Clinical note

Nerve resection, crush and re-location relieve complex regional pain syndrome type II: A case report

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1. Introduction

Chronic neuropathic pain due to nerve trauma (complex regional pain syndrome [CRPS] type II, or causalgia) is usually not treated by peripheral nerve section, grafting, or relocation surgery by chronic noncancer pain specialists. This appears to be due to a perception of lack of efficacy and fear of pain exacerbation or of the expectation of the inevitable return of pain. The experience of peripheral nerve surgeons is to the contrary [19]. It is time for a re-evaluation of surgical treatment in light of advances and experience in reconstructive plastic surgery and hence, the need for the publication of reports of successful surgery of this type. We selectively searched pain journals, books, and book chapters on CRPS to determine the evidence base for chronic noncancer pain specialists regarding the surgical treatment of causalgia. A few reports were found in the pain literature of the relief of upper-limb nerve causalgia by nerve section and grafting [14,27] and a report of infraorbital nerve causalgia relieved by nerve section, grafting, and relocation [37]. Here we report the remarkable case of severe, very long-standing, and intractable lower-limb causalgia with immediate and long-term relief following peripheral nerve surgery.

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Funded psychological pain management with one of the authors. At age 18 years (2009) she was assessed for social, emotional, and cognitive functioning and was described as having difficulties in each domain. Over the next 2 years, with continued treatment by a pain psychologist (T.C.) her pain continued unabated and in the severe (7–10/10) range for all components despite the variety of medications and procedures listed in Supplementary Table 1.

During the period of 2009–2010, the patient gained 80 pounds (probably related to antidepressants and gabapentinoids), acquired benign intracranial hypertension (headaches and papilledema) attributed to the birth control pill, and acquired idiopathic thrombocytopenic purpura attributable to diclofenac. The latter 2 complications respond to treatment.

An electromyogram and nerve conduction study 18 months before the surgery described below identified absence of conduction of the left superficial peroneal nerve. Sural nerve conduction was present and symmetrical. The diagnosis by the physiatrist-electrophysiologist was CRPS type II involving one nerve (the superficial peroneal) based on this test and the clinical findings. A consultation with a neurosurgeon specializing in peripheral nerve surgery at this time concluded that there was also possible involvement of the sural nerve (due to the extent of sensory disturbance [13]).

When examined in October 2010 (P.W.), the patient reported a steady burning pain, frequent electric shocks, and extreme sensitivity of the left lower lateral leg with touch-evoked pain in the same area, all rated as severe and between 7 and 10 on a 0–10 scale (Fig. 1). She slept with her leg exposed (Fig. 2) and slept poorly because of the pain evoked by contact with the bed linens. She remained severely restricted in activities, getting about in a wheelchair for short distances at home. She moved about on her hands and knees to avoid tactile contact with the lower left leg (Supplementary Fig. 1). She could not wear shoes, socks, or long pants (wearing shorts instead) because of the aggravation of the skin sensitivity and steady, burning pain (Supplementary Fig. 2). She wrapped her leg in ice before a shower (Supplementary Fig. 3A, B) and could not submerge the leg in a bath. An ankle foot arthrosis brace failed to provide protection (Supplementary Fig. 4).

She was taking long-acting oxycodone 120 mg every 12 hours, transdermal fentanyl 25 μg/hour every 3 days, pregabalin 150 mg twice a day, amitriptyline 150 mg at night, and oral ketamine 25 mg twice daily. The area of “all pain” was over a wide area of the left lower lateral leg (Fig. 1) with an area of “deep” pain over the anterolateral ankle. She had exquisite allodynia to touch, both punctate and dynamic, and hyperalgasia to pin and cold on the left lateral lower leg (Fig. 1). Here the skin was equally dry and of the same temperature as the corresponding area on the right leg. There was no weakness of the ankle or in the limb proximally, and the reflexes were present and equal. There were no trophic changes in skin, hair or nails, or swelling. There was pain-limited restriction of left ankle movements. The diagnosis was CRPS II based in part on the previous observations of others of lower-limb erythema, edema, hair coarsening, and allodynia. The lesion was thought to lie in either the superficial peroneal plus sural nerves [13], or in the superficial peroneal nerve alone, with centrally mediated extraterritorial pain [29] extending into the territory of the sural nerve.

