Neurosurgical Technique
Assistance of intraoperative microvascular Doppler in the surgical obliteration of spinal dural arteriovenous fistula: cases description and technical considerations

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Summary

Background. Intraoperative microvascular Doppler may be valuable in assisting in the surgical obliteration of dural arteriovenous fistula of the spinal cord. It enables identification, through flow spectrum analysis, of the anatomic components and haemodynamic features of this type of vascular malformation.

Methods. In two cases, intraoperative microvascular Doppler was used to assist in the surgical obliteration of dural arteriovenous fistula of the spinal cord. The fistulas were identified prior to the dura opening, and for this only minimally invasive surgery was required. Direct recordings of the arterialised draining vein and the nidus of the fistula demonstrated a pathological spectrum caused by the arterial supply and the disturbed venous outflow in which a high-resistance flow pattern and low diastolic flow resembling an arterial-like flow velocity were observed.

Findings. The fistulas were obliterated by interruption of the draining vein, and Doppler measurements provided information on flow velocity changes in the medullary veins from an arterial to a venous pattern. The absence of any residual flow in the draining vein confirmed successful haemodynamic treatment.

Interpretation. Intraoperative microvascular Doppler recording is valuable assistance in surgical closure of spinal arteriovenous fistula.

Keywords: Dural arteriovenous fistula; intraoperative monitoring; spine; ultrasound.

Introduction

The most important goal in the treatment of a spinal dural arteriovenous fistula is to achieve complete obliteration of the fistula without impeding spinal cord venous drainage. Clinical symptoms relate to the reversal of flow in the perimedullary veins, resulting in venous hypertension [2] and recurrence of the fistula is associated with an extremely high risk of progressive myelopathy. In this article, we present a simple, noninvasive, intraoperative monitoring method, in which 16-MHz pulsed microvascular Doppler ultrasonography with a 1-mm-diameter probe, is used to provide a simple and immediate assessment of blood flow. The goals of this report were to determine if it is possible to differentiate the arterialised veins from the normal venous drainage pathway; to localize precisely the intradural fistula, to enable a minimally invasive surgical approach; and to confirm the disappearance of the arterial spectrum after interruption of the fistula.

Material and methods

Case report n° 1

Presentation. A 51-year-old woman was admitted to our neurosurgical department with a 6-month history of progressive lower-limb weakness, bilateral lower-extremity hypaesthesia and paraesthesia, loss of vibratory sense, and spastic-ataxic gait.

Examination. A spinal MR imaging examination revealed high intramedullary signal intensity in the T2-weighted images at the T-7 level and a slightly enlarged spinal cord simulating an intramedullary tumor. Selective spinal arteriography demonstrated a dural AVF at the T7–8 level, which was fed by a single radicular artery, as well as a tortuous and ectatic
venous plexus, grossly developing downward to the lumbar region.

The patient underwent surgery in which the AVF was obliterated by a microvascular Doppler-assisted surgical occlusion of the arterialized vein. The surgical treatment consisted of a limited unilateral approach: under fluoroscopic control a right-sided partial T7–8 hemilaminectomy was performed after making a midline skin incision. Using a microvascular Doppler device, transdural localization of the fistula was performed allowing a minimal (2-cm) dural incision centered over the lesion (Fig. 1). An abnormal intradural vessel was noted adjacent the right-sided T-7 nerve root. The nidus of the fistula was comprised of large, dilated, tortuous vessels developing on the dorsal surface of the cord (Fig. 2). Additional Doppler ultrasonography measurements were acquired to identify the arterialised intradural draining vein which was then closed using vascular clips. After these procedures, the distended perimedullary veins became darker in color, and the absence of flow signal confirmed interruption of the abnormal shunt.

Follow-Up Course. The follow-up examination showed improving motor and sensory functions at 1, 3, and 6 months postoperatively.

Case report n° 2

Presentation. A 71-year-old man suffered paraesthesia in both legs for two years. A CT scan showed lumbar spine stenosis at the level L4–L5. For this a two level laminectomy was performed permitting a transitory and moderate relief of the symptoms. In the last 9 months a progressive lower-limb weakness reappeared. When the patient was admitted to our neurosurgical department he couldn’t walk and was presenting also urinary problems. At admission he was severely paraparetic, had bilateral lower-extremity hypothenia and paraesthesia, and urinary retention.

Examination. A spinal MR imaging examination showed a vascular malformation involving the T7–T11 levels. Selective spinal arteriography confirmed a dural AVF originating from the left radicular artery at the T7 level, a tortuous and ectatic venous plexus, grossly developing downward for several levels and the venous drainage was identified at the T6–T7 level (Fig. 3). The surgical treatment was almost less invasive than the previous case: under fluoroscopic control, a limited left partial T7 hemilaminectomy was performed. After opening of the dura a turgid venous malformation was visualized. Intraoperative micro-Doppler ultrasonography measurements were acquired to identify the different vascular structures and in particular the arterialised intradural draining vein which was obliterated (Fig. 4). At this point, the absence of flow, determined by the micro-Doppler examination, confirmed visual inspection of AVF interruption.

Follow-up course. In the following days the patient showed a dramatic motor improvement in both legs.