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Extradural autologous temporal muscle graft mimicking a meningioma. Case report

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ABSTRACT

Meningiomas are the most common dural tumour, but there are also many other dural masses which mimic their appearances, such as neoplastic and non-neoplastic lesions. In this paper we report another mass which may mimic a dural lesion, namely a muscle graft harvested from the temporal site and left in situ, used to achieve haemostasis in a posttraumatic temporal extradural hematoma in a young male patient. Solid knowledge of differentiating neuroimaging characteristics of dural masses, as well as its corroboration with the patient's medical history are extremely helpful in establishing an accurate diagnostic.

INTRODUCTION

Meningiomas are intracranial tumours and make up about one third of all primary central nervous system tumours, with an incidence rate that has increased in recent years (1, 2, 3, 4, 5), at the same time being the most common dural tumours. However, there may be a variety of other dural lesions (neoplastic and non-neoplastic lesions) mimicking their imagining appearance (6) (Table 1). Unfortunately, the information about the prevalence of these dural lesions is limited, and most of the examples in literature are small case series and case reports.

Many of these dural lesions share similar computed tomographic, magnetic resonance imaging and angiographic characteristics with meningiomas such as increased vascularity, avid enhancement, a dural tail and similar signal characteristics (7). In addition to these multiple dural lesions mimicking meningiomas, we report in this paper the existence of a muscle graft harvested from the temporal site and left *in situ*, used to achieve haemostasis in a case of left temporal extradural hematoma (Figure 1).

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Case report

We report the case of a 40-year-old male patient, victim of a road accident (bicyclist knocked over by a car), who was brought to the emergency room of our hospital with a GCS of 3 and anisocoria (pupil in the left eye > right eye). The cranial CT scan carried out on his admission revealed a left temporal extradural hematoma with left temporal fracture (Figure 1). A surgical procedure was performed immediately to remove the hematoma and the patient's subsequent evolution was excellent, with no post-operative neurological deficiencies. During surgery, the source of bleeding was identified as being the middle meningeal artery and in order to achieve better haemostasis, a piece of the temporal muscle was left in situ, which was later revealed by the cranial post-operative follow-up CT scan (Figure 1. D, white arrow). Also, during surgery, in order to reach the skull base and stop the bleeding, the bone flap was complemented by temporal craniectomy, for which a cranioplasty with titanium mesh was later performed (Figure 2). During periodic imaging follow-up, we noticed that the piece of temporal muscle left *in situ* for haemostasis purposes had become vascularized and a native cranial CT scan revealed its homogeneous appearance (Figure 3). Also, the electroencephalogram did not reveal any pathological changes.

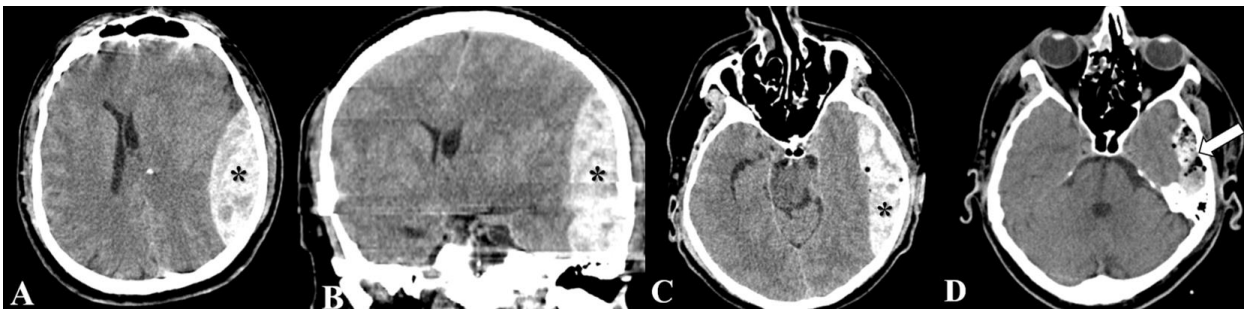

Figure 1. Preoperative cranial CT scan with left temporal extradural hematoma (*) (A, B, C). Postoperative cranial CT scan showing temporal muscle left *in situ* (white arrow) (D)

