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OTOLOGY

A modified method of local infiltration for endoscopic stapes surgery: how I do it

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Abstract

Purpose To present a modified method of local infiltration (MMLI) for endoscopic stapes surgery to reduce surgical time, bleeding and complications.

Materials and methods This study involved 70 patients who underwent stapes surgery for otosclerosis by endoscopic and microscopic approaches. The MMLI was applied as follows: local infiltration was performed with one hand while the other hand inserted the endoscope into the ear canal to observe vasoconstriction signs on the monitor; the single site of infiltration was located at the center of the anterior conchal cartilage. Operative time, intraoperative blood loss, preservation of anatomical structures, postoperative hearing and complications were evaluated.

Results The MMLI allowed for quick bleeding control and a clear and dry operative field. Operative time, intraoperative blood loss and preservation of anatomical structures were significantly reduced in the endoscopic group ($P < 0.00$) versus the microscopic group. The scutum was removed less frequent in the endoscopic group 7.1% versus 53.6% of the microscopic group ($P < 0.00$). The chorda tympani was preserved in all cases but it was more manipulated in the microscopic group 39.3% versus 9.5% of the endoscopic group ($P < 0.00$). No complications were observed and the hearing outcomes were significantly better than the preoperative thresholds.

Conclusions This is the first report on the use of a MMLI for endoscopic stapes surgery. Using this method, the surgeon performs the infiltration at one site and concurrently observes the vasoconstriction signs without the use of a microscope, frontal lamp or speculum. This method provides benefits in terms of operative time and complications.

Keywords Endoscopic stapedectomy · Endoscopic ear surgery · Technique of local infiltration · Endoscope · Operative time

Abbreviation

MMLI Modified method of local infiltration

Introduction

During the past few decades, the use of an endoscope in middle ear surgery has had many advantages for all types of ear pathologies. The feasibility of the technique, excellent visibility and less trauma to the anatomical structures have increased the margin of safety for endoscopic ear surgery; therefore, many ear surgeons no longer use the conventional operating microscope. Today, modern endoscopic ear surgeons who have learned to work with one hand while holding the endoscope with the other hand need to learn the modified method of local infiltration (MMLI) for endoscopic surgery. Currently, they still prefer to use the traditional local infiltration technique under the operating microscope, which involves employing a speculum to open the external meatus and commonly involves penetration of four sites through the ear canal subperiosteum at the 12, 3, 6 and 9 o'clock positions [1, 2]. However, if local or general anesthesia is administered during surgery, the MMLI for otoendoscopy surgery offers many advantages. The endoscopic ear surgeon may appropriately perform the infiltration at one site and concurrently observe signs of vasoconstriction in the area without using the operative microscope, frontal lamp, speculum and otoscope. Furthermore, if the surgical field is kept clean, it

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is not necessary to aspirate continuously and endoscopic ear surgeon can work with comfort and ease because only one hand is used to performs the surgical procedure [3–7].

The techniques used to inject the anesthetic solution vary according to the type of ear surgery, modalities of anesthesia (local or general anesthesia) and the experience and preference of the surgeon. Several techniques have been advocated as follows: the Plester technique that includes eight injection points through the retroauricular ear canal skin and the ear canal subperiosteal folds; the Wullstein technique for mastoidectomy that involves one injection behind the postauricular fold, after which the needle is introduced toward the superior and inferior attachment of the auricle; the Yongkees technique for an endaural approach that employs five injection points; and other techniques have used up to 12 anesthetizing points [8, 9]. However, in cases in which general anesthesia is chosen, it is not necessary to use several injection sites for local infiltration because the objective is to provide a bloodless surgical field. In 1996, Morizono [10] described a technique of local infiltration in an endaural approach. He uses one site of infiltration at the posterior wall of the ear canal employing the operating microscope and a curved nasal speculum to observe the tympanic membrane for ischemia, which would indicate vasoconstriction in the area. In Mexico, Morizono's technique was modified for endoscopic ear surgery. It consists of three relevant points: first, the local infiltration is performed with one hand while the other hand inserts the endoscope into the ear canal to observe vasoconstriction signs on the monitor; second, the unique site of infiltration is at the center of the anterior conchal cartilage; and third, the technique to hold the insulin syringe with the hand (Fig. 1).

