

Effectiveness of endoscopy in cochlear implantation

Efectividad de la endoscopia en la implantación coclear

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Abstract

Objective: Determine the effectiveness of endoscopy in cochlear implantation as compared to microscopy. **Method:** Study comparing microscopy and endoscopy in cochlear implant placement in 34 patients (23 endoscopic implants and 20 implants via microscopy), between 2014 and 2019, at the Centro Medico Naval, Mexico City. The study was performed under informed consent and according to the Council for International Organizations of Medical Sciences (CIOMS). **Results:** Of the 34 patients, 12 were children or adolescents and 22 were adults. The visualization of the round window classified via microscopy per St. Thomas Hospital's classification showed that type IIB prevailed in 30.2% of patients, and type III in 41.9%, and when using the endoscope, the round window was observed in full in 82.6% of patients (type I), and type IIA was only observed in 17.4% (four patients). The number of attempts made to place the cochlear implant was greater with the microscope. The time to insertion of the electrode was 1.6 minutes. No differences were observed ($p > 0.05$) in the number of inpatient days. Cochleostomy was more frequent when using the microscope. **Conclusions:** Endoscopy is an effective resource in cochlear implantation for posterior tympanotomy, with no complications observed, offering greater safety in inserting the electrode through the round window.

Keywords: Ear. Cochlear implant. Endoscopy. Microscopy. Ear surgery.

Resumen

Objetivo: Determinar la efectividad de la endoscopia en la implantación coclear en comparación con la técnica microscópica. **Método:** Se comparó la microscopía frente a la endoscopia en la colocación de implante coclear en 34 pacientes (23 endoscópicos y 20 microscópicos), del año 2014 al año 2019, en el Centro Médico Naval de la Ciudad de México. El estudio se realizó bajo consentimiento informado y apegado a las normas del Council for International Organizations of Medical Sciences. **Resultados:** De los 34 pacientes, 12 eran niños o adolescentes y 22 eran adultos. La visualización de la ventana redonda fue clasificada con microscopio según la clasificación del St. Thomas Hospital, predominando la tipo IIB (30.2%) y la III (41.9%), y al utilizar el endoscopio se observó completa en el 82.6% (tipo I) y tipo IIA en tan solo el 17.4% (cuatro pacientes). El número de intentos en la colocación del implante coclear fue mayor con el microscopio. El tiempo en el que se insertó el electrodo fue de 1.6 minutos. No hubo diferencias ($p > 0.05$) en la estancia hospitalaria. Fue más frecuente la cocleostomía cuando se usó el microscopio. **Conclusiones:** La endoscopia es un instrumento efectivo en la implantación coclear por timpanotomía posterior, sin presentarse complicaciones y dando mayor seguridad para insertar el electrodo por la ventana redonda.

Palabras clave: Oído. Implante coclear. Endoscopia. Microscopía. Cirugía de oído.

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Introduction

Endoscopy continues to evolve and expand its applications in otology; its use is well-established in procedures such as stapedectomy, tympanoplasty, ossiculoplasty, cholesteatoma removal, and chronic ear management^{1,2}. Endoscopy is an innovative tool that enhances visualization and identification of anatomical structures that are difficult to observe with a microscope^{3,4}.

Recently, options for cochlear implantation have been described, such as the transcanal approach, but the transmastoid approach remains the most widely used technique, requiring optimal mastoidectomy with posterior tympanotomy⁴, where the facial nerve may be at risk, requiring electrophysiological monitoring for its localization⁵.

In our study, we compared endoscopy and microscopy in 43 ears, defining an effective endoscopic procedure as performing the surgery in a single attempt with complete electrode insertion through the round window without the need for cochleostomy in 1 or 2 attempts, no associated electrode complications, and hospital discharge within 48 hours.

Research question

What is the effectiveness of endoscopy vs microscopy for cochlear implant placement in patients treated at the Naval Medical Center?

Hypothesis

Endoscopy in cochlear implant placement is more effective than the microscopic technique, as it shows a lower frequency of complications associated with electrode insertion and cochleostomy, higher complete insertion rates, fewer implant placement attempts, and shorter lengths of stays.

Objective

To determine the effectiveness of endoscopy in cochlear implantation compared to the microscopic technique.

Study type

Observational, cross-sectional, ambispective, and comparative.

Method

This study was conducted at the Naval Medical Center in Mexico City between 2014 and 2019, through a systematic review of health records and surgical video recordings of patients who underwent cochlear implant surgery by the otorhinolaryngology and head and neck surgery department, where all patients were operated on by the same neuro-otologist.

To determine the effectiveness of endoscopy in implant recipients, 2 groups were created: Group #1 (23 ears), where the cochlear implant was placed endoscopically, and Group #2 (20 ears), where microscopy was used.

