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CIRCULAR MULTIPLE BURR HOLE FOR SURGICAL REMOVAL OF AN EXTRA AND INTRACRANIAL MENINGIOMA (TECHNICAL NOTE)

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Introduction. Intracranial meningiomas are the most common primary central nervous system tumors and are mostly benign, arising from the meninges surrounding the brain, nerves, and vessels. An obstacle to the surgical resection of meningiomas is the risk of injury to the superior sagittal sinus and the resulting compromise to the integrity of the venous drainage. This article describes a circular multiple trepanation technique, which can be used to safely perform resection of extracranial and intracranial meningiomas, aiming to reach the largest possible tumor area, since patient prognosis is directly proportional to tumor resection.

Surgical technique. The first step is to make a horseshoe incision, then drill burr holes, forming a circumference around the bone meningioma. The next step is to connect the orifices, incising the dura mater affected by the tumor along the periphery of the extracranial meningioma. Subsequently, the bone and the dura mater are elevated. Thus, the bone and dural part are separated from the intradural part, which is, in turn, removed later.

Results. The circular multiple trepanation technique was performed and a gross total resection of the extracranial and intracranial meningioma (Simpson grade I) was achieved. The postoperative period showed positive results, with an improvement in the patient's eye disorder and interruption of generalized tonic-clonic seizures.

Conclusion. The circular multiple trepanation approach for treating extracranial and intracranial meningiomas described in this note is performed safely and effectively, with good patient prognosis. Although it is a recognized option, it has been insufficiently described, and it is therefore important to expand the knowledge and proper use of this technique among neurosurgeons.

Keywords: multiple trepanation, parasagittal meningioma, extracranial meningioma, intracranial meningioma, burr holes

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Круговое множественное отверстие для хирургического удаления экстра- и интракраниальной менингиомы (техническое примечание)

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Введение. Внутричерепные менингиомы являются наиболее распространенными первичными опухолями центральной нервной системы и в основном доброкачественными, возникающими из менингиом, окружающих мозг, нервы и сосуды. Препятствием для хирургической резекции менингиом является риск повреждения верхнего сагиттального синуса и связанное с этим нарушение целостности венозного дренажа. В данной статье описывается техника циркулярной множественной трепанации, которая может быть использована для безопасного выполнения резекции экстракраниальных и интракраниальных менингиом с целью достижения максимально возможной площади опухоли, поскольку прогноз пациента прямо пропорционален резекции опухоли.

Хирургическая техника. Первым шагом является подковообразный разрез, затем просверливают отверстия, формируя окружность вокруг костной менингиомы. Следующий шаг – соединение отверстий, разрез твердой мозговой оболочки, пораженной опухолью, по периферии экстракраниальной менингиомы. Затем кость и твердая мозговая

оболочка приподнимаются. Таким образом, кость и дуральная часть отделяются от интрадуральной части, которая, в свою очередь, удаляется позже.

Результаты. Была выполнена круговая множественная трепанация и достигнута грубая тотальная резекция экстракраниальной и интракраниальной менингиомы (I класс по Симпсону). Послеоперационный период показал положительные результаты. Уменьшилось глазодвигательное расстройство пациента и прекратились генерализованные тонико-клонические припадки.

Заключение. Описанный метод циркулярной множественной трепанации для лечения экстракраниальных и интракраниальных менингиом выполняется безопасно и эффективно, с хорошим прогнозом для пациента. Хотя это признанный вариант, он недостаточно описан, поэтому важно расширить знания и правильное использование этой техники среди нейрохирургов.

Ключевые слова: множественная трепанация, парасагиттальная менингиома, экстракраниальная менингиома, интракраниальная менингиома, бурсовое отверстие

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INTRODUCTION

Intracranial meningiomas are primary central nervous system tumors and are mostly benign [1, 3]; 15–20 % are atypical and only 1–2 % are malignant [3].

A typical intracranial meningioma is an extra-axial [3] and dural-based mass, originating from the arachnoid cap cells. These tumors are more common at sites of dural folds, so these cells are associated, for example, with the villi of the venous sinuses [2].

