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Open thoracic cordotomy for intractable cancer pain: a how I do it

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Abstract

Background:

Some cancers of the lower extremity involve nerves and plexuses and can produce extreme drug-resistant nociceptive pain. In these cases, open thoracic cordotomy can be proposed.

Method:

This procedure involves disruption of the spinothalamic tract, which sustains nociceptive pathways. After placement in the prone position, selection of the side to be operated on (contralateral to the pain), and dura exposure, microsurgery is used to section the anterolateral spinal cord quadrant previously exposed by gently pulling on the dentate ligament.

Conclusion:

Open thoracic cordotomy is a moderate invasive, safe, and effective option for the management of drug-resistant unilateral lower extremity cancer pain in well-selected patients.

Key Words: Cordotomy ; Cancer pain ; Open cordotomy

Relevant surgical anatomy

Pain pathways

The nociceptive stimulus is supported by small myelinated delta A and unmyelinated C nerve fibers to the dorsal horn of the spinal cord, where it is transmitted to a spinothalamic second-order neuron. The axon of the secondary neuron immediately decussates anterior to the ependymal canal to form the contralateral lateral spinothalamic tract, in the ventrolateral quadrant of the spinal cord. This tract conducts information to the somatosensory thalamus, where it makes synaptic contact with a third neuron [5].

Approximately, 80% of nociceptive fibers decussate to form the contralateral lateral spinothalamic tract. The decussation is oblique, extending over two to five metamers. Therefore, the section must be made significantly higher than the upper limit of the painful area. The spinothalamic tract has somatotopic distribution. Indeed, the fibers of the caudal roots are located in the posterior part of the tract, whereas the fibers of the cervical roots are located in the anterior and medial part [8].

Surrounding anatomical structures

The spinothalamic tract is surrounded by several functional anatomical structures. The cortico-spinal tract is located behind the spinothalamic tract. The dentate ligament corresponds to the boundary between these two tracts and is, therefore, a fundamental anatomical landmark for surgery. The emergence of ventral rootlets bounds extrapyramidal tracts (olivospinal and vestibulospinal tracts) and marks the anterior limit for the section. The ventral spinocerebellar tract is located laterally and is injured during surgery leading to an ipsilateral ataxia of the arm. It should also be noted that the anterior spinal artery is located medially and deeply in the spinothalamic tract. Cordotomy consists of sectioning the

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spinothalamic tract to interrupt the nociceptive message. A schematic illustration of the sectioned area and surrounding anatomical structures is provided in Figure 1.

Description of the technique

We present here the case of a 71-year-old woman presenting with right hip pain related to an undifferentiated coxofemoral carcinoma. The pain persisted despite high-dose morphine (with adverse effects) and local radiotherapy.

Anesthesia and positioning

Under general anesthesia, three-point head fixation is performed before placing the patient in the prone position. The Th1 vertebra is identified using radioscopy (Figure 2). Intravenous antibiotic prophylaxis is given by anesthesiologists.

Exposure

A median incision is made between Th1 and Th2 spinous processes. A Th1-Th2 laminectomy enlarged on the side contralateral to the pain is performed to expose the dura. Durotomy is next performed paramedially with a no. 11 blade, and the dura is suspended. After placement of the surgical microscope, the arachnoid is opened (Figure 3A), and the dentate ligament is located (Figure 3B). When the dentate ligament is identified, it is sectioned and gently pulled with a 5.0 Prolene® suture to allow 20° rotation of the spinal cord (Figure 3C). This allows for the exposition of the anterolateral part of the spinal cord. Subsequently, the emergence of ventral rootlets is identified at the anterior boundary of the section (figure 3C).

