ORIGINAL ARTICLE

Can use of a cold light source in endoscopic middle ear surgery cause sensorineural hearing loss?

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Abstract

Objectives: To investigate possible sensorineural hearing loss created by the use of a cold light source in patients undergoing endoscopic tympanoplasty surgery. **Materials and Methods:** The medical records of 203 patients, who underwent endoscopic Type 1 tympanoplasty surgery in our ear, nose, and throat clinic between 2012 and 2015, were checked retrospectively. Ninety-one patients were male and 112 were female, and their mean age was 34.4 ± 11.2 years. Results of audiometric measurements performed during the preoperative period and repeated 1 and 3 months postsurgery were compared to each other. **Results:** The mean duration of the operations was determined to be 52.4 ± 9.1 min. In addition, average preoperative bone-conduction was 11.4 ± 7.4 dB nHL. However, it was 9.57 ± 7.1 dB nHL and 9.51 ± 7.4 dB nHL, respectively, in the 1st and 3rd postoperative months. Levels of postoperative average bone-conduction at the 1st and 3rd month, as well as the thresholds of bone-conduction at 500, 1000, and 2000 Hz, were significantly lower than the preoperative results ($P < 0.05$). However, there was not a remarkable difference at 4000 Hz ($P > 0.05$). **Conclusion:** Based on our findings, the increased heat generated by the use of a cold light source during an endoscopic tympanoplasty surgery is unlikely to cause the development of sensorineural hearing loss.

Keywords: Audiological surgical procedures, Cold light sources, Tympanoplasty

Introduction

Traditionally, middle ear microsurgery is performed using a microscope. However, the linear view field of a microscope prevents visualization of features such as facial recesses and sinus tympani. This limitation requires the use of an endoscope for some kinds of middle ear surgery. Because endoscopes provide highly detailed visual views of different aspects of the ear, their use has become more popular in audiological surgery.[1] Previously, endoscopes were applied only for diagnosis or were accompanied by a microscope in middle ear surgery. However, it was recently reported that endoscopes may facilitate various audiological surgeries including tympanoplasties, stapedectomies, mastoid surgeries, and cochlear implants.[2-7] Similarly, to endoscopic sinus surgery, rigid endoscopes of different diameters (2.7, 3, or 4 mm), angled at 0° and 30°, and utilizing a number of different light sources such as halogen, xenon, and light-emitting diodes (LEDs), are used in endoscopic ear surgery. These endoscopic systems have certain technical disadvantages, the most serious of which is an increase in heat created by the light source. Neurosensorial cells in the cochlea are excessively sensitive and may be affected by a

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number of factors including trauma, noise, and alterations in heat.[8] Therefore, the potential for thermal injuries is a major concern in endoscopic ear surgery. Although previous experiments have confirmed that cold light sources cause an excess of heat during endoscopic middle ear surgeries,[9-13] there has not been any reported damage in the inner ear as a complication of endoscopic ear surgery. Moreover, no large-scale clinical analysis has been performed. To clarify this issue, the development of sensorineural hearing damage resulting from a thermal injury was retrospectively assessed in a group of 203 patients, who had undergone endoscopic tympanoplasty surgery.

Materials and Methods

Data were collected from the medical records of patients who were diagnosed with tubotympanic chronic otitis media and underwent transcanal endoscopic Type 1 tympanoplasties between May 2012 and October 2015. Patients' demographic data, audiometric examination results, surgical methods, and operation duration were retrospectively reviewed. Cases that intervened in the ossicular system and required a touring process during surgery were excluded from the study. This study was approved by the Local Ethics Committee and informed consent from all patients was obtained preoperatively, with the understanding that their surgical information might be used in medical literature without including any personal information.

All surgical procedures were performed under general anesthesia with orotracheal intubation. Endoscopes with an 18 cm, 4-mm diameter, 0° angle (Karl Storz, Tuttlingen, Germany) and power LED 175 type of light source (Karl Storz, Tuttlingen, Germany) were used in the all surgery. Audiogram results obtained at the preoperative stage and 1 and 3 months postsurgery were evaluated. Thresholds of bone-conduction at 500, 1000, 2000, and 4000 Hz were calculated, along with levels of average bone-conduction, considering the outputs of audiogram analysis. Pre- and post-operative test results were compared using a paired sample *t*-test.

Results

About 203 patients were included in this study: 91 males (44%) and 112 females (55%). Their mean age was 34.4 ± 11.2 years (range: 10–62 years). The surgery was performed on the right ear of 88 patients (43.3%) and the left ear of 115 patients (56.6%). The mean operation duration was 52.4 ± 9.1 min (range: 35–90 min). Among these patients, the mean preoperative average bone-conduction was 11.4 ± 7.4 dB nHL. In addition, the postoperative average bone-conduction was determined at the 1st and 3rd month as 9.57 ± 7.1 dB nHL and 9.51 ± 7.4 dB nHL, respectively. Table 1 lists the bone-conduction data. During the postoperative period, a significant decrease was detected in the thresholds of bone-conduction at the 500, 1000, and 2000 Hz levels, compared to the preoperative results ($P < 0.05$). However, no remarkable difference was determined at 4000 Hz ($P > 0.05$).