Parasagittal meningiomas comprise 20 % to 30 % of all meningiomas [7]. This tumor is defined by Harvey Cushing and Louise Eisenhardt as one that fills the parasagittal angle, without brain tissue between the meningioma and the superior sagittal sinus (SSS). Based on their location along the SSS, parasagittal meningiomas are divided into those located in the anterior, middle and posterior third of the sinus [7].

Furthermore, there are also extracranial meningiomas, rarely visualized and commonly found in the head and neck region (sinonasal tract, temporal bone, and scalp). They may be originated from primary intracranial meningiomas, which can enlarge and develop a direct extension, or from ectopic arachnoid cells [4].

Additionally, extracranial meningioma might arise from mesenchymal cells, which are capable of differentiating into countless other cells [4]. As an unusual tumor, it poses a challenge in medicine, often resulting in erroneous diagnoses of patients with extracranial meningiomas.

Advances in neurosurgical techniques are extremely necessary. Proposed surgical procedures for resection of meningiomas are complicated by the risk of injury to the superior sagittal sinus and the resulting compromise to the integrity of the venous drainage. This article describes the circular multiple trepanation, which is a resection of extracranial and intracranial meningiomas. The surgical approach performed is innovative and unusual. Although it is already used, it has been poorly described to date. Its objective is to resect the tumors, minimizing the risk of injuring the superior sagittal sinus, and achieve optimized performance in the resection of meningiomas. Moreover, it aims to reach the largest possible tumor area, since patient prognosis is directly proportional to tumor resection.

SURGICAL TECHNIQUE

After general anesthesia is administered, the patient is positioned in ventral decubitus and the skull is placed in a Mayfield three-pin skull fixation device (Codman, USA). The first step is the horseshoe incision (fig. 1-*a* and fig. 2-*a*). Since the meningioma is extensive, it is necessary to leave about three centimeters for visualization of the meningioma margin when opening. Trepanation holes are performed (fig. 1-*b* and fig. 2-*b*), forming a circumference around the bone meningioma (tumor-invaded bone). The orifices are connected with a rongeur, and the dura mater affected by the tumor is incised around the periphery of the extracranial meningioma by the trepanation holes (fig. 2-*c*), therefore isolating the bone and dura mater. The bone and affected dura mater are elevated. Thus, the bone and dural part are separated from the intradural part, which is, in turn, removed later (fig. 1-*c*). In the intradural part, the SSS and a two-centimeter area around it are completely visible, exposing both sides of the sinus. The veins draining the tumor are coagulated and the dissection of the meningioma occurs away and separated from the cerebral parenchyma. The part of the tumor closest to the SSS is dissected last.

RESULTS

A 43-year-old woman with generalized tonic-clonic (GTC) seizures underwent imaging examination that revealed an extracranial and intracranial meningioma (fig. 3). Upon investigation, it was found that, in addition to GTC seizures, she had grade IV left hemiparesis, attention deficit and papilledema, detected on fundoscopic examination.

Tumor resection was performed using the circular multiple trepanation technique and a gross total resection of the extracranial and intracranial meningioma was achieved. The degree of resection on the Simpson grading scale was Grade I. Postoperative imaging confirmed successful meningioma removal (fig. 4-*b*), and the patient failed to present GTC seizures, in addition to obtaining improvement in the ophthalmologic disorder.

