Intraoperative Ultrasound and Contrast-Enhanced Ultrasound (CEUS) Features in a Case of Intradural Extramedullary Dorsal Schwannoma Mimicking an Intradural Lesion

Introduction

Primary spinal tumors are relatively rare lesions, representing 4–8% of all central nervous system tumors (Duong LM et al. Cancer 2012; 118: 4220–4227). Magnetic resonance imaging (MRI) represents the gold standard for the diagnosis and assessment of intradural tumors. Nevertheless, sometimes MRI may not accurately differentiate between intramedullary and extramedullary tumors. The role of intraoperative ultrasound (ioUS) on the other hand is not yet well-defined and standardized for this surgical field.

We report a case of a dorsal schwannoma in which preoperative MRI showed findings compatible with an intramedullary lesion with an exophytic component. However, ioUS with the adjunct of contrast-enhanced ultrasound (CEUS) helped to reveal the lesion to be completely extramedullary. To the best of our knowledge, this is the first reported case of use of CEUS during spinal tumor surgery.

Case description

A 33-year-old female patient with a two-month history of slowly progressive hypostenia of the lower extremities and dysesthesia of the left leg was admitted at our institution. An MRI scan showed the presence of an intradural dorsal lesion. No posterior scalloping of the vertebral body and widening of the neural foramina were recorded. MRI depicted widening of the spinal cord at the D3-D11 level. Focal enhancement of the tumor nidus at the D8–D9 level was seen. Associated plurisepimental enlargement of the ependymal canal or tumor cysts were also observed above and below the solid portion of the tumor at D3–D7 and D10–D11 levels, respectively. The neuro-radiological diagnosis was intramedullary tumor (Fig. 1). The patient underwent surgery in the prone position via a posterior approach (D7-D9 laminectomy) and neurophysiological monitoring. After dural exposure, the surgical field was examined with transdural, direct B-mode and CEUS ultrasound, as we previously reported (Prada et al. Neurosurg 2014; 74: 542–552). The standard B-mode imaging examination showed an ovular, hyperechoic lesion with cranial cystic areas and an ill-defined border caudally (Fig. 2). The spinal cord was not clearly visible and it was not possible to distinguish the edematous spinal cord from an infiltrative lesion. CEUS was performed, showing a slow and homogeneous enhancement of the lesion as compared to the spinal parenchyma, with a slow transit time and late wash-out. The peri-lesional cysts did not show contrast enhancement, nor did the edematous spinal cord surrounding the lesion (Fig. 3).

Intraoperatively, we found no differences between the tumoral and medullary surface. Guided by the information that the lesion was intramedullary, dissection was performed along the midline, revealing a fine capsule, which was sent for intraoperative histological examination. The results indicated a schwannoma. The lesion was debulked. We then found a pseudocleavage plane with the spinal cord. The lesion showed a cranial portion embedded and firmly attached to the spinal cord and a posterior central exophitic component.

Fig. 1 Preoperative MRI. Sagittal T2- a and T1- b, axial T2- c-e and axial T1- d-f weighted images. a, b show widening of the spinal cord at the dorsal level (D3–D11) and a tumor with a nodular enhancement component at the D8–D9 level (star). The spinal cord appears edematous above the lesion (thick arrow). Below it the spinal cord is less homogeneous and appears with thin superficial enhancement (black arrow) with less demarcated borders with the nodular portion. Associated plurisepimental enlargement of the ependymal canal or tumor cysts were also seen above the solid portion of the tumor (thin arrow). In c, d the tumor is growing in the extramedullary space and the spinal cord appears invaded, compressed and displaced into the spinal canal (thick arrows). Note in e, f the enlargement of the ependymal canal or tumor cysts (thin arrows).

Analyses of the figures reveal a number of key features of CEUS that are particularly useful in the diagnosis of intradural tumors. First, CEUS allows for the identification of tumor vascularity, which can be an important diagnostic feature in differentiating intramedullary from extramedullary tumors. Second, CEUS can provide information about the extent and distribution of tumor involvement, which is crucial for planning the surgical approach. Third, CEUS can help in the identification of potential surgical planes and landmarks, which can be particularly helpful in complex surgical cases.

