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Technical Note

Intraventricular trigonal meningioma: Neuronavigation? No, thanks!

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Abstract

Background: Most of the time meningiomas are benign brain tumors and surgical removal ensures cure in the vast majority of the cases. Thus, whenever possible, complete surgical resection should be the goal of the treatment.

Methods: This is a report of our surgical technique for the operative resection of a trigonal meningioma in a resource-limited setting. The necessity of accurate and deep knowledge of the regional anatomy is outlined.

Results: A 44-year-old male presented to our outpatient clinic complaining of cephalalgia increasing in frequency and intensity over the last month. His neurological exam was normal, yet a brain computed tomography scan revealed a lesion in the right trigone of the ventricular system. The diagnosis of possible meningioma was set. After thoroughly informing the patient, tumor resection was decided. An intraparietal sulcus approach was favored without the use of any modern technological aids such as intraoperative magnetic resonance imaging or neuronavigation. The postoperative course was uneventful and a postoperative computed tomography scan demonstrated the complete resection of the tumor. The patient was discharged two days later with no neurological deficits. In a two-year-follow-up he remains recurrence-free.

Conclusion: In the current cost-effective era it is still possible to safely remove an intraventricular trigonal meningioma without the convenience of neuronavigation. Since the best neuronavigator is the profound neuroanatomical knowledge, no technological advancement could replace a well-educated and trained neurosurgeon.

Key Words: Neuronavigation, surgical resection, trigonal meningioma

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INTRODUCTION

Even though it has been almost a century since the first meningioma was radically removed from the lateral ventricle by Cushing, the surgical management of these tumors still remains a challenging task.[6] Intraventricular meningiomas as a rule arise in the trigone[29,42,54,61] and several surgical approaches to this region have been meticulously described.[7,9-12,15,17,20,22,23,28,30,33,38,39,41-44,46,49,53,54,57,58,60,61] For these lesions, many neurosurgeons currently employ new technological adjuncts intraoperatively, and neuronavigation is one of them.[54] At the same time, there are many resource-limited Neurosurgical Departments globally (and the authors' Department is certainly not excluded) that strive to treat a vast variety of lesions without having access to such sophisticated tools.

Hereby, the authors present the excellent surgical outcome of a patient presenting with a right trigonal meningioma (TM) using the intraparietal sulcus approach. The meningioma was excised without the aid of a neuronavigational system. It is the authors' belief that such lesions can be safely treated if a profound knowledge of the regional surgical anatomy is acquired even in the current era of healthcare budget cuts.

CLINICAL AND SURGICAL DESCRIPTION OF THE CASE

A 44-year-old male had a history of intermittent mild headaches for a period of two years. The symptom had been increasing in frequency and intensity during the last month prior to the medical consultation. The neurological exam failed to detect any abnormality. Visual function was intact. The history revealed no other pathology. A brain computed tomography (CT) scan with contrast medium was obtained demonstrating a hyperdense lesion with homogenous contrast enhancement located at the right trigone of the lateral ventricle [Figure 1]. The lesion was compatible with a TM.

Surgical technique

After obtaining an informed consent, the patient was taken to the operating room. Due to the tumor's location, the authors opted for an intraparietal sulcus approach. An enlarged trigone due to a 32 cm^3 tumor favored the option for this approach, making the distance from the cerebral sulci to the trigone shorter than the usual. No lumbar spinal drainage was performed preoperatively.[54]

The patient was placed in an elevated supine position, with the head in a neutral position, maintained by a three-point fixation device and slightly flexed under general endotracheal anesthesia. A "C"-shaped right parietal skin incision was made verifying that the Keen's point (found 3 cm above and 3 cm behind the external auditory meatus) was at the centrum of the craniotomy [Figure 2a]. A paramedian rectangular craniotomy was then performed using four burr holes and extending 6 cm laterally to the sagittal suture and 8 cm anterior to the lambdoid suture in order to expose the parietal lobe without extending beyond the superior sagittal sinus [Figure 2b].

