck Surg.* 2005;13(5):273-276. [\[CrossRef\]](#)
10. Yellon RF. Combined atresioplasty and tragal reconstruction for microtia and congenital aural atresia: thesis for the American Laryngological, Rhinological, and Otological Society. *Laryngoscope.* 2009;119(2):245-254. [\[CrossRef\]](#)