



# Endolymphatic duct blockage for Meniere's Disease treatment



Issam Saliba, MD, FRCSC

*From the Division of Otolaryngology-Head and Neck Surgery, Montreal University Hospital Center (CHUM), University of Montreal, Montreal, Quebec, Canada*

## KEYWORDS

Meniere's Disease;  
 Endolymphatic duct;  
 Endolymphatic sac;  
 Decompression;  
 Sac surgical operation;  
 Duct surgical operation;  
 Vestibular aqueduct;  
 Vertigo;  
 Hearing loss;  
 Ear fullness;  
 Tinnitus

An ideal treatment for Meniere's Disease would be nonablation of the vestibular system, with a conservative effect on hearing. We have reported in January 2015 a novel surgical technique for the treatment of Meniere's Disease—endolymphatic duct blockage (EDB)—performed as an outpatient surgical operation. It is an effective surgical nonablative technique in the event of failure of medical therapy; there is no cochlear damage clinically, and no additional vestibular damage. There is a significantly better control of the vertigo attacks when compared with the traditional endolymphatic sac decompression. We block the dissected endolymphatic duct with two small titanium clips. Postoperative wound management and postoperative care are similar to those in other mastoid surgical operation. Our hypothesis is that in Meniere's Disease there is imbalance of the homeostasis of the endolymph at the level of the endolymphatic sac, with an increased secretion outweighing a decreased absorption resulting in an increased pressure in the inner ear. Thus, by blocking the endolymphatic duct, we decrease the volume of endolymph in the inner ear coming from the sac, which helps alleviate the symptoms of Meniere's Disease; in absence of this result, all our patients operated by the EDB should develop a worsening of their symptoms, which is not the case. EDB operation remains a safe and effective novel procedure for the treatment of intractable Meniere's Disease with minimal adverse effects.

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## Introduction

Meniere's Disease, first described by Prosper Meniere,<sup>1</sup> is characterized by episodic vertigo, fluctuating sensorineural hearing loss, aural fullness, and tinnitus. Incidence of Meniere's Disease is variable between populations, ranging from 4.3–15.3 cases per 100,000.<sup>2,3</sup> The pathologic marker of this disease, endolymphatic hydrops, remains poorly understood despite decades of research. A number of etiologic factors have been proposed to explain the origin of endolymphatic hydrops—allergies,<sup>4</sup> viral infections

such as cytomegalovirus,<sup>5</sup> altered glycoprotein metabolism,<sup>6</sup> autoimmune processes,<sup>7,8</sup> hormonal dysfunction, genetic mutations, or inner ear malformations.

The exact underlying pathophysiological mechanism of this disease remains unknown. Therefore, its treatment remains controversial, empirical, and mainly symptomatic against the vertigo attacks. Several medical and surgical therapies are used to control the symptoms of Meniere's Disease.

Medical treatment consists of diuretics, vasodilators, and symptomatic therapy for the nausea and vomiting accompanying the vertigo attacks in addition to restriction of caffeine, alcohol, theophylline [exists in tea and chocolate], and salt (CATS) It allows a control of the disease in almost two-thirds of the patients.<sup>9</sup> Medical therapy often aims to reduce water retention or provide symptomatic treatment for the severe nausea and vomiting that com

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**Address reprint requests and correspondence:** Issam Saliba, MD, FRCSC, Division of Otolaryngology-Head and Neck Surgery, 1560, rue Sherbrooke East, Montreal, Quebec, Canada H2L 4M1.

E-mail address: issam.saliba@umontreal.ca

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plicate vertigo spells. On failure of medical therapy, Meniere's Disease is considered intractable. Several interventions are available to provide the best possible relief to patients, ranging from minimally invasive intratympanic corticosteroid injections<sup>10</sup> to more aggressive procedures such as endolymphatic sac decompression (ESD) or shunting and destructive procedures such as vestibular neurectomy or intratympanic gentamicin injection. ESD was described by Portmann in 1927.<sup>11</sup> It has always been considered a favorable option for patients with Meniere's Disease as it does not ablate hearing level and has low surgical morbidity. However, the results of this surgical operation are widely variable in the literature, and there are several debates on its efficacy. In the literature, the results regarding a complete vertigo control (Class A) with ESD largely vary (Sennaroglu 30%,<sup>12</sup> Silverstein 40%,<sup>13</sup> Jackson 46%,<sup>14</sup> Smith 41%,<sup>15</sup> Pensak 64%,<sup>16</sup> and Huang 72%<sup>17</sup>). Nevertheless, given this wide variety of results, it is acceptable to say that use of this technique is still debatable in the literature. A recent Cochrane review of the literature for all surgical interventions could only find 2 studies that satisfied all inclusion criteria. In these 2 articles, only endolymphatic shunt surgical operation was properly evaluated, with 52 patients, and no solid evidence for its efficacy was found.<sup>18</sup>

An ideal treatment for Meniere's Disease would be nonablation of the vestibular system, with a conservative effect on hearing.

