Internal Auditory Canal Reconstruction After Vestibular Schwannomas Removal Through Retrosigmoid-Transmeatal Approach

Reconstrução do Meato Acústico Interno após Remoção de Schwannoma Vestibular por Acesso Retrosigmoide-Transmeatal

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ABSTRACT

Objectives: To present a technique of internal auditory canal (IAC) reconstruction using a pediculated dural flap, after removal of vestibular schwannomas through the retrosigmoid craniotomy.
Methods: From a series of 213 patients with vestibular schwannomas operated between January 2008 and March 2016 through the retrosigmoid-transmeatal approach, 183 underwent reconstruction of the internal auditory canal with a pediculated dural flap. The IAC was drilled towards the fundus preserving the labyrinthine structures. The dura mater over the IAC was dissected from the bone, remaining pediculated at the entrance of the jugular foramen. This dural flap was used to cover the cranial nerves inside the IAC after tumor removal. Opened mastoid cells and the IAC were closed with muscle or fat grafts and fibrin glue.
Results: Reconstruction of the IAC using the described technique was possible in in 183 cases. Fifteen patients (6.8%) developed postoperative cerebrospinal fluid (CSF) leakage and seven patients required reoperation (3.2%) to close the fistulae. Postoperative magnetic resonance imaging (MRI) examinations showed the presence of CSF within the IAC around the preserved cranial nerves.
Conclusions: This technique of IAC reconstruction after surgical resection of vestibular schwannomas may avoid scar and adhesion of muscle or fat tissue with preserved cranial nerves, allowing CSF enter inside the IAC. It may help to identify tumor remnants and/or recurrences in postoperative MRI examinations. Comparative studies are needed to evaluate if this technique improves postoperative hearing and facial nerve outcomes.

Key words: Vestibular Schwannomas; Retrosigmoid Approach; Internal Auditory Canal; Reconstruction; CSF-leakage

RESUMO

Objetivo: Apresentar técnica de reconstrução do meato acústico interno (MAI) com retalho dural pediculado após remoção de schwannoma vestibular através de craniotomia retrosigmoide. Métodos: Cento e oitenta e três pacientes, de uma série de 213 pacientes operados com schwannomas vestibulares, entre janeiro de 2008 a março de 2016, foram submetidos à reconstrução do conduto auditivo interno com flap dural pediculado. O MAI foi aberto através de broqueamento de sua parede posterior com preservação das estruturas labírintricas. A dura mater adjacente ao MAI foi dissecada do osso permanecendo pediculada na entrada do foramen jugular. Este retalho dural foi utilizado para cobrir os nervos cranianos dentro do MAI após a remoção tumoral. Células mastoides internas e o MAI foram fechados com músculo ou enxertos adiposos e cola de fibrina. Resultados: A reconstrução do MAI com a técnica descrita foi possível em 183 casos, com 15 pacientes (6,8%) apresentando no pós-operatório vazamento de líquor e sete necessitaram de nova cirurgia para fechamento de fistula. Exames de MRI pós-operatório mostraram a presença de líquor no CAI circundando os nervos cranianos preservados. Conclusões: Esta técnica de reconstrução do MAI após ressecção cirúrgica de schwannomas vestibulares pode evitar a formação de cicatrizes e aderência de músculo ou tecido adiposo aos nervos cranianos preservados, permitindo que o líquor penetre no MAI. Esta técnica pode auxiliar a identificação de restos tumorais e/ou recorrências em exames MRI pós-operatórios. Estudos comparativos são necessários para avaliação de melhora em resultados pós-operatórios na audição e função do nervo facial.

Palavras-chave: Schwannoma vestibular; Acesso Retrosigmoide; Meato Acústico Interno; Reconstrução; Vazamento de Líquido Cefalorraquidiano

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**INTRODUCTION**

Management of vestibular schwannomas (VS) has been a theme of debate. Clinical observation, surgical removal and radiosurgical treatment are the options. CSF leak after surgery is a common complication and potentially dangerous situations that can lead to post-operative meningitis and eventually death. This can occur up to 16% of patients operated through lateral suboccipital approach. CSF leak may occur through opened mastoid air cells and petrous bone cells around the internal auditory canal (IAC). To avoid this complication different IAC reconstruction techniques have been used. Sealing the opened mastoid and petrous bone air cells with bone wax, fat and muscle grafts are the most used. The use of endoscope is useful to identify the opened cells at the fundus of the IAC. The rate of petrous bone pneumatization was found to be related to post-operative CSF leak. A multilayer reconstruction of drilled IAC was described. After tumor removal within the internal auditory meatus (IAM) fat and/or muscle fat is inserted in close contact with the preserved nerves. This “foreign material” in close contact with the nerves may, in some cases, cause scar and adhesions and difficulties to identify the presence of tumor remnants in the postoperative MRI examinations.

The purpose of this paper is to describe a reconstruction technique of the IAC using a pediculated dural flap covering the nerves inside the IAC.