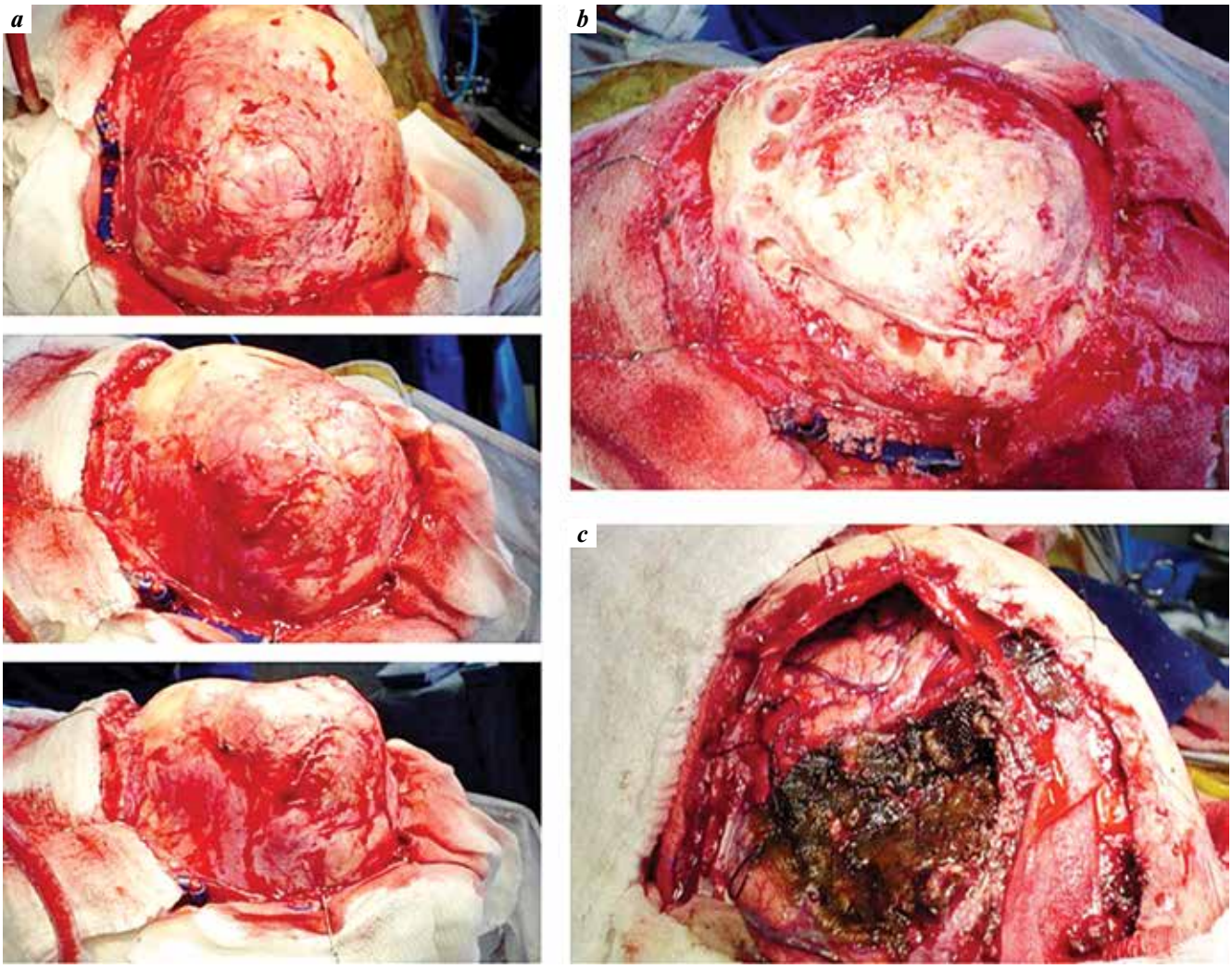

Fig. 1. *(a) Skull deformations caused by the transitional meningioma. (b) Surgical technique – circular multiple trepanation for tumor resections. It's used an extended and wide approach. (c) Tumoral bed after resection. Hemostasy using Surgicel*

