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Fully Endoscopic Microvascular Decompression for Trigeminal Neuralgia

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Trigeminal neuralgia (TN) is a chronic, progressive facial pain disorder characterized by severe paroxysmal episodes in the distribution of the trigeminal nerve. The most common cause of (TN) is compression of the trigeminal nerve by a vascular structure within the posterior fossa at the dorsal root entry zone (DREZ). Initially described by Dr. Peter Janetta, microvascular decompression has been clearly demonstrated to be a safe and effective treatment for TN with excellent immediate and long-term pain relief. Although neuroimaging has advanced significantly allowing for improved pre-operative visualization of the trigeminal nerve and determination of vascular conflict, most neurosurgeons continue to practice the MVD procedure in a very similar manner to Dr. Janetta's 1967 description. While the retrosigmoid craniotomy and operative microscope allows for an excellent view of the posterior aspect of the trigeminal nerve within the cerebellopontine angle, visualization of the anterior aspect of the nerve is limited. Additionally, adequate visualization of the DREZ may be difficult and require additional retraction of the cerebellum, potentially resulting in complications such as hearing loss and cerebellar injury. As neurosurgical experience with the endoscope has grown, a variety of authors have described performing microvascular decompression with endoscopic assistance which involves using the endoscope to inspect the trigeminal nerve for sites of compression but performing the decompression under the microscope. While the main advantage of the endoscopic approach compared to the microscopic approach is improved visualization of the trigeminal nerve from the DREZ to Meckel's cave including its inferior, anterior and superior surfaces, evolution of the procedure to a fully endoscopic approach has the additional benefits of being less invasive with minimal soft tissue dissection and cerebellar retraction allowing for reduced patient discomfort and accelerated recovery. In this technical review, we describe our approach to performing a fully endoscopic microvascular decompression including the surgical nuances that allow the procedure to be performed safely and efficiently.

**SURGICAL PLANNING AND INSTRUMENTATION**

The indications for the fully endoscopic MVD do not differ from those of the microscopic approach. However, surgical instrumentation varies considerably beyond use of the endoscope. While the asterion represents an...
INCISION AND CRANIOTOMY

We typically perform an approximately 2cm linear or curvilinear retroauricular incision enabling placement of a 14mm diameter burr hole-type craniectomy at the sigmoid-transverse junction (Figure 2). In patients with thicker skin and musculature, the curvilinear incision is preferred as the slight posterior extension does not allow the soft tissue and self-retaining retractor to restrict the angle of the endoscope along the posterior petrous bone. If instrumentation optimized for endoscopic utilization is not available, we recommend using a slightly increased craniectomy size of approximately 18mm. Minimal muscular disruption is performed due to the more superior location of the craniotomy and a self-retaining retractor or stay-sutures can be used to retract the skin edges. The burr hole is drilled with a 6mm-round cutting bit providing approximately 2mm of exposure of the inferior aspect of the transverse sinus and posterior aspect of

important landmark for any retrosigmoid craniotomy, we prefer to also utilize image-guidance during the fully endoscopic approach as accurate placement of the incision is critical to perform the procedure. Additionally, we utilize bipoars (SILVERGlide Bipolar Forceps, Stryker, Kalamazoo MI) with ultra-thin tines of variable lengths that enable increased maneuverability when working through small craniotomies and bayoneted, rotating microdissectors (Evans Rotatable instruments, Mizuho America Inc., Union City, CA) designed for endoscopic use. Although dynamic endoscopy is extremely helpful in establishing depth of field and is the preferred technique for endonasal endoscopy, the restricted anatomy of the cerebellopontine angle lends itself better to fixed endoscopy. Although several endoscopic holders are commercially available, we have utilized the Mitaka holding arm (Mitaka Kohki Co., Tokyo, Japan) which is OR-table mounted with multiple joints and pneumatically controlled, allowing for one-handed manipulation (Figure 1). We typically begin the procedure using a 4mm, 0-degree rigid endoscope (Karl Storz, Tuttlingen, Germany) that is attached to the holder arm. However, if access is limited, we not infrequently utilize a pediatric 2.4mm rigid endoscope to increase our working area for bimanual dissection. Angled endoscopes (30-degree, 70-degree) are employed as necessary. A high-definition camera and monitor are critical for performance of the fully endoscopic approach as safe dissection of the arachnoid is contingent upon subtle visual cues. Although obscuration of the endoscope lens may occur, we do not utilize an endoscope lens cleaner during this procedure as this device increases the circumference of the endoscope and further restricts working area. We have found that gentle intermittent irrigation of the endoscope by the assistant effectively restores image quality.