Consultation with 3 experienced and highly respected pain neurosurgeons in different North American centers counseled against nerve resection. The patient was then referred to a plastic surgeon in St. Louis, Missouri, USA (S.M.) based on previous success with a similar case [37].

Pain descriptors (see Dr. Mackinnon’s rating scale online) chosen just prior to surgery in St. Louis were of “throbbing,” “smarting,” “aching,” “shooting,” “stabbing,” “tingling,” and “hypersensitive.” Pain severity in the left leg “now,” “over the past month,” and “past week” was severe and 10/10 on a 0–10 rating scale where 10 means worst possible pain. A quality-of-life visual analogue scale was 10/10 and also “100% affected.” A visual analogue scale for depression was 7/10, for stress 7/10, and coping 5/10. Pain was reported to be increased by activity and by hot and windy weather. Difficulty falling asleep and remaining asleep

![Fig. 1. Interrupted line: area of “all pain” (dotted line, white arrow), area of “deep pain” (open circles, white double-headed arrow), area of dynamic and punctate allodynia to touch and hyperalgasia to pin (interrupted line, black arrow), scar from first operations in 2004 and 2005 (marked with x).](image-url)
were identified. Intimate personal relations were described as affected, as well as frequent suicidal rumination and inability to work and do household chores. Three wishes expressed were: 1) “to be normal and have no pain, be on no meds, and no side effects and to want my brain back,” 2) “to go to school to study psychology and acupuncture,” and 3) “be able to have normal relationships and to learn who I really am without meds.”

3.2. Surgical procedure (Sept 28, 2011, full details online; Supplementary Figs. 5A–C, 6A & B), further details of surgical rationale and technique: http://nervesurgery.wustl.edu and references [3,4,10,19,32]

Surgery entailed resecting and cauterizing the superficial peroneal and sural nerves near the ankle, relocating the proximal nerve stumps into deep muscle around the gastrocnemius/soleus interface, and crushing both nerves [3] near the fibular head, for 30 seconds with a hemostat about 35 cm proximal to the ankle. See online description for further details.

3.3. Postoperative course

Immediately and at 12 days postoperatively, there was an absence of all neuropathic pain components (steady burning, shocks, and skin sensitivity [alldynia]), and strikingly, the patient was immediately able to wear socks and tolerate clothing and bedclothes on the lower left leg due to relief of the alldynia (Fig. 3) (Supplementary Fig. 7). She said, “It is the first time in 7 years that I have been without pain.” The severe, constant, nontriggered “nerve pain” in the alldynia area was also much diminished. The predominant steady pain after surgery she described as “joint pain” slowly diminished.

At 5 months after surgery the patient was re-assessed in Toronto (P.W.). She said that since immediately after the surgery, the skin sensitivity had been gone and she had been able to wear socks, shoes, and pants. Her previous pain was replaced by a different postoperative “pressure-pain” clearly distinct from the preoperative “nerve pain” and rated at 2/10 and “mild” without medication. This pain was “0.5/10” with medication consisting of pregabalin 50 mg twice daily, amitriptyline 50 mg at bedtime, long-acting oxycodone 80 mg every 8 hours, transdermal fentanyl 100 µg/hour every 3 days, and oxycodone 50 mg every 4 hours as needed (this was used infrequently). There was a problem with withdrawal symptoms due to opioid dose reduction, and an increased opioid dose may also relate to the reduction in amitriptyline and pregabalin because of weight gain and the discontinuation of ketamine at this time. Her HADS score was 5 (no significant depression or anxiety), all BPI interference scales and PDI scales were 0–4 at most or “moderate,” and the SF12v2 indicated a good health-related quality of life. There was a problem with insomnia but this was not believed to be pain-related. She was driving, going out socially, and walking 50 feet, but stopped at this distance by ankle soreness, which she felt as an ache that was unlike her previous “nerve pain.” Examination revealed healed scars. There was a large area of reduced sensation to touch, pin, and cold over the lateral left leg, conforming to the superficial peroneal and sural nerve territories (Supplementary Figs. 6A & B and 8). There was no allodynia, hyperesthesia, or hyperalgesia. The skin, hair, and nails of the left leg appeared normal. A plan for gradual medication reduction was developed.