We have reported in January 2015 a novel surgical technique for the treatment of Meniere's Disease—endolymphatic duct blockage (EDB).<sup>19</sup> It is an effective surgical nonablative technique—there is no cochlear damage clinically, and no additional vestibular damage. There is a significantly better control of the vertigo attacks when compared with the traditional ESD. In addition, there were no significant complications or adverse events. Control of Meniere's Disease symptoms was successful by EDB; the aim of the intervention is to block the endolymphatic canal with 2 titanium clips.<sup>19</sup>

## Patients selection

EDB surgical operation is indicated for definite category of the patients with Meniere's Disease, a clinical diagnosis of Meniere's disease according to the 1995 AAO-HNS criteria.<sup>20</sup> We included patients who underwent medical therapy and CATS restriction for at least 6 months without improvement and who had three or more vertigo attacks for the last 6 months before the operation. In addition, vestibular migraine has to be ruled out, as the diagnosis of Meniere's Disease and vestibular migraine may overlap and is primarily based on clinical criteria. In the study by Ghavami et al,<sup>21</sup> 15 of 37 patients with definite Meniere's Disease fulfilled the new criteria for Vestibular migraine (VM) (41% of all patients and 79% of those with migraine according to the *International Headache Society* criteria). Neff et al<sup>22</sup> presented 55 patients with Meniere's Disease and 71 patients with vestibular migraine, with an overlap of 21 patients meeting both criteria (38% of patients with

Meniere's Disease fulfilled the vestibular migraine criteria). However, differentiation of these 2 diseases is often difficult; sometimes patients with vestibular migraine are misdiagnosed as having Meniere's Disease.<sup>23</sup> Currently, there are no known definitive diagnostic tests that can reliably distinguish the 2 conditions. Patients with Meniere's Disease and those with vestibular migraine have different therapeutic options<sup>24</sup>; if there is any doubt in the differentiation of these 2 diagnosis, a medical treatment trial for vestibular migraine should be started first. Nevertheless, some patients may have the 2 diseases.

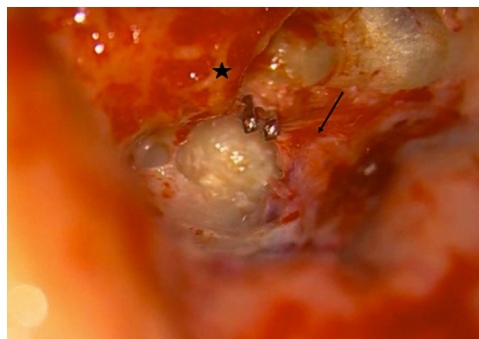
Audiogram, electrocochleography, and videonystagmography are performed during the last month preoperatively. From the first day of the operation, all operated patients were asked to stop all kinds of medication for Meniere's Disease and to stop CATS restriction.

Eligible patients were fully informed about the surgical techniques, the risks, the complications, and the alternatives to the treatment. Patients gave their consent.

## Surgical technique

Patients are operated under general anesthesia in an outpatient surgical operation setting.

First, we performed a canal wall-up mastoidectomy; the tegmen mastoideum, sigmoid sinus, and sinodural angle are identified, and the posterior bony ear canal wall is thinned. We identify the posterior semicircular canal and the dura matter of the posterior fossa. Using the prominence of the horizontal semicircular canal, Donaldson line is identified to approximate the position of the endolymphatic sac. Bone over the sac and the dura is thinned with a diamond burr. The sac is completely skeletonized and decompressed. The infralabyrinthine dura is exposed, because the main body of the sac and its lumen often lie within this area. The sac is not incised neither dissected off the posterior fossa dura. The sac is then completely decompressed, and we continue to dissect the bone of the vestibular aqueduct operculum and the posterior fossa dura from the retrolabyrinthine bone medial to the sac around the endolymphatic duct to identify the duct in its superior and inferior part in continuity from the



**Figure 1** Right ear mastoidectomy and endolymphatic sac dissection (arrow) showing the two titanium clips blocking the endolymphatic duct behind the posterior semicircular canal (star). (Color version of figure is available online.)



**Figure 2** It shows the clip applicator used to tighten titanium clip and perform the endolymphatic duct blockage, similar to the one used in vascular operation. (Color version of figure is available online.)

endolymphatic sac and to create a place to insert the tips of the forceps to clip the duct. At this level, care must be taken not to traumatize the dura, which is often thin. Finally, we block the dissected endolymphatic duct with two small titanium clips (Figure 1). The titanium clips were applied by using the ligating clip applicator, similar to the one used in vascular operation (Figure 2).

Postoperative wound management and postoperative care are similar to those in other mastoid surgical operation.