Section

1
2 The section is gently performed from the dentate ligament to the emergence of ventral
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4 rootlets with an ophthalmologic (for cataracts) scalpel to a depth of 4-5 mm (figure 4A). The
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6 dissection is then checked using a right-angled microdissector and continued with water
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8 (figure 4B). No coagulation is performed. In cases of bleeding, soft dabbing with a hemostatic
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10 sponge is recommended. Owing to somatotopy, the section should be more posterior for pain
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12 localized in the lower limbs and more anterior for pain localized in the thorax.
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Closure

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21 Finally, the suspension suture is cut, and the spinal cord rotation is released. Abundant
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23 irrigation with a saline solution is performed. The dura is then watertightly closed. Closure of
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25 the musculo-fascial, subcutaneous, and cutaneous planes is at the surgeon's discretion, but
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27 must be watertight.
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Indications:

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39 - Pain must be unilateral and below Th5 level.
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42 - Usually, this surgery is possible in selected patients with advanced oncologic disease and
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44 a limited life expectancy. It should be performed if lasting pain relief fails despite maximal
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46 medical treatment [1].
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49 - Patients in whom intrathecal therapy was ineffective or had severe morphine-related
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51 adverse effects.
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54 - Other indications for non-malignant pain have been described [7]:
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56 ○ Postherpetic neuralgia,
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58 ○ Multiple sclerosis,
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- Post-spinal cord injury pain.
- We do not advise bilateral cordotomy, as it increases the risk of postoperative complications, especially urinary dysfunction.
- Open thoracic cordotomy is particularly useful in patients for whom percutaneous cordotomy is not possible.
 - The patient was afraid of local anesthesia.
 - A prolonged prone position was not possible.
 - Percutaneous procedures are not accessible.
 - Respiratory risk too high.
 - Patients' unwillingness to risk upper limb paresis.
 - Children [6].
- Berger et al [1] suggest an algorithm for selection of the appropriate procedure for the patient's pain syndrome.
- Although it has been questioned over the past 20 years, open thoracic cordotomy continues to be used for specific indications and should therefore be part of the pain neurosurgeon's toolbox [3].

Limitations:

- Pain relief is observed in 95% of patients after surgery but lasts between 6 months and 1 year [2, 9].
- Not available for bilateral and visceral pain.
- Pain above the Th5 level is not possible with this technique but can be treated by a percutaneous CT- guided C1-C2 cordotomy
- Requires general anesthesia in palliative care patients.

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The main contraindications are as follows:

- Visceral pain.
- Abdominal/pelvic and bilateral lower extremity pain (opting for myelotomy).
- Dying patient.
- Active infection.

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How to avoid complications:

- Anatomical landmarks must be perfectly identified during surgery: the section is made strictly between the dentate ligament and the anterior rootlets, to a maximum depth of 5 mm.
- The opening must be perfectly clean and free of bleeding to avoid contamination at the surgical site. Intradural blood contributes to postoperative arachnoiditis.
- Closure should be as tight as possible to avoid CSF leakage. We used biological glue to prevent this complication, but no study has shown its effectiveness in preventing this complication.

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Specific perioperative considerations

When surgery is successful, the postoperative visual analogue score decreases to 0. The morphine dose is gradually reduced to avoid withdrawal. The patient is placed in a 30° supine position for 48 hours to prevent CSF leakage.

Specific information for the patient

- The main postoperative complications includes [4]:
 - Ipsilateral motor weakness (cortico-spinal tract injury) in 3,5%-11% of cases
 - Urinary dysfunction (autonomic fibers injury) in 11%-33% of cases
 - Permanent dysesthesia in 7-11% of cases
- Other classic complications related to this approach are as follows.
 - CSF leakage
 - Surgical site infection and meningitis
- Cerebellar ataxia is almost systematic but transient, and the disorders usually regress within 2–3 weeks.
- The loss of temperature perception is complete and permanent.
- Open thoracic cordotomy is more invasive than percutaneous cordotomy, but it has the advantage of not risking respiratory paralysis or upper limb motor impairment.

Conclusions

In well selected patients, open thoracic cordotomy is safe, moderate invasive and highly effective option for the management of morphine-resistant unilateral lower extremity cancer pain.

Compliance with ethical standards

Conflict of interest

The authors declare no competing interest

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the Institutional Ethics Committee of Caen University Hospital (Caen, France) and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Patient consent

Informed consent was obtained from the patient included in the study.

