Percutaneous cervical cordotomy for cancer-related pain

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Abstract

The anatomic rationale of cordotomy involves interruption of pain fibres in the spinothalamic tract. Cordotomy is indicated in cancer patients with limited life expectancy who have severe, unilateral pain. The goal in patients with limited life expectancy should be to improve the quality of survival, which includes improving the patient's ability to interact with others, and to reduce the amount of time spent in contact with healthcare providers. Analgesic optimization alone may fail to adequately control cancer related pain. When successful, percutaneous cervical cordotomy allows significant reduction in pain medications, and reduces the need for clinic visits. Percutaneous procedures are preferred over open procedures for their lower morbidity. The percutaneous cervical cordotomy procedure is technically not simple and requires considerable skills of the physician performing the procedure.

Keywords Cancer pain; cordotomy; mesothelioma

Royal College of Anaesthetists CPD Matrix: 3E00; 2E03; 2A08

Learning objectives

After reading this article, you should:

- understand the indications for percutaneous cordotomy
- be able to identify patients within the scope of your practice who could potentially benefit from this technique
- understand the neuroanatomy and hence the rationale of the technique used
- recognize the possible complications and side effects

Introduction

The technique of percutaneous cervical cordotomy involves interruption of the spinothalamic tract on the contralateral side of medically refractory cancer pain through radiofrequency lesioning. Cordotomy is very effective for unilateral medically refractory cancer pain below the 4th cervical dermatome in carefully selected patients.[1,2] Mesothelioma treatment guidelines recommend access to cordotomy services for uncontrolled cancer related pain.[3] Incident pain (no pain at rest and severe pain on slight movement) which responds poorly to opioids and adjuvant analgesics, can respond well to cordotomy. Although nociceptive pain is a well established indication, neuropathic pain does also respond well in our experience.

Historical perspective

Cordotomy in human beings was first carried out by Martin and Spiller in 1911 using a surgical technique. The percutaneous technique was pioneered by Mullan et al. who used a Strontium^{90} needle to make an anterolateral cord lesion at C1/2. This technique was further refined by Rosomoff who used a radiofrequency technique for lesioning first in 1965.[4] The technique was used even for non malignant pain in the past but is now recommended for cancer-related pain.[2] The technique was popularized by Dr Sampson Lipton in the UK (Liverpool) in the 1960s. Improvement in pharmacological treatments led to a decrease in interest in cervical cordotomy but now with improved understanding of the limitations and side effects of opioids, cordotomy has regained its place and is recommended for complex unilateral cancer pain in carefully selected patients.

Patient selection

At our centre the referrals are screened further to which we do an expedited joint pain and palliative care assessment during which the selection criteria we apply are as follows:

- medically refractory unilateral cancer related pain below the 4th cervical dermatome (below the shoulder)
- pain predominantly nociceptive (movement related or incident pain)
- satisfactory ventilatory reserve, ability to lie supine for approximately 45 minutes
- expected survival less than 1 year
- confirmed tissue diagnosis of cancer.

Unilateral chest wall pain (costopleural syndrome) due to malignant pleural mesothelioma is a strong indication,[3] but other good indications we have performed this procedure for have included incident pain due to metastatic pathological fractures of long limb bones, brachial plexus invasion due to pancoast tumours, breast cancer, lung cancers and others. In mesothelioma, we recommend early referral, ideally when the patient first commences strong opioids or once chest wall invasion occurs, so we are able to perform the procedure while the patients are in a more physiologically stable state.

Dyspnoea is a common symptom and simple bedside respiratory capacity tests can help make a reasonable judgement. Pain is usually just not the only symptom in a terminally ill cancer patient; hence in our experience working jointly with the palliative care teams helps us deliver a more holistic approach to patient care.

Contraindications are relative and include coagulation abnormalities, local infection, inability of the patient to co-operate, and limited respiratory and physiological reserve. This is not a rescue analgesic technique in the terminal stage of the disease; these patients are best supported by the palliative care teams.