All patients in both groups underwent mastoidectomy with optimal posterior tympanotomy with microscope support, preserving anatomical references. The round window was described using the St. Thomas Hospital classification (Type I: complete round window exposure; Type IIa: exposure of more than 50% of the round window; Type IIb: exposure of less than 50% of the round window; Type III: round window not visible)⁴ in all patients, and for the group in which endoscopy was used (0°, 3 mm, 6 cm), the visibility of the round window was reevaluated using the same classification. Attempts for implant placement, complete insertion, complications associated with electrode insertion through the round window, and insertion time (quantified from the appearance of the electrode in the endoscope view range of the round window entry until complete insertion, measured in min/s) were reported.

Means and standard deviations, frequencies, and percentages were determined, and Student t-tests, chi-square tests, and Fisher's exact tests were used. Data analysis was conducted using SPSSv23 and GraphPad Prism v5. A p-value ≤ 0.05 was considered statistically significant.

Results

The study included a total of 34 patients who received cochlear implants, treated at the otorhinolaryngology and head and neck surgery service of the Naval Medical Center. Of these, 38.24% (13) were women and 61.76% (21) were men.

There were 12 children or adolescents and 22 adults in this research. The mean age of those younger than 18 years was 6.33 ± 5.56 years, with a minimum age of 1 year and a maximum of 17 years, while the adult population had a mean age of 48.36 ± 16.23 years, with a minimum of 23 years and a maximum of 78 years.

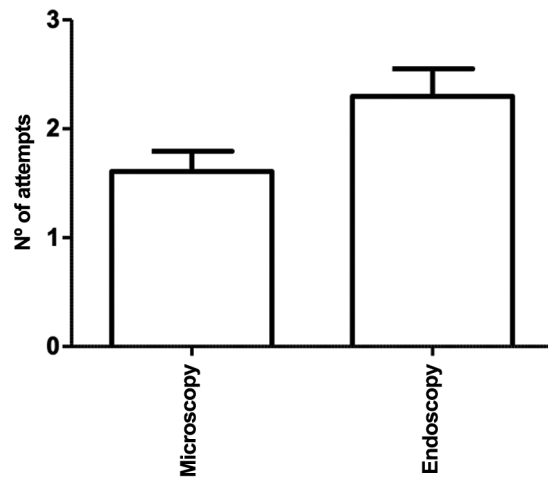


Figure 1. Comparison of the mean number of attempts for cochlear implant placement in surgeries using endoscopy and microscopy.

A total of 43 cochlear implants were performed. Most bilateral implants were done in children (9) ($p < 0.05$). Regarding surgical management, 53.5% (23) of the implants were performed using the endoscopic technique, and 46.5% (20) were performed using microscopy.

In the classification of the round window observed in surgeries performed with endoscopy, Types I and IIA predominated, unlike those performed with microscopy (Table 1).

The effectiveness of each type of surgery for cochlear implant placement was compared in terms of the presence of surgical complications, the need for cochleostomy, whether the insertion was complete, implant placement attempts, and length of stay.

No differences ($p > 0.05$) were observed in the frequencies of surgical complications between endoscopic and microscopic surgeries (Table 2).

The number of attempts for cochlear implant placement was higher in patients with surgical complications (3.5 ± 2.12 vs 1.85 ± 0.96 ; Student t-test, $p = 0.02$), and the insertion time was also longer in patients with surgical complications (5.0 ± 0.72 vs 1.64 ± 1.14 min/s; Student t-test, $p = 0.0001$).

Figure 1 illustrates the comparison of the mean number of attempts for implant placement in surgeries using endoscopy and microscopy. The mean number of attempts for endoscopic surgery was 1.6 ± 0.89 vs 2.3 ± 1.12 for the microscopy group, with the difference being statistically significant (Student t-test, $p = 0.03$).

Table 3 shows the comparison of cochleostomy outcomes with endoscopy and microscopy. In 22 patients, cochleostomy was not required ($p < 0.05$),

Table 1. Categorization of the round window in surgeries with endoscopy and microscopy

Round window classification	Microscopy (n = 43)	Endoscopy (n = 23)
Type I	11.6% (5)	82.6% (19)
Type IIA	16.3% (7)	17.4% (4)
Type IIB	30.2% (13)	-
Type III	41.9% (18)	-

Table 2. Comparison of the frequencies of intraoperative complications based on the type of surgery used for cochlear implant placement

Intraoperative complications	Type of surgery		Total
	Endoscopy (n = 23)	Microscopy (n = 20)	
Yes	0	10% (2)	4.6% (2)
No	100% (23)	90% (18)	95.3% (41)

Fisher's exact test, $p = 0.21$.

Table 3. Comparison of the frequencies of cochleostomy results based on the type of surgery used for cochlear implant placement

Cochleostomy	Type of surgery		Total
	Endoscopy (n = 23)	Microscopy (n = 20)	
Yes	4.3% (1)	70% (14)	34.9% (15)
No	95.7% (22)	30% (6)	65.1% (28)

Fisher's exact test, $p = 0.0001$.

being more frequent in patients treated with microscopy. Also, 100% of patients who required 5 attempts for implant placement underwent cochleostomy, a finding that was statistically significant ($p < 0.05$).

