



Contents lists available at ScienceDirect

International Journal of Surgery Case Reports

journal homepage: www.casereports.com

Double concentric craniotomy: Safe and effective technique to achieve an en bloc resection of tumor involving both skull and dura



Fornaro R., Altieri R. *, Garbossa D., Zenga F., Tartara F., Ducati A

University of Torino, Dept. Of Neuroscience, Institute of Neurosurgery, Italy

ARTICLE INFO

Article history:

Received 7 January 2015
 Received in revised form 7 May 2015
 Accepted 8 May 2015
 Available online 14 May 2015

Keywords:

Concentric craniotomy
 Skull tumor
 En bloc resection
 Brain tumor

ABSTRACT

INTRODUCTION: Many tumors can involve the skull. Meningiomas are one of the most common intracranial neoplasms and invasion of the bone was described in 49% of cases. Other neoplastic lesions that can arise in bone, or involve it, are metastases, hemangiomas, aggressive cutis carcinomas and sarcomas. Radical excision is the golden standard of treatment but elevating a bone flap when the tumor involves both the skull and the dura could represent a technical challenge.

PRESENTATION OF CASE: We report the technical details of our approach to remove a meningioma involving both skull and dura in a man aged 45. Patient underwent gross total excision and cranioplasty with PEEK custom made prothesis (Synthes™).

DISCUSSION: We describe a double concentric craniotomy (DCC) technique where the tumor involving the bone is before left in situ, exposing normal dura, to perform afterwards en-bloc excision with minimal traction of brain surface.

CONCLUSION: DCC is a safe and effective technique to remove tumor involving both skull and dural structures under direct vision.

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1. Introduction

Many types of tumors can involve the skull. These neoplasms generally have a tendency to invade surrounding tissues. En bloc excision is mandatory but can represent a real technical challenge, especially if tumor involves both the skull and the dura. Meningiomas are the most common intracranial neoplasms, second only to gliomas [1,2]. The meningiomas that secondarily involve the calvaria are 49% [3]. The term primary intraosseous meningioma (PIM) is used for an extradural meningioma that arises from the cap cells staying in the bone [4]. Generally they are diagnosed at the fifth decade [5]. PIMs of the calvaria originate either from the convexity or from the skull base. PIMs of the convexity are mostly slow-growing scalp lesions. They are painless and make no changes on the overlying skin [6]. They are mostly met at the periorbital and frontoparietal regions [7] and they are, generally, devoid of neurological findings [5]. PIMs have a tendency to be more malignant than intradural meningiomas [4]. Other tumors that can involve the skull are hemangiomas, metastases, many types of carcinoma and sarcoma arising directly by bone or by contiguous tissue (cutis, muscle, dura) and invading secondarily the skull. Total surgical excision should be the goal of treatment. The degree of resection is the most important factor correlating with recurrence and clinical

long-term outcome [2]. The aggressive surgery that is needed in these cases could bring a large bone defects to fill. The removal of a tumor involving the skull and the intracranial space could present a technical challenge, especially if the tumor has a dural and/or brain attachment. With a standard craniotomy, the maneuver of separating the intraosseous portion of the tumor from the intracranial portion might produce hemorrhage, traction and injury to the underlying brain. We describe a technique where the tumor involving the bone is before left in situ, normal dura is exposed around the tumor, and the tumor can be afterwards removed en bloc with direct vision and minimal traction of the brain surface. We called this technique double concentric craniotomy (DCC).

2. Presentation of case

We report the technical neurosurgical details to perform a DCC. In our institute 8 patients, with different tumors involving both skull and dura, were treated with this technique. The histological examination of these patients' specimens showed: atypical meningioma, PIM and anaplastic meningioma. All these patients underwent DCC with good oncological and neurological results. Below, we describe this technique used in the last patient treated, a man aged 45 with no neurological signs. Patient underwent DCC, total surgical excision of PIM and cranioplasty with PEEK custom made prothesis (Synthes™). A 45 years old man, B.V., presented to our Department of Neurosurgery with a mass arising from the right frontoparietal bone. He had not neurological signs and symp-

* Corresponding author. Tel.: +39 3335740036.

E-mail address: roberto.altieri.87@gmail.com (R. Altieri).

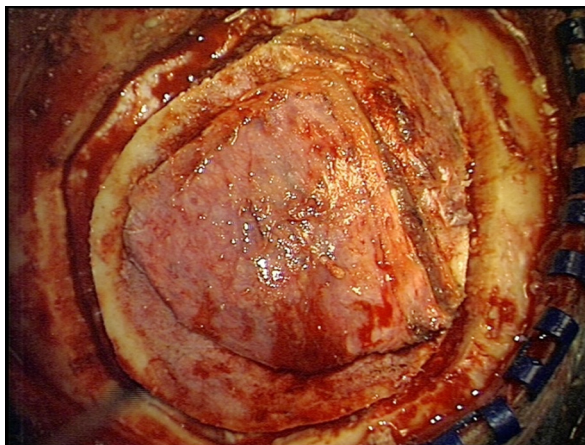


Fig. 1.