Figure 1
A. Illustration of placement of the incision (dotted line) and bony opening (shaded area) relative to the transverse and sigmoid sinuses. B. Slightly curvilinear 2cm incision is planned for endoscopic MVD, which is significantly reduced in length compared to our standard microscopic MVD incision (C). D. The bony opening for the endoscopic MVD is made to be the same size as a 14mm burr-hole cover.

Figure 2
A. Illustration of placement of the incision (dotted line) and bony opening (shaded area) relative to the transverse and sigmoid sinuses. B. Slightly curvilinear 2cm incision is planned for endoscopic MVD, which is significantly reduced in length compared to our standard microscopic MVD incision (C). D. The bony opening for the endoscopic MVD is made to be the same size as a 14mm burr-hole cover.
maneuverability. Additionally, the endo-
scopic view may be compromised by a
prominent suprameatal tubercle. The
lateral cerebellar surface is covered with
a rubber dam to allow for easy repetitive
introduction of instruments without incur-
ing cerebellar surface injury. Although
cottonoids can serve a similar function,
their thickness can prove obtrusive during
this minimally invasive approach. Similar
to the microscopic approach, bimanual
manipulation of the trigeminal nerve and
offending artery is then performed with
buffering of the nerve with a small piece
of polytetrafluoroethylene (Figure
4).

Once the decompression has been
performed, circumferential inspection of
the trigeminal nerve should be repeated
with angled endoscopes to ensure no
further areas of compromise, including
the DREZ, prior to endoscope removal.

**EXPOSURE AND DECOMPRESSION OF THE TRIGEMINAL NERVE**

The dura is then opened in a C-shaped
fashion extending from the transverse
sinus edge to the sigmoid sinus edge
followed by a bisection of the dura toward
the sigmoid-transverse sinus junction.
The dural leaflets are then retracted with
stay-sutures. Similar to the skin incision,
the posterior opening of the dura over
the cerebellum allows the endoscope
to be inserted with increased degree of
freedom and to achieve the optimal angle
for visualization and instrument maneu-
verability. The supero-lateral aspect of
the cerebellum is then gently retracted
and the endoscope advanced into the
cerebellopontine angle along the tento-
rium under endoscopic visualization.

As access to the cisterna magna is not
possible, temporary placement of a
fixed retractor may be necessary at this
point to allow for the arachnoid above
the cranial nerve 7/8 complex to be
sharply dissected and cerebrospinal fluid
gently aspirated to facilitate cerebellar
relaxation. The trigeminal nerve is then
inspected from the DREZ to Meckel’s
cave for any sights of vascular compres-
sion with the 0-degree and angled
endoscopes dynamically (Figure 3). At
this point, the fixed cerebellar retractor
is removed and the endoscope reposi-
tioned to its optimal location, typically
along the tentorial edge allowing for
instruments to be passed more inferiorly.
No further cerebellar retraction is neces-
ary throughout the procedure, although
sacrifice of the superior petrosal vein is
frequently necessary to achieve optimal
positioning of the endoscope. Placement
of the endoscope along the posterior
petrous face allows for an excellent view
of the inferior aspect of the trigeminal
nerve but requires a more oblique angu-
lation of the endoscope that restricts
maneuverability. Additionally, the endo-
scopic view may be compromised by a
prominent suprameatal tubercle. The
lateral cerebellar surface is covered with
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ing cerebellar surface injury. Although
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**DURAL AND BONY RECONSTRUCTION**

Similar to the microscopic approach,
careful attention to dural closure is
important to prevent post-operative cerebrospinal fluid leakage, however, with the endoscopic approach, the dura can typically be repaired primarily as there is no thermal injury to the dura. The craniectomy site is inspected for any air cells and waxed appropriately followed by reconstruction with a 14mm titanium burr hole cover plate (Figure 1).

REFERENCES