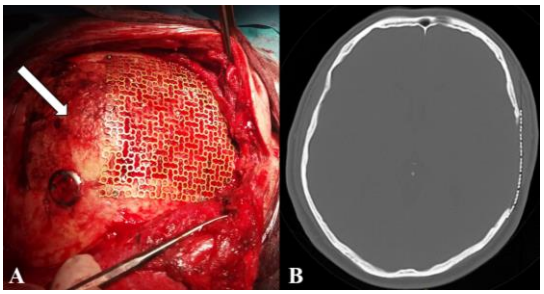

Figure 2. Intraoperative photo showing the bone flap (white arrow) and cranioplasty with titanium mesh (A). Postoperative CT scan showing the cranioplasty (B)

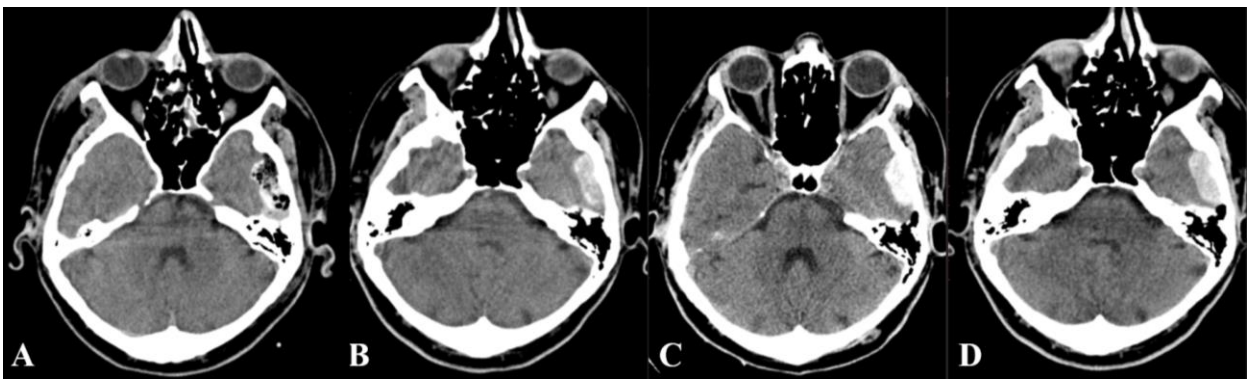

Figure 3. The follow-up cranial CT scan performed after 1, 2 and 3 years (B, C, D) revealed the hypervascular muscle graft mimicking a meningioma or other hypervascular lesions

Discussions

In neurosurgery, just like in all the other surgical fields, proper haemostasis is a *sine qua non* requirement when it comes to preventing dramatic postoperative bleedings the consequences of which are not negligible. Among the various local haemostatic agents used in neurosurgery (8, 9, 10), fresh muscle harvested from the temporal muscle or thigh is still commonly used to achieve haemostasis (8).

Before the 1950's, neurosurgeons used fresh chicken breast as topical haemostatic agents, which were delivered before the surgical procedure. The muscle grafts were applied on the brain during ten minutes, while washing the surgical field with warm serum, and they were removed before closing the dura (8). The first reports on the use of muscle grafts in haemostasis belong to Cushing and Horsley (11, 12). Later, Clute also reported the efficient use of both free and viable muscle grafts in achieving haemostasis in different organs (13). The idea of fresh muscle harvested from the temporal site or thigh, which may be left *in situ*, appeared later. The technique is still used sometimes. In addition to muscle grafts, neurosurgeons have also used other autologous human tissues for haemostasis, such as clots, fascia, dura or fat, yet these have not proven better (12, 14). Moreover, autologous human muscle grafts have proven their efficiency and superiority in the management of significant haemorrhage not only in brain surgery, but also in all the other surgical fields which they were used in (15, 16, 17, 18, 19, 20).

The use of muscle grafts for haemostasis during neurosurgery has reemerged these last few years (21), and fresh muscle graft is also used in neurosurgery in case of cerebrospinal fluid leak (20) or to repair the internal carotid artery during endoscopic surgery (22). Thus, extensive research has proven muscle tissue efficiency in controlling carotid artery bleeding, both in animal and in human models (16, 18, 23, 24). Moreover, research on animal and patients undergoing endoscopic sinus surgery has shown that muscle tissue may efficiently control high-flow and high-pressure carotid artery bleeding (16, 18, 23).

In a study on human muscle extracts, in which Rajiv *et al*. investigated the haemostatic potential of muscle tissue through various coagulation and platelet aggregation tests, the authors concluded that platelet aggregation plays an important role in the haemostatic efficiency of muscle grafts and the muscle grafts adhere well to blood vessels (21). Jukes *et al.* also showed in a study conducted on autologous but crushed muscle, that this caused a consistently increased ratio of platelet activation when compared with uncrushed muscle (25).

