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The relevance of the artery of Adamkiewicz for microsurgical resection of spinal tumors- short overview and case series: technical note

Importance de l'artère de l' Adamkiewicz pour la resection microchirurgicale des tumeurs intramédullaires- à propos d'une série de cas

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Abstract

Introduction: There is of major interest to know the exact anatomical location of artery of Adamkiewicz (AKA) for many spinal microsurgical procedures, so as to avoid postoperative ischemia of the spinal cord, with further devastating clinical impact.

Methods and results: We detail the interest of preoperative angiography for medullary lesions in our experience. We further report two cases where the AKA was located at the

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same level and side with the treated lesion. The first case underwent an intracapsular decompression. The second patient undertook radiosurgery by Cyberknife.
Conclusion: For spinal tumor where the AKA is exactly on the same level and side, an intracapsular decompression can be safely performed, with an immediate decrease of the symptomatic mass effect, while decreasing the risk of neurological injury. A second valuable alternative in such situations can also be radiosurgery, for small to medium size tumors. In our experience, this proved safe and effective both for tumor and eventual pain control.

Key words: Adamkiewicz, spinal tumors, neurinoma, radiosurgery, schwannoma, Cyberknife

Short title: Artery of Adamkiewicz for microsurgical resection of spinal tumors

Introduction

Spinal cord vascularization relies on 3 main arteries: the anterior spinal (ASA, supplying the anterior two thirds) and the two postero-lateral spinal (supplying the posterior third)(1). The ASA originates at the level of the foramen magnum, from the 2 vertebral arteries. Anterior segmental medullary vessels from the aorta further supply it, the biggest of which is the artery of Adamkiewicz (AKA, from the descending aorta)(1). The AKA classically rises from the left side of the aorta, between T8 and L2, frequently T9-T12, in a vast majority of 80% of cases. However, it might be found above T8 in approximately 15% of people. Anatomical variations include: arising from the right side, levels outside T8 to L2, variances in the angle of how the AKA joins the anterior spinal artery, or presence of more than one AKA. As the AKA is the main arterial supply for the entirety of the lower thoracic cord, the former has been traditionally been seen as a watershed area.

There is of major interest to know the exact location of AKA for many surgical spinal procedures, to avoid postoperative ischemia of the spinal cord, with their further clinical impact (see below). Our department is specialized, among other procedures, on the resection of spinal tumors, including intramedullary lesions. In this context, the preoperative anatomical evaluation of AKA via computer tomography (CT-angio)(2), magnetic resonance imaging

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(MRI) or spinal angiography (SA, depending on the case) is, for us, of crucial importance(3). Some indications for spinal angiography, in our experience, can be seen in figure 1. Are illustrated vascular lesions (Figure 1, A), endocanalar juxtaforaminal lesions (Figure 1, B), foraminal lesions (Figure 1, C) or dumbell lesions (Figure 1, D).

Surgical considerations

The precise position of AKA is extremely important for many surgical procedures of several subspecialties, not limited to neurosurgery only. Lack of flow within this vessel can cause ischemia to the spinal cord (see below). Care should be given in neurosurgery (resection of intramedullary tumors, thoracolumbar spine surgery) but also in vascular surgery (thoracoabdominal aortic aneurysm repair), urology and pediatric surgery (retroperitoneal dissections)(4).

In a recent study, the dural crossing of AKA was located on the left side in 86 % of cases, between T8 and T10 in 73.33 % of cases and L1-L2 in 26.67 % of cases(5). The authors further suggested a classification, including the descending branch of AKA which was a continuation of ASA (type I) and ASA at the top of the arch (type II). The type I and its variant correlated to high neurological risk were present in 93.33 % of cases, while the type II, correlated to medium or low neurological risk, was present in 6.67 % of cases(5).

Technical pitfalls

A first aspect is related to preoperative neuroimaging, which might be more challenging for some specific conditions, including coexistent bony abnormalities, such as scoliosis, osteophytes, narrow intervertebral foramen or extensive arterial disease(4, 6).

A second important aspect is to change the surgical side if the AKA and the initially planned approach are on the same flank (please see below, our illustrative cases 1 and 2).

A third is to distinguish the AKA from the anterior radicuomedullary vein, the former being similar in shape and might closely follow the course of the AKA. A simple way to avoid confusion is to apply the so-called “continuity technique”, while tracing the artery of Adamkiewicz from the aorta(7).

Clinical syndrome

Injury of the AKA results in anterior cord syndrome, frequently related to interrupted supply of the anterior spinal artery or the AKA (its major supplier), having as the major cause

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the atherosclerotic disease (or posttraumatic, multiple sclerosis, infectious). However, other possible cause is iatrogenic, occurring due to surgical approaches.

