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Case Report

Posttraumatic rapid growing extradural meningioma: A case report on the effectiveness of echosonography

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ABSTRACT

Background: Most meningiomas related to head trauma have been reported to show intradural lesions; however, they can also occur as primary extradural meningiomas (PEMs) and have often been reported to histologically demonstrate atypical or malignant subtypes. Therefore, early detection and complete resection of related tissues are required; however, to date, only a few PEM cases related to trauma or injury have been reported. Herein, we present a patient with a rapidly growing posttraumatic PEM, in which echosonography is efficient not only for early diagnosis but also for intraoperative strategies.

Case Description: A 62-year-old male presented to a nearby clinic with a complaint of a painless head bump that gradually grew larger in relation to trauma 6 weeks earlier. He underwent echosonography and pointed out the possibility of a cranial tumor and consulted our hospital. Although preoperative imaging studies, such as computed tomography or magnetic resonance imaging, did not provide reliable information on dura mater invasion, echosonography demonstrated dural invasion and intradural lesions in which large vessels passed the surface of the lesion. Based on these findings, we could safely resect the lesion within a sufficient range.

Conclusion: Echosonography may not only be a cue for an early diagnosis but also provide important information for the treatment strategy of PEM that is related to head trauma.

Keywords: Echosonography, Posttraumatic, Primary extradural meningioma, Rapid growing

INTRODUCTION

Although controversial, head trauma has been reported to contribute to the occurrence of meningioma.[1,8,12,14,17] Most of the reported cases of posttraumatic meningioma show intradural lesions; however, they can also occur epidurally. Meningiomas that occur in epidural tissue, such as the epidural space, bone, skin, orbit, and others, are called primary extradural meningiomas (PEMs). PEM is a rare tumor that accounts for <2% of all meningiomas.[2-4,7,9,13,15] Therefore, only a few cases of PEM related to trauma or injury have been reported to date.

Clinically, whether PEM invades the dura mater and/or intracranial structures are a serious concern since postoperative recurrence is somewhat associated with the extent of tumor removal and invading tissues as well as the grades of the tumor or their location.[10] Therefore, careful operative planning should be done, which leads to complete resection of not only the tumor but also all involved tissues should be employed. Clinicians usually plan surgical strategies through

imaging studies, such as computed tomography (CT) and magnetic resonance imaging (MRI); however, these image studies do not always clearly depict the relationship between the PEM and the surrounding structures.

Herein, we present a case of rapidly growing posttraumatic PEM in which subdural invasion could be confirmed by echosonography, which is not clear from CT or MRI findings. To the best of our knowledge, this is the first report to discuss the period from injury to the appearance of tumor-induced symptoms and demonstrates the efficacy of echosonography for the diagnosis of posttraumatic PEM.

CASE DESCRIPTION

A 62-year-old male with a curatively resected renal cell tumor had a head injury 45 days prior. The patient, without wearing a helmet when he stood up, hit his head in the left frontal region against the arm of a stopping power shovel. He had not experienced any pain or skin damage in the area of trauma before the incident. Following the trauma, he noticed a small protuberance which looks like after a mosquito bite, but after a while, the pain caused by the bruise disappeared, although the painless bump gradually grew larger. He visited a nearby clinic complaining that the bump did not get smaller even though more than 6 weeks had passed. He underwent echosonography (picture was not available) and suspected a depressed skull fracture in the clinic.

He was referred to our hospital the same day the echosonography was performed. On arrival, there was no neurological deficit, but a soft and firm swelling was palpated in his left frontal lesion approximately 3 cm in diameter. CT revealed a mass lesion with osteolytic changes in the frontal skull [Figures 1a and b], which made us suspect a fast-growing tumor. Magnetic resonance imaging (MRI) showed a heterogeneous mass approximately 2 cm in diameter, extending through the calvarial defect with an extracranial soft-tissue component. It did not appear in contact with the cerebrum and no definite invasion of the dura mater was observed [Figures 1c and d], although the tumor had not been evaluated by contrast MRI examination due to a poor renal function of the patient.

Echosonography, the GE LOGIQ e ultrasound system (General Electric Healthcare, Waukesha, WI, USA) using an L4-12t probe, conducted preoperatively revealed that the mass penetrated the dura mater and was in contact with the cerebrum [Figure 2a], and in addition, a relatively large vessel passing his cerebrum surface continuous with the mass under the dura mater [Figure 2b].