Regarding the prospective beneficial effects observed in our department using endoscopes in otologic procedures, the purpose of the present article was to present a method of local infiltration for endoscopic stapes surgery as well as analyze the outcomes and highlight the advantages of this technique.

Materials and methods

A pilot, single-blind, open label study was performed to evaluate the modified method of local infiltration (MMLI) for endoscopic stapes surgery compared with traditional local infiltration technique under the operating microscope. The protocol and the consent form were approved by the "UMAE, IMSS" (R-2011-1301-87), and patients provided written consent before the surgical procedure.

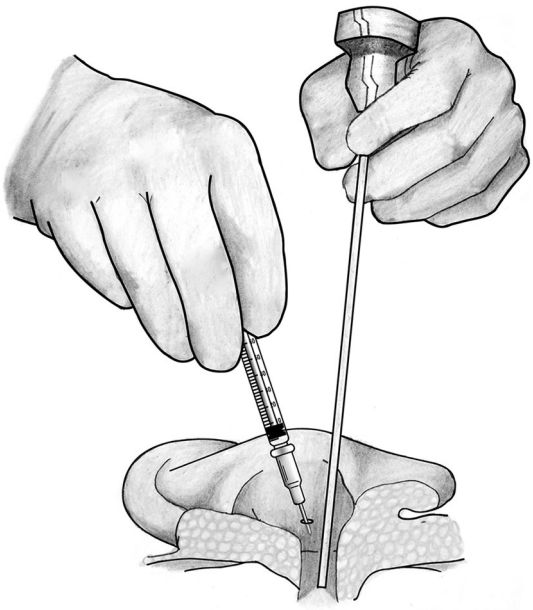

Fig. 1 The otoendoscopy surgeon performs the local infiltration with one hand while holding the endoscope in the other hand. The endoscope is inserted into the ear canal to observe the vasoconstriction signs on the monitor. The technique used to handle the insulin syringe when performing the infiltration is very important

Patients and procedure

From June 2011 through February 2017, 70 patients aged 18–46 years were selected who met the criteria of otosclerosis described by Nogueira et al. [11]. The patients were divided into two groups: endoscopic (study group) and microscopic (control group). In both groups all patients underwent stapes surgery under general anesthesia. All procedures were performed by the same surgeon. For endoscopic surgery, the position of the patient was similar to that in routine otomicroscopy ear surgeries. Conventional ear surgery instruments were used with some modifications, such as slightly curved suction tubes, picks, scissors and forceps. The curved modification of the instruments allows the surgeon to observe the tip of the instrument at each moment and improves the visibility of the anatomical structures. A high-definition monitor was positioned in front of the surgeon, and a camera system (Stryker Endoscopy, HD 3 chip, USA) was used together with an 18-cm, 2.7-mm, or 4-mm rigid endoscope with a 0° or 30° angle of view. Furthermore, in both groups a micro-curette was employed if the scutum was removed. Prior to infiltration, the vibrissae were trimmed to prevent the endoscope lens from fogging and distorting the image via the continuous entrance and exit of the endoscope from the external ear canal. Then, in both groups the surgical field was prepared in the standard manner, i.e., the auricule

and external auditory canal were sterilized with aqueous povidone-iodine and draped. Immediately following this preparation, the endoscope or microscope was used to inspect the tympanic membrane and external ear canal.

In both groups, the solution used was 2% lidocaine hydrochloride with 1:50,000 epinephrine [12]. The solution was prepared by adding 1 mg/mL of epinephrine to 50 mL of 2% lidocaine hydrochloride. The total amount injected was not more than 2 mL [10]. The preparation and administration of the infiltration solution were performed only by the surgeon. An insulin syringe with a 27-gauge needle was used to perform the extravascular infiltration. The local infiltration procedures for endoscopic stapes surgery were performed under the MMLI. For microscopic surgery, the external meatus was open using a curved nasal speculum and 0.5 mL was injected superiorly in the bone meatus at the 12 o'clock position and another 0.5 mL was injected posteriorly; then, the same amount of solution (0.5 mL) was injected inferiorly at the 6 o'clock position and anteriorly.

