THE RETROSIGMOID SUBOCcipital APPROACH TO TUMOURS OF THE CEREBELLOPONTINE ANGLE.

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ABSTRACT

Tumours of the cerebellopontine angle (CPA) account for 5% to 10% of all intracranial neoplasms. Various surgical approaches are possible for providing access to tumours of the CPA. The retrosigmoid approach to the posterior cranial fossa is the latest of numerous modifications of the classic suboccipital approach originally popularized by Harvey Cushing. The aim of this review is to discuss the evolution and technique of retrosigmoid suboccipital approach in relation to tumours of the CPA.

KEYWORDS: Retrosigmoid suboccipital approach, tumours cerebellopontine angle, acoustic neuromas, vestibular schwannomas, retrosigmoid approach, suboccipital approach, petroclival meningiomas.

INTRODUCTION

Tumours of the cerebellopontine angle (CPA) account for 5% to 10% of all intracranial neoplasms.1 The most common lesion in the CPA is an acoustic neuroma or, more properly renamed, a vestibular schwannoma. In a large series of 1,354 lesions reported by Brackmann and Bartels2 in 1980, 91% of the tumours were vestibular schwannomas, 3% were meningiomas, 2% were primary cholesteatomas and the remaining 4% were of widely varied histologic types.

The cerebellopontine angle (CPA) is a complex triangular space bounded by the brainstem medially, the cerebellum posteriorly and superiorly and the temporal bone laterally. Magnetic resonance imaging (MRI) has considerably improved the preoperative evaluation of tumour type. It enables the detection of CPA tumours at a much earlier stage. Lesions of only a few millimetres in size, at a time when symptoms may be limited to mild hearing loss or even simply unilateral tinnitus, can be identified with MRI with gadolinium enhancement.

In the early 1800s, Jean Cruveilhier presented a fascinating yet tragic account of a young woman with an acoustic neuroma. He carefully documented her progressive symptoms, both localized and generalized. The local symptoms resulted from direct tumour pressure and included headaches, blindness, hyposmia and dysgeusia. She lived with these symptoms from age 19 until her death at age 26 years. Cruveilhier subsequently performed a postmortem examination and provided a remarkable description of a large acoustic neuroma: a firm, benign lesion arising from the internal auditory canal. It had eroded the temporal bone and compressed the surrounding nervous tissue, but true invasion was not seen. This detailed account is the first well documented case of the clinical and pathological findings of a CPA lesion.

It was Harvey Cushing,3 in the early 1900s, who brought focused attention to CPA lesions and took the first large step towards successful surgical removal of these tumours. He emphasized early detection through high clinical suspicion, careful history taking and thorough physical examination. To minimize the high morbidity associated with total tumour removal, he advocated debulking and partial tumour excision. Indeed, this tactic lowered morbidity rates. The modern era of surgical removal for CPA lesions began in the 1960s, when the suboccipital approach was refined with the aid of operating microscope, by the neurosurgical community. Today, the multidisciplinary skull base team is well versed in a variety of surgical approaches and tailors the surgical planning for each individual patient. Mortality rates have dropped to 1% in large series and morbidity has been steadily decreasing.
THE RETROSIGMOID SUBOCCIPITAL APPROACH.\[4,5,6,7,8\]

The retrosigmoid approach to the posterior cranial fossa is the latest of numerous modifications of the classic suboccipital approach originally popularized by Harvey Cushing.\[3\] The approach was modified by Dandy\[9\] in 1941, with a significant reduction in mortality and morbidity. The approach traditionally used a sitting position and a large bone window extending from the midline to the sigmoid sinus and necessitated partial cerebellar resection. With the advent of the operating microscope and accompanying improvement in microsurgical technique, improved results were obtainable with less morbidity and smaller craniotomies. The suboccipital approach is augmented by the “transmeatal” opening of the internal auditory canal to gain access to the intracanalicular portion of the tumour. In some temporal bones, the anatomic configuration of the labyrinth and canal makes it impossible to expose the most lateral portion of the tumour without entering the labyrinth. Failure to access and resect tumour in the lateral aspect of the internal auditory canal may result in recurrent tumour.

