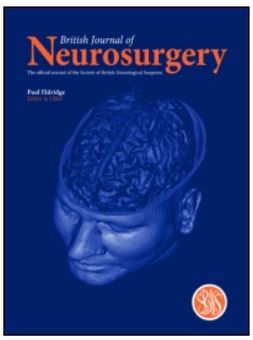

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ORIGINAL ARTICLE

Stereotactic mesencephalotomy for palliative care pain control: A case report, literature review and plea to rediscover this operation

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ABSTRACT

Introduction Stereotactic mesencephalotomy is an ablative procedure which lesions the pain pathways (spinothalamic and trigeminothalamic tracts) at the midbrain level to treat medically refractory, nociceptive, contralateral pain. Sparsely reported in contemporary English language literature, this operation is at risk of being lost from the modern-day neurosurgical practice. **Methods** We present a case report and brief review of the literature on stereotactic mesencephalotomy. A 17-year-old girl with cervical cord glioblastoma and medically refractory unilateral head and neck pain was treated with contralateral stereotactic mesencephalotomy. The lesion was placed at the level of the inferior colliculus, half way between the lateral edge of the aqueduct and lateral border of the midbrain. **Results** The patient had no head and neck pain immediately after the procedure and remained pain-free for the remainder of her life (five months). She was weaned off her pre-operative narcotics and was able to leave hospital, meeting her palliative care goals. **Conclusions** Cancer-related unilateral head and neck nociceptive pain in the palliative care setting can be successfully treated with stereotactic mesencephalotomy. We believe that stereotactic mesencephalotomy is the treatment of choice for a small number of patients typified by our case. The authors make a plea to the palliative care and neurosurgical communities to rediscover this operation.

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Mesencephalotomy; midbrain; pain; palliative care; spinothalamic tract; trigeminothalamic tract

Introduction

Stereotactic mesencephalotomy is an ablative neurosurgical procedure, which lesions the pain pathways at the midbrain level to treat medically refractory, nociceptive, contralateral pain. Stereotactic intra-axial ablative procedures were common in the second half of the last century but have been rarely performed in the twenty-first century. In the English language literature, a number of stereotactic mesencephalotomy case series were reported for both cancer pain[1] and non-malignant pain[2] from the 1950s to the 1990s. Since the year 2000, however, only a single case report can be found.[3] This trend of declining reports on this procedure may imply a shrinking pool of qualified physicians able to perform (or teach) this operation[1] and presents a danger that the mesencephalotomy may soon be lost from the neurosurgical repertoire.

The declining popularity of ablative procedures for pain may be due to an increased reliance on powerful opioids by palliative care physicians and a lack of the necessary surgical knowledge by the current generation of neurosurgeons. Neuromodulation techniques for pain (e.g. spinal cord stimulation, intrathecal pumps) have also replaced lesioning in all but a few centres. Although various neuromodulations have found wide use in treating non-malignant pain in patients with good longevity, their use for palliative care patients with medically refractory nociceptive pain has been limited to intrathecal pumps. In the palliative care setting, however, some patients may not be candidates for a pump (e.g. no CSF space, ineffective test infusion, intolerable side effects or head and neck pain). What can we do for these patients when the comprehensive medical management based on the WHO pain management guidelines[4] has failed?[5] Our centre offers cordotomy for patients with unilateral nociceptive medically refractory pain below the neck with expected life spans less than a year.[6] This case had unilateral nociceptive pain in her neck and posterior head rostral to the expected benefit from cordotomy and was offered a stereotactic mesencephalotomy.

The authors present the details of this case and a brief review of the literature of steretotactic mesencephalotomy.

Methods

A 17-year-old girl presented with rapidly progressing quadriparesis and was diagnosed with a cervical cord glioblastoma after a biopsy of the enhancing lesion (Figure 1). She received local radiotherapy and concurrent Temozolomide (Merck) chemotherapy but progressed to quadriplegia and required a tracheostomy with ventilation and a percutaneous gastrostomy tube. She remained cognitively intact.

Neurosurgery was consulted for her right-sided neck and posterior head pain. This pain began three months after the diagnostic biopsy and had been persistent for six months regardless of intensive medical management by her palliative care team. She described the pain as being located to the right of the midline of her upper neck and lower occiput with periodic radiation into her right shoulder. The pain fluctuated in intensity from 'mild aching' to 'severe shooting, sharp and burning pain' reaching 10 out of 10 on a visual analog scale. The pain was responsive to hydromorphone, but she suffered severe nausea from that medication. The pain was aggravated by movement but not associated with allodynia. She had high anxiety levels with respect to her pain management and