**MATERIALS AND METHODS**

From January 2008 to March 2016, 213 patients harboring VS were surgically treated at our Institute. Tumor size was classified according to the modified Hannover Classification as T1 (23 cases), T2 (38 cases), T3 (52 cases) T4A (44 cases) and T4B (62 cases). All patients were operated by the same neurosurgeon (RR) in dorsal (mastoid) position through the retrosigmoid-transmeatal approach. The IAC was widely opened to expose tumor extension at the IAC fundus, preserving the semi-circular canal. Endoscopes have been increasingly used to find hidden air cells as well as tumor remnants at the IAC fundus. Reconstruction of the IAC with a pediculated dural flap was performed in 183 patients.

**Surgical technique of IAC reconstruction**

Opening of the dura mater around the IAM started 0.5 cm below the tentorium margin, superiorly to the suprameatal tubercle. The dura incision extends laterally for about 1.5 cm over the IAC (Fig. 1). It goes down to end at the jugular foramen. This dural flap is cut at the border of the IAM and remains attached to the entrance of the jugular foramen. It is rotated down covering the lower cranial nerves exposing the bone over the IAC (Fig 2). The dura inside the IAC is dissected from the bone at entrance of the IAM with a small hook (Fig. 3). In patients with larger tumors (T4 A,B) resection of the cisternal portion of the lesion is first performed to allow identification of the IAM and IAC. After drilling the posterior wall of the IAC, the dura mater is incised to expose the tumor inside the IAC. After complete tumor removal, the reconstruction of the IAC is performed in four steps. Step 1 – Identification of all opened air cells during drilling of the IAC. A 30 degrees endoscope is very useful to identify those air cells (Fig. 4). Touching the fundus of the IAC with a small hook is an alternative to the endoscope to identify the opened air cells. Step 2 – Closure of the opened air cells with small pieces of muscle or fat tissue. It is carried out through microscope or direct endoscopic view of the cells (Fig. 5). Fibrin glue is instilled over the grafts to keep them in place. Step 3 – Protection of cranial nerves inside the IAC. The dissected dural flap is rotated over the preserved cranial nerves and the muscle or fat grafts covering the air cells (Fig. 6). Step 4 – A larger muscle graft is used for complete occlusion of IAC opening and fibrin glue is instilled to maintain it in place (Fig. 7). The dura mater is watertight closed with running sutures, all opened mastoid air cells are occluded with bone wax or muscle grafts, the craniotomy flap is fixed with mini-plates or sutures. The wound is closed in the usual way. Total tumor removal was performed in 215 patients (98%). In two cases of NF2 (the only hearing ear with tumor) subtotal removal was carried out. In all cases the tumor within the IAC could be totally resected.
Fig. 1 Dura incision over the IAC.

Fig. 2 Dural flap pedicle at the entrance of the jugular foramen covering the lower cranial nerves.

Fig. 3 Dissection of the dura inside internal auditory canal.

Fig. 4 Mastoid air cells identification A. through the microscope; B. through an angulated endoscope.

Fig. 5 Closure of mastoid air cells inside the auditory canal with small muscle grafts.
RESULTS

Reconstruction of the IAC using the described technique was performed in 183 cases. Fifteen patients (6.8%) developed postoperative CSF leak with paradoxical rhinorrhea. An external lumbar drainage was inserted in all cases for 48 hours. CSF fistula was solved in eight patients. Seven patients required reoperation (3.2%). The fistulae were closed in three patients through the retrosigmoid approach (in one case the leak was through the mastoid air cells and in two cases through the air cells in the IAC) and in four patients (with no hearing preservation after surgery) through the mastoid.

Three cases developed postoperative meningitis successfully treated with antibiotics. Postoperative MRI examinations showed the presence of CSF within the IAC around the preserved cranial nerves and no tumor remnants (Fig. 8).

DISCUSSION

CSF fistula is one of the most frequent complications in skull base surgery. Meningitis is a common complication of postoperative CSF leak and may have serious and even fatal consequences. In most cases of VS removal, extensive drilling of the IAC is required to achieve total removal. Mastoid air cells are usually opened during IAC drilling increasing the risk of postoperative CSF leak. To reduce the risk of postoperative CSF fistula an adequate closure of the opened air cells is needed. Different techniques of IAC closure have been described in the literature. Fat and muscle grafts are the most used material to close the IAC. Fat or muscle grafts in direct contact with preserved cranial nerves within the IAC may cause scar and adhesions that will not allow CSF to enter inside the IAC. This scar tissue may enhance gadolinium in postoperative MRI examinations suggesting the presence of residual tumor. Protecting these nerves with a pediculated dural flap, as described in this technical note, may avoid scar formation and adhesions allowing CSF to flow into the IAC. With this technique CSF around the VII and VIII cranial nerves can be visualized in postoperative MRI (T2-WI) (Fig. 8). It helps the identification of tumor remnants and recurrences within the IAC. A possible additional advantage of this technique is to increase functional outcomes of preserved cranial nerves. Comparative studies are needed to evaluate if it
indeed improves postoperative hearing preservation and facial nerve results. Endoscopes with angulated lens (30 degrees) provide excellent view of the deep portion of the IAC, which is not always possible under microscope view. Endoscopes have been increasingly used to identify and close the opened air cells as well as to identify tumor remnants at the fundus of IAC. In this series only seven patients (3.2%) developed CSF fistula requiring reoperation spite of wide drilling of the IAC to achieve radical removal of the tumor inside the IAC (Fig. 9).


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**REFERENCES**