Discussion

Mastoidectomy with posterior tympanotomy is the most widely used surgical procedure for cochlear implantation, and it requires a microscope. With the development of endoscopy as a tool, its use has expanded over the years, initially in sinonasal surgery and now in ear procedures, such as tympanoplasty, stapedectomy, cholesteatoma removal, and ventilation tube placement, and it is now considered an optional tool in cochlear implantation¹⁻³.

The visibility provided by the microscope is a straight and “tubular” line of sight, while the endoscope offers a wide field of view¹. The microscope requires constant angling and repositioning of the patient to expose the anatomical structures being worked on, which limits the adequate anatomical identification of the round window and consequently increases the need for cochleostomies (11% up to 22% of patients)⁴. In the free-hand endoscopy technique, free manipulation is allowed without having to move the patient, with a wide field of view and clear images, achieving precise identification of the anatomical references of the middle ear^{2,5}.

This research compared microscopy and endoscopy in 43 ears of 34 patients (children, adolescents, and adults). Men and the adult population predominated, differing from documented international series.

Regarding surgical management, all patients underwent mastoidectomy with optimal posterior tympanotomy, supported by Tarabichi et al.¹ who concluded that posterior tympanotomy provides the most direct route to the round window for implant placement. Implantation was performed with a microscope in 20 ears, and in the rest with the support of an endoscope (23 ears). Regarding patient age and technique used for electrode placement, no difference was found, ruling out possible anatomical differences due to development and physiological growth that might prevent the use of endoscopy; this was described by the same authors mentioned previously, who found no significant trends related to age in the cochlear basal turn or the orientation of the round window¹.

The round window was classified using the St. Thomas Hospital microscopic classification⁴ in all cases studied, with Types IIB (30.2%) and III (41.9%) predominating. With the endoscope, the visibility of the round window niche improved significantly, with complete observation in 82.6% (Type I) and Type IIA in only 17.4% (four patients). In these last cases, it may have been due to bony prominences limiting the niche. The improvement in visualization and identification with the endoscope of the window itself was evident. These results align with those reported by Jain et al.², who describe improved visualization of the round window region with better St. Thomas Hospital classification using the endoscope.

No differences ($p > 0.05$) were observed in the frequencies of complications associated with implant insertion between endoscopy and microscopy, although no complications were presented with endoscopy, while 2 were reported with microscopy: 1 false track (outside the tympanic ramp) and 1 perilymphatic fistula. Complications

described in other reports were due to the approach route for cochlear implantation, such as damage to the tympanic membrane, facial nerve injury, and cerebrospinal fluid fistula, among others^{6,7}. On the other hand, Carner et al.⁸, in 25 cases with ear malformations implanted with endoscopy, had no complications; this supports the use of the endoscope. However, there is no historical record of studying complications associated with implant insertion as was done in this work.

The number of attempts for cochlear implant placement was recorded and analyzed for each group, requiring more attempts with the microscope than with the endoscope, with insertion achieved on the first or second attempt in most cases where endoscopy was used; insertion was also more challenging in patients with complications. The time for complete electrode insertion was measured, which was 1.6 minutes in those without complications.

Cochleostomy was more frequent in the group where implantation was performed under microscopic vision: 70% vs 4.3% with endoscopic vision, and the need for the only cochleostomy performed with the latter was due to a special cochlear condition (intra-cochlear bands), in the same patient who had difficulty with electrode insertion (greater number of attempts and longer time for implant insertion).

The length of stay was documented and no differences ($p > 0.05$) were observed between endoscopy and microscopy. Patients who were hospitalized longer were due to decompensation of their own comorbidity.

Endoscopy is effective in posterior tympanotomy as no surgical complications were presented, significantly improved visibility of the round window, did not require cochleostomy, and allowed complete electrode insertion through the round window, with minimal manipulation (1 or 2 attempts) and within an appropriate time, without extending the length of stay. Our results are similar to those reported by Jain et al.², who used endoscopy in the transmastoid approach with excellent results. Previously, Marchioni et al.⁷ reported the use of endoscopy but via the transcanal approach without posterior tympanotomy, and later Dia et al.³ and Migirov et al.⁹ suggested that endoscopy could be a viable, safe, and feasible alternative or complement in standard open transmastoid cochlear implantation.

Conclusions

Endoscopy is an effective, feasible, and safe instrument in cochlear implantation through posterior

tympanotomy. No complications were presented, and it offered greater safety in electrode insertion through the round window into the cochlea. Visualization and identification of the round window niche were improved, avoiding the need for cochleostomy, and allowing verification of all electrode insertions through the round window.

Therefore, it is recommended to perform cochlear implant placement with endoscopy to achieve a safe insertion through the round window without complications and potentially greater auditory gain. Additionally, endoscopy reduces morbidity in cochlear implant recipients and can be used as a review tool in cases where insertion is done with a microscope.

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Conflicts of interest

None declared.

Ethical disclosures

Protection of human and animal subjects. The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical

research ethics committee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors have obtained approval from the Ethics Committee for analysis and publication of routinely acquired clinical data and informed consent was not required for this retrospective observational study.

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