**Dorsal Root Ganglion Stimulation for Complex Regional Pain Syndrome Recurrence After Amputation for CRPS, and Failure of Conventional Spinal Cord Stimulation**

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Word Count: 1439

Abstract word count: 72

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**Abstract**

Limb amputation is sometimes being performed in longstanding CRPS, although little evidence is available guiding management decisions, including how CRPS recurrence should be managed. This report details the management of a young soldier with CRPS recurrence 2 years after mid-tibial amputation for CRPS.

Conventional Spinal Cord stimulation did not achieve paraesthetic coverage, or pain relief in the stump, whereas L4 dorsal root ganglion stimulation achieved both coverage, and initially modest, over time substantial pain relief.

Implications are discussed. Current evidence does not support the use of amputation to improve either pain, or function in CRPS; dorsal root ganglion stimulation should be considered in those exceptional cases under review for referral for consideration of amputation, *before* referral, and in those patients with CRPS recurrence in the stump *after* amputation.

**Background:**

Complex Regional Pain Syndrome is a - usually post-traumatic - limb pain associated with autonomic signs, of unknown origin. In about 15% of cases the condition persists beyond 18 months, and these patients are less likely to get better later[1](#_ENREF_1). There is evidence for symptomatic efficacy of spinal cord stimulation in about 50% of cases, a neuromodulation method, where an electrical lead is placed over the dorsal column, overriding pain arising from an extremity [2](#_ENREF_2). This treatment has been endorsed by the UK National Institute for clinical Excellence for this patient group [3](#_ENREF_3). However many patients with persistent CRPS will achieve no satisfactory pain relief. Patients with persistent CRPS sometimes demand for their affected limb to be amputated, and surgeons occasionally comply in spite of poor evidence for the efficacy of this intervention, and some evidence for futility [4](#_ENREF_4),[5](#_ENREF_5). In our clinics, patient demand for referral for amputation has been increasing, and we also receive more referrals of patients who have had amputation at an outside centre and are now complaining about severe complications. There is little evidence about how complications arising from limb amputation in CRPS should be treated. A more recently developed neurostimulation technology, ‘dorsal root ganglion stimulation’ (DRG), involves one or more electrical leads placed from the epidural space close to those dorsal root ganglia receiving input from the painful area [6](#_ENREF_6). The latter method may be effective in CRPS, including in some cases of failure of conventional spinal cord stimulation treatment[7](#_ENREF_7).

We report on the treatment of recurrent CRPS in the lower-limb stump of a young soldier who had received amputation for pain relief from CRPS, and for whom conventional spinal cord stimulation treatment had been ineffective.

**Methods/Results:**

Cpl AM (name changed) developed CRPS of the left foot in January 2009, following soft-tissue injury. Conservative treatment was ineffective. A primary surgical trial, and then surgical implant of a paddle lead spinal cord stimulator was performed at an outside center (08.2010). Projection into the clinically relevant foot-ankle area was not fully achieved during either trial or implant, and repeated lead repositioning under general anaesthesia remained unsuccessful.

Following repeated requests by the patient, and after multidisciplinary assessment, trans-tibial amputation was arranged, and performed in 01.2011, which resolved the painful problem and allowed prosthesis use, with only little phantom limb pain. The patient was able to return to administrative work from 05.2011, and from 07.2012 to policing work.

Eighteen months after his amputation, the patient reported increasing pressure-induced pain in the stump. Stump-neuroma was diagnosed, which was excised in 01.2013; the neuroma was histologically confirmed. Unfortunately, this operation triggered CRPS-recurrence in the stump. The patient still denied experience of significant phantom limb pain. Early management consisted of treatment with pamidronate, steroids, opioids, and repeated participation in an intensive rehabilitation program, with limited success. The patient experienced occasional small skin breaks in the stump, each followed by infection, controlled with antibiotics. He stopped working in 09.2013.

On examination at our center (Walton Centre, 01.2014), the patient had signs of CRPS in the stump in all four Budapest categories [8](#_ENREF_8). He had marked limb-allodynia; there was excellent movement in the knee, however with unpredictable episodes of distressing limb tremors. His average pain intensity was 7-8/10. His sleep was 3-4h/night, broken. He had increased values for anxiety and depression and disability, as is typical for patients with ongoing CRPS[9](#_ENREF_9) (HADS A/D: 12/9 indicating clinically relevant anxiety, and borderline depression, Oswestry Disability Index (ODI): 58% indicating severe pain related diability , Brief Pain Inventory (BPI) interference subscale: 9/10 indicating severe interference of pain with daily activities). He used a wheelchair most of times.

Our treatment recommendation included consideration of neuro-stimulation, and a referral for multidisciplinary assessment was made. The assessment team agreed with the suitability of a neuromodulation approach, and also suggested consideration of subsequent Pain Management Program treatment, after permanent implant, to help maximize adjustment to life with a chronic pain condition.

The patient agreed to first participate in a research trial on immune modulation with intravenous immunoglobulin, over 6-months in 2014, where he experienced no benefit including in the open phase receiving active drug.