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Anatomy

Cordotomy is based on the current neuroanatomical and neurophysiological knowledge. Pain fibres enter the spinal cord, ascend a few segments, cross the midline and form the anterolateral spinothalamic tract. It is however recognized that not all pain fibres may cross the midline. The spinothalamic tract carries pain and temperature sensation. The distribution of the fibres in the tract is somatotopic; sacral fibres are located more posteriorly and superficially (laterally) while the cervical fibres are deeper and located anteriorly (medially) (Figure 1). The relations medially are the diaphragmatic reticulospinal tract; posteriorly the corticospinal tract; and anteriorly the ventral horn. The dentate ligament is an important anatomic landmark during the procedure as marks the equator of the cord lying just posterior to the spinothalamic tract and is used to guide the placement of the needle for PCC. If the probe is placed posterior to the dentate ligament in close proximity to the corticospinal tract, then motor stimulation at low thresholds will result in arm or leg movement on the ipsilateral side.

Percutaneous cervical cordotomy (PCC) is carried out between the 1st and 2nd cervical vertebral levels as this is the widest space (no facet joint) and allows easy access to the intrathecal space and needle trajectory adjustments. Thermal radiofrequency lesion at this level controls pain below C4 on the contralateral side. The extent of analgesia just like with other radiofrequency techniques depend on the position of the electrode within the tract and the size of the thermal lesion. The radiofrequency electrode used is specifically manufactured for this technique and has a 2-mm active tip. Because PCC is selective for pain and temperature sensation, it achieves pain relief without numbness, and preserves motor power and proprioception. Itch is the other sensation which is lost as well.

Technique

Computed tomography (CT)-guided technique has been described,[5] but the cordotomies performed in the UK are by percutaneous radiofrequency (RF) technique under fluoroscopic guidance and this is what is described here. It can be a technically challenging procedure and requires considerable skill, experience, patient co-operation and good team work. We perform this procedure in an operating theatre under conscious sedation. This subgroup of patients usually are not opioid naïve, and may also be taking other medicines with a sedative potential, and a conscious sedation technique to alter levels of alertness dependent on the stage of the procedure and simultaneously ensuring adequate analgesia during lesioning could itself be a challenge. We prefer to use target controlled infusions administered by a senior anaesthetist who is well versed with the procedure and implications of RF lesioning in the spinal cord.

The patient is carefully positioned supine on a radiolucent table, with oxygen delivered by nasal speculae and the head supported on a carbon fibre cordotomy frame (Wolverson Medical) (Figures 2 and 3). The radiofrequency lesion generator should have the cordotomy software. Audible impedance tone is turned on to detect impedance changes. After local anaesthetic infiltration, a 20G spinal needle is introduced under fluoroscopic guidance into the spinal C1/C2 intervertebral foramina contralateral to the side of the pain. Once free flow of CSF is established a myelogram is performed using a lipid-based dye mixed with CSF or saline. Identification of the dentate ligament helps facilitate placement of the cordotomy probe in the anterolateral quadrant of the spinal cord (Figure 4). A stereotactic needle holding device can help guide the insertion of the cordotomy probe in the correct trajectory. Penetration of the spinal cord is confirmed by an increase in impedance from low (electrode in CSF) to high (electrode in spinal cord). Impedance tone pitch rises and impedance value will increase from 400 Ω to 1200 Ω, approximately. Motor stimulation at 2 Hz is used to exclude cordotomy probe tip placement within or closely adjacent to the ipsilateral corticospinal tract. At this stage, the co-operation of the patient to report the sensory experience accurately and reliably is essential. The correct position within the spinothalamic tract is identified based on the patient's perception of sensation of hot or cold either on the whole of the contralateral side or in the area affected with pain on sensory stimulation. The interpretation of the responses to motor and sensory stimulation is crucial to the success or failure of this procedure. If there is any doubt as to the position of the

