The role of neurosurgery in the treatment of chronic pain

Neurosurgical training should formally incorporate chronic pain management, and future generations will need to direct the development of rational surgical intervention

Peter J Teddy
DPhil, FRACS, FFPMANZCA

Department of Neurosurgery, Royal Melbourne Hospital, Melbourne, VIC.

PeterTeddy@precisionneurosurgery.com

doi: 10.5694/mja16.00156

Podcast with Professor Peter Teddy available at mja.com.au/multimedia/podcasts

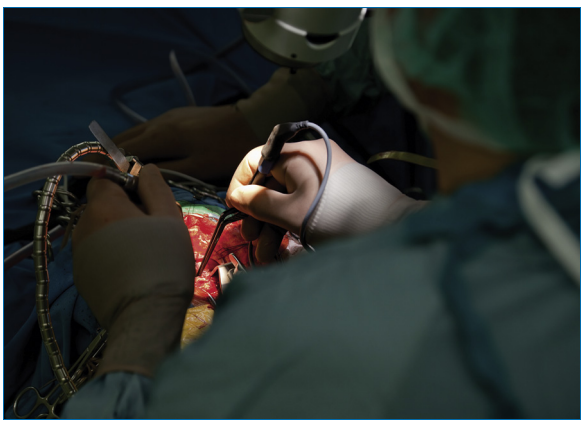
Until the early 1980s, neurosurgical intervention for intractable pain consisted almost exclusively of targeted neuroablative procedures aimed at disrupting nociceptive pathways at some point between peripheral nerve and cortex.

Used predominantly in the treatment of malignant pain in the trunk, pelvis and lower limbs, the most successful of these — dorsal rhizotomy, spinothalamic cordotomy and myelotomy — were considered to demonstrate, invariably in non-randomised case series, good to excellent results in selected patients with nociceptive cancer pain. Pain relief would usually be maintained through a survival period of 9–12 months but there were risks of operative mortality, post-lesion dysaesthesia, and impaired motor, sensory and sphincter function. Generally confined to use in cancer patients with a life expectancy of less than 1 year and with more widespread use of opiates, hospice care and the development of intrathecal drug delivery, these operations became almost redundant.

Recent advances in image-guided percutaneous cordotomy, a new understanding of the pain pathways within the dorsal columns, and the introduction of minimally invasive punctate myelotomy have led to some resurgence both of cordotomy and myelotomy in treating cancer pain patients.[1,2] One ablative procedure yet to be unequivocally surpassed by newer techniques is that of dorsal root entry zone lesioning.[3,4] Thermal lesions target the nociceptive fibres of the lateral part of the dorsal rootlets and medial aspect of Lissauer's tract. Used in its proper context — for intractable upper limb pain following brachial plexus avulsion — it has demonstrated up to 80% long term excellent pain relief with few operative complications.

With the exception of microvascular decompression and ganglionic procedures for trigeminal neuralgia, almost all neurosurgical procedures for chronic pain have, over the past 30 years, moved firmly towards reversible, low risk neuromodulation techniques (electrical stimulation of some part of the nervous system or the use of intrathecal drug delivery to control pain or modify physiological function).

Medial thalamotomy and anterior cingulectomy — used to modify transmission and affective aspects of pain perception (via lateral and medial pain pathways respectively) have been supplanted by the use of deep brain stimulation. Used mostly for treatment of medically and surgically intractable trigeminal neuralgia and other facial pains, cluster headache, post-stroke pain and various painful deafferentation states, convincing data regarding long term effectiveness of deep brain



stimulation in large numbers of chronic pain patients remain limited. Evidence for the benefits of motor cortex stimulation is even less compelling.[5]

Intrathecal infusion of baclofen for spasticity and mini-dose opiates for chronic nociceptive malignant pain consistently produce effective, durable results in appropriate cases. The potential for serious management morbidity coupled with the paucity of useful and safe intrathecal medications direct that extreme caution be exercised in applying this therapy to patients with neuropathic, non-malignant, and generalised pain syndromes. Neurosurgeons deal largely with complications such as catheter tip granuloma, infection, and catheter displacement or extrusion.

Pioneered in 1967 by the neurosurgeon C Norman Shealy using an intradural, radiofrequency-controlled system to relieve intractable malignant pain of the pelvis and lower limbs,[6] spinal cord stimulation has evolved massively in terms of technology, technique, safety, and understanding of its uses and limitations. In Australia, percutaneous, epidural electrodes are now implanted predominantly by pain medicine specialists. Neurosurgical input is required for insertion of plate electrodes in cases where epidural access is limited, and for accessing difficult sites such as the cervico-medullary junction.

Advantages of spinal cord stimulation include its low risk, reversibility and straightforward procedural techniques. On this basis, some have advocated earlier neuromodulation so as to avoid or delay major or repeat surgeries such as in the treatment of failed back surgery syndrome, and of pure low back pain with poorly defined pain generators. The downside is the now widespread, often ill-considered and repeated application of an expensive mode of treatment to unsuitable patients and

pathologies. Unfortunately, this trend seems matched by a substantial increase in equally ill-considered, minimally invasive, instrumented spinal fixation for back and neck pain. Both forms of surgery as applied to chronic spinal pain are in urgent need of rationalisation.