## Complications

### Intraoperative cerebrospinal fluid leak

We reported in our pilot study that 14% of our operated patients had a minor cerebrospinal fluid (CSF) leak during the EDB surgical operation owing to a small tear damage of the very thin dura matter from the petrous bone around the endolymphatic duct.<sup>25</sup> CSF leaks were managed by patching the dura matter tear with a temporalis fascia graft, covered by BioGlue (albumin-glutaraldehyde sealant) with no postoperative restriction.<sup>25</sup> However, the risk of CSF leak may cause reluctance among physicians or patients to consider the procedure; no postoperative CSF leak or meningitis was reported postoperatively. Our results show that vertigo control and hearing threshold are the same regardless of the occurrence of intraoperative CSF leaks, thus preserving the most desirable outcome for the procedure.

### Benign paroxysmal positional vertigo

After EDB, 30% patients experienced a postoperative benign paroxysmal positional vertigo of the posterior semicircular canal; of which, 24% had it in the ipsilateral ear and 6% had it in the contralateral ear.

None of the patients had a posterior semicircular canal (PSCC) injury, facial nerve injury, sigmoid sinus injury with hemorrhage, or significantly increased hearing loss.

In some cases, it is very difficult to localize the endolymphatic sac. A fibrous tissue connecting the posterior

fossa dura to the labyrinthine bone can easily be considered as the sac and its duct. Therefore, this tissue could be clipped. To prevent this kind of disappointment, we recommend after the clipping of the duct to use a beaver knife and perform a small opening in the sac to confirm its identity. If operated patients continue to experience Meniere's Disease symptom attack postoperatively, a mastoid computed tomography scan is mandatory to identify the position of the clips and to confirm the duct clipping.

## Success rate

*Vertigo control:* The mean  $\pm$  standard deviation number of spells for the last 6 months before the surgical operation and at 2 years postoperatively was  $8.4 \pm 5$  and  $0.3 \pm 0.7$ , respectively; 96.5% of this cohort did not reported any vertigo attacks at 2 years.

*Aural fullness:* All the patients had aural fullness preoperatively. However, 24 months postoperative, 75% showed improvement of aural fullness.

*Tinnitus:* Overall, 31% of the EDB group had persistent tinnitus at 24 months postoperatively.

*Bone conduction:* Concerning the bone conduction level at the 0.25-, 0.5-, 1, 2-, and 4-kHz frequencies, there was no difference in the preoperative and 24 months postoperative levels. However, 20% of patients showed a significant improvement of their bone conduction or their speech discrimination score level, or both, at 12 months after the surgical operation.

Hearing improvement, bone conduction threshold, and speech discrimination score remained stable along the 24 months of follow-up.

*Videonystagmography:* The caloric test in the operated ear done before the operation showed a total mean deficit of 47%. Postoperatively, the mean deficit was 58%. There was no statistically significant difference in the vestibular deficit between the preoperative and the postoperative periods.

## Discussion

We consider EDB an ideal treatment for Meniere's Disease by its advantages of being a nonablative surgical procedure for the vestibular system, with a conservative effect on hearing. It has been hypothesized that the endolymphatic hydrops causing Meniere's Disease is partially because of a decrease of the absorption of the endolymph at the level of the endolymphatic sac. This is not in accordance with the retrolabyrinthine approach for acoustic neuroma excision, where none of the operated patients by this technique developed Meniere's symptoms, even though the endolymphatic duct was totally sectioned.<sup>26,27</sup>

Our hypothesis is that in Meniere's Disease there is imbalance of the homeostasis of the endolymph at the level of the endolymphatic sac with an increased secretion

outweighing a decreased absorption resulting in an increased pressure in the inner ear. Thus, by blocking the endolymphatic duct, we decrease the volume of endolymph in the inner ear coming from the sac, which helps alleviating the symptoms of Meniere's Disease; in absence of this result, all our patients operated by the EDB should develop a worsening of their symptoms, which is not the case fortunately.

In 1996, Gibson reported an avulsion of the extraosseous portion of endolymphatic sac in patients experiencing Meniere's Disease. Removal of the extraosseous part of the endolymphatic sac without any drainage procedure did not increase the frequency or severity of the attacks of vertigo in any patient during a follow-up period of 2 years. In 56% of the operated ears, the hearing was deteriorated by at least 10 dB HL. To the author, endolymphatic sac removal appeared to provide better relief from vertigo than a simple drainage procedure with less tendency for recurrence

several months or years after the initial operation.<sup>28</sup> Vertigo control in this procedure could be comparable to the results of EDB; however, hearing loss is more enhanced by doing a sac avulsion. Herein lies the great advantage of duct clipping.

In a previous study, we reported the quality-of-life assessment of EDB. A response rate of 89% was obtained with the Meniere's Disease outcome questionnaire. The preoperative (S1) score was 21.4 ( $\pm 12.6$ ), and the postoperative score (S2) was 64.6 ( $\pm 21.6$ ), with a change in QOL (S3) of 43.3 ( $P < 0.001$ ). These results show that EDB is associated with a significant improvement of QOL among patients experiencing severe Meniere's Disease.<sup>29</sup>

EDB surgical operation remains a safe and effective novel procedure for the treatment of intractable Meniere's Disease with minimal adverse effects.

## Disclosure

The author reported no proprietary or commercial interest in any product mentioned or concept discussed in this article.

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