Modified method of local infiltration (MMLI)

The steps of this modified method are described as follows: (1) The local infiltration is performed with one hand while the other hand inserts the endoscope into the ear canal (Fig. 1). (2) The method used to hold the insulin syringe in the hand (right or left) is very important. Initially, the syringe is charged with 1 mL of local infiltration solution. With the palm of the hand down, the barrel of the insulin syringe is held by the index and middle fingers. During infiltration, the plunger is pushed by the palm of the hand, specifically by the thenar eminence and never with the thumb (Fig. 2a, b). (3) There is one site for infiltration. The bevel of the needle is introduced into the center of the anterior conchal cartilage in the direction perpendicular to the bone, and approximately 0.5 mL of 2% lidocaine with epinephrine 1:50,000 is injected subperiosteally (Fig. 2c). Using the same injection point, the needle is gently removed from the bone. Then, without removing the needle from the site of infiltration, the bevel of the needle is directed toward

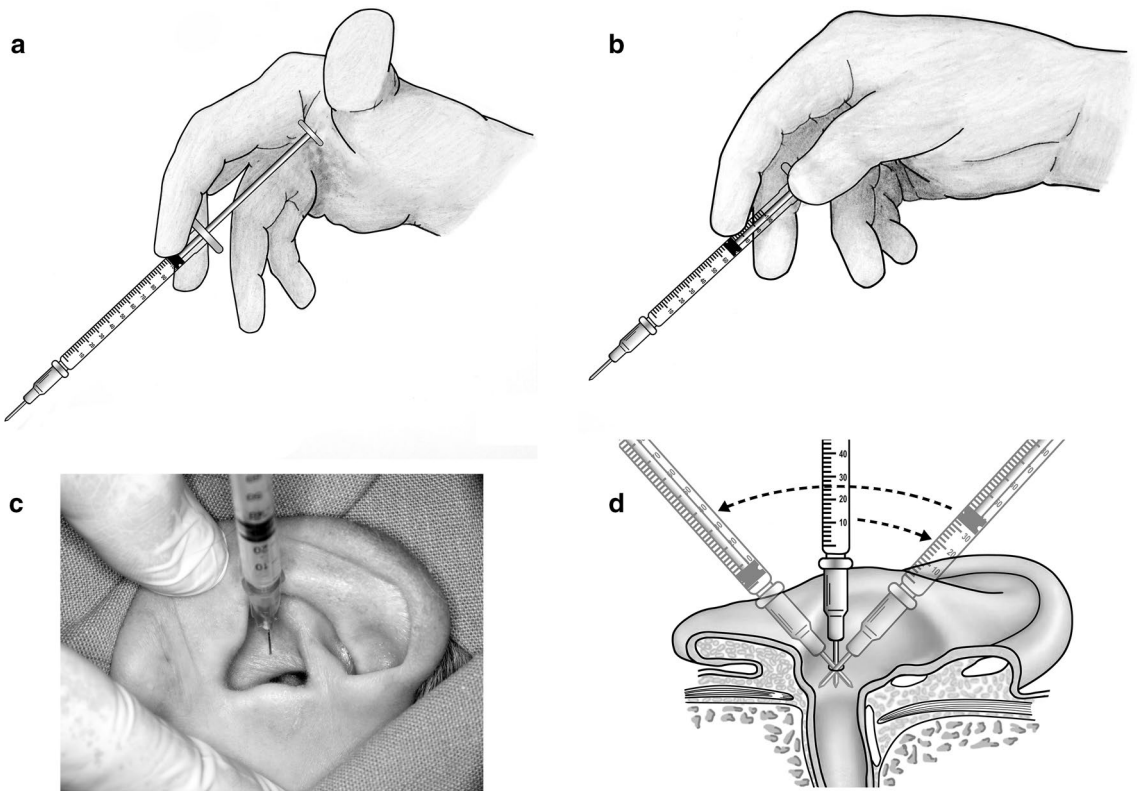

Fig. 2 Steps of the modified method of local infiltration for endoscopic ear surgery. **a, b** The technique used to hold and manipulate the syringe with the hand is as follows: With the palm of the hand in a downward position, the barrel of the insulin syringe is held by the index and middle fingers. During infiltration, the plunger is pushed by the thenar eminence and never with the thumb. **c, d** The bevel of the needle is introduced into the center of the anterior conchal cartilage in the direction perpendicular to the bone, and approximately 0.5 mL of 2% lidocaine with epinephrine 1:50,000 is injected subperiosteally. Using the same injection point, the needle is gently removed from the subperiosteum, and without removing the needle from the site of infiltration, the bevel of the needle is directed toward the subperiosteum of the superior meatal wall and subsequently toward the inferior meatal wall (dotted lines). The same amount of solution (0.5 mL) is infiltrated into each point. The ear canal is not injected