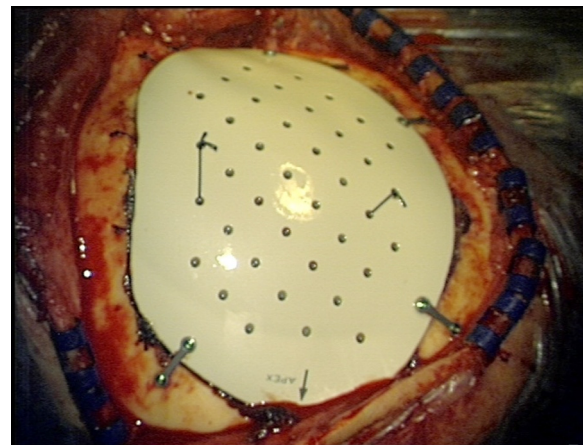


Fig. 3.

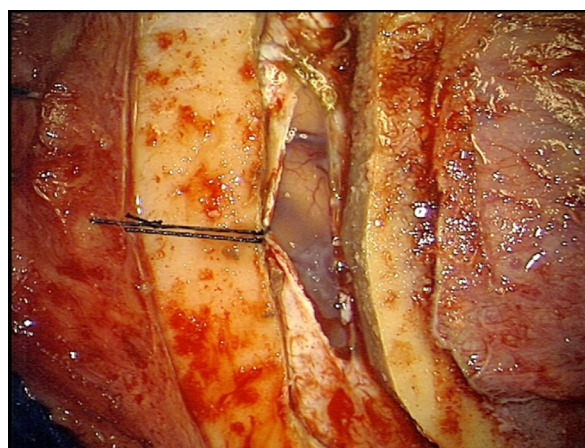


Fig. 2.

toms. Computed tomography (CT) scan showed a homogeneous expansive bone lesion at the right fronto-parietal region, without contrast enhancement. On magnetic resonance imaging (MRI), the lesion was hypointense on T1- and T2-weighted images with no contrast enhancement after intravenous gadolinium administration, but contrast enhancement was seen at the adjacent dura. In the differential diagnosis, were first considered a fibrous dysplasia and primary bone tumors. Patient undergoes tumor removal and cranioplasty with PEEK custom made prosthesis (Synthes™). Under general anesthesia, patient was placed on the operating table in a pin head holder. The patient was positioned with the head turned approximately 30° toward the contralateral side, to expose the skull mass, with a pillow under the ipsilateral shoulder. A right pterional flap was elevated. The temporal muscle was splitted, the muscular part that covering the tumor was left in situ for a completely radical resection and the remaining part was overturned. One only burr hole was performed laterally to the midline and we performed the first circle craniotomy around the lesion. Then, using the same burr hole, a second and more enlarged circular concentric craniotomy was performed. The bone ring resulting from the DCC was then removed (Fig 1). There was no tumor in the bone ring and the dura beneath the ring was not involved. The normal dura was opened around the tumor (Fig 2). The inner surface of the dura was amply involved by the tumor, and it was dissected by the underlying brain surface under direct vision thanks to the space guaranteed by bone ring removal. En-bloc excision was performed. The dural defect was repaired with pericardium bovinum patch and a PEEK custom made cranioplasty was performed (Fig 3). The patient was

discharged home on the third postoperative day. The tumor was diagnosed as an atypical meningioma (WHO II).

3. Discussion

Tumor involving many tissues should be resected en bloc for minimizing risk of seeding and recurrency. In fact, meningioma with calvarial hyperostosis is commonly associated with an increased rate of recurrence if limited bone resection is performed [8]. Although radical excision of tumor involving the skull is the gold standard of oncological treatment, elevating a bone flap when the tumor involves both the skull and the dura could be very hard and represents a technical challenge. With a standard craniotomy, it would be necessary to separate the tumor from the overlying infiltrated skull. This maneuver, done without direct vision, could produce hemorrhage and unwanted traction on the underlying brain surface [9]. We have described a technique, a DCC, that permit to expose the normal dura surrounding the tumor and permit the resection of entire specimen with a direct vision of the underlying brain. In our opinion DCC must be apply for all malignant tumors involving skull and surrounding tissues. All patients should be individually evaluated preoperatively for the need of plastic surgical repair. This technique worked very well for this case, a PIM. Michael et al. have described a similar technique for hemangioma resection [9]. Spennato et al. also have described a similar procedure for the removal of nail that was hammered in both the skull and the brain [10]. Sekhar et al. have utilized the concentric craniotomy technique for a fronto-orbital approach and Ibarra-de la Torre et al. for a posterior fossa craniotomy to protect the underlying dura and vascular structures [11,12].

4. Conclusion

We believe that DCC is an optimal alternative on standard technique because permits the total removal of tumor involving both skull and dura structures, minimizing tractions on the underlying brain and permitting the direct vision during the dissection.

Conflicts of interest

No conflicts of interest.

Funding

No sponsor.

Author contribution

Fornaro Riccardo: study design.
 Altieri Roberto: writing.
 Garbossa Diego: data collection.
 Zenga Francesco: data analysis.
 Tartara Fulvio: study design.
 Ducati Alessandro: supervision.

Consent

There are no information in the text that permit to recognize the patient.

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