Endoscopic transnasal eustachian tube reconstruction *via* light cable technique: A technical report

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Patulous eustachian tube (pET) is a rare but disabling condition in which the cartilaginous portion of the ET is open at rest. Normally, the tube valve remains closed, opening transiently during swallow and yawn. Patients with pET describe autophony, aural fullness, and hearing one's own physiological sounds such as swallowing and respiration. Imbalance can also occur along with these other symptoms.[1] The condition has been described as disabling to many patients.[2] pET has been treated surgically with varying degrees of success using autologous cartilage grafting,[2] silicone plugging,[3] autologous fat grafting,[4] suture ligation,[5] transtubal cautery,[1,5] and luminal reconstruction.[6] Recently, the senior author published a longitudinal case series showing that a multilayer approach using cautery, fat plugging, and suture ligation of the ET to be effective in decreasing the autophony of pET.[7]

One patient in our series unexpectedly developed complete obliteration of her ET several months postendoscopic ligation. Although her autophony had resolved, she was now faced with constant middle ear effusion, myringotomy tube clogging, and ear pain and pressure, all of which severely limited her function. Her symptoms became even more debilitating than those caused by the original pET condition. After several attempts to suction the ear and replace the myringotomy tubes, it became evident that reopening the obliterated ET was the only option. Because her anatomy was drastically altered by scar tissue, there was no lumen visible and hence a conventional endoscopic dissection was not viable. In this technical report, a novel tuboplasty method using a fiberoptic light cable is described.

METHODS

A 27-year-old woman presented with longstanding symptoms of pET. The autophony interfered with both speech and hearing, and she was bothered by auditory respirations and swallowing sounds. She had normal hearing bilaterally, with intermittent bilateral tinnitus. She was diagnosed with left-sided pET after tympanic membrane excursions were seen during nasal respiration. Nasopharyngoscopy showed an abnormally wide ET orifice with a scaphoid defect. Surgical correction of the pET proceeded uneventfully *via* periumbilical fat grafting with endonasal placement, cauterization, and purse-string closure of ET orifice as per our previously published technique.[7] There were no immediate perioperative complications.

At 1 month after surgery the patient's autophony had improved considerably and she was very satisfied. At 4 months postoperatively, however, the patient began noticing fluctuating left-sided ear fullness and crackling sounds. The fullness would be spontaneously relieved every 4–5 days, accompanied by a "popping sound." The fullness would then gradually build up again. Hearing was still subjectively normal and the patient's autophony had completely resolved. The patient denied any pain or otorrhea. Nasopharyngeal examination at this point revealed that the patient's ET had closed down to a tiny pinhole. She underwent several myringotomies with tubes after which she would be symptom free for a few days. However, her ear continued to produce thick ear glue, which occluded the myringotomy tubes. The patient began to have debilitating ear pain and pressure in her left ear, to the extent that she was unable to work and considered going on disability. Undergoing regular ear suctioning and myringotomy tube replacement indefinitely was unacceptable to the patient. Revision tuboplasty was then proposed and undertaken.

Scarring from previous pET repair had altered the patient's nasopharyngeal anatomy and there was no surface landmark visible to indicate where the torus tubarius should be. The lumen was completely obliterated by thick scar tissue and not visible endoscopically. We attempted using image guidance to find the ET orifice but this was not successful. Hence, we initiated a combined transtympanic transnasal correction. Under microscopic binocular guidance, a very thin fiberoptic light cable (Relieva Luma Sentry Sinus Cable; Acclarent, Menlo Park, CA) was passed transtympanically *via* a small myringotomy made in the anterior inferior quadrant, through the bony isthmus and into the cartilaginous portion of the medial ET. A little bit of pressure was needed to pass the tip of the light cable through the bony isthmus. The tip of the light cable

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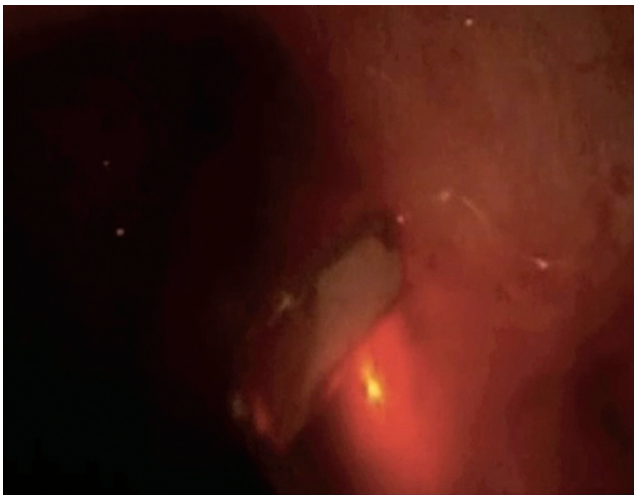