the subperiosteum of the superior meatal wall, and another 0.5 mL is injected. Subsequently, in the same procedure, the bevel of the needle is directed toward the inferior meatal wall, and the same amount of solution (0.5 mL) is injected (dotted lines) (Fig. 2d). (4) Through the monitor, the surgeon can easily observe the pallor of the meatal skin or the location at which the blood vessels disappear into the tympanic membrane (signs of vasoconstriction) while the solution is infiltrated slowly (Fig. 3). This mechanism allows observation of the vasoconstrictive effect and determination of the correct amount of solution required to achieve this effect. Only one site and 1.5 mL of the local infiltration solution are necessary to observe the changes or the anatomical signs of vasoconstriction. Usually, 15 min is required to establish the vasoconstrictive effect before starting the incision of the tympanomeatal flap. It is important that infiltration is performed slowly to avoid the formation of blebs and rupture of the skin of the ear canal. The ear canal is not injected, which prevents damage to the future tympanomeatal flap.

Surgical technique

For endoscopic stapes surgery, the surgical technique was essentially the same as the procedure used in microscopic stapes surgery. Briefly, this included the following seven basic steps: elevation of the tympanomeatal flap, exposure of the stapes, confirmation of ossicular fixation, removal of the stapes suprastructure, footplate removal or creation of a fenestra, prosthesis placement and repositioning of the tympanomeatal flap. Finally, the ear canal was filled with gelfoam and antibiotic drops.

Outcome measures

The data collected included demographic characteristics (age and gender). Depending on the type of stapes surgery (stapedectomy or stapedotomy), the operative time was estimated as the time between the elevation of the tympanomeatal flap and the repositioning of the flap. Middle ear surgery rarely presents significant bleeding, so quantifying blood loss would be unrealistic. In this way, intraoperative blood loss was evaluated using a qualitative scale to demonstrate the comparative effect between the groups. Thus, the blood loss was recorded using a three-grade scale; slight (1–5), moderate (6–10) and severe (> 11). Each scale depicting number of times the suction tube was used to aspirate the bleeding in the surgical area. Information on the integrity or preservation of the anatomical structures, such the scutum or chorda tympani, was recorded. Intraoperative complications included laceration of the tympanomeatal flap, tympanic membrane perforation, chorda tympani injury, damage to the ossicular chain and paralysis of the facial nerve. Postoperative complications included severe vertigo, sensorineural hearing loss and tinnitus. Complications were evaluated during the first 6 postoperative hours and at discharge from the hospital (12 h). Pre- and postoperative audiometric data included the average of air and bone conduction thresholds (AC, BC) and air bone gap (ABG) measurements at 500, 1000 and 2000 Hz. The preoperative ABG was calculated as preoperative AC threshold-preoperative BC threshold. Postoperatively, two ABG values were calculated: (a) ABG (with postop BC) = postoperative AC-postoperative BC; (b) ABG (with preop BC) = postoperative AC-preoperative BC [2, 5]. The success of surgery was defined as the closure of the ABG to within 10 dB. Hearing was assessed at 1, 3 and 6 months following surgery, and results of the last assessment were recorded. For comparisons of parametric data, unpaired Student *t* test was used, with a significance factor of $P < 0.05$. Chi square or Fisher test was used for nonparametric data with a significance level of $P < 0.05$. A Mann–Whitney *U* test was used to analyze the intraoperative blood loss. The means (standard deviation) and 95% confidence interval (CI) were calculated for each set of results.

