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RESEARCH ARTICLE

Ependymoma of the Filum Terminale, Technical Operative Note

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ABSTRACT

Background: Spinal cord tumors represent 2-4% of all CNS tumors. Ependymomas are the most frequent lesions of the spinal cord¹. Gross total resection remains the gold standard².

Method: We describe the mini-invasive surgical technique using a fixed tubular retractor performed for the resection of an ependymoma of the filum terminale, along with its advantages and limits.

Conclusion: This mini-invasive technique has shown to be safe and effective for the resection of filum terminale ependymoma, with a good impact on postoperative pain and less risks of CSF leak, which is probably secondary to a limited dead space.

Keywords: minimal invasive surgery; filum terminale; ependymoma; tubular retractor.

Relevant surgical anatomy

The lumbar vertebrae are five in numbers and the largest of the spine. Each lumbar vertebra is composed of a body, pedicles, laminae, transverse processes, spinous process and a superior (oriented supero-laterally) and inferior (oriented infero-medially) articular processes forming the facet joint. The lamina, interlaminar space and articular processes are important anatomy landmarks to correctly position the tubular retractor.

The filum terminale is a condensation of pia mater, which extends directly from the conus medullaris (level L1 / L2 in the adult) and continues in the dural sac to penetrate it at the level of the second sacral vertebra. It continues then to form the coccygeal ligament, which attaches to the posterior surface of the coccyx. At the lumbar-sacral levels, the spinal roots descend considerably in the dural sac, surrounding the filum terminale and forming the cauda equina, while reaching their respective intervertebral foramina. The identification of the origin of the ependymoma from the filum terminale and the dissection of the different spinal roots around the tumor during the procedure should be carefully performed, to avoid unnecessary complications.

Description of the technique

The patient is positioned in prone position and the O-arm and the neuronavigation system are positioned (figure 1). MEP and SEP are recorded. A 25 mm paramedian incision is made according to the neuronavigation. The muscular fascia is opened and we position the fixed tubular retractor. A hemilaminectomy and a cross over are performed under microscope in order to expose the dura mater. A midline durotomy is performed with preservation of the arachnoid layer. The arachnoid is then opened and clipped against the dura. The superior and inferior limits of the ependymoma are identified. Tumor dissection starts at the upper pole, under electrophysiological neuro-monitoring. The filum terminale should be identified early during surgery to safely perform the procedure (figure 2). We performed a progressive shrinking of the tumor through bipolar coagulation. Once the upper pole of the tumor is completely dissected, we cut the proximal filum terminale 1 cm apart from the tumor. With this maneuver, the tumor is then released and dissection from the ventral arachnoid adhesions is possible. The distal filum terminale is then identified and cut 1 cm distal to the tumor mass. The cauda equina is respected during the whole procedure. The dura is closed watertight.

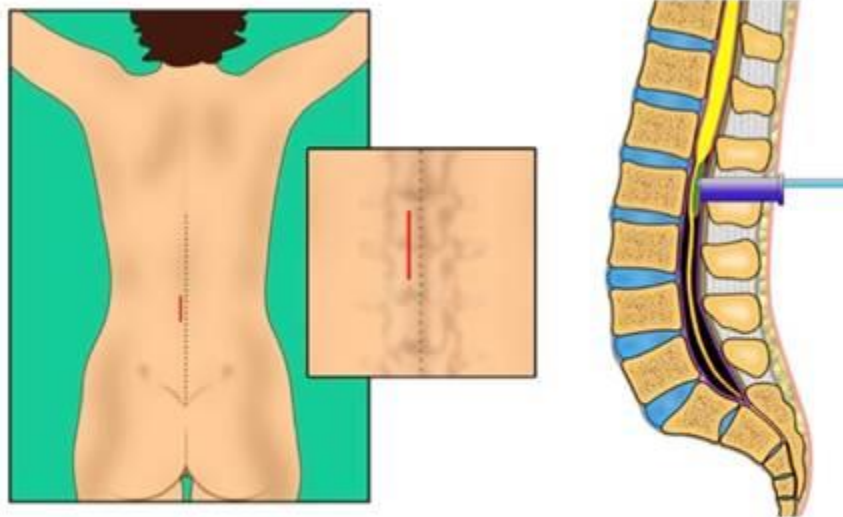


Figure 1. The patient is positioned in a prone position with the head placed in a cushioned head rest to avoid pressure sores. The incision is made 25 mm paramedian and the tubular retractor is placed according to the neuronavigation/fluoroscopy.

Indications

The mini-invasive technique using a fixed tubular retractor could be used to access ependymomas of the filum terminale and others intra-dural lesions while minimizing muscles stripping, bony resection and the dead space compared to a traditional

open corridor. The post-operative pain is thus decreased.

The classical open corridor can be time consuming and the placement of the tubular retractor can spare time with the muscles dissection and retraction to access the lesion.

This technique spares the articular facets and abolishes the risk of instability³. The tubular retractor can be rigid or expendable to increase the vision under microscope.

The use of navigation can facilitate the placement of tubular retractor; nevertheless, it could be placed with a simple fluoroscopy.

Limitations

The mini-invasive technique limits the working space and may need adaptation of the surgeon compare to the classic open corridor for the instruments handling. The dural closure can be more challenging and need experience from the surgeon because of the restricted space.

This approach can be not suitable in extensive lesions with a large rostro-caudal extension, which may need a multilevel exposure.

How to avoid complication

The use of navigation or fluoroscopy may help in correctly placing the tubular retractor and avoid in misleading the level.