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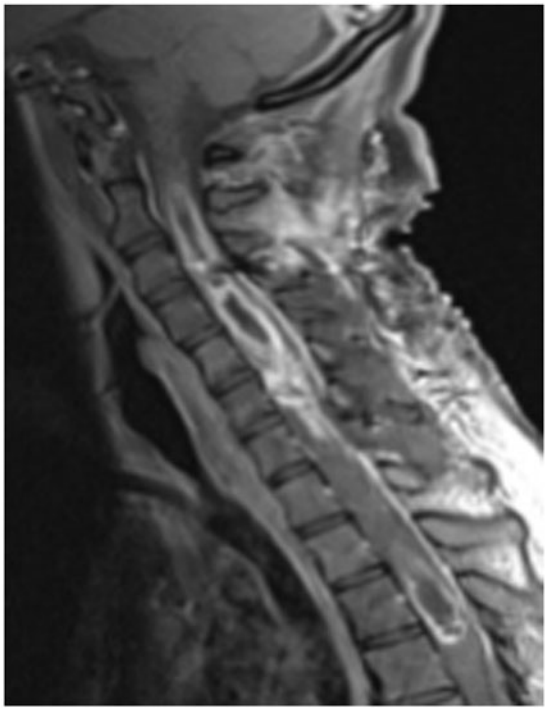

Figure 1. Cervical sagital T1 MRI with contrast demonstrating the intra-axial enhancing lesion of the cord.

Table 1. The medication profile of our patient before and after the mesencephalotomy procedure.

Pre-mesencephalotomy medications	Post-mesencephalotomy medications
Naproxen 500 mg G-tube BID	Methadone 5 mg G-tube TID (tapering)
Fentanyl Patch 50 mcg Q1H	Nabilone 1 mg SL BID
Gabapentin 900 mg G-tube TID	Ondanzetron 8 mg G-tube TID PRN
Clonidine 0.15 mg G-tube TID	Clonazepam 0.25 mg SL BID PRN
Ondanzetron 1.2 mg/H IV Infusion	
Tylenol # 3 1–2 tabs G-tube Q4H PRN	
Hydromorphone 2 mg IV Q4H PRN	
Sufentanyl 5 mg SL Q1H PRN	
Oxybutynin 5 mg G-tube TID	
Lorazepam 1 mg G-tube TID PRN	
Ondanzetron 8 mg IV Q8H PRN	

considered her pain to be poorly controlled by her medications. The complexity of her pain and anti-nausea medications (Table 1) prevented her from being cared for at home. On examination, she had good insight into her condition and was able to clearly articulate her concerns about the pain. The sensation in the back of her scalp and upper neck was intact to light touch and pin-prick with no allodynia or hyperpathia. The biopsy-related scar had healed and was caudal to the area of her pain. There were no skin changes suggesting local inflammation in the region of her pain. She had no sensation or movement below C4. Her goals were to be pain-free and able to leave hospital.

A left stereotactic mesencephalotomy was performed under local anaesthetic after consent from the patient and her family. After attaching a stereotactic head frame to the skull (Radionics), MRI sequences were obtained with axial T2 images of the region of interest and T1 images with contrast through the entire brain. The images were uploaded to a neuronavigational computer (Medtronic) and used to select the target at the level of the inferior colliculus, 5 mm below the posterior commissure (PC). The target was directly lateral to the aqueduct (5 mm posterior to the PC) and half way between the lateral edge of the aqueduct and lateral border of the midbrain (6 mm lateral to midline). The approaching ring (46°) and arc (24°) angles from the anterior left frontal lobe were selected to stay intra-axial and avoid vessels. Electrophysiologic confirmation (and subsequent lesioning) of the target was performed with a 1.8 mm diameter, 1.5 mm exposed tip macroelectrode (Cosman, Burlington, MA).

Using 50 Hz, 1 ms square wave pulses, the patient reported reproducible, right facial and head pain at 0.3 V. A lesion was made at 60 °C for 60 s under a brief pulse of Propofol (Pharmascience, Montreal, Canada). Following the first lesion, however, her sensation to pin-prick in her neck, face and posterior head was unchanged (still reported as sharp). A second stimulation then reproducibly required 0.6 V to cause facial and head pain. A second lesion was made at 70 °C for 60 s but still did not change her response to pin-prick. A third stimulation then reproducibly required 0.8 V to cause head pain but also caused paresthesia on the right body (but not in her head). Following a third lesion at 80 °C for 60 s, pin-prick was reported as dull on the right side in her neck and head. Our desired endpoint was loss of pain/temperature sensation in region of her pain.

Results

Immediately after the surgery, the patient reported '0 out of 10' head and neck pain. Follow-up MRI, 5 d later, demonstrated the lesion at the intended midbrain target (Figure 2). Over the following weeks, the palliative care team was able to discontinue her narcotics completely. At one month post-operative, she developed a diffuse headache which was ameliorated with a low dose of methadone. She was diagnosed with communicating hydrocephalus (all ventricles), which was corrected with CSF diversion. Although the headaches resolved, at the request of the patient and her family, the palliative services continued her Methadone, with the intention of slowly weaning her off of it (Table 1). She lived five months after mesencephalotomy, remaining pain-free and being able to leave the hospital on a regular basis for extended visits to her home.