Under the diagnosis of a frontal bone origin tumor, such as a metastatic tumor or meningioma, the patient underwent a craniotomy to acquire a pathological diagnosis and remove

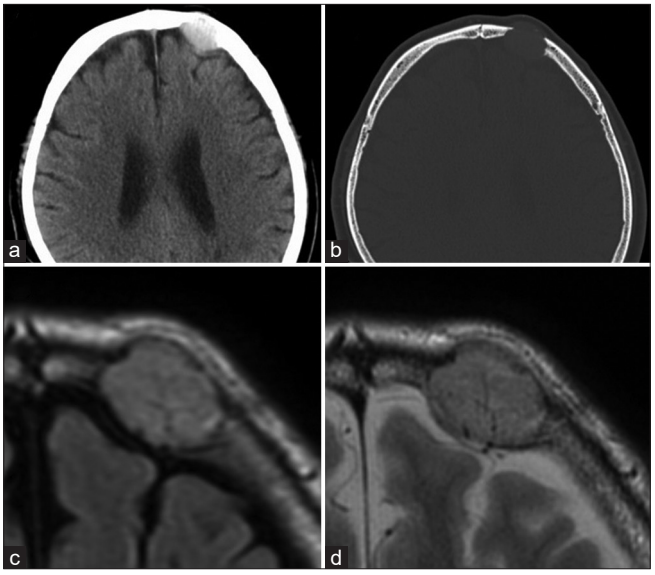

Figure 1: Preoperative computed tomography (CT) and magnetic resonance imaging (MRI). (a) Axial head CT image showing the right calvarium mass. (b) Axial CT bone window image showing an expansion of the frontal region with osteolysis of the calvaria. (c and d) T1- and T2-weighted axial MR images at the level of the mass showing the tumor, but there was no evidence of an intradural invasion or signs of edema in the underlying cerebral cortex.

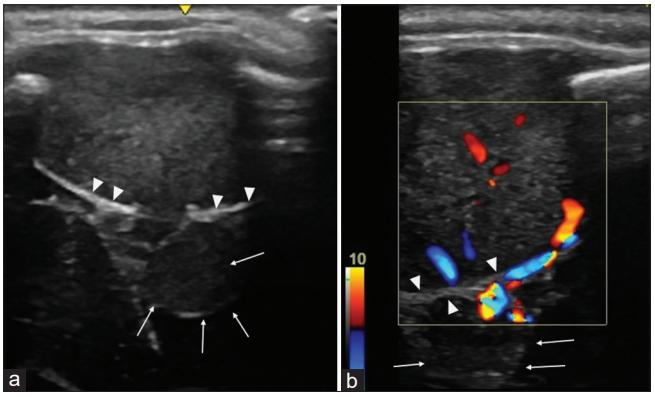

Figure 2: Preoperative echosonography. (a) Preoperative echosonography showing that the mass progressed beyond the dura mater. The dura mater underlying the bone lesion is completely invaded, and an intradural mass is depicted. (b) Doppler echosonography showing that vessels run in and around the tumor, which implies a vascular-rich tumor, and that the cortical vessels run between the intradural component of the tumor and the brain surface. In both image of (a) and (b), the arrowheads indicating dura mater, and the arrows indicating intradural mass.

the mass together with the related dura mater. A curved skin incision was made along the hairline to reflect the scalp anteriorly. The tumor connecting the subcutaneous tissue was easily exposed as it was not tightly adherent to the overlying tissue. The lesion appeared as a firm, grayish, and vascular-rich mass that destroyed the frontal bones. The skull around the tumor was drilled with a ≥10 mm margin [Figure 3a]. We

made a circular dural incision to surround the tumor and dissected the intradural component from the brain surface with the sacrifice of cortical veins involved in the tumor using microsurgical tools [Figure 3b]. The lesion was resected with the surrounding bone and dura mater; Simpson Grade I was achieved [Figures 3c and d]. We replaced the dural defect with a collagen-based dural graft matrix (DuraGen®; Integra Life Sciences Corp., Princeton, NJ, USA), and the extent of the skull defect was reconstructed with an implant that was prepared before the procedure.

The postoperative course was uneventful, and histopathological examination confirmed an atypical meningioma according to the WHO 2016 classification with a Ki-67 proliferation index of 40% [Figures 4a-c].

DISCUSSION

A case–control study showed that meningioma patients had a higher history of head trauma than controls,[12] and the relationship between head trauma and the occurrence and/or development of meningioma has been long recognized.[6,15] Since the incidence of PEM has been reported occasionally, PEM associated with head trauma is extremely rare. Only 0.2–4% of PEM have been reported to have a previous head injury.[10,11] To the best of our knowledge, only 13 cases have been described, and we have added one more [Table 1].

