Intraoperative ultrasound for intradural spinal tumor

Intraoperative ultrasound is a valuable tool to detect spinal tumors, evaluate the surgical approach and plan the surgical strategy considering the position and relationships of the lesion with bony, neural and vascular structures [1].

Surgeons should consider the use of intraoperative ultrasound when approaching intradural spinal tumor or when addressing pathology ventral to the thecal sac via a posterior approach [2].

Three-dimensional intraoperative ultrasound for intradural spinal tumor

see Three-dimensional intraoperative ultrasound for intradural spinal tumor

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In 69 intradural spinal tumors, operated on between 2012 and 2016. A 5-8 MHz probe of IOUSG was used, before and after durotomy to perform the exact durotomy and myelotomy, and after tumor resection, to detect a residual tumor. A retrospective review of parameters including demographic data, localization, and histopathology of the tumor, IOUSG findings, and the amount of tumor resection was made.

In a total of 69 intradural spinal tumors (42 extramedullary, and 27 intramedullary tumors) IOUSG was used during surgery. Total excision was performed in 68 cases, and subtotal excision in one case. Pre-durotomy IOUSG showed sufficient laminectomy in 62 cases. In 7 cases, as the IOUSG failed to show all borders of the tumor, laminectomy was extended.

IOUSG is an important tool, which contributes to intradural spine surgery. This modality shows the tumor appearance before durotomy and is therefore helpful in deciding the amount of laminectomy and durotomy in addition to the exact location of myelotomy. It also provides the surgeon with information about residual tumor after excision, thereby increasing the safety and success of the surgical procedure [3].

From January to July 2016, Stefini et al. performed 10 navigated procedures for intradural spinal tumors by merging MRI and 3-D fluoro images. Nine patients had an intradural extramedullary tumor, 6 had neurinomas, and 3 had meningiomas; 1 patient had an intramedullary spinal cord metastasis. : The surgically demonstrated benefits of spinal navigation for the removal of intradural tumors include the decreased risk of surgery at the wrong spinal level, a minimal length of skin incision and muscle strip, and a reduction in bone removal extension. Furthermore, this technique offers the advantage of opening the dura as much as is necessary and, in the case of intrinsic spinal cord tumors, it allows the tumor to be centered. Otherwise, this would not be visible, thus enabling the precise level and the posterior midline sulcus to be determined when performing a mielotomy [4].

A total number of 158 intradural spinal lesions were operated on using iUS. Of these, 107 lesions (68%) were intradural extramedullary and 51 (32%) were intramedullary. All lesions were clearly visible using the ultrasound probe. The high-frequency linear probes (10-12 MHz) provided a better image quality compared with lower-frequency probes. Color and power-angiography modes were helpful in assessing the vascularization of the tumors and location of the major vessels in the vascular lesions.

Ivanov et al. documented how iUS was used to facilitate safe and efficient spinal tumor resection at each stage of the operation. iUS was beneficial in confirmation of tumor location and extension, planning myelotomy, and estimation of degree of resection of the intramedullary tumors. It was particularly helpful in guiding the approach in redo surgeries for recurrent spinal cord tumors.

iUS has a fast learning curve and offers additional intraoperative information that can help improve surgical accuracy and therefore may reduce procedure-related morbidity [5)].

Twenty-six patients with intradural spinal cord tumors were surgically treated under intraoperative ultrasonographic guidance between January 2007 and May 2011. Guidance with IOUSG was used in 26 patients, of which 14 fourteen had extramedullary and 12 had intramedullary tumors. Intraoperative ultrasound assistance was used to localize each tumor exactly before opening the dura. The extent of tumor resection was verified using axial and sagittal sonographic views. The extent of tumor resection achieved with IOUSG guidance was assessed on postoperative early control MRI sections.

Total tumor resection was achieved in 22 (84%) of 26 cases. All of the residual tumors were typically intramedullary and infiltrative. The sensitivity of IOUSG for the determination of the extent of resection was found to be 92%. Ultrasonography was found to be effective in identification of tumor boundaries and protection of spinal cord vessels. The average time spent for IOUSG assessment was 7 minutes.

Intraoperative ultrasonography is practical, reliable and highly sensitive for spinal cord surgery. It not only enhances surgical orientation, but also reduces morbidity and helps to resect the tumor completely [6)].

Between January 2006 and July 2007, 30 patients with suspected intradural spinal tumours underwent surgery with the aid of IOUS. There were 13 patients with intramedullary tumours (ependymoma=2, astrocytoma=5, hemangioblastoma=2 and metastasis=4); and 14 patients with extramedullary tumours (meningioma=6, neurinoma=6, filum terminale ependymoma=1 and lipoma=1). In 3 patients histopathology did not reveal any neoplasm despite an MRI suggesting tumour. Their sonographic features are analyzed and the advantages of IOUS are discussed.

The shape and expansion of intradural tumours could be visualized on IOUS. The sonographic visualization allowed adapting the approach to an appropriate location and size before dura opening. Certain sonographic features can be used for a differential diagnosis of different intradural tumours. In addition, IOUS can inform neurosurgeons about the location of the neoplastic tissue, its relation to the

spinal cord and the size of residual tumour following excision.

IOUS is a sensitive intraoperative tool. When appropriately applied to assist surgical procedures, it offers additional intraoperative information that helps to improve surgical precision and therefore might reduce the procedure related morbidity [7].

From 1997 to 9/2002 32 patients with the diagnosis of an ependymoma (n = 9), astrocytoma (n = 5), haemangioblastoma (n = 5), neurinoma (n = 4), meningeoma (n = 4) and filum terminale ependymoma (n = 5) were investigated by intraoperative transdural sonography. The sonographic results were correlated to the preoperative MRI-findings and histopathological work-up.

Intramedullary tumours characteristically present with a heterogenous morphology, sometimes carrying intralesional or perilesional cysts. The tumour margins are frequently poorly defined, and there is a perifocal oedema. Extramedullary tumours frequently display a homogenous signal intensity, well defined tumour margins and the abscence of perifocal oedema. Haemangioblastomas turned out to be a specific sonographic entity among intramedullary tumours, as they most often contain only a cystic part with a small tumour nodule. IOUS influenced the surgical approach as laminotomy has to be extended in 7/32 cases to reach the tips of the tumour.

The precision of surgical exposure of intradural spinal lesions can be optimised by IOUS which shows a high correlation with MRI characterizing extra- and intramedullary tumours. Using IOUS, the exact position of the laminectomy/laminotomy can be adapted to the true extent of the tumour, thus avoiding the necessity of further bone work in the case of the frequently oedematous spinal cord protruding through the opening in the dura. Overall, IOUS guidance can help to reduce postoperative morbidity in surgery for all spinal intradural lesions [8].

References

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