In conclusion, the use of CEUS during spinal tumor surgery can provide valuable diagnostic and surgical planning information. However, further studies are needed to determine the optimal use of CEUS in the management of intradural tumors.
The tumor originated from a posterior rootlet, and was completely resected with a microneurosurgical technique, as confirmed by IoUS control at the end of the procedure (Fig. 3). The patient had an uneventful postoperative course and was sent to undergo physical rehabilitation. At the three-month follow-up, the patient showed full recovery of her motor symptoms while still presenting mild proprioceptive deficit.

**Discussion**

MRI represents the gold standard for the diagnosis of intradural tumors. However, as shown in this case, MRI findings can sometimes be misinterpreted. Some minor details were not considered in the correct diagnosis. In sagittal T2 and T1-weighted images post-gadolinium, a small portion of the tumor showed contrast enhancement and growths in the extramedullary space. The medullary cord appeared invaded but also compressed and displaced in the spinal canal. The cysts above and below the solid portion of the lesion were considered as part of the tumor and not as tumor-associated syringomyelia. However, the differentiation of tumor-associated cysts and tumor-associated syringomyelia is difficult, even with the use of contrast enhancement. Another misleading finding was the presence of a satellite cyst at the preoperative MRI, often present in intramedullary lesions such as ependymomas. Furthermore, the altered spinal cord signal cranial and caudal to the lesion due to the edematous tissue indicated an intramedullary tumor. The surgical technique differs between intramedullary and extramedullary lesions, and the differentiation is of critical importance not only for surgical stra-
strategy but also when explaining the potential risks and benefits of surgery to the patient.

IoUS might also represent a useful tool for spinal tumor surgery, as we previously reported in a study about the IoUS characteristics of different spinal lesions and its role in surgical planning and during spinal tumor resection (Prada F. et al. J Ultrasound 2014; 17: 195–202). The main role of IoUS examination is to assist in the exact localization of intradural tumors. Standard B-mode examination usually is sufficient to depict the lesion prior to dural opening. A normal spinal cord in most cases appears hypoechoic, whereas in our case it appeared highly hyperechoic because of consistent edema, and it was therefore not possible to distinguish between the lesion and the compressed spinal cord.

As already established in brain tumor surgery, iCEUS is indeed a valuable tool to better highlight cerebral lesions (Prada F. et al. Neurosurgery 2014; 74: 542–552) and obtain additional information regarding their vascularization and perfusion patterns (Prada F. et al. Biomed Res Int 2014; 2014: 484261. DOI: 10.1155/2014/484261). Relying on our experience with iCEUS in brain tumor surgery, as described in our previous papers (Prada F. et al. Neurosurgery. 2014; 74: 542–552; Prada F. et al. Biomed Res Int 2014; 2014: 484261. DOI: 10.1155/2014/484261), we performed iCEUS during spinal tumor surgery such as in this case. As a contrast agent, we used sulphur hexafluoride (Sonovue, Bracco, Italy). iCEUS was performed with a linear probe using low-power insonation. The consequent harmonic signals were transduced with contrast-specific modes. iCEUS made it possible to further highlight the lesion and differentiate it from the spinal cord, which did not show any contrast enhancement ([Fig. 2]). In particular, the anechoic polar cystic areas did not reveal contrast enhancement, giving useful information on the anatomic situation and facilitating the surgical strategy. In fact, even after dural opening, on direct microscopic observation, the spinal cord was anteriorly compressed and not visible, and the lesion still appeared very similar to the surrounding compressed neural tissue and was embedded into it in the polar areas. iCEUS limitations in this case were mainly due to technical aspects. In fact we were exploring a superficial lesion and the depth of the explored surgical field was highly reduced compared to brain surgery, giving us less defined imaging.

Nevertheless IoUS proved to be of high value in the surgical approach chosen, and iCEUS indeed offered further insight in highlighting the lesion and its boundaries and in describing its perfusion pattern.

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