At 1 year postoperatively, the patient continued as before and could walk for 30 minutes. She remained on 10 mg long-acting oxycodone every 8 hours, celecoxib, transdermal fentanyl 100 µg/hour every 3 days, pregabalin 150 mg/day, and amitriptyline.
50 mg/day, and occasionally used short-acting oxycodone 50 mg as needed, but not daily.

Rating scales administered at 15 months postoperatively (January 2013) rated the “nerve pain” at 0/10, the ankle “joint pain” at 5/10 with walking and other activity, PDI, BPI domains were all <5 (except BPI for walking, which was 7/10), “pain relief” was 10/10, with the comment that “I do not normally have ‘nerve pain’ any more.” The HADS was 11/44 and not indicative of significant anxiety or depression. At this time she was off oxycodone, pregabalin, and amitriptyline, but continued transdermal fentanyl 25 μg/hour.

Measures administered by the psychologist also indicated a significant decrease in symptoms of anxiety and depression. Her psychologist (T.C.) stated that, “psychologically, the patient is working on now adjusting to life without pain in terms of planning for her future and living with hope. The normal developmental trajectory was interrupted by the pain experience over many years. She is currently working on developmental stages her same aged ‘normal’ peers navigated four and five years ago.”

The patient continued to have complete relief of neuropathic pain symptoms at 21 months after surgery (July 2013) At this time, the “joint pain” (felt at the ankle joint area dorsally on the foot) was absent while sedentary. Walking steadily for >10 minutes also caused a rise in the “joint pain” to 6–7/10 and was relieved by stopping after about 30 minutes. She had no “nerve pain” at this time.

At 26.5 months postop, the patient had no “nerve pain” and describes “ankle pain” at 4/10 at rest, increasing to 7/10 with prolonged activity such as walking about a block, and is currently on transdermal fentanyl 12 μg/hour every 3 days with continued slow gradual withdrawal.

4. Discussion

We describe here a patient with intractable lower-limb CRPS II of long duration relieved by a surgical procedure.

4.1. What caused this patient’s pain?

In retrospect, it is very probable that this patient had 2 kinds of pain that had co-existed at least since the time of her ankle surgery in 2004. The first kind was clearly neuropathic, with burning pain, alldynia, hyperalgesia, and electric shock-like pains. It is probable that this was subsequent to an initial injury to the superficial peroneal nerve, with possible aggravation and additional insult to the sural nerve at the time of her ankle surgery. The second pain was a musculoskeletal pain from some pathology of the ankle joint that is yet to be defined. After surgery had relieved the neuropathic pain, the patient could clearly describe this musculoskeletal pain as a deep and aching pain that was exacerbated by walking. The patient insisted that her remaining “ankle pain” was clearly different from her prior “nerve pain.”

It is probable that the patient’s neuropathic pain followed injury that interrupted axons in the superficial peroneal and sural nerves. Thus, her spontaneous pain may have been a consequence of spontaneous ectopic discharge from axotomized afferent axons [8]. Such discharge may have also initiated and maintained central changes (sensitization) that generated her alldynia and hyperalgesia. However, the ectopic discharge that caused pain and central sensitization may not have been “spontaneous” [2].