The anterior two-third of the spinal cord include the majority of anterior and lateral white matter funiculi, the central grey matter, the bilateral lateral and anterior horns, and the basis of posterior horns. Clinically, patients present with neurological deficit specific to the relevant structures: 1- corticospinal tract, bilateral loss of motor function (spastic paralysis below the lesion, flaccid at the level of the lesion); 2- spinothalamic tract, bilateral loss of pain and temperature one level below the lesion; 3- descending autonomic tracts, sexual dysfunction and urinary and fecal incontinence. The posterior columns are spared and so touch, vibration and proprioception remain intact. Motor recovery occurs in less than half of the patients(8).

Illustrative cases with AKA on the same level and site as the treated pathology

Illustrative case 1 (figure 2)

Forty-two years old male presented with left hip pain, with further intractable cruralgia on the left side, with continuous exacerbation during the past months. Clinical exam revealed L2 hypoesthesia. He didn't have any lack of force, nor cauda equina signs.

Lumbar MRI revealed a left intradural extramedullary, with intraforaminal expansion lesion, located at the L1-L2 level, with homogenous enhancement (Figure 2, A). Preoperative diagnosis was neurinoma. Spinal angiography showed the Adamkievicz's artery located at left L1 level.

Intracapsular decompression was proposed and performed.

Postoperative clinical exam was unremarkable, with disappearance of pain and a resumed physical exercise.

Six months follow-up MRI showed minimal residual tumor (2, B, with further proposal for "wait-and-scan" strategy.

Illustrative case 2 (figure 3)

Forty years old patient presented with left intercostal intractable T6 neuralgia during the past 6 months.

MRI revealed a left T6-T7 intraforaminal lesion, with homogenous enhancement (Figure 3, A). Radiological diagnosis was neurinoma. Spinal angiography showed the Adamkievicz's artery located at left T6 level, same as the tumor.

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A radiosurgical treatment was proposed and performed by Cyberknife (Accuray) radiosurgery (Figure 3, B).

Following radiosurgery, the intercostal neuralgia initially exacerbated during several weeks, and further disappeared 6 months later. One year follow-up MRI revealed tumor stability.

Our recommendations

An opened question is whether to perform or not a preoperative SA on a regular manner and in all spinal tumor cases.

We usually perform such an investigation if we observe vascular abnormalities on preoperative MRI, or if the surgical approach involves any level between T4 and L2, especially (but not exclusively) for anterior approaches.

We also consider embolization in cases of extramedullary tumors, which are hypervascular. Some authors might argue that a hypervascular tumor is more likely to recruit feeding vessels from major radiculomedullary arteries supplying the spinal cord. Moreover, the thoracic spine is, for instance, the most frequent site of the metastatic disease, suggesting that the AKA may frequently be involved. Such connection would place the patient at risk for having a stroke during an embolization procedure. There is, however, no demonstration that hypervascular spinal metastatic tumors are associated with major arterial feeders to the spinal cord and some authors (9) suggested that using SA during preoperative embolization procedures, only 11.8% had an associated radiculomedullary arteries.

For spinal tumor where the AKA is exactly on the same level and side, an intracapsular decompression can be safely performed, with an immediate decrease of the symptomatic mass effect, while decreasing the risk of neurological injury. A second valuable alternative in such situations can also be radiosurgery, for small to medium size tumors. In our experience, this proved safe and effective both for tumor and pain control in the illustrative case 2.

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Compliance with Ethical Standards: yes

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Ethics approval: Ethical Committee Approval has been required, according to the French rules, at the Assistance Publique, Hopitaux de Paris, Paris, France for this retrospective review of cases.