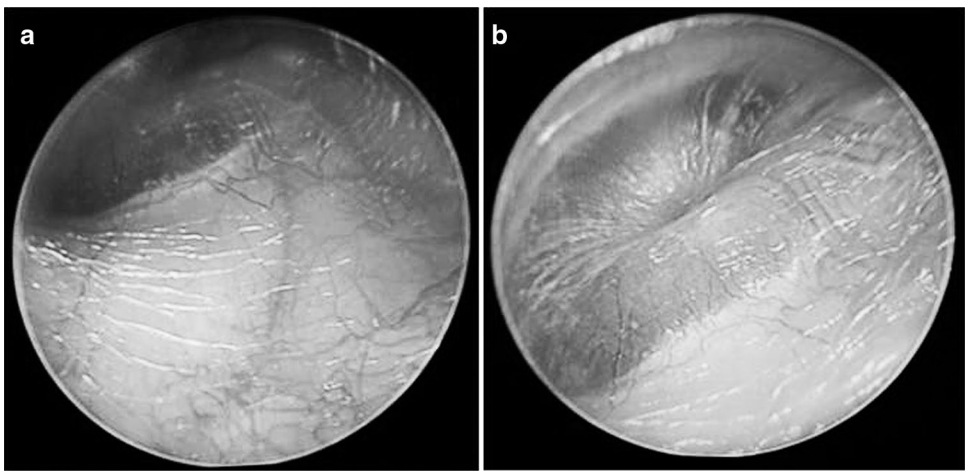

Fig. 3 The endoscopic view of the vasoconstriction signs before and after infiltration is shown. **a** Before local infiltration, the blood vessels are strongly evident in the ear canal walls and tympanic membrane. **b** During the infiltration, the wall of the ear canal and the tympanic membrane become pale. These signs indicate the amount of solution required to achieve the vasoconstriction effect

Results

During the 6-month evaluation time, a total of 70 patients underwent primary stapes surgery by endoscopic or microscopic approaches. There were 42 patients in the endoscopic group and 28 in the microscopic group. In the endoscopic group a fully endoscopic procedure was applied and no cases were converted from endoscopic to microscopic. The average age was 36.3 years ± 8.4 years (range 17–56 years), and 80.0% of enrolled patients were females. The gender distribution and mean age were not significant different. Stapedectomy was more common (80%) than stapedotomy (20%). Surgery was performed in the right and left ears in 38 (54.3%) and 32 (45.7%) patients, respectively.

Operative time, intraoperative blood loss and preservation of structures were significantly reduced in the endoscopic group (Table 1). The mean operative time was 48.1 min for the endoscopic group (range 35–63 min) and 74.8 min for the microscopic group (range 45–95 min), ($P < 0.00$). The number of times the suction tube was used to aspirate the bleeding in the surgical area was significantly reduced in the endoscopic group. Patients in the endoscopic group were observed to have a higher significant percentage of slight intraoperative blood loss (90.5%, 95% CI 0.81–0.99) than patients in the microscopic group (17.9%, 95% CI 0.27–0.32; $P < 0.000$). Instead, the microscopic group was characterized by moderate and severe intraoperative blood, 71.4% (95% CI 0.53–0.89) and 10.7% (95% CI 0.15–0.22) versus 9.5% (95% CI 0.002–0.18) and 0% of endoscopic group ($P < 0.000$).

Furthermore, the use of endoscope and the characteristics of an operative field clear and dry resulted in a significant preservation of anatomical structure, such as the scutum. In the endoscopic group, 92.9% of patients preserved the scutum (95% CI 0.84–1.00), whereas only 46.4% (95% CI 0.26–0.66) of patients in the microscopic group preserved it ($P < 0.00$). Thus, the scutum was removed less frequent in the endoscopic group 7.1% versus 53.6% of the microscopic group ($P < 0.00$). It was necessary to carefully remove the scutum with a micro-curette to visualize the stapes. The chorda tympani was preserved in all cases; however, 9.5% (95% CI 0.002–0.187) of patients of the endoscopic group had temporary dysgeusia because of manipulation of this structure during the procedure versus 39.3% (95% CI 0.20–0.58) in the microscopic group ($P < 0.00$) (Table 1). One patient from the microscopic group had slight vertigo after surgery and was treated with intravenous steroids and ondansetron. The vertigo was resolved 1 day after surgery, and he was asymptomatic at the time of discharge from the hospital. Furthermore, laceration of the tympanomeatal flap, tympanic membrane perforation and facial nerve damage did not occur.