The dura was opened in a horseshoe fashion so that

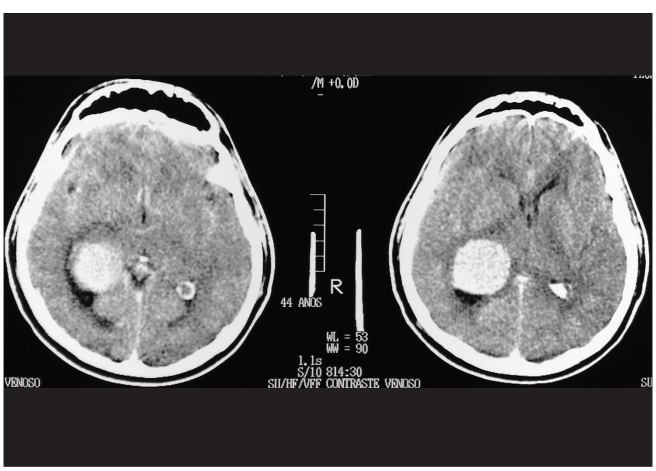

Figure 1: Preoperative imaging, brain computed tomography scan (with contrast)

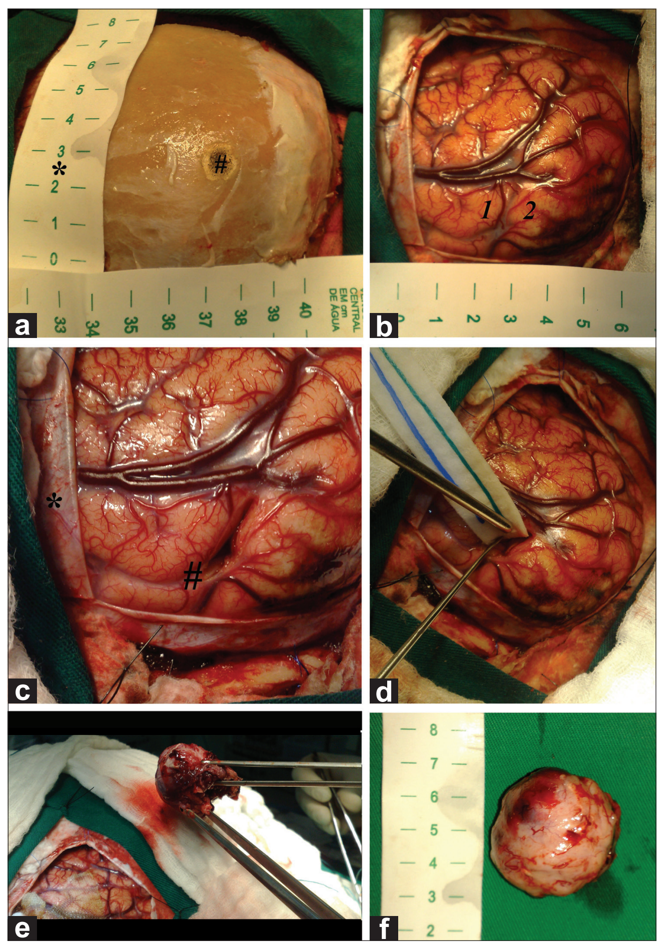

Figure 2: Intraoperative images. (a) craniotomy planning (*: sagittal suture, #: Keen's point) (b) exposure of right parietal lobe (1: superior parietal lobule, 2: inferior parietal lobule) (c) identification of the intraparietal sulcus (#) and sagittal sinus (*) (d) dissecting the intraparietal sulcus (e) en bloc resection of the tumor (f) macroscopic appearance of the trigonal meningioma

the superior sagittal sinus could be easily located and protected. Since the intraparietal sulcus is the only sulcus that usually runs almost parallel and 3 cm lateral to the midline in this area dividing the parietal lobe in the superior and inferior parietal lobules,[59] its identification was not laborious [Figure 2c]. After having identified the intraparietal sulcus, careful microsurgical techniques were employed to reach the bottom of the sulcus [Figure 2d].