Acknowledgement

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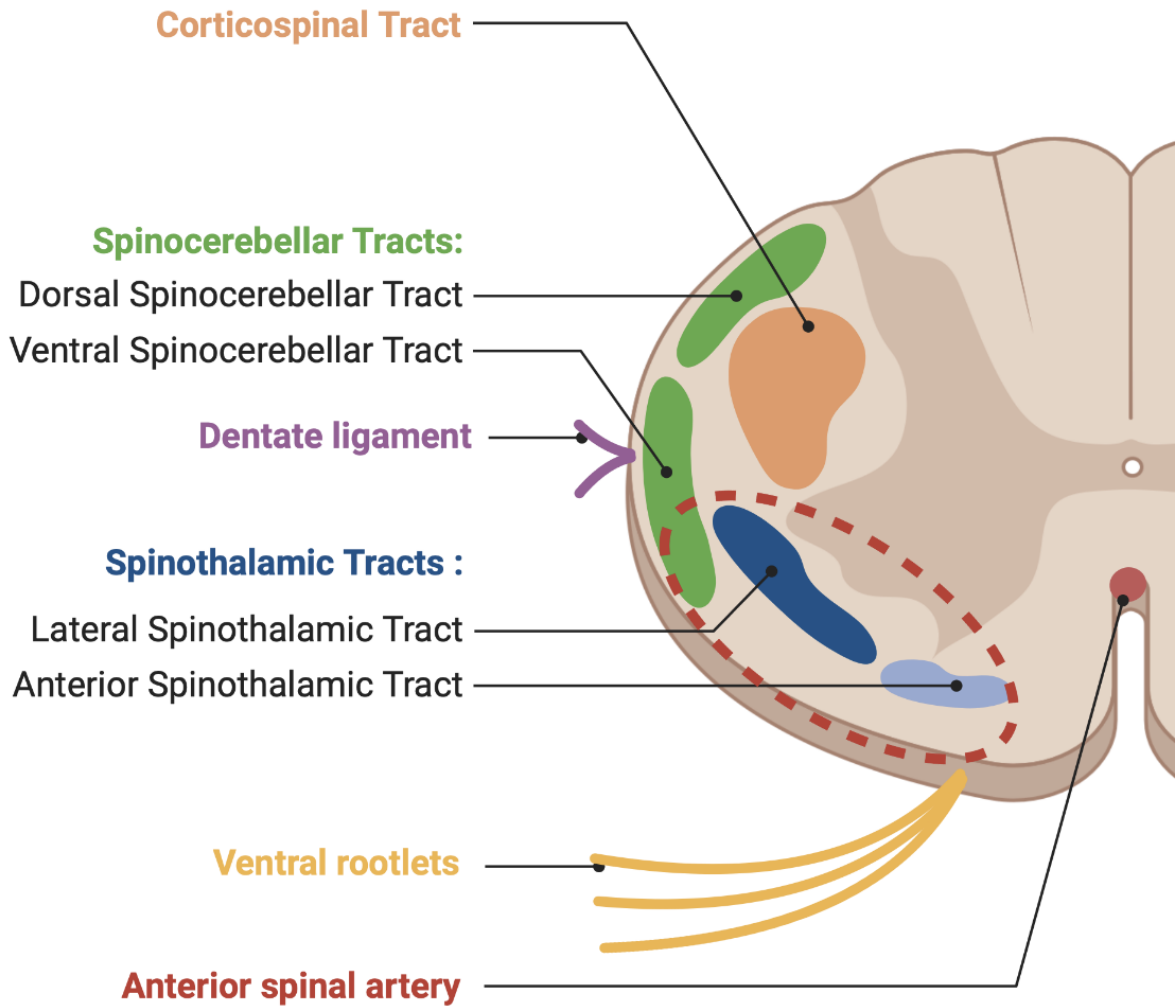


Figure 1. Cross section of the upper thoracic spinal cord. The red dotted line represents the target for cordotomy. The anterior spinal artery and the corticospinal tract are the most at-risk structures. The dentate ligament is a fundamental anatomical landmark that delimits the lateral spinothalamic tract from the corticospinal tract.