Discussion

The primary indication for stereotactic mesencephalotomy has become the management of cancer pain involving the head and neck. It is not recommended for non-malignant pain[7] or for patients with a normal life expectancy.[8] Unilateral pain below the shoulder can usually be managed with cordotomy.[6]

The midbrain is a densely compact neural structure with the two pain pathways (lateral and medial) located in close proximity (Figure 3). The spinothalamic and trigeminothalamic tracts, which convey nociceptive pain information from the body and the face, respectively, are located laterally in the midbrain tegmentum (lateral pathway); and the spinoreticular pathway, which is implicated in pain-related arousal and negative emotional affects, makes connections to the midbrain reticular formation and is located medially in the midbrain tegmentum (medial pathway). The major potential side effects following mesencephalotomy are severe dysesthesia following damage to the medial lemniscus[9,10] and disorders of ocular motility.[11,12]

The idea of an 'ideal lesion' within the midbrain evolved over time. The pioneers of stereotactic surgery, Spiegel and Wycis, targeted the spinothalamic and trigeminothalamic tracts to treat facial 'dysesthesia' and chronic pain in the 1950s and 1960s.[11,13] In the 1970s, Nashold and co-workers reported on targeting the spinoreticular pathway and demonstrated cases of pain relief

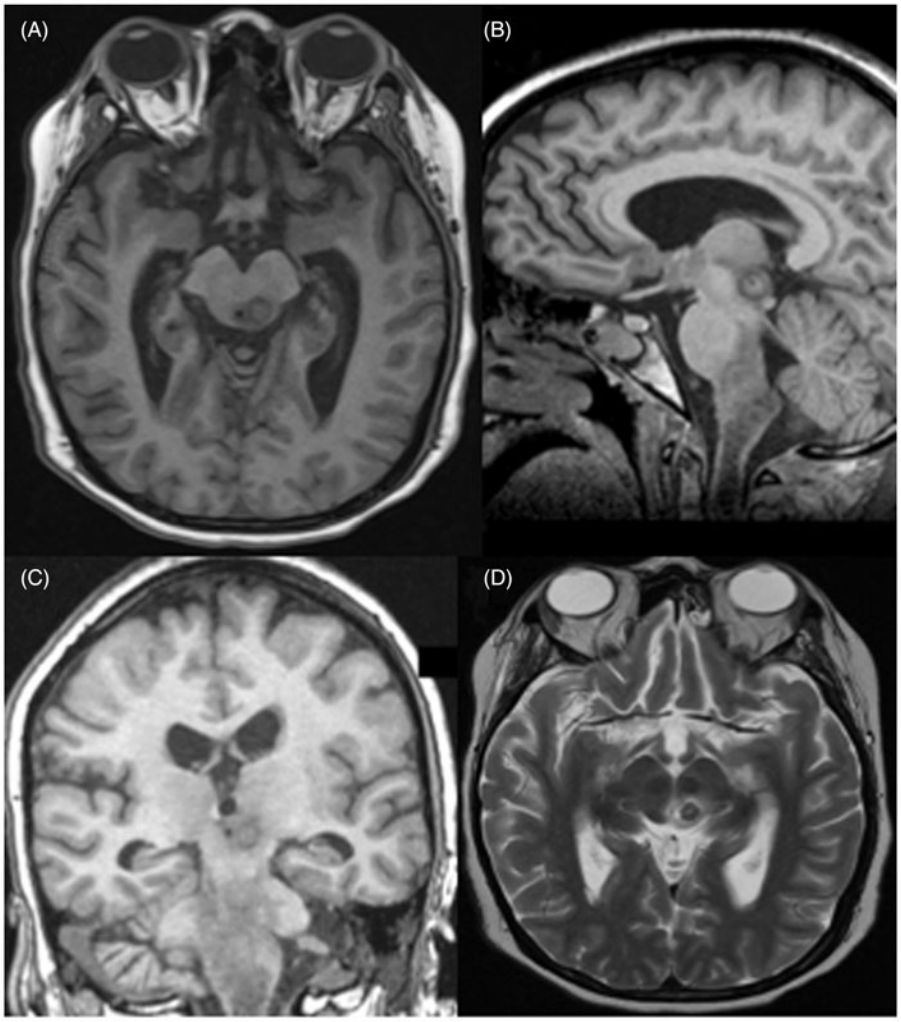

Figure 2. Post-mesencephalotomy brain MRI demonstrating the ablation lesion in the midbrain with T1 axial (A), sagittal (B) and coronal (C) images, and T2 axial (D) image at the level of the inferior colliculus.