After the tubular placement, the use of the microscope is mandatory for the mini-invasive dissection and resection of the lesion, while limiting the potential damage to normal neural structures. Identification of the filum terminale is a key part of the procedure to avoid lesion of the spinal roots, and it can be identified by the vessels on the surface and the whiter appearance compared to the nerve roots (figure 2). Furthermore, the filum terminale has a ligamentous-strand like running on it. The final confirmation of the identification should be done with the the electrophysiological neuro-monitoring. The filum should be initially cut above the lesion to avoid upwards retraction, which can compromise the total resection. Progressive dissection and shrinking of the ependymoma with a low bipolar coagulation should be done carefully and under electroneurophysiological neuro-monitoring control to avoid spinal roots lesion.

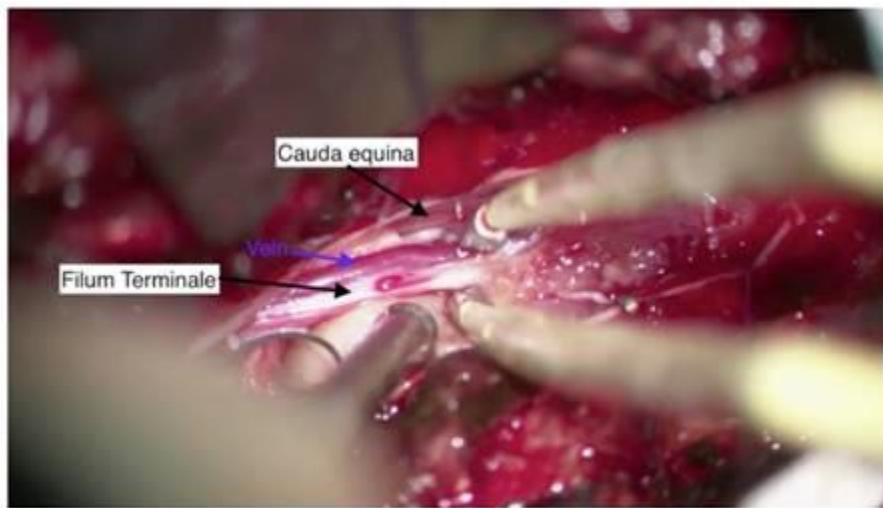
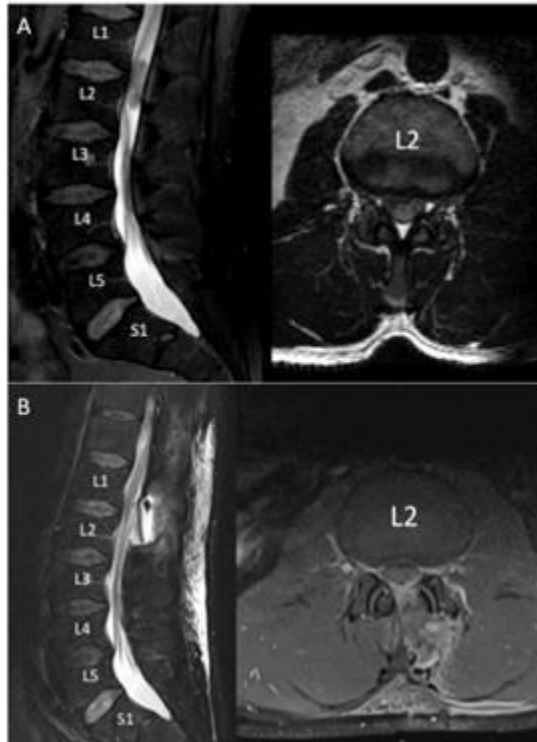


Figure 2. Intra-operative image showing the cauda equina, the filum terminale with a vein coursing parallel to it and the tumor attached to the filum terminale. Identification of the filum terminale, the superior and inferior poles of the ependymoma and the roots composing the cauda equina is mandatory to avoid complications



Video 1. A 55-year-old man presented a history of progressive weakness of right's feet flexion and progressive pain in right S1 territory for 2 months. The lumbar magnetic resonance showed a lesion of the filum terminale compatible with an ependymoma. A mini-invasive surgical technique using a fixed tubular retractor was performed with complete resection of the lesion. The patient experiences a complete relief of his symptoms and no complication secondary to the procedure was noticed.

Specific information for the patient

Ependymoma are the most frequent lesion of the spinal cord¹. The myxopapillary subtype (WHO grade 1) is in general located at the filum terminale. They are slow growing tumors and if left untreated could lead to clinical symptom as paraparesis and sphincter dysfunction⁴. Gross total resection is the gold standard².

The mini-invasive technique for intradural lesion as the filum terminal ependymoma allows a complete resection with decrease the post-operative instability and kyphosis³. The limitation of the dead space probably diminished the post-operative pain, the risk of CSF leak and time of hospitalisation when compared to open procedures.

Key points

1. Prone position with head in a cushioned head rest to avoid pressures sores
2. Correct placement of the tubular retraction with navigation / fluoroscopy to perform a unilateral laminectomy and crossover while limiting muscular retraction and dead space
3. The use of expendable retractors can increase the vision for lesion with more rostro-caudal extension

4. Opening of the dura on the midline under microscopic control
5. Identification of the superior and inferior poles of the tumor, of the filum terminale and nerve roots
6. Electrophysiological monitoring and stimulation are useful for identification of the different structures during surgery
7. Dissection of the tumor with Rhoton's dissectors and progressive shrinkage of the lesion with low bipolar coagulation
8. The filum terminale should be initially cut above the lesion and secondarily under the lesion
9. Complete resection of filum terminale ependymoma is the gold standard
10. The mini-invasive technique decrease the post-operative instability and pain

Compliance with ethical standards

Patient consent statement: The patient/next of kin/guardian has consented the study for submission to the journal.

Conflict of interest: The authors declare that they have no conflict of interest.

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