This corresponds to the roof of the atrium which is free of optic radiations and is formed by the body, splenium and tapetum of the corpus callosum.[22,28,49,57,59] Of note, the optic radiations are separated from the lateral wall of the atrium by tapetum fibers.[28,49] Consequently, it is imperative to maintain a straight course during dissection, from the cerebral surface to the roof of the atrium, in order to preserve the optic radiations located laterally.[57,58]

The authors were able to perform an "en bloc" resection of the tumor with preservation of the neuroanatomical structures [Figure 2e]. No brain retractors were used. The macroscopic aspect of the tumor was compatible with meningioma [Figure 2f]. Standard hemostasis was achieved with electrocautery and oxidized cellulose (Surgicel®, Ethicon, Inc., Somerville, NJ, USA). The dura mater was closed in a watertight manner. The bone flap was repositioned and fixed to the bone with silk sutures.

The histopathologic findings were consistent with meningothelial meningioma (Grade I, 2007 WHO classification). A photomicrograph showing the tumor specimen could not be retrieved. The postoperative course was uneventful and a new postoperative head CT scan was asked that documented no residual tumor [Figure 3]. The patient left the hospital two days later, being neurologically intact. Two years after the operation, he is still being followed up in the outpatient clinic and he is recurrence-free.

Figure 3: Postoperative image, brain computed tomography scan (with contrast)

DISCUSSION

This technical note presents the favorable surgical outcome of a patient harboring a right TM using an intraparietal sulcus approach. Due to limited financial support, our Department lacks many modern tools such neuronavigational systems,[54] tractography,[50] titanium plates, such as Craniofix® plates (Aesculap AG, Tuttlingen, Germany), potassium titanyl phosphate lasers,[54] and endoscopic adjuncts to intraventricular surgery.[27] The operation was pulled off based solely on the adequate knowledge of the anatomical elements that surround this kind of lesions.

In adults, meningiomas comprise about 14-20% of all brain tumors,[8,42,55] while only 1-4.2% of all primary pediatric intracranial tumors are meningiomas.[48] Intraventricular meningiomas are responsible for only 0.5–5% of all adult meningiomas series.[4,8,15,41,42,51,55,58,61] An intraventricular location is found in 9.4-20% of children.[10] The majority of intraventricular meningiomas are located in the lateral ventricles, 90% of them occurring in the trigone.[29,42,61] They show a predilection for the left side,[5,6,8-10,25,31,34,36,42,53,55,56,61] even though many TM have been described on the right side too.[11,21,29,32,35,44,46-48,51,61] They are more common in females,[2,5,6,9,10,29,32,36,38,42,44,47,51,54,56,58,61] while male patients have also been documented.[8,11,21,25,30,35,41,46,48,53,55,61] The age at diagnosis ranges from 22 to 75 years.[5,46]

TM seem to originate from the arachnoidea of the choroid plexus and the tela choroidea.[2-4,58,61] The histological diagnosis includes many types, namely fibroblastic (which is the predominant one),[31,38,41,47,54] meningothelial,[2,31,32,35,41,46] transitional,[2,10,25,31,55,61] lymphoplasmacytic metaplastic,[2] psammomatous,[29] atypical,[2,9,11,53] and rhabdoid-papillary.[8] Malignant meningiomas[5,9,10,21,25,31,48] could metastasize to the spine through the cerebrospinal fluid (CSF)[8,9,21] but extraneural metastases (liver) are also possible.[11] In addition, transitional meningiomas can progress to anaplastic meningiomas and metastasize via the CSF.[51] An encapsulated by dura-like membrane TM has also been reported.[61]

A group of entities mimicking TM includes choroid plexus metastases of renal cell carcinoma with[16] or without[24,45] intraventricular hemorrhage, glioblastoma multiforme,[49] and cavernous malformations.[19,26]

TM could be an incidental finding.[2,42,44] When symptoms are present, the most common ones are related to the gradual increase of intracranial pressure rather than the location of the tumor,[2,3,36,37,42,58] and they are usually delayed because TM usually do not obstruct the CSF pathway. Actually, TM may be very large at diagnosis and the principal symptoms and signs are motor, sensory and cognitive disturbances, as well as visual field deficits.[10,42]

Symptoms frequently encountered include: fatigue,[47] cephalalgia[5,8-12,29,30,35,38,41,42,48] that is often aggravated by body posture changes,[58] nausea,[2,29,35] dizziness,[30,41,44,56] vomiting,[2,10,29,38,44,48] tinnitus,[35] impairment of vision,[2,56,58] apathy,[47] epileptic attacks,[2,10,36,37,55] speech difficulty,[53] and numbness of lower extremities.[54]