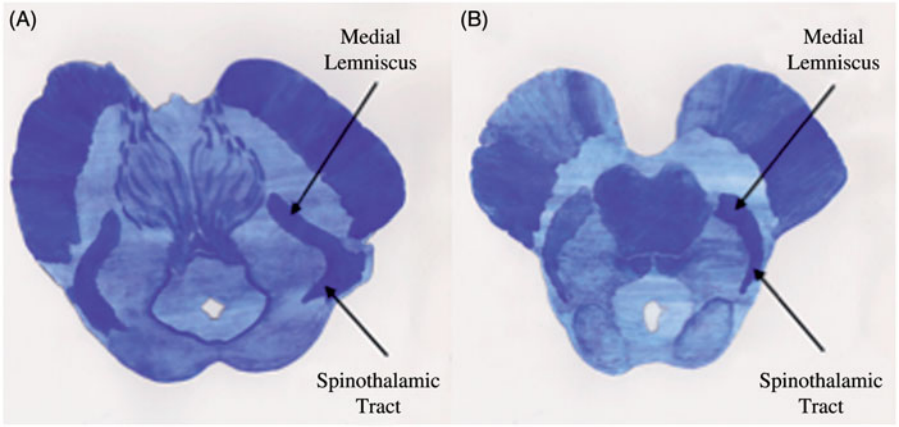

Figure 3. Diagram highlighting white matter tracts in the midbrain at the level of superior (A) and inferior (B) colliculi.

without significant impingement on the spinothalamic tract.[14] Lesions in the spinoreticular pathway were associated with alleviation of the emotional aspects of pain, subsequently the patients becoming indifferent to the pain. In the following decades, interruption of both the lateral and medial pain pathways were advocated to alleviate the sensation of pain by transecting the spinothalamic and trigeminothalamic pathways and to alleviate the pain-associated 'suffering' by transecting the spinoreticular pathway.[5]

The 'classic' target has been described (in the pre-MRI era) as located 5 mm below the intercommisural line, 5 mm posterior to the

posterior commissure and 5–10 mm lateral to the midline.[5] We would advocate direct MRI-based targeting for the lateral and anterior coordinates at a level 5 mm below the PC.

We postulated that the midbrain was the ideal pain target for our patient because her pain was too rostral for a cordotomy and likely originated within the cord (Figure 1) precluding C2–C4 dorsal root rhyzotomy or C2–C4 dorsal root entry zone (DREZ) lesions. Cingulotomy has been utilised for pain syndromes and is reported to remove the suffering component,[15,16] although patients still feel the pain. Our patient had pronounced anxiety, but ultimately wanted the pain reduced not just to be 'disconnected' from the pain.

We used intra-operative electrophysiological stimulation to ensure we were within the trigeminothalamic pathway and distant from medial lemniscus and ocular mobility pathways. During the first stimulation trial, 0.3 V (at 1 ms 50 Hz) caused facial and head pain – indicating we were within or very close to the pain pathway – but did not cause paresthesia (medial lemniscus) or eye movements (oculomotor pathways). After the first lesion (60 °C), stimulation required a higher voltage (0.6 V) to again elicit head pain, indicating that some of the pain fibres had been damaged. Clinical exam showed the presence of pin-prick sensation in the target area suggesting that not all of the pain fibres had been destroyed. After the second lesion (70 °C), stimulation at 0.8 V elicited head pain but also tingling in the contralateral side of the body – indicating the electrical field was now reaching the medial lemniscus. Clinically, pin-prick was still present in the region of pain so one final lesion was made (80 °C). After this, pin-prick and temperature was absent in the region of pain (posterior head and neck) as well as face but light touch was preserved in these areas (changes below C4 could not be detected because she had already lost those functions due to the tumour).

Pain recurrence after ablative procedures for cancer-related pain is unusual because of the reduced life span. The recent case report about mesencephalotomy performed for cancer-related facial pain reported pain recurrence within a week, which then gradually increased and plateaued at two months.[3] The time course of the initial but temporary benefit in that case suggests it was partially due to lesion-induced oedema. Our patient remained pain-free for five months suggesting that the pain pathways had been destroyed.

Conclusions

We present a case of medically refractory, unilateral head and neck nociceptive pain in a palliative care setting who was successfully treated with stereotactic mesencephalotomy. The surgery met her two goals of pain relief and leaving hospital. The sparse representation of this ablative procedure in the English language literature over the last 20 years suggests a fading interest in this modality of pain treatment and a potential risk of losing stereotactic mesencephalotomy from the neurosurgical repertoire. Acknowledging the need for careful patient selection, we believe that stereotactic mesencephalotomy is the treatment of choice for a small cohort of patients typified by our case.

Declaration of interest

The authors declare no conflict of interest.

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