Preparation
The first important step in the suboccipital approach is the patient positioning because an oblique line of sight from a posterior lateral viewpoint is necessary for adequate exposure of the CPA. The patient is placed in the three-quarters lateral or park bench position, with the head in pinions (Fig. 1). Care is taken to cushion and support the upper leg and arm to prevent pressure sores. A roll is placed under the dependent axilla and a mattress pad is suggested. The patient should be firmly secured to the table so that it may be rotated towards and away from the surgeon. This is achieved with straps across the shoulders, hips and legs. The shoulder is gently depressed using tape extending from the shoulder to the foot of the bed. The Mayfield head rest with its anterior border and transverse sinus as its superior border, measuring approximately 4 × 4 cm in extent (Fig. 3). Either a craniotomy or craniectomy may be performed. If a craniotome is used to create a bone flap, it is still prudent to use a bur when removing bone over the sigmoid sinus (Fig. 4). This allows careful dissection of the delicate dural sinus and emissary vein with less risk of bleeding and easier exposure when bleeding occurs. Mastoid air cells are usually encountered lateral or anterior to the sigmoid sinus. They should not be avoided because of a concern over CSF leak because the sinus must be well exposed to gain adequate anterior exposure. The air cells are occluded with bone wax at the end of the procedure. Once the bone has been removed, the dura is opened. The dural incision forms an anteriorly pedicled dural flap (Fig. 5). The corners of the dural two-layer closure (Fig. 2). The insertions of the neck musculature are freed from the skull with electrocautery and reflected inferiorly. Dissection proceeds onto the interior surface of the occiput; the periosteum is elevated off the lateral mastoid and occiput, along with the muscular attachments. Self-retaining retractors are inserted, one in the skin and one in the muscular layer.

![Fig. 1: The patient is placed in the three-quarters lateral position with the head placed in Mayfield Tongs. A “lazy-S” incision is created four fingerbreadths behind the postauricular crease.](image1)

![Fig. 2: The skin and subcutaneous tissue flaps are elevated and retracted with a self-retaining retractor.](image2)

Dexamethasone is administered intravenously every 8 hours for 48 hours at a dose of 0.1 mg / kg body weight, with the first dose given before surgery. General anaesthesia is induced and maintained by tracheal intubation after the administration of a short-acting muscle relaxant. No further muscle relaxants are used for the remainder of the procedure.

Procedure
The surgical incision is a “lazy - S” configuration four finger breadths behind the postauricular crease, extending below the bony occiput to the upper neck (Fig. 1). After the subcutaneous layer has been divided, a small amount of undermining is performed, in anticipation of a
flaps are retracted with silk stitches. A moist cotton pledget is placed over the cerebellum and a flat blade retractor is used gently to retract the cerebellum. The arachnoid tissue is incised and decompression of the posterior fossa is achieved at the cisterna magna inferiorly or at the CPA cistern. CSF is aspirated until adequate working space is exposed. Some surgeons choose to use mannitol to enhance intracranial decompression: this is usually administered in a dose of 1 gm / kg body weight intravenously before opening the dura. Arachnoid adhesions between the cerebellum and dura are lysed and the flat blade retractor is introduced into the CPA. When the tumour (or the audiovestibular nerve complex) can be well visualized, the retractor is stabilized, using a large, saline-soaked cottonoid to protect the cerebellum (Fig. 6).

With small tumours, several landmarks may be visible at this time. Cranial nerves VII and VIII are seen passing from the brainstem into the internal auditory canal. Superior to this, the trigeminal nerve may be seen, with the abducens and trochlear nerves anteriorly. Inferiorly, cranial nerves IX, X and XI create a fan-shaped formation before they pass into the jugular formation and are covered by an arachnoid sheath. Larger tumours often obscure these landmarks and require debulking before all of these structures can be identified. Once adequate exposure of the posterior face of the petrous bone and the operculum is achieved, the dura over the internal auditory canal is incised, elevated and reflected as superiorly and inferiorly based flaps (Fig. 7).
Fig. 7: Incisions are created in the dura over the petrous bone, creating superiorly and inferiorly based flaps.

Before exposure of the internal auditory canal, tumours greater than 1.5 cm, measured from the porous acousticus, are debulked with a Cavitron ultrasonic aspirator (Fig. 8). Tumour debulking remains within the confines of the capsule to avoid inadvertent injury to surrounding structures. Smaller tumours are debulked with bipolar cautery and cup forceps. A biopsy is obtained at this point in the procedure and sent for frozen-section histologic examination.

Fig. 8: the Cavitron ultrasonic aspirator is used to debulk the intracapsular tumour in the cerebellopontine angle.