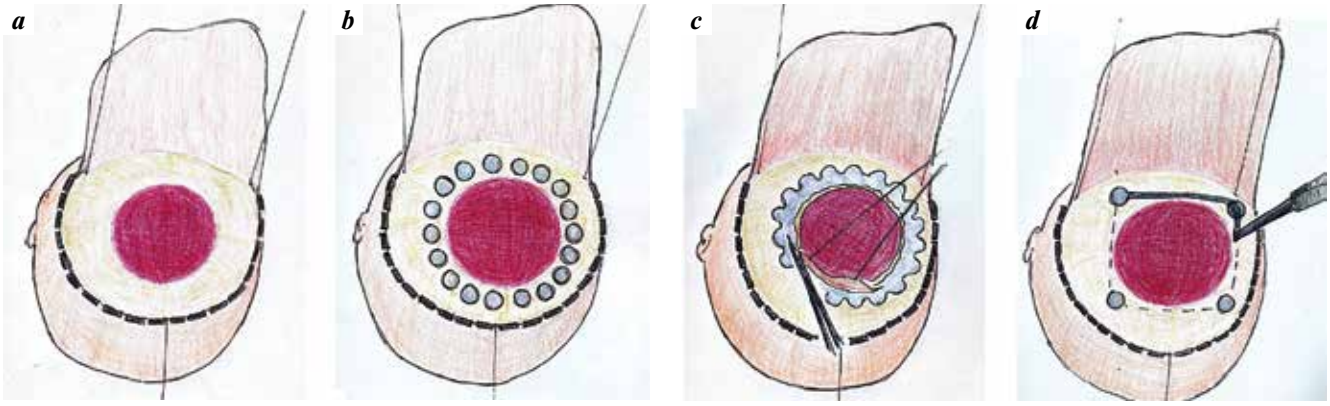

Fig. 2. *Demonstration illustrations. (a) Horseshoe incision with extensive exposure of the bone respecting the limits of the tumor margins. (b) The circumference formed by the trepanation holes around the bone invaded by the meningioma. (c) The connected burr holes and the dura mater affected by the tumor incision around the bone meningioma. (d) Parietal craniotomy with four burr holes around the parasagittal meningioma*

DISCUSSION

Treatments of extracranial and intracranial parasagittal meningiomas consist of simple observation ("observe and wait"), partial resection and radiosurgery, which may be an adjunctive treatment to surgery or a primary intervention. However, in the vast majority of cases, surgery is the gold

Fig. 3. *Contrast-enhanced T1-weighted coronal, sagittal and axial magnetic resonance demonstrates a left parasagittal meningioma. It is possible to visualize the neural tail of the meningioma and the midline shift*

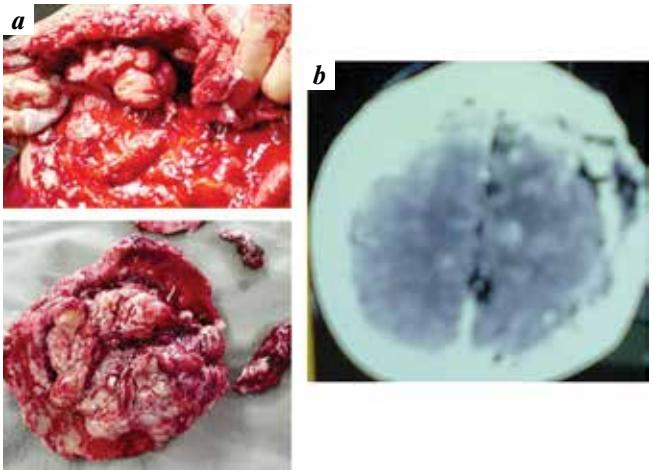

Fig. 4. *(a) Precise visualization of the tumor bone infiltrative pattern. (b) Postoperative axial CT scan showing total resection of the parasagittal meningioma and brain midline centered*

standard intervention, with complete or incomplete resection depending on the accessibility of the tumor [5, 7].

According to Pires de Aguiar PH (2010) [12], total resection is associated with better surgical outcomes, but it is a treatment that generates complications that less aggressive techniques do not.

Although benign and slow growing, this neoplasm compromises several brain functions. Initial symptoms are headache, focal neurological deficits, convulsions, personality changes, progressive hemiparesis (especially in large middle-third tumors), confusion and altered level of consciousness [3, 7]. In this case, the patient manifested papilledema and papillary disorder due to increased intracranial pressure. It is important to understand that the symptomatology is based on the location of the tumor [3, 4, 7, 12].