The most commonly reported signs are: corticospinal disturbance[2,5] (including hemiparesis[2,9,10,12,21,32,35,36,41,55] and hemisensory disturbance,[32,47,53]), altered mentation,[5,6,12,36,41] memory impairment,[6,10,42] decreased rapid alternating movements on one hand,[30] dressing apraxia,[47] gait disturbance,[9,30,32,35,41,48] papilledema,[12,30,35,36,42] homonymous hemianopsia,[5,12,30,32,35,36,38,41,47,49] inferior quadranopsia,[42,61] even oculomotor nerve paresis,[38] visual,[35] and consciousness loss.[2,21,38] Cognitive changes such as dysphasia/aphasia, dyslexia/alexia, dysgraphia/agraphia and dyscalculia/acalculia are also presented.[2,53]

On CT images there are certain characteristic features that suggest the diagnosis of TM. An isodense[8] or hyperdense mass attached to the plexus, enhancing homogeneously[2,10,12,35,41,52] or heterogeneously[8] after contrast infusion and having a smooth margin[41,55] is often seen.[4,10,11,12,35,47] In many instances, one could observe a calcified mass in the atrium[2,3,8,10,29,56] or local widening of the ventricle.[41,52] Not seldom, a varying degree of cerebral edema is noticed.[2,41] TM rarely present with a central low-density cystic region suggesting necrosis,[52,53] and intraventricular hemorrhage.[29,38]

The magnetic resonance imaging (MRI) manifestation of TM consists of a well-demarcated[55] lobular mass abundantly enhanced on T_1-weighted images after gadolinium-diethylenemtriaminepenta-acetic acid (Gd-DTPA) administration. The enhancement is usually homogeneous,[2,6,29,32,47,61] but heterogeneously enhanced TM have been also described.[8] TM show low signal intensity on T_1-sequences and high signal intensity on T_2-sequences.[9,10,12,18,29,41,47,53] Multiple cystic components[9,48,53] as well as edema around the mass could occasionally be distinguished.[2,54]

Magnetic resonance spectroscopy (MRS) has been recently incorporated in the diagnostic armamentarium. It shows a high choline peak with undetectable creatine and N-acetyl-aspartate peaks, thus excluding an aggressive intraaxial origin of the tumor.[12,35,55]

Furthermore, angiography is employed for demonstrating not only the vascular supply and the effects imposed upon the surrounding cerebral vasculature by TM,[4,5,12,52] but also confirming the position of prominent parasagittal draining veins.[12] TM are essentially supplied by the anterior choroidal artery[2,29,35,41,44,46,47,54,61] which eventually becomes hypertrophic.[10,40,52] Trigone-specific signs include the 'flare sign' (dissociation of the two plexal branches of the anterior choroidal artery due to a TM), and the displacement of the inferior ventricular vein anteriorly delineating the anterior margin of TM.[40] Besides, arterial supply could be derived from various other arteries; postero-lateral choroidal,[2,4,6,29,35,41,42,44,47,54,56] medial posterior choroidal,[2,6,35,41,44,47,53,54] and posterior cerebral (thalamoperforating artery).[47]

Nowadays, the surgical treatment of TM remains a challenge, even with the new neurosurgical technologies available (neuronavigation, functional-MRI, MRI-tractography, diffusion tensor imaging, embolization).[1,6,28,47,50,54] This is mainly due to the fact that the trigone is in close proximity to the fibers of the internal capsule, the striate cortex and the optic radiations.[1,22,28,49,57,58,60] Hence, during an operation, there is an increased risk of injuring the visual, motor, sensory and speech conduction tracts.[22,28,49,60] The main approaches to these lesions involve three basic pathways: a superior approach, a posterior approach and a lateral approach.[22,23,33,39,49,60] It is a common sense that when there are numerous approaches for the same area, none of them is perfect. Indeed, this is true regarding TM. Each approach has its own distinct advantages and disadvantages. One should perform the approach that he/she is more comfortable with.[1,34] Detailed description of all the approaches is beyond the purpose of this technical note. Only a brief outline of them will be presented in the following paragraphs.