Figure 1. *This figure shows the tip of light cable visible deep to scar tissue.*

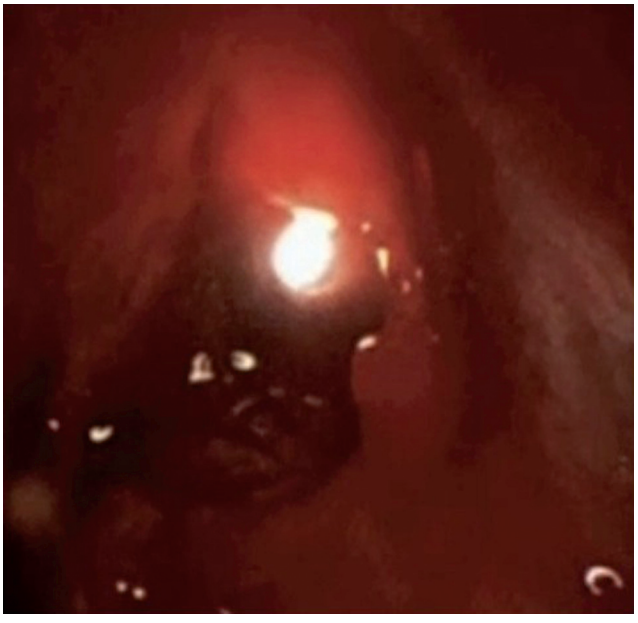

Figure 2. *The light cable dissected clear of scar tissue is shown in this figure.*

was visualized endoscopically through the nasopharyngeal scar tissue as a dull red light (Fig. 1). A series of dissecting instruments such as angled probes and blades were used to cut through the scar tissue toward the light (Fig. 2). A right-cup forceps was used to identify the tip of the light probe and pull it through the remainder of the cartilaginous ET and out into the nasal cavity (Fig. 3). This established a neolumen of the previously scarred-shut ET.

With patency of the patient's ET established, the next step was revision endonasal augmentation. A 10 French catheter was threaded over the light cable and, using the Seldinger technique, the catheter was passed back through the cartilaginous isthmus until it wedged

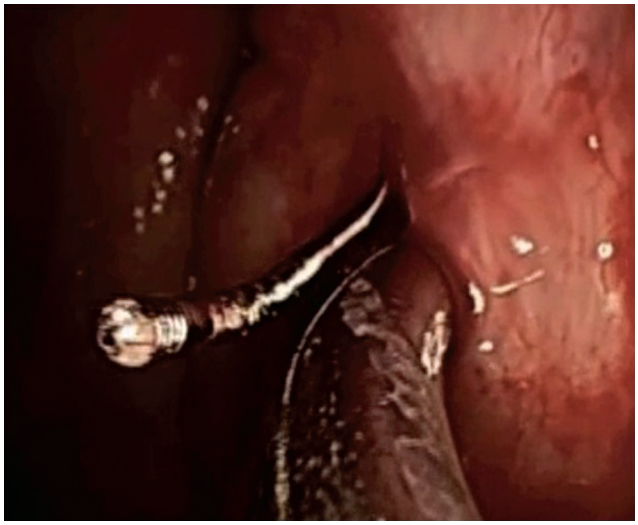

Figure 3. *This figure shows the light cable pulled into nasopharynx thus creating neolumen of the eustachian tube (ET).*