Dissection revealed that the superficial peroneal and sural nerves were trapped in scar tissue that tethered the nerves to adja-
The following discussion is based on a search of books and articles in the pain literature likely to form the evidence base of pain specialists. In Mitchell’s 1872 description of causalgia, a term he coined for nerve trauma pain (now CRPS II) in Civil War soldiers [21], there is an account of median nerve resection that moderated pain in the distribution of the resected nerve. Noordenbos and Wall’s (1981) report [22] of surgical outcomes in 7 cases of pain from nerve trauma (3 upper and 4 lower limbs) emphasized the lack of satisfactory relief by nerve resection. They concluded that, “This operation should not be done in patients with this condition. Reasons are given to suggest that peripheral nerve damage induces changes in the central nervous system which are not reversed by treatment directed at the area of the original injury.” This article by 2 eminent pioneers in the pain field may have contributed to a negative view. However, details given of these 7 patients did reveal that 3/7 had some evidence of improvement.

The results of experimental studies of the consequences of nerve injury in rats probably also contributed to a reluctance to operate on CRPS II patients. First, it was shown that transected primary afferent sensory fibers ending in a stump neuroma acquired a spontaneous discharge that originated at both the end of the transected axon and in the axon’s cell body in the dorsal root ganglion [11,16,34,35]. Insertion of microelectrodes into human stump neuromas confirmed that these phenomena occurred in man and that they were present even many years after the nerve injury [23,24]. Spontaneous discharge offered a ready explanation for the presence of spontaneous pain and dysesthesia. It was known that exciting a neuroma is followed by the growth of a new neuroma. This may have suggested to some that one could hope for no more than partial and temporary cessation of pain-evoking spontaneous afferent discharge. It should be noted that the experimental evidence is not as clear-cut as it might seem. The appearance of spontaneous discharge in sensory axons after nerve transection is not always seen [20], and to the best of our knowledge, no one has ever demonstrated the return of spontaneous discharge after neuroma resection.

Although there are many articles in a general search, and particularly of articles found in plastic surgery journals, only a few reports of surgery for CRPS II have appeared in the pain literature in the last 2 decades. Inada et al. (2005) [14] reported 2 cases of relief of digital nerve injury pain in the hand by nerve sectioning and the use of an artificial nerve guide tube. Two of the current authors (P.W. and J.D.) and their colleagues reported (2007) the case of a youth with intractable infraorbital nerve injury pain due to orbital fracture who had gradual (unlike this patient), but eventually complete, relief (now at 9 years) after nerve resection proximal to the injury with grafting and nerve relocation [37]. Stovkis et al. (2010) [27] reported on 34 patients operated on for upper-limb “neuroma pain” by nerve resection with either restoration of nerve continuity or burying of the proximal stump in bone or muscle. Nineteen of 34 (56%) reported satisfaction with the result at a mean of 22 months and with functional improvement. However, none of the 34 patients had complete resolution of “spontaneous” pain.

4.3. Conclusions

The option of peripheral nerve surgery, with or without a graft or nerve reconstitution, for patients with CRPS II needs to be more widely recognized. A surgeon skilled in nerve reconstruction and familiar with the techniques described here is essential. More details of this type of surgery are available in the additions to this article online, at http://nervesurgery@wustl.edu, and in reference [19]. Crushing the nerve proximal to the neuroma excision may be essential for a positive outcome [3,19] (see also online surgery description re: Schwann cell senescence). A search for “tinel sign(s)
before surgery may help in patient selection. It may be possible to identify a positive Tinel response even when the skin is allodynic because the localized response (electric shock-like pain) ought to be distinct from the pain of dynamically touching an allodynic area. Consideration of the involvement of more than one nerve may be important, as a wide area of allodynic skin may not necessarily be due to central sensitization. It may be critical to search for tethering by neuromatous adhesions. Involvement of a nerve(s) with a significant motor component may be a contraindication. The risk that this type of surgery may fail or even exacerbate pain is unknown, and the true outcomes of this procedure can only be known from careful, quantitative follow-up of many other cases.

Conflict of interest statement

The authors have no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.pain.2014.01.025.

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