In order to understand the imaging appearance of muscle graft left in situ better, the knowledge about dura mater vascularization and about the encephalo-duro-myo-synangiosis mechanism is the key (26, 27). The dura mater is a thick non-elastic membrane made up of fibrous and elastic connective tissue, which surrounds the brain and spinal cord. The cranial dura mater consists of two layers: an external periosteal layer and an inner meningeal layer which are generally fused except when they separate to allow the passage of the dural venous sinuses. Of the two layers, the external periosteal layer adheres closely to the skull bone and is highly vascular and innervated and contains blood vessels that supply the bone, exhibits greater angiogenic activity and is like an internal periosteum for the cranium (7, 28, 29). The inner meningeal layer of the dura is smooth and avascular and is lined on its inner surface by mesothelium (7, 28). The neovascularization in the outer layer cannot extend to the inner layer to the cortical surface, so that it is safe to say that the meningeal layer is a natural barrier between the circulation of the external and internal carotid arteries (30, 31).

Practically, in the case of our patient, the existing vessels in the scalp tissue and temporal muscle passed through the titanium mesh and recruited the vessels in the muscle graft. This vascularization of the external periosteal layer of dura mater has also contributed to the repermeabilization and neovascularization of the muscle graft left *in situ* to achieve haemostasis. The various vascularized tissues communicate through the titanium mesh (32) and this was also considered by Badie *et al*. who used a reconstruction technique involving the placing of a titanium mesh between two layers of continuous vascularized pericranium in patients with large anterior skull defects. The technique has been proven safe and effective (33).

This revascularization mechanism is essential for the effectiveness of burr holes for indirect revascularization in patients with moyamoya disease (34). It seems that new vessels are formed by two distinct phenomena: angiogenesis and

arteriogenesis (34, 35). Angiogenesis is the formation of new vascular segments altering the preexistent vascular network, whereas arteriogenesis is the formation of blood vessels from endothelial precursors (35). Whether these processes occur simultaneously or sequentially is still to be determined (36, 37). In our patient, the muscle graft became hypervascularized by the double contribution of the meningeal arteries irrigating the dura and the superficial temporal artery vascularizing the scalp tissue, a model which was also taken into consideration by other authors (38).

The follow-up CT scan performed after 1, 2 and 3 years, respectively (Figure 3) revealed that the muscle graft became hypervascular and had higher perfusion values, mimicking a meningioma or other hypervascular lesions (e. g. renal tumour metastases), compared with most other extra-axial lesions (6). For the treatment of moyamoya disease, Houkin *et al.* showed that collateral circulation develops within 3-4 months after surgery (39) and is directly related to the size of the bone flap (40, 41). This explains the good vascularization of the muscle graft revealed by the periodic cranial CT scans (Figure 3). The medical imaging examination of the muscle graft perfectly mimics a dural lesion, therefore the differential diagnosis with the other dural lesions is required (Table 1). Also, the patient's clinical examination and personal medical history may be extremely helpful in guiding the diagnosis setting process.

TABLE 1. Dural lesions (after 6 and 42 ref)

Neoplastic: • Meningioma • Metastasis (colon, breast, lung, prostate, leiomyosarcoma) • Glioblastoma • Lymphoma • Hemangiopericytoma • Solitary fibrous tumor • Hodgkin's Disease • Carcinomatosis • Plasmocytoma • Ewing sarcoma • Epstein-Barr virus-associated smooth muscle tumors
Granulomatous: • Tuberculosis • Neurosarcoidosis • Granulomatosis with polyangiitis • Plasma cell granulomas
Lymphoproliferative: • Rosai-Dorfman disease • Erdheim-Chester disease
Autoimmune: • IgG4-related disease
Other: • Extramedullary hematopoiesis

CONCLUSION

In neurosurgery, there are many pathologies affecting the dura and mimicking meningiomas. They include primary and secondary neoplastic lesions, inflammatory and infectious lesions, which may be mistaken for one another because of their similar imaging characteristics. In addition to all these dural lesions, in this case report we mention the existence of autologous muscle graft left *in situ* mimicking a dural lesion. Solid knowledge of differentiating neuroimaging characteristics, as well as its corroboration with the patient's medical history may help set the right diagnosis and find new optimal therapeutic approaches.

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