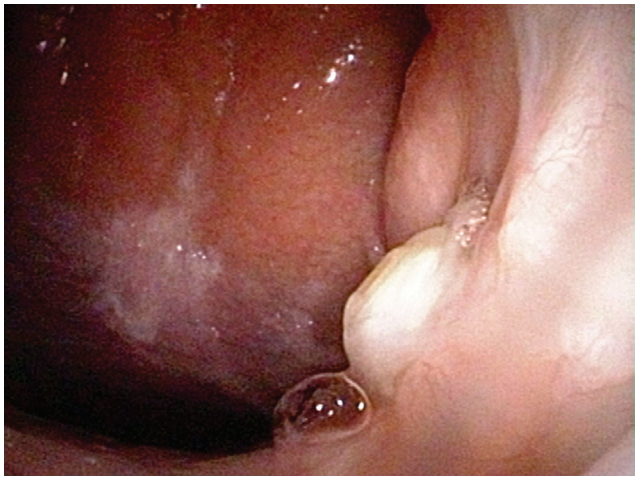

Figure 4. *Shown is this figure is the stent threaded up light cable and wedged into bony isthmus.*

into the bony isthmus and could be advanced no further (Fig. 4). The light cable was pulled back out through the ear, and a Baxter T-tube was placed. Ciprodex drops were administered. We then visually confirmed the catheter was firmly wedged in the bone. The nasal cavity was flushed clean. Intranasal hemostasis was obtained. The patient was reversed from anesthesia. The patient remained in stable condition and there were no operative complications.

One year after surgery she continued to have a patent ET lumen, with normal hearing, normal middle ear ventilation, and no further symptoms of pET.

DISCUSSION

To our knowledge, this technical report is the first of a successful endoscopic-assisted recanalization of an ET using a fiberoptic light cable.

Stenting the ET is not a new idea: Zollner used silk threads in the late 1950s.[8] In 1963 he began using polyethylene tubes to stent the lumen.[9] The stents were a problem because of extrusion and obstruction, as well as the risk of carotid artery injury during insertion.[10] Furthermore, he was never able to probe or reopen the completely obliterated tube, especially when the osseous tube was severely blocked by bone or connective tissue.[10] Drilling the bony isthmus to widen the tube has been attempted in various incarnations with limited success.[11] In 2008, a nickle–titanium stent was used with good outcomes in one case report of ET atresia.[12] A recent study by Ho and others used 16G angiocatheters to stent ETs in 28 patients postnasopharyngectomy. They found that stenting the ET was a low-risk procedure that significantly decreased the rates of otitis media with effusion and other complications, compared with not stenting.[13]

Balloon dilation of cartilaginous ET was studied in 20 ears of people suffering from chronic obstructive ET dysfunction. At 1-year follow-up, these people had significantly improved tube scores, without adverse effects.[14] However, this method has only been studied in patients with a still-patent ET. Perhaps this method could have been used in our patient when the narrowing was first noticed, but it would have been impossible once the lumen was completely obliterated by scar tissue.

Fiber-guided laser ablation of the posterior half of the tubal ostium was performed in a prospective study of 38 patients.[15] Just over 70% of the patients showed improvements and none showed any complications after 1 year. Similar results were achieved in a study of 31 patients by Caffier *et al.* in 2011.[16] This procedure is minimally invasive and performed under local anesthetic.[16] However, this method uses only a transnasal approach and was not tested in any patients with completely obliterated ETs. Our patient had no anatomic features to guide in a transnasal approach, hence the use of the transtympanic light cable. A prospective surgical trial by Kujawski and Poe studied 108 ETs with intractable middle ear atelectasis or effusion during which laser vaporization of the mucosa and cartilage from luminal posterior wall was used to dilate the tube as needed. Over two-thirds of patients achieved normal middle ear aeration, and this was sustained over 3 years. One of the complications of this procedure was peritubal synechia in 8.3% of patients.[17]

Microdebrider tuboplasty appears to be equally effective as laser in preliminary studies.[17] Twenty patients with ET dysfunction had hypertrophied mucosa from the posterior ET cushion removed with a microdebrider.[17] Like the patient in our case report, all patients in this study had concurrent sinonasal disease and underwent endoscopic sinus surgery concurrently with microdebridement. Seventy percent of patients had subjective improvement in symptoms, and 65% of patients had measurable improvements in hearing. There were no complications after a mean follow-up of 13 months.[17] The microdebrider technique may have been appropriate for our patient.

CONCLUSION

Our technique is a novel method for relumenizing an ET obstructed by scar tissue. Such a situation can occur after nasopharyngeal surgery for a variety of reasons (*e.g.*, extensive adenoidectomy, removal of tumors, and postradiation) and may also be appropriate for those who have not responded to balloon dilation. Although technically challenging initially, the concept is straightforward and could well be adapted for multiple applications in experienced hands.

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