All patients at each visit (1, 3 and 6 months) reported hearing improvement. In each group, the average AC, BC and ABG measurements at 500, 1000 and 2000 Hz were significantly better than the preoperative averages ($P < 0.001$). However, in both groups, the difference between the

Table 1 Patient demographics and operative measures between groups

Characteristics	Endoscopic ($n = 42$)	Microscopic ($n = 28$)	P value
Age	35.1 ± 9.1	38.1 ± 7.0	0.17
Sex			
Female	35.9 ± 9.0	38.2 ± 7.4	0.45
Male	31.0 ± 9.1	37.5 ± 5.7	0.41
Operative time, min	48.1 ± 8.0	74.8 ± 16.6	0.00†
Intraoperative blood loss (%)			
Slight	90.5	17.9	0.00†††
Moderate	9.5	71.4	
Severe	0	10.7	
Stapes surgery (%)			
Stapedectomy	81.0	78.6	0.80
Stapedotomy	19.1	21.4	
Preservation of structures (%)	92.9	46.4	0.00††
Scutum removed	7.1	53.6	0.00††
Chorda tympani manipulation	9.5	39.3	0.00††
Complications (%)	–	–	

Mean (± SD)

†*t* test

††Chi square test

†††Mann–Whitney *U* test

preoperative mean ABG and the postoperative mean ABG (with preop and postop BC) was not statistically significant ($P > 0.05$) (Table 2). Furthermore, in the endoscopic and microscopic groups the difference between the preoperative and postoperative BC averages were 3.9 ± 2.9 versus 4.3 ± 2.1, respectively, showing no significant difference ($P > 0.05$) but demonstrating in both groups better results postoperatively. Six months following surgery, in both groups, 85.7% (95% IC=71.4–94.5) had closure ABG < 10 dB, and 14.2% (95% IC=5.4–28.5) had achieved an ABG of 11–20 dB. In the patient who had slight vertigo after surgery, the average postoperative ABG was 15.7 dB, compared with the average preoperative ABG of 28.3 dB. There were no cases of sensorineural hearing loss or tinnitus following surgery.

Discussion

The findings in the present study demonstrate that MMLI is effective in endoscopic stapes surgery. The authors modified the number of injections and the site of the injection by introducing the needle only in the center of the anterior conchal until it reached the bone. In addition, a new technique for handling the syringe in endoscopic ear surgery was presented. It was shown that if the endoscopic approach is applied, frontal lamp and speculum are not necessary to perform the local infiltration, as it is easily performed with one hand while the other hand holds the endoscope and the surgeon watches a monitor to observe the vasoconstriction signs. In contrast, if the surgeon prefers to use the traditional local infiltration technique under the operating microscope; one hand will open the external meatus with a nasal speculum while the other hand performs the local infiltration. In this way, the surgeon will not be able to observe the vasoconstriction signs while anesthesia is administered, because surgeon look directly through binocular the site of external meatus that will be infiltrated and not the tympanic membrane. Likewise, the ear surgeon will not be able to perform the new technique of handling the syringe of MMLI because hand that holds the syringe would block the lighting and objective lens of operative microscope. Endoscopic approach overcomes these limitations because endoscopes provide a wide angle, that during the infiltration can be seen in one surgical field the entire area of external ear canal and tympanic membrane.

The MMLI of easy application improves the observation of vasoconstriction signs and allows the operative area to stay clean and dry during the surgery, which improves the visibility of key anatomical structures for safe entry into the tympanic cavity and makes endoscopic stapes surgery easier. The benefits of this method compared with the control group became evident in the significant improvement in operative time, reduction in bleeding, preservation of anatomical structures (e.g., scutum and chorda tympani) and absence of complications, all of which were important parameters that improved patient recovery and hearing satisfaction. Moreover, the tympanomeatal flap remains intact because it is not necessary to inject the local solution into the ear canal.