Bone removal is then performed with a 3 or 4 mm coarse diamond bur and copious suction-irrigation. In hearing conservation procedures, it is imperative to avoid entering the posterior semicircular canal and vestibule. One important landmark is the operculum, a bony projection along the posterior face of the petrous bone at which point the endolymphatic duct enters the bone (Fig. 9). Remaining medial and anterior to the endolymphatic duct and following it through its “inverted J" - shaped course reduces the risk of inadvertent entry into the vestibule and posterior semicircular canal. As the bony dissection proceeds, care is taken to identify the “blue lines” of these structures before their damage. In general, upto 7 mm of bone can be removed safely from the medial aspect of the internal auditory canal. The anatomy of the labyrinth and degree of lateral extension of the tumour may prohibit hearing conservation. Often, undesirable anatomy and very lateral tumour extension can be assessed before surgery on the gadolinium-enhanced MRI. In situations in which patients have no usable hearing or extremely poor prognostic factors for useful hearing conservation, wider bone removal is performed. If the most lateral extent of the tumour cannot be accessed without labyrinthine injury because of the anatomic relationships, the hearing is sacrificed.

Fig. 9: The internal auditory canal is skeletonized using the operculum and endolymphatic duct as landmarks. Dissection of bone is performed medial and anterior to the endolymphatic duct to avoid inadvertent entry into the vestibule and posterior semicircular canal. In general, up to 7 mm of bone can be removed safely from the medial aspect of the internal auditory canal.

As the internal auditory canal is skeletonized along its entire length, an eggshell thickness of bone is left over the dura. This final layer of bone is removed by careful dissection with a diamond bur. The area is then copiously irrigated to remove all bone dust.

At the lateral extent of the internal auditory canal, “Bill’s bar” is identified, which delineates the superior vestibular and facial nerves. The location of the facial nerve is ascertained by stimulation. The dura of the internal auditory canal is incised along the edges of the canal. The superior vestibular nerve is removed from its attachments to the labyrinth and retracted medially. Dissection of tumour and vestibular nerve then proceeds in a lateral to medial direction along the length of the canal (Fig. 10). At this point, the location of the facial nerve has been verified. It typically is displaced anteriorly and splayed over the anterior surface of the tumour capsule as it exits the porus.
Fig. 10: The vestibular nerves and intracanalicular tumour are dissected off of the facial and cochlear nerves.

After removal of the intracanalicular portion of the tumour, the cerebellopontine component of the tumour is debulked. Depending on the extent of the tumour, debulking is performed with cup forceps and bipolar cautery or the Cavitron ultrasonic aspirator. As the contents of the tumour are excised, the capsule is rolled inward and dissected off of the underlying facial and cochlear nerves. As debulking progresses, the brainstem origination of cranial nerves VII and VIII is identified and the tumour dissected off of the brainstem.

Closure
After completion of tumour removal, a careful check is performed to ensure hemostasis. Valsalva maneuvers and irrigation are used to identify sites of bleeding and bipolar cautery and hemostatic agents such as Surgicel or Avitene are used as necessary.

Bone wax is carefully placed into all air cells around the internal auditory canal and the mastoid air cells at the edge of the craniotomy to prevent CSF leak through the mastoid and middle ear. A continuous sheet of the bone wax reduces the risk of gaps allowing penetration of CSF into air cells. It is often difficult to see the entire face of bone around the internal auditory canal to inspect for exposed air cells because of the angle of exposure.

The dura that had originally been on the face of the petrous apex, overlying the internal auditory canal, is reflected into the surgical defect. A piece of temporalis fascia is then placed over the internal auditory canal. The large, anteriorly based dural flap is closed with a watertight closure, if possible, using 4-0 silk. The craniotomy bone flap is secured into position with nylon sutures from the bone flap to the edges of the craniotomy. The bone chips that were saved in normal saline are placed around the remaining exposed perimeter (Fig. 11). The attachments of the neck musculature are reattached to the skull by suspension sutures, which pass through holes at the edge of the craniotomy. The skin is closed in three layers: galea, subcutaneous and skin. A pressure dressing is applied and left in position for 48 hours.

CONFLICT OF INTERESTS
The authors declare that there is no conflict of interests that could influence this work.

FUNDING ACKNOWLEDGEMENTS
The authors declare that there was no financial aid obtained from any source for the preparation of this manuscript.

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