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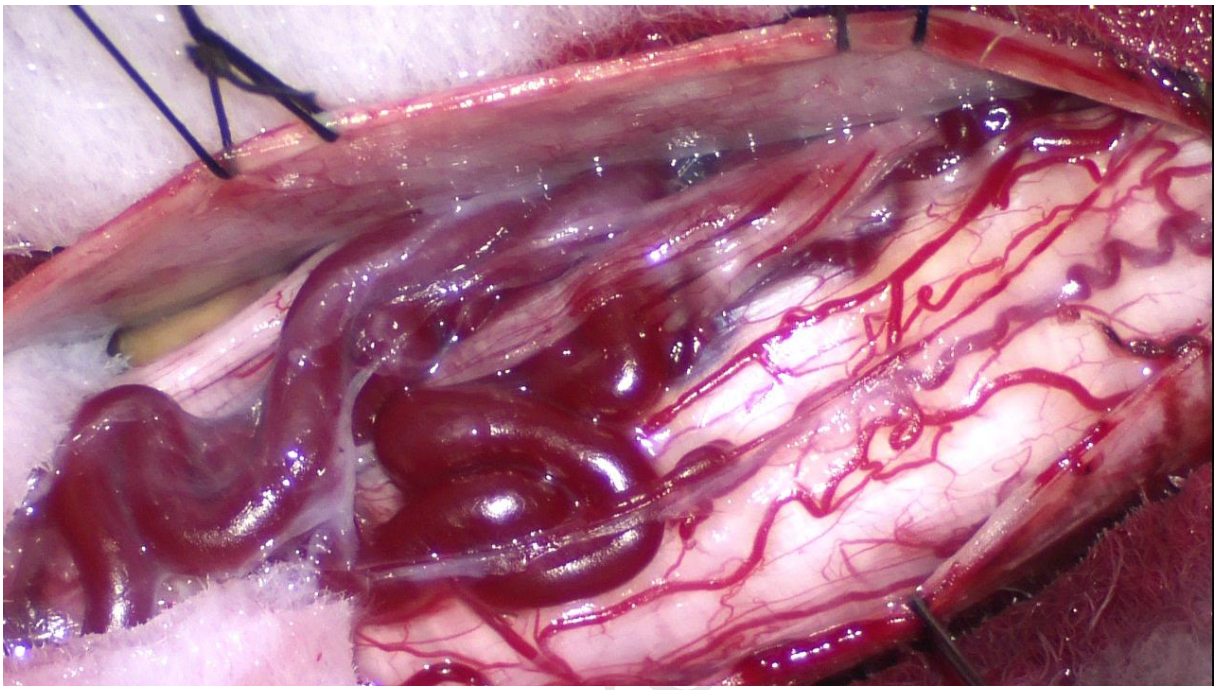
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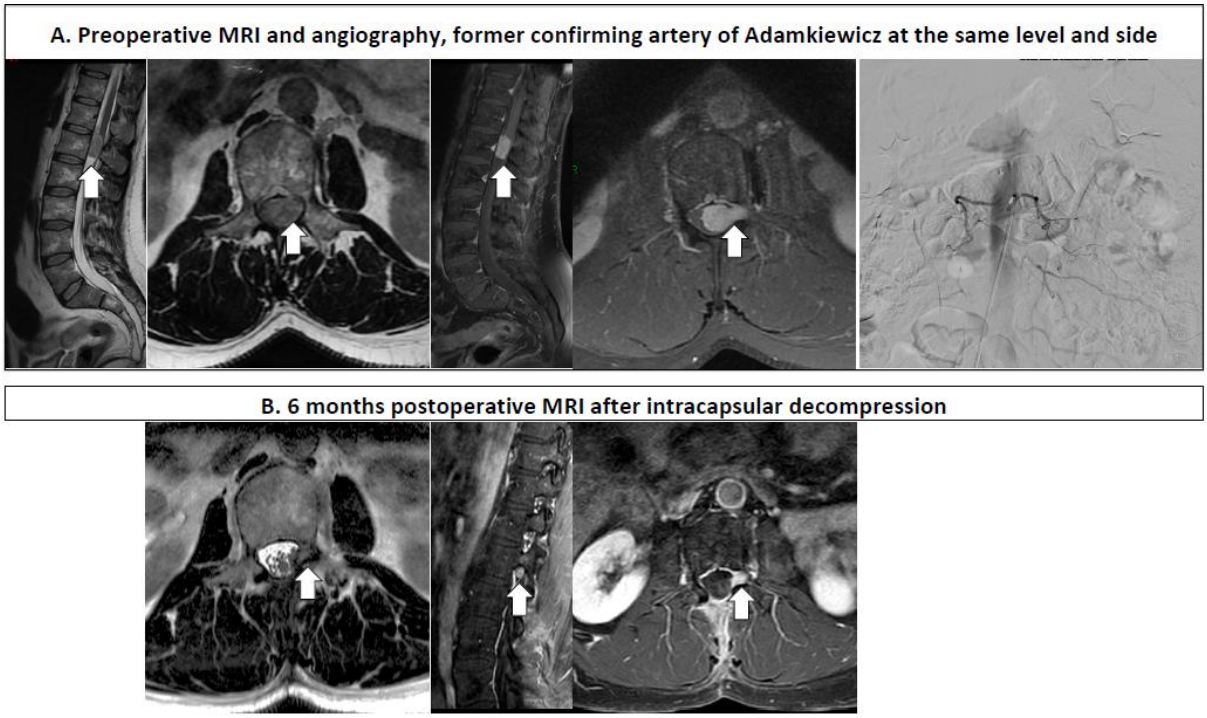
Figures:

Figure 1: indications for angiography, in our experience: vascular lesions (Figure 1, A), endocanalar juxtaforaminal lesions (Figure 1, B), foraminal lesions (Figure 1, C) or dumbell lesions (Figure 1, D)



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Figure 2: illustrative case 1- A: preoperative imaging with, from left to right, sagittal and axial T2 and sagittal and axial T1 Gadolinium injected MRI; spinal angiography (left) confirming the Adamkievicz artery on the left side and L1 level; B: 6 months postoperative MRI, with axial T2, sagittal and axial T1 Gadolinium injected MRI, showing minimal residual tumor



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Figure 3: illustrative case 2- A: preoperative axial and sagittal MRI and preoperative spinal angiography; B: radiosurgical planning (courtesy Thomas Lacornerie, Center Oscar Lambret, Lille, France)