Figure 2. Patient positioning in the prone position on three-point head fixation. T1 level is identified with radioscopy. The side to be operated on (contralateral to the pain) is marked with a cross.

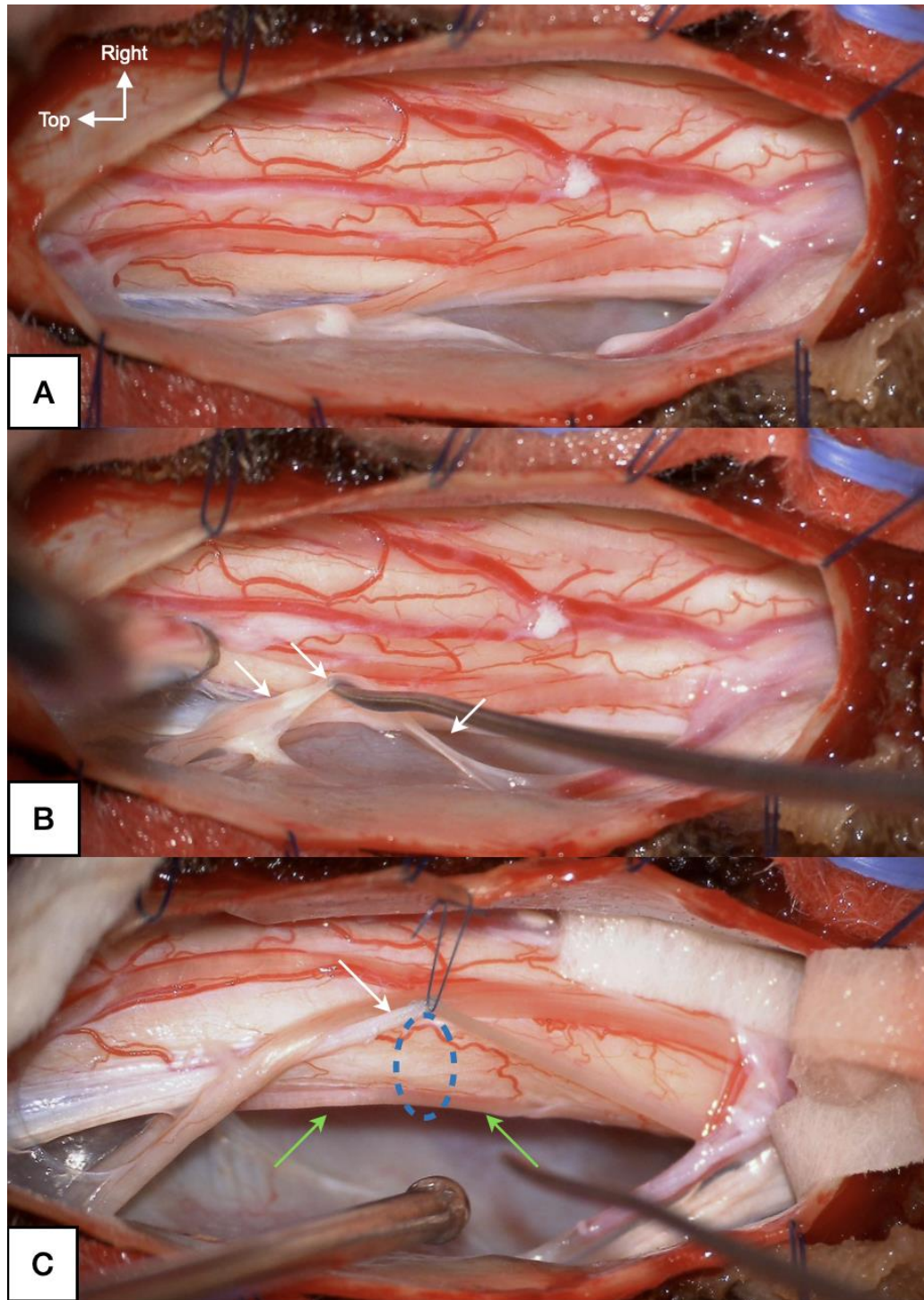


Figure 3. Spinal cord after paramedian dura opening (A). The dentate ligament (white arrows) is identified (B) and then suspended with 5.0 prolene suture to rotate the spinal cord by 20° (C). The section (blue dotted lines) is made between the anterior rootlets (green arrows) and the dentate ligament (white arrows).