In 1996, Morizono [10] described a similar technique (one site) of local infiltration with epinephrine in an endaural approach, which provided a bloodless surgical field. He administered the first injection in the posterior wall of the canal approximately 5 mm from the orifice and lateral to the junction of bone and cartilage. In addition, he published the vasoconstriction signs that were observed after the local anesthesia was administered. However, in contrast to our proposed method, he used an operating microscope, a curved nasal speculum to expose the ear canal and there was not a technique for handling the syringe. Similarly, other publications described similar variations of our proposed method with regard to the advancement of the needle in three directions without removing the needle from the first site. The needle was advanced toward the posterior, superior and inferior external ear canal of the retroauricular region, but the ear surgeries were performed under local anesthesia [2, 8].

Likewise, in this study it was important to identify the vessels involved with regard to the site of infiltration and to observe the vasoconstriction signs published by Morizono [10]. Bien et al. [8] reported that hemostasis and vascular supply are significant factors in ear surgery and according to the proposed method; the vasoconstrictive effect of the anterior conchal cartilage compromises the vascular supply of the perforating branches of the posterior auricular artery.

Table 2 Average postoperative air–bone gap with pre- and postoperative bone conduction between groups

ABG	Mean ± SD		*P* value*
	Endoscopic ($n = 42$)	Microscopic ($n = 28$)	
Preoperatively (dB)	29.4 ± 6.3	30.5 ± 5.4	ns
Postoperatively with postop BC (dB)	7.6 ± 4.7	8.5 ± 5.0	ns
Postoperatively with preop BC (dB)	3.7 ± 2.9	4.1 ± 2.8	ns

ns not significant, *dB* decibels, *BC* bone conduction, *postop* postoperative, *preop* preoperative, *SD* standard deviation

*Unpaired student *t* test ($P < 0.05$)

When injecting the superior external ear canal, the vasoconstriction is achieved via the vascular supply of the anterior auricular branches of the superficial temporal artery. Similarly, the deep auricular artery branches from the first part of the internal maxillary artery are involved in infiltrating the inferior external ear canal. This artery gives off branches that form a vascular ring around the tympanic membrane and the descending or manubrial artery. Thus, endoscopic ear surgeons cannot initiate surgeries until these signs, which are indicative of sufficient vasoconstriction in the area, are observed.

Another aspect of interest in the present study was the concentration of epinephrine used, as most surgeons have reported its importance in achieving effective hemostasis during surgery. Shoroghi et al. [12] reported the effect of different epinephrine concentrations on intraoperative bleeding and hemodynamic changes during skin surgery. They administered three different concentrations of epinephrine (1:50,000, 1:100,000 and 1:200,000) with 1% lidocaine. The rate of intraoperative bleeding was significantly lower with 1:50,000 epinephrine than with the other epinephrine concentrations. For this reason, the first author used this epinephrine concentration (1:50,000) routinely for over 10 years because it provides optimal intraoperative bleeding control and reduces the occurrence of complications.

Recently, Sarkar et al. [5] described some areas of concern in endoscopic stapes surgery. These investigators described that excessive bleeding causes problems and increases the operative time, as the surgeon must switch between the instrument and the suction device with the only working hand. In recent years, other studies demonstrated that the main disadvantage of endoscopic ear surgery is that it only allows the use of one hand. Therefore, it requires a blood-free field [13, 14]. However, in this study, these disadvantages of endoscopic stapes surgery were resolved by applying the MMLI with only one site of infiltration and a 15-min waiting period after infiltration. Although the majority of ear surgeons know that middle ear surgery rarely has significant hemorrhage so quantifying blood loss in a quantitative scale would be unrealistic and this variable should be quantified as possible. Thus, our study demonstrated in a qualitative scale that number of times the suction tube was used to aspirate the bleeding in the surgical area was significantly reduced in the endoscopic group. In both groups the characteristics of the operative fields were different. Whereas the operative field in the endoscopic group was kept dry and clean, in the microscopic group, continuous blood runoff from the ear canal allowed the tympanic cavity was saturated with blood. This effect required continuous aspirations. Thus, in the endoscopic group the operative time was reduced because the surgical field was kept free of blood; in this manner, continuous aspirations were avoided, allowing the surgeon to hold the endoscope with one hand and work with the other hand. In contrast, when stapes procedures are performed under a microscope, the surgeon uses both hands for the stapes surgery, suctioning and hemostasis; thus, the surgical manipulation is performed with one hand while the other hand is used to aspirate.