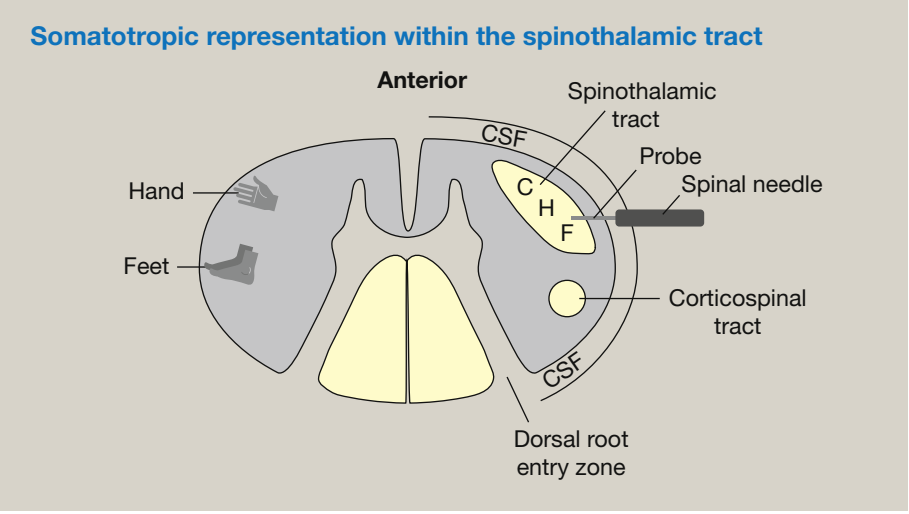

Figure 1

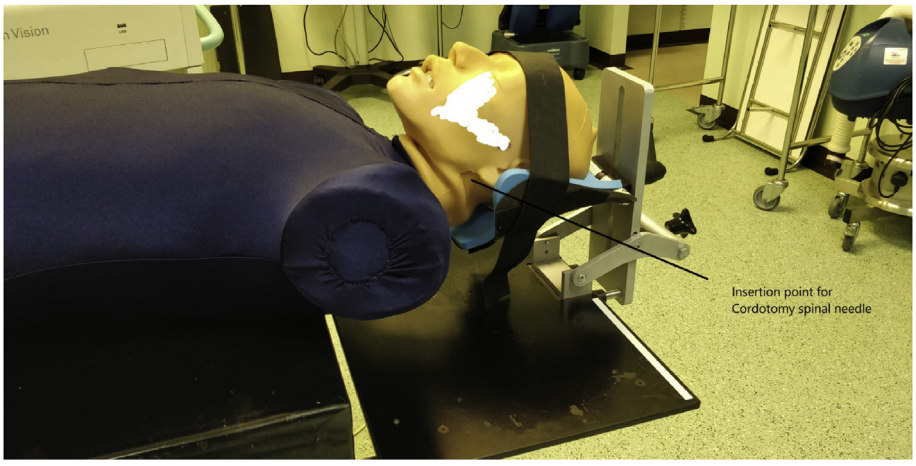

Figure 2 Careful patient positioning with head supported in the cordotomy frame.

electrode, an RF lesion is not created. The electrode is repositioned with further stimulation testing.

After confirmation of correct placement, we perform varying number of radiofrequency lesions incrementally starting at 75 degrees increasing to 85°C, each lesion is done for 25 seconds using an automatic RF generator with the cordotomy software. The process of lesioning can be painful and unpleasant, and requires an increase in the target controlled infusion/s prior to the start of the lesion and titrated to effect. Patients usually report immediate and complete pain relief after one or two lesions. The effect is confirmed by objective testing to pain and temperature by comparing with the opposite side, and the effect of the procedure is apparent straight away. We use ice cubes to assess the loss of temperature sensation objectively on table, and patients usually report a complete loss of sensation to temperature in the painful area although touch is preserved. Post procedure the level of sensory loss can be ascertained by pin prick testing. After the first lesion, we again check the motor power in the ipsilateral arm and leg and confirm preservation before proceeding with further lesioning. Post PCC MR scan showing lesion (Figures 5 and 6).

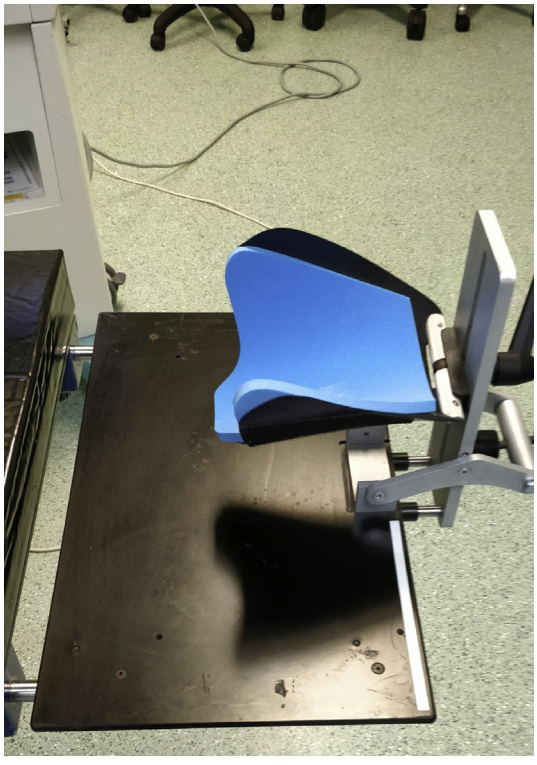

Figure 3 Cordotomy frame (radiolucent) Wolverson X ray limited.