Evidence-based recommendations for patient selection in spinal cord stimulation in Australia and New Zealand were published in 2011.[7] These have remained consistent with all literature reviews to date. The most valid indication is in cases of failed back surgery syndrome. Generalised acceptance of neuromodulation has been limited partly by medical territorialism but also by scepticism generated by the lack of high level evidence for efficacy and of cost benefit. It was not until 2005[8] and 2008[9] that level 2 evidence was established in these domains. The ability to provide level 1 evidence has been hampered until very recently by a lack of placebo controls owing to stimulation-induced paraesthesiae, while the very existence of an organic basis to some pain syndromes (eg, complex regional pain syndrome type 1 and non-traumatic occipital neuralgia) that may be treated by neural stimulation has been questioned.

Trials of stimulation using exteriorised leads (time-limited by infection risk) are sometimes too short to allow adequate assessment regarding permanent implantation. There is little commercial incentive to correct this problem. Careful patient selection is paramount, yet in the United States, where trial to permanent implantation may be office based, reported trial to permanent implantation rates vary between 20% and almost 100%. Research and development worldwide are heavily sponsored by industry, which gives rise to inevitable concerns of investigator bias and unseemly haste in publishing case series. All those entering or already working in this field are recommended to read the sobering chapter by Coffey in *Surgical management of pain*.[10]

Spinal cord stimulation aims at a spinal level to suppress wide dynamic range neuronal activity in the dorsal horns and suprasegmentally via the dorsal column nuclei to modulate activity in the medial thalamus and cingulate gyrus. It has traditionally entailed tonic stimulation with a frequency of around 40–60 Hz. Recent pragmatic randomised controlled trials suggest that high frequency stimulation at 10 kHz and burst (phasic) stimulation offer superiority in the treatment of chronic back and neuropathic leg pains.[11] Each of these provides paraesthesia-free analgesia and has the potential finally to allow sham stimulation. Closed-loop feedback systems promise to even out stimulation efficiency while Wi-Fi and magnetic resonance imaging compatible devices are becoming well established.

Dorsal root ganglion stimulation may hold the key to treating pains less well treated by spinal cord stimulation, including groin pain, foot pain, post-herpetic neuralgia, persistent post-surgical pain (herniorrhaphy, mastectomy, thoracotomy), and in complex regional pain syndrome. Despite multiple positive case series, there is only weak evidence for occipital nerve stimulation benefitting a variety of chronic headaches, although it does appear useful in treating post-craniotomy neuropathic head pain.

"at present, fewer than ten practising neurosurgeons in Australia and New Zealand have a major subspecialist interest in pain surgery"

Unless results from very necessary, very carefully conducted prospective, randomised, placebo-controlled trials dictate otherwise, neuromodulation is likely to continue as the predominant form of interventional treatment for intractable neuropathic pain for the foreseeable future. If so, incorporation of all these developments within a single system would maximise flexibility and efficacy. Advances in Wi-Fi and miniaturisation technology should simplify implantation beyond current imagination. Improved functional imaging may lead to anatomically discrete electrical or drug micro-implantation or even to highly focussed neuroablative procedures.

Nationally, the quality of intractable pain management remains erratic. Neurosurgeons are well qualified to play a leading research and clinical role in optimising both benign and cancer pain treatment. However, at present, fewer than ten practising neurosurgeons in Australia and New Zealand have a major subspecialist interest in pain surgery. Broader exposure to pain management in neurosurgical and spinal surgical training would be of substantial benefit to recruitment and in the treatment of acute (postoperative) and chronic pain states.

Competing interests: No relevant disclosures.

Provenance: Commissioned; externally peer reviewed. ■

References are available online at www.mja.com.au.

1 Collins KL, Patil PG. Flat panel fluoroscopy O-arm guided percutaneous radiofrequency cordotomy: a new technique for the treatment of unilateral cancer pain. *Neurosurgery* 2013; 72(Suppl Operative): 27-34.

2 Nauta HJW, Soukup VM, Fabian RH, et al. Punctate midline myelotomy for the relief of visceral cancer pain. *J Neurosurg* 2000; 92(Suppl 2): 125-130.

3 Sindou MP, Blondet E, Emery E, Mertens P. Microsurgical lesioning in the dorsal root entry zone for pain due to brachial plexus avulsion; a prospective series of 55 patients. *J Neurosurg* 2005; 102: 1018-1028.

4 Nashold BS Jr, Ostdahl RH. Dorsal root entry zone lesions for pain relief. *J Neurosurg* 1979; 51: 59-69.

5 Boccard SG, Pereira EA, Aziz TZ; Deep brain stimulation for chronic pain. *J Clin Neurosci* 2015; 22: 1537-1543.

6 Shealy CN, Mortimer JT, Reswick JB. Electrical inhibition of pain by stimulation of the dorsal columns: preliminary clinical report. *Anesth Analg* 1967; 46: 489-491.

7 Atkinson L, Sundaraj SR, Brooker C, et al. Recommendations for patient selection in spinal cord stimulation. *J Clin Neurosci* 2011; 18: 1295-1302.

8 North RB, Kidd DH, Farrokhi F, Piantadosi SA; Spinal cord stimulation versus repeat lumbosacral spine surgery for chronic pain: a randomised controlled trial. *Neurosurgery* 2005; 56: 98-106.

9 Manca A, Kumar K, Taylor RS, et al. Quality of life, resource consumption and costs of spinal cord stimulation versus conventional medical management in neuropathic pain patients with failed back surgery syndrome. *Pain* 2008; 12: 1047-1058.

10 Coffey RJ. Evidence, the practice of pain surgery, and the Institute of Medicine report. In: Burchiel KJ. Surgical management of pain. 2nd ed. New York: Thieme, 2014: pp 605-621.

11 Grider JS, Manchikanti L, Carayannopoulos A, et al. Effectiveness of spinal cord stimulation in chronic spinal pain: a systematic review. *Pain Physician* 2016; 19: E33-E54. ■