In the superior parietal approach, which is commonly used, an incision is made in the superior parietal gyrus to access the medial and lateral regions of the trigone.[7,15,28,41,42,49,53,57,58,60] This approach provides a direct route to the atrium but some complications such as apraxia, acalculia, and homonymous hemianopsia have been described.[31,42,49,60] The authors do not favor this approach in order to avoid cortical incisions. It is their belief that it can increase the risk of epileptic seizures, although a large series comparing transcortical and transcallosal approaches for intraventricular tumors failed to validate this assumption.[37] In fact, the transcallosal approach was associated with a higher risk of postoperative seizures.[37]

The lateral approaches involve incisions on the posterior aspect of the medial or inferior temporal gyrus and on the temporoparietal junction.[9,10,12,22,28,38,39,43,44,46,49,57,58,61] The morbidity related to lateral access to the trigone includes language deficits, ideomotor apraxia, acalculia (dominant hemisphere), visual fields disturbances (quadranopsia), and impaired recognition of emotions (nondominant hemisphere).[5,31,42,60] Yet, an approach inferior to the inferior temporal sulcus seems to avoid traversing through the optic radiations.[43] The authors avoid lateral approaches because magnetic resonance tractography and awake brain mapping surgery require funds that are currently unavailable.

The posterior transcallosal approach does not affect the optic radiations but it is associated with auditory and visual disconnection syndromes resulting from posterior callosotomy.[10,20,22,23,28,30,41,44,49,57,58,60]

Another commonly used approach is the parieto-occipital interhemispheric approach (or occipital transcingulate approach) described by Yasargil.[10,11,22,33,44,49,54,57,59,60] This approach does not transect the corpus callosum, does not damage the optic radiations and is not associated with language deficits, once it does not violate the eloquent language cortex.[33,44,49,60] Nonetheless, postoperative recent memory disturbance has been documented.[54] An anatomical advantage of this approach is the parallel course of the parieto-occipital ascending draining veins before joining the sinus which provide a free corridor toward the splenium and the posterior callosal and dorsal mesencephalic cisterns.[60] In the authors' opinion, this approach presents two disadvantages. The first one is the sitting position required to perform this approach and its possible complications. The second is the need of brain retractors to gain an adequate surgical corridor.

A contralateral transfalx approach has also been described recently as an alternative approach.[57] It provides access to the contralateral atrium by cutting the falx while at the same time avoids damage to the visual cortex, splenium, and optic radiation. Moreover, the atrium is exposed with a wider surgical angle compared with the conventional homolateral posterior interhemispheric transprecuneus gyrus approach.[33] However, some drawbacks that should be mentioned are: the retraction of the contralateral occipital lobe, the potential injury of the visual pathways homolaterally, endangering the integrity of the venous sinuses by cutting the falx, and the disadvantages of the semi-sitting position.[13,57]

A few neurosurgeons prefer the supracerebellar infratentorial approach. This one provides access to the inferior part of the atrium by sectioning the occipitotemporal gyrus or the collateral sulcus on the inferior surface of the temporal lobe.[57]

Another approach proposed is the supracerebellar transtentorial transcollateral sulcus one for access to the medioposterior aspect of the atrium by cutting the tentorium cerebelli.[17] No damage to optic radiation fibers is caused but there is a potential risk of injuring the veins.[17] Air embolism and transient deafness may also follow this approach.[17,22]

Irrespective of the neurosurgeon's approach preference,[1,34] TM can be permanently cured with complete removal.[1,3,7,12,14,34,42,58] And is neuronavigation really absolutely necessary for treating them? No. As almost all older colleagues used to say, the best neuronavigator is the deep knowledge of surgical anatomy.[34,49] Neuronavigational systems could and do assist neurosurgeons in treating deep-seated lesions but by no means should their absence prevent us from acquiring a secure surgical outcome.

EPILOGUE

The take-home message that should be imprinted in one's mind is that Neurosurgery cannot be practiced rationally without profound knowledge of neuroanatomy. A sound understanding of tracts and other vital structures could render (at least in part) modern technological amenities less necessary. Lack of availability of neuronavigation in the case presented was not an obstacle for safely removing a TM through the intraparietal sulcus approach.

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