Post procedure care

Patients are usually admitted for 3–4 days for supportive care either in the hospice or in the hospital. After cordotomy patient are usually advised bed rest for a day. Any initial movement out of bed is carefully monitored in case there are any proprioception or motor weakness related issues (these are not uncommon and there is a potential risk of falls and fractures). They may need intravenous fluids, antibiotics and oxygen for a day or two depending on their pre-procedure condition. Usually opioids are reduced by half immediately post cordotomy and this reduction is very well tolerated by patients. Generally it is difficult to completely wean off opioids as these may be needed for other pains.

Complications

It is difficult to quote definite figures for complication rates for cordotomy as new and adverse events attributable to the underlying cancer pathology are also to be expected, the number of procedures performed is small and the outcomes also depend on the skill of the operator. There is a one in ten chance of failure to achieve adequate spinothalamic cordotomy. Serious complications can include death (6% incidence in earlier studies, but 0.5% with meticulous patient selection) or serious hemiplegia. Rarely severe mirror pain has occurred in a very few patients but mild mirror pain occurs in about 15–25% of patients.[6] There have been suggestions that respiratory inadequacy after cordotomy could be a problem, but this has not been the case in our experience. A study carried out in the Portsmouth Unit concluded that cordotomy was well tolerated with regard to lung function.[7] Other minor side effects of the procedure include post dural puncture headache, neck pain (usually of a short duration, and easily controlled). Patients do

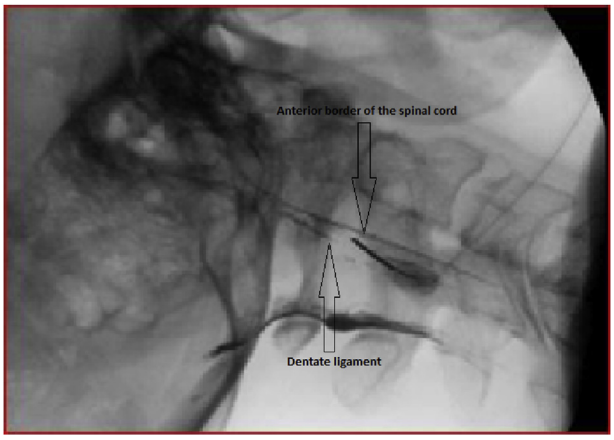

Figure 4 Landmarks on myelogram relevant for cordotomy.

feel a bit rough for couple of days afterwards, possibly as a result of the systemic response to the procedure and reduction of opioids. Patients are also warned of the risks which include a one in twenty chance of leg weakness, taking up to 1 month to resolve, one in five chances of temporary leg weakness lasting 24–48 hours and rapidly resolving, and interference with bladder function, but this has been extremely rare in our experience. Contralateral dysaesthesia is to be expected although patients rarely report this to be troublesome.

Outcome post PCC

Prospective outcomes data collected over a 3-year period (2009–2012) at the Walton Centre Liverpool demonstrated significant reduction from baseline in pain scores at 2 days and improvement in pain scores was sustained at 28 days. There were no serious adverse events observed such as respiratory failure or neurological deficits.[8] Our more recent yet unpublished prospective outcomes data (2016–2017) re-established the previous findings and confirms that cordotomy is a safe and effective procedure to treat intractable unilateral cancer pain. The National Cordotomy Registry now holds dataset for more than 250 patients post PCC from the UK centres offering PCC at the moment. Unpublished multicentre registry data suggests safety of PCC with improved pain relief, reduction in analgesic intake and improved quality of life at follow up.[9] However registry data has highlighted problems with late referrals in context of cancer related pain for consideration of PCC.

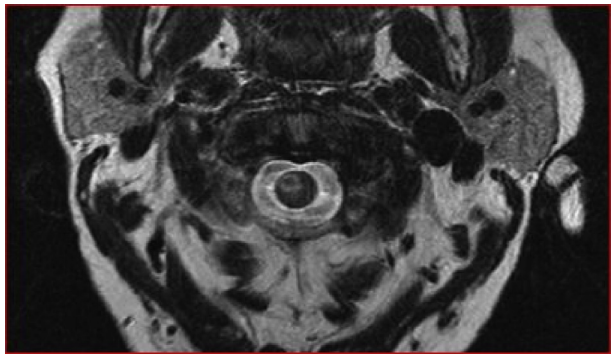

Figure 6 Axial T2 weighted MR scan showing cordotomy lesion.