More recently, several studies have demonstrated the benefits of endoscopes for stapes surgery with regard to the operative time, preservation of anatomical structures and complications [3–6, 15, 16]. These studies described an operative time that varied between 53 and 31 min. Kojima et al. [6] compared the outcomes of endoscopic stapes surgery with those of surgery using a microscope. They reported that the operative time was not significantly different between the groups (53.0 versus 54.1 min), removal of the scutum was less extensive in the endoscopic group than in the microscopic groupand postoperative dizziness was mild in all patients who underwent endoscopic surgery. Dursun et al. [4] published the results of 31 endoscopic stapes surgeries in 2016. They reported a mean operative time of 50.5 min and some complications in the early postoperative period, such as temporary facial nerve paralysis, perilymphatic gusher, tympanic membrane perforation and chorda tympani injures. In contrast, Iannella and Magliulo [15] compared the surgical outcomes of endoscopic and microscopic stapes surgery in 40 patients. They reported the operative time with respect to the learning curve. Endoscopic surgery showed a mean operative time of 45 min, whereas the microscopic approach required a mean time of 36.5 min. However, the average duration of endoscopic surgery varied as the surgeon gained experience. After 4 months of endoscopic surgeries, there were no significant differences between the endoscopic and microscopic approaches. Our study demonstrated an operative time within the published range for endoscopic stapes surgeries. The good operative time was possible because of application of the MMLI, the characteristics free of blood of the operative field and the experience of the surgeon.

Similarly, other publications have reported several results on the preservation of anatomical structures and decrease in complications. In a multicenter study on endoscopic stapes surgery, Hunter et al. [17] reported the complications and postoperative hearing function of 65 patients. Among the subjects, 71.7% required scutum removal, and the chorda tympani was manipulated in 94.0% and transected in 12.0%. Furthermore, the tympanic membrane suffered tears in 8.0% of subjects. In contrast, Migirov and Volf [3] published the results of eight endoscopic transcanal stapedotomies, with the chorda tympani being preserved in all cases. These were excellent results because studies in the literature describe that postoperative taste disorders after stapes surgery occur in 20–60% of patients whose chorda tympani is manipulated or transected [18, 19]. Damage to the chorda tympani is common if the scutum is removed to visualize the stapes or

the oval window niche; however, as previously reported, it is more common in microscopic than endoscopic surgery [13]. In the present study, the rate of preservation of anatomical structures in the endoscopic group, such as the scutum and chorda tympani, was high, as their removal and manipulation were minor. In contrast, in the microscopic group the results were similarly as previously described [13]. One patient had slight vertigo after surgery, which did not persist beyond one day. This result was presumably due to the effect of the fenestration of the stapedial footplate. Moreover, in both groups, postoperative hearings were satisfactory, with no differences in hearing observed between microscopic and endoscopic approaches. No complications were observed.

The main advantage of the MMLI over the ear endoscopic approach is that it does not require special training or a learning curve. It is a simple method and easy to learn in the first surgical procedure. Another advantage of this method is the reduction in continuous aspirations because the operative field remains free of blood during surgery. It has numerous benefits for surgeons and patients, such as improvement in visibility during surgery and in the surgeon's ability to identify and preserve key anatomical structures, reduction of complications and improvement in patient outcomes. However, the most significant challenge is for the endoscopic surgeon to gain enough experience to perform the surgical procedure with the hand that does not hold the endoscope and achieve a shorter operative time. The disadvantages reported in other publications, such as the use of only one hand by the surgeon and the requirement of a blood-free field, were eliminated with the use of the proposed method. However, the inexperience of the surgeon is a strong disadvantage, and as with all surgical procedures, there is an obligatory learning curve.

Conclusion

This is the first report of a method of local infiltration for endoscopic stapes surgery. Moreover, the MMLI is designed for all types of endoscopic ear surgeries. The beneficial effects obtained with this method have made it the standard of practice for us and other endoscopic ear surgeons. The results of this study were excellent in terms of decreased operative time, intraoperative bleeding, complications and preservation of anatomical structures.

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Compliance with ethical standards

Conflict of interest The author(s) declare no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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