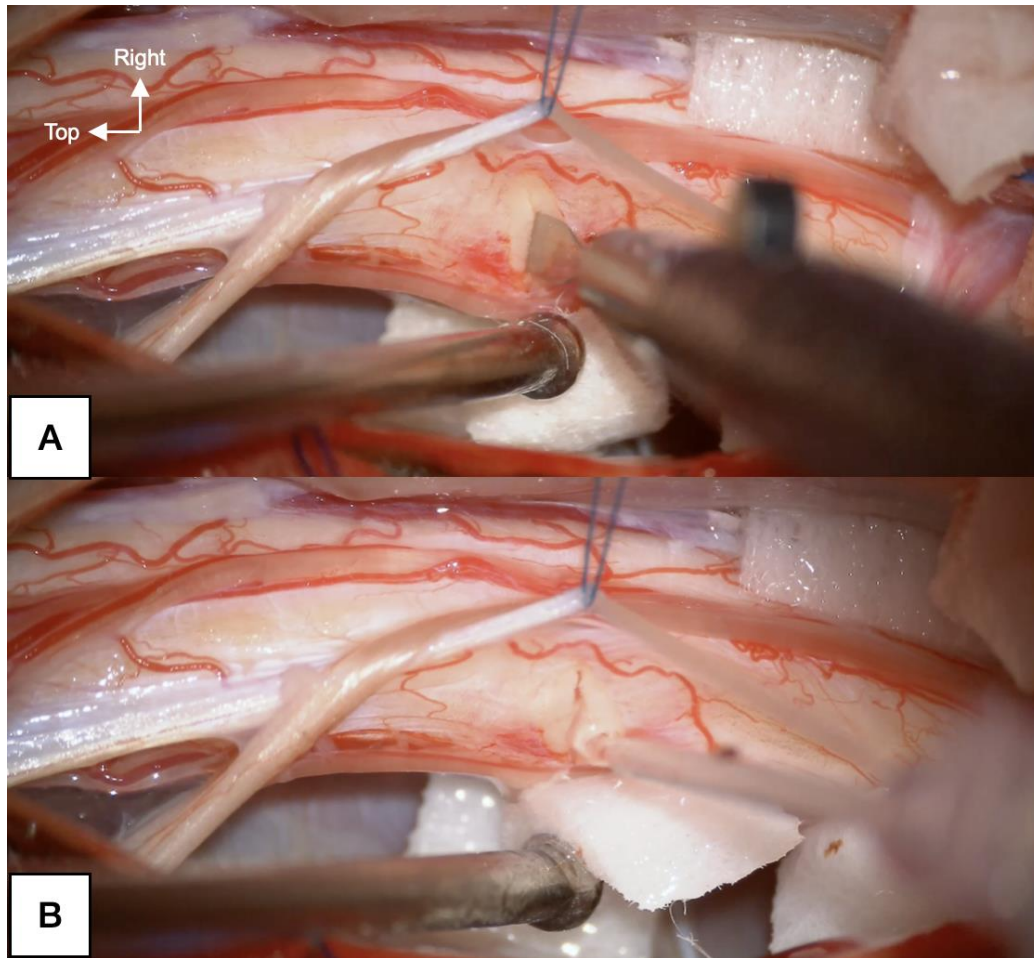


Figure 4. Section of the lateral spino-thalamic tract with an ophthalmologic scalpel (A) then irrigation with saline solution (B).



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Supplementary Material (e.g. video)
Cordotomie video 2.mp4