The course of our patient provides some clinical suggestions. First, PEMs can show rapid growth triggered by trauma. Table 1 shows that a few posttraumatic PEMs can grow rapidly, although PEM usually takes a long interval between trauma and presentation of symptoms. In our case, according to the past hypotheses, the arachnoid cells that entered the skull during the embryonic period might have neoplastic changes due to external stimuli. Another interpretation is that intradural lesions are already present before the head injury, and tumor cells that have invaded the skull due to trauma grew to the skull and subcutaneous. However, the details remain unknown.

Our case does not prove trauma as an etiological factor of meningioma and our case does not meet established criteria for relating tumor growth to antecedent trauma that requires reasonable periods of time between head injury and the beginning of the tumor-related symptoms.[5] However, these rapidly growing cases, including our patient, clearly show that rapid growth of the tumor is triggered by a head injury.

Second, echosonography may help in the early detection of skull tumors. In our case, the cue for the early detection of the tumor was that the general clinician noticed the abnormal findings: echosonography transcended the skull and visualized the dura mater and brain parenchyma, although the clinician thought that there was a depressed fracture. Early diagnosis of PEM is essential because complete

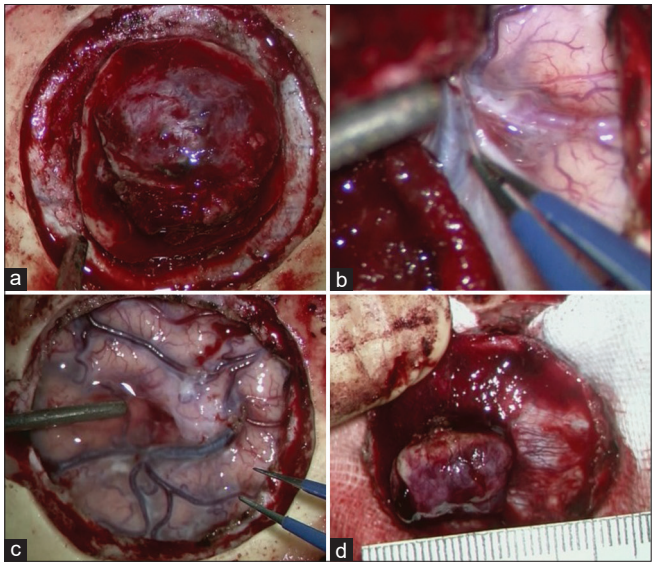

Figure 3: Intraoperative images of tumor resection. (a) Intraoperative image of tumor resection showing that the tumor is a grayish, vascular-rich mass. Note that the skull around the tumor is drilled into a circle, and the tumor remains island shaped. (b) After the circular dural incision, the tumor is dissected from the brain surface using microsurgical tools. The cortical vein involved in the tumor is excised. (c) An *en bloc* resection is performed. (d) The resected lesion, in view from inside the dura mater, showing that it penetrated the dura mater as demonstrated by the preoperative echo.

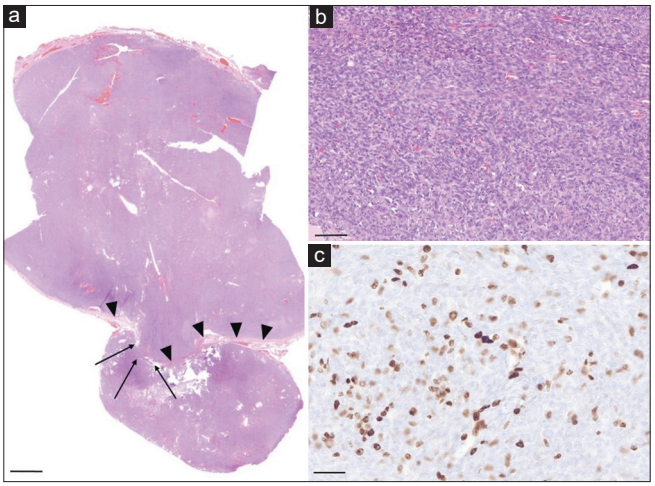

Figure 4: Histopathologic findings of the resected tumor. (a) Photomicrographs of atypical meningioma (hematoxylin and eosin [H&E] stain, scale bar represents 2000 μm) showing that the tumor penetrates the dura mater (arrowheads) and proliferates in the subdural space (arrows). (b) A high-power view of a photomicrograph (H&E stain, scale bar represents 100 μm) showing that the tumor is composed of spindle-shaped cells with many mitoses, consistent with atypical meningioma. (c) Immunostaining with the Ki-67 antibody (scale bar represents 50 μm) showing that the neoplastic cells have high proliferative activity; positive nuclei in the hotspot are measured to occupy approximately 40%.