Bilateral and open surgical cordotomy

Percutaneous bilateral cervical cordotomy has been described in the literature.[10] It is generally not recommended because of the perceived risk of the 'Ondine' curse. If patient develops severe pain on the side opposite to the initial pain and if the pain is below T6 dermatome, then, they are offered open surgical cordotomy at T1–3 level in our centre. This is well tolerated as it is carried out under general anaesthesia, but there is very high risk of bowel and bladder control impairment. This may be acceptable in patient who is terminally ill and has very severe uncontrollable pain. Open bilateral surgical cordotomy has been described recently with good outcome for pain relief.[11] Rarely, open surgical cordotomy can be offered to patient who may not be able to tolerate PCC and if the pain is below T6 dermatome. Open thoracic cordotomy needs laminectomy for adequate surgical exposure and once the dura is opened the dentate ligament attached to lateral border of spinal cord is lifted to rotate the spinal cord to bring anterior–lateral quadrant in to view and a surgical knife is used to incise anterolateral quadrant. It is not possible to judge how deep the incision should be for adequate pain relief in comparison with PCC where the RF lesion can be titrated to desired segmental loss of spinothalamic sensation of pain and temperature. In complex cases with severe bilateral

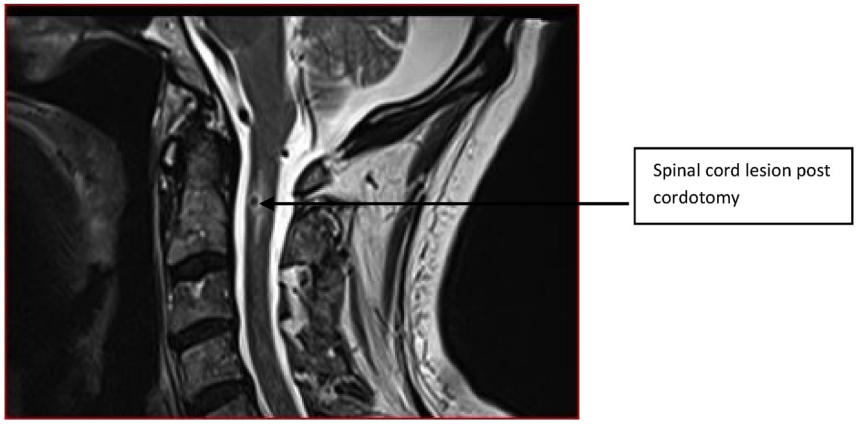

Figure 5 Sagittal T2 weighted MR scan showing cordotomy lesion.

pain below T8–10, bilateral open surgical cordotomy has been described with good pain control.

Technical challenges of PCC and risk mitigation

Challenges of performing PCC include careful but detailed explanation of risks and benefits of the PCC to patients who may be on high dosages of a range of pain killers (informed consent). Serious catastrophic complications can happen and have been reported and needs to be informed in context of benefits. This needs specialized support from anaesthetic colleagues experienced in sedation for PCC and theatre team members as patients do find the procedure distressing despite the use of various sedation regimens. It is not uncommon to have difficulty in accurately localising the spinothalamic tract with sensory and motor stimulation and this can be mitigated by small incremental cordotomy probe adjustment with interpretation of myelogram and knowledge of anatomy of spinal cord. CT-guided technique may offer advantage by visualising the needle and cordotomy probe trajectory in multiplane views, thus mitigating any risks associated with multiple spinal cord punctures.

For patients who have chest wall pain only limited to a few dermatomes, or in a poor physical condition to be able to undergo a cordotomy, and have cancer related pain with limited life expectancy, intrathecal neurolysis remains an option. Discussion on the detailed technique is beyond the scope of this article.

Conclusion

Percutaneous cordotomy remains an important technique for management of unilateral cancer related pain, the number of centres offering this currently is small, hence maintenance of skills and training is crucial to minimise the risk of this technique becoming extinct. CT/MRI guided techniques may offer some advantage more so in patients with difficult anatomy. The evidence base for the use of cordotomy is mostly case series, but demonstrates good pain relief in most patients; this has also been replicated in our outcomes data collection[8] and the National Cordotomy Registry. ◆

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FURTHER READING

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