Parietal craniotomy is the indicated approach for parasagittal meningiomas. A great risk posed by this technique is to reach the superior sagittal sinus: due to the lack of brain tissue between the meningioma and the sinus, the SSS ends up surrounded by the tumor [12]. In a craniotomy, four trepanation holes are drilled (fig. 2-*d*), and it is necessary to include the midline to ensure that both sides of the SSS are visible (the bone flap extends at least two centimeters beyond the midline). Great care is required when using the craniotomy to prevent sinus laceration. Firstly, the sinus is separated with a Penfield dissector, and then the holes are connected with a high-speed drill [8].

Unlike craniotomy, the multiple trepanation technique consists of a circular perforation of the skull around the periphery of the parasagittal meningioma. Thus, more trepanation holes are drilled along the circumference of the meningioma, and then connected to each other. The advantage of this technique is the number of holes; as there are more orifices than in a craniotomy and they are at minimum distance, sawing between holes avoids a possible damage to the dura mater and lesions in the superior sagittal sinus, one of the major complications of parasagittal meningioma resections.

Both techniques must be performed with great care to prevent injury to the superior sagittal sinus, since an injury in the SSS compromises the venous drainage and can cause numerous lesions to the cerebral venous system and neurological complications, such as deficiency in spatial awareness, impaired central nervous system afferent and efferent function and visual processing disorder [9].

In order to avoid damage to the venous system, it is extremely important for the surgeon to differentiate displaced vessels and nerves outside the tumor from those who are irrigating the tumor, because the procedures are different. In the first case, the vessels and nerves are separated and protected by sponges, while in the second case, blood vessels supplying the tumor are coagulated [10].

In addition, both craniotomy and multiple trepanation create irregular and sharp edges. Therefore, it is necessary that the bone flap is replaced without gaps, using suture, screws, and plates so that bone edges do not protrude and hurt the skin. A disadvantage of multiple trepanation in relation to craniotomy is the greater loss of bone tissue [11].

The table shows that the circular multiple trepanation technique has numerous advantages and compares it with

Advantages, indications and disadvantages of techniques in surgical approach of parasagittal meningiomas

Techniques	Indications/advantages	Disadvantages
Circular multitrepanation technique	– Decreases the risks of sawing and aggression to the dura mater. – Lower risk of injury to the superior sagittal sinus. – Wide surgical field. – Exposure of the entire tumor. – Indicated for large tumors	– Great loss of bone tissue. – Jagged and sharp edges – Limited view of the SSS
Parietal craniotomy [13]	– Wide surgical field. – Is considered the gold standard technique	– Jagged and sharp edges – Injury to the superior sagittal sinus and overlying cortical veins. – Burr holes placed over the midline can cause an injury to the SSS. – Limited view of the SSS
Two-Part Parasagittal Craniotomy [14]	– Wide surgical field. – Better visualization of the midline and SSS than other techniques. – Direct vision of the epidural space. – Better control of venous bleeding and the SSS is more secure	This option needs further exploration
Endoscopic removal [15]	– Minimally invasive technique. – Less loss of bone tissue. – Indicated for patients with severely atrophic scalp skin that greatly increases the risk of significant healing complications with calvarial craniotomy. – The major bridging veins that are located on the surface and more superficially do not darken and get in the way the tumor	– Limited surgical field. – More difficult to achieve complete tumor resections

Abbreviation: *SSS – superior sagittal sinus.*

other techniques: parietal craniotomy, two-part parasagittal craniotomy and endoscopy removal.

CONCLUSION

The circular multiple trepanation approach for extracranial and intracranial meningiomas described in this note is performed safely and effectively, with good patient prognosis. The surgical technique aims at the lowest possible risk of injury to the SSS, and the largest possible resection of the meningioma. Although it is a recognized option, it has been insufficiently described. We aim to describe it in order to expand the knowledge and proper use of this technique among neurosurgeons.

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