Table 1: Literature review of the posttraumatic extradural meningiomas.

Age/sex	Tumor type*	Location	Duration‡	Rapid growing	Osteolytic lesion	Histological examination	WHO classification	Author, year
10/M	I	Orbit	3 years	No	No	Meningothelial§	I	Johnson T E, 1993
16/F	I	GG	4 years	No	No	Meningothelial	I	Chung C J, 1997
29/M	I	Spine C1-4	2 or 4 years	No	No	Fibrous¶	I	Sartor K, 1977
29/NA	I	Occipital	12 years	No	No	Meningothelial	I	Shaw R, 2004
32/M	I	Parotid	2.5 years	No	No	NA	NA	Farr H W, 1973
51/M	I	Temporal	11 years	No	No	Transitional§	I	Pacheco Compaña F J, 2016
65/F	I	Orbit	46 years	No	No	Transitional§	I	Walters G A, 1994
68/F	I	Orbit, Skull base	14 years	No	NA	Meningothelial	I	Borggreven *P* A, 2004
55/M	IIC	Parietal	1 month	YES	YES	Meningothelial	I	Muthukumar N, 1997
40/M	IIIB	Orbit	6 years	No	No	Meningothelial§	I	Reid D, 1994
46/M	IIIB	Orbit	13 years	No	NA	Malignant	II≥	McGonigal L J, 1995
66/M	IIIC	Parietal	7 years	No	No	Meningothelial§	I	François P, 2010
66/F	IIIC	Parietal	1 month	YES	YES	Meningothelial	I	Klein E W, 1975
72/F	IIIC	Parietal	5 months	YES	YES	Atypical	II	Niwa A, 2019
62/M	IIIC	Frontal	6 weeks	YES	YES	Atypical	II	Present Case

NA: Not available, GG: Geniculate ganglion, *I purely extracalvarial with no attachment to bone, IIB purely skull base, IIC purely skull convexity, IIIB skull base with extracalvarial extension, IIIC skull convexity with extracalvarial extension, ‡duration from trauma to the first symptom appearance, §with invasion of the adjacent structures, ¶with regressive changes

resection of not only the tumor but also all tissues involved is the ideal treatment for PEM,[2,11,16] and the extent of removal may depend on the range of tumor progress. Furthermore, many PEMs have been reported to histologically demonstrate atypical or malignant subtypes, and osteolytic PEMs might have a higher incidence of atypical or malignant features.[11] Table 1 shows that rapidly increasing PEMs often proliferate osteolytically in the calvaria and shows that rapid increase of the PEMs often contains atypical or malignant subtypes.

Furthermore, the effectiveness of echosonography is not only a clue for early diagnosis but also provides important information for surgical procedures. Since preoperative echosonography demonstrated that the cortical vessel adheres to the tumor, we performed elaborate surgical techniques; a "donut-like" bone drilling, circular dural incision, and avoidance of inadvertent bone flap removal which was performed after dealing with cortical veins. In the literature, many cases have been reported in which dural or intradural invasion was found intraoperatively or by histological examination, even if there was no infiltration in preoperative imaging studies.[2] Therefore, we consider it dangerous to judge only using preoperative imaging studies, such as CT and MRI, in developing a surgical strategy and the use of echosonography was added a valuable information for preoperative programing.

Echosonography, of course, is not always effective for PEMs in its diagnosis and treatment because not all PEMs can be detected by echosonography. Echosonography can only be used in limited sites and conditions of PEMs, such as skull convexity and osteolytic lesions. Approximately two-thirds of PEMs have been reported to show osteosclerotic changes and only one-third of PEMs show osteolytic changes similar to our case.[9,10]

CONCLUSION

PEM should be listed as a differential diagnosis of cranial lesions after head trauma, although it is rare. When a painless, rapidly growing mass that persists for a long time after a head injury is found; we recommend performing echosonography because it may become a cue for early diagnosis in clinics without CT equipment.

Ethical statement

The patients have consented to submission of this case report to the journal and the publication of this case report was approved by the Ethics Committee of Saiseikai Shiga Hospital (Permission number: 490).

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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