Table 1: Pre- and post-operative (1 and 3 months) thresholds of bone-conduction

	Preoperative (*n*=203)±SD	Postoperative 1st month (*n*=203)±SD	Postoperative 3rd months (*n*=203)±SD	*P*
500 Hz	11.6±8.4	9±7.9	9.1±7.4	<0.005
1000 Hz	10±7.1	7.2±7	7.5±6.5	<0.005
2000 Hz	9.9±7.7	8.4±7.1	8.5±7.4	<0.005
4000 Hz	14±12.1	13.5±11.7	13.1±11	>0.005
Average bone-conduction	11.4±7.7	9.57±7.1	9.51±7.4	<0.005

SD: Standard deviation

Discussion

Using an endoscope in middle ear surgery provides important benefits including a wider visual field and better visualization of certain hidden areas. Previously, endoscopes were applied as helpful supplements to the microscope to assess the middle ear recesses that were difficult to see and intervene in. In recent years, endoscopes have been used exclusively in a wide range of middle ear surgeries.[2,14] However, there is still a possibility of the development of traumatic damage caused by increased heat due to the use of cold light sources.[5,9,11] Over the past 20 years, a number of studies were conducted to evaluate the possibility of thermal damage created by the use of endoscopes in sinus and skull base surgeries. Recently, temperatures were suggested to be below body temperature for halogen, xenon, and LED light sources (<36°C) when they were applied at a 5-mm distance from the tip. In addition, although the light sources seem to be harmless, direct contact with tissues or vital structures should be avoided.[15]

While these results are helpful, the middle ear cavity is smaller than the nasal cavity and has more vascular structure. Moreover, the cochlea and vestibular canals are close to neurosensory cells which are extremely sensitive to environmental changes.[8] Therefore, thermal injury due to excess heat generated by the light source is a concern in endoscopic ear surgery though no case reports have been published of sensorineural deafness due to thermal injury. Currently, halogen, xenon, and LED are the most common light sources used for endoscopic surgery. Although all of them are called cold light sources, the development of heat is observed at the end of an endoscopic strip.[16]

There have been a few experimental studies conducted to evaluate thermal damage caused by the use of endoscopes in middle ear surgery. Nevertheless, a large-scale clinical assessment has not been previously conducted. In this study, the level of sensorineural hearing was assessed at an early and late period of time among patients operated on endoscopically. Sensorineural hearing levels were determined to be significantly improved in both the early and late postoperative periods, in comparison to preoperative levels. Moreover, no increase of more than 5 dB in postoperative average bone-conduction was determined in any patients. Recent findings suggested that chronic otitis media in an active period cause a decrease in the threshold of bone-conduction by affecting the inner ear. Likewise, it has been shown that treatment of chronic otitis media may lead to improvement in the bone-conduction threshold.[17,18] In concordance with these findings, results obtained from the current study showed that threshold of bone-conduction is better in the postoperative period compared to the preoperative period.

Kozin *et al*. conducted a study to evaluate the thermal effects of cold light sources in freshly frozen temporal bones of the human cadaver. A rapid heat increase of up to 46°C was observed 0.5–1mm from the tip of the endoscope within 30–124 s after the use of xenon or an LED. In addition, it has been demonstrated that the use of an endoscope in the middle ear results in significant heat elevations at the round window. To counteract this heat increase, Kozin *et al*. suggested using suction, in combination with submaximal light intensity and frequent repositioning of the endoscope.[9] Along similar lines, results of an experimental animal study performed by Dundar *et al*. revealed that the use of a rigid endoscope and light source in endoscopic ear surgery may cause significant increases in heat in the middle ear and round window. However, tissue damage due to this thermal excess was not evaluated. When the effects of three light sources (xenon, halogen, and LED) were compared to each other, the lowest heat increase was observed with LED sources, and the tissue rapidly cooled when the endoscope was withdrawn.[10]

In another study, the potential thermal effects of xenon and halogen light sources used in audiological surgery was assessed audiologically by Aksoy *et al*. Findings obtained in this study suggested that an increased thermal effect is generated by an endoscope with a xenon cold light source, when applied to the middle ear for 5 min periods with 15 s intervals, up to a total of 45 min. It has also been proposed that the use of xenon cold light in this fashion may ultimately lead to a decrease in distortion-product otoacoustic emission values and an increase in the auditory brainstem response threshold.[11] In the present study, the absence of sensorineural hearing loss among the participants may have been caused by the surgeons' preference for using an LED light source in endoscopic systems, and by repeated cleaning of the end edge of the endoscopic strip by anti-fog treatments during the surgery.

Conclusion

The findings collected in the current study suggest that excess heat caused by an application of endoscopic systems featuring an LED cold light source in middle ear surgery, especially in tympanoplasties, may not lead to the development of sensorineural hearing loss. However, this study possesses some limitations that could impair its efficiency including the absence of an audiometric high-frequency assessment. Future studies should evaluate a larger sample, ideally one that includes multiple types of cold light sources, to solidify and extend this study's conclusions.

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Conflicts of interest

There are no conflicts of interest.

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