We decided to conduct an awake percutaneous trial of conventional spinal cord stimulation, however projection of paraesthesia into the stump was not achieved during the procedure, or upon post-interventional re-programing in 01.2015, (Figure 1A), and the trial was classed negative after one week. An awake trial of DRG stimulation of the left L4 dorsal root ganglion was then performed in 03.2015 (Figure 1B, C). About 75% coverage with pleasant paraesthesia of the painful area was achieved during an on-table trial, which was confirmed by mapping, and implantation was completed under local anaesthesia. At one month after the operation, the patient reported a marked reduction in the frequency of pain flares, and 25% overall pain relief.

At his referring rehabilitation centre (Headley), he was subsequently fitted with a series of prosthetic devices and sockets that initially allowed the lower leg to remain unenclosed, progressing through to a true trans-tibial socket with thigh corset for additional support (Fig. 2).

At 17 months follow up (08.2016) the patient reports complete paraesthetic cover of the painful area, and overall 60% pain relief with the device turned on, an average 24h pain intensity of NRS 3-4/10; the improvement from the original 25% pain relief had occurred gradually over 12 months. When he turns the pulse-generator off, the patient reports, that his pain returns to high intensity (‘severe pain’) within about 3.5h, and it reduces again to low values within an hour of being switched on.

At follow up (08.2016) the sensitivity in the stump is reduced; the patient attributes this to both an improved ability to perform his own desensitization exercises under DRG paraesthesia cover, and also to increased prosthesis use which provides a desensitizing stimulus. The patient remains on Tapentadol SR 50mg BD (reduced from 250mg BD at DRG implant), Pregabalin 150mg OD (reduced from 300mg BD), Nortriptyline 10mg nocte. He now has 6-7h/night uninterrupted sleep, and reports improved, stable mood. He uses his prosthesis for 12h/day walking independently, and he has stopped using crutches. His 6-minute walking test has doubled over the 12 months since implant, to 500m. The average BPI interference values are still moderately raised at 5.9/10.

In April 2016, the patient reported new onset of pressure-dependent, neuroma-type shooting pain in the stump, with little affect on function at follow-up (08.2016); this is still being investigated.

**Discussion:**

This case highlights a number of critical issues around treatment of longstanding CRPS, including neuromodulation. Low-dose Ketamine infusion treatment is, to our knowledge the only pharmacological option that has been shown to achieve temporary pain relief in this group, however unlike with neuromodulation, data about efficacy and risks of repeated administrations are not available; in a UK setting the cost-effectiveness of this treatment, which requires regular repeat infusions is not established, and we have abandoned it’s use at our center [10-12](#_ENREF_10). The primary surgical trial of spinal cord stimulation, i.e. asleep surgical insertion, is a technique in keeping with international guidelines, but uncommonly used nowadays [13](#_ENREF_13). Because the patient was asleep during re-positioning, the causes of the failure to achieve coverage *before amputation*, a relatively rare type of complication, thus remain unclear; they include, amongst others, spinal cord re-organisation, and/or failure to appropriately position the lead [14](#_ENREF_14). It should be noted, that there is variability between DRG techniques. Awake versus asleep-plus-neuromonitoring techniques have been described for DRG insertion; we used an awake technique[15](#_ENREF_15). Sub-threshold techniques have been described and may be more effective in some patients although others seem to struggle with the concept; we used above-threshold stimulation[15](#_ENREF_15).

Dorsal root ganglion (DRG) stimulation has, to our knowledge not previously been discussed in the context of amputation for CRPS [7](#_ENREF_7). Although in this case report this method proved effective in treating stump-CRPS, we don’t know, whether correctly applied either this technology, or an awake conventional percutaneous trial might have prevented amputation.

We suggest that DRG stimulation should be considered in CRPS patients failing to achieve coverage with conventional spinal cord stimulation, including *before* any planned amputation, and for CRPS recurrence *after* amputation. Of note, recent preliminary evidence suggests, that outcomes with DRG stimulation up to 1 year may generally be better than with traditional SCS stimulation for the treatment of CRPS 1[15](#_ENREF_15). Independently, conventional spinal cord stimulation when applied for a different pain condition, phantom limb pain after amputation, has a low success rate, and contrasting this, a recent case series has suggested that DRG stimulation may often provide satisfactory pain relief for this pain condition.[14](#_ENREF_14),[16](#_ENREF_16)

Since DRG stimulation did initially only partially reduce AM’s skin sensitivity, we suggest that the graded increase in prosthetic socket design at his referring rehabilitation centre has been a key element in increasing his tolerance and progressing him up to a virtually full time prosthesis user. A limitation of our approach is, that it is not possible to be certain about how each element of the multidisciplinary treatment has contributed to this patient’s improvement.

Independently, it is notable that this patient now advocates *against* amputation for CRPS amongst UK soldiers who consider this. Long-term outcomes from amputation for CRPS are not well understood; outcome measures used in published case series were not in line with IMMPACT criteria, and are thus unsatisfactory [4](#_ENREF_4) [17](#_ENREF_17). As was the case in this patient, late complication may substantially alter the perception about the intervention’s success. Further, this patient’s experience of the subsequent successful DRG treatment differs from the experience of patients who may report high satisfaction about the amputation procedure in the apparent absence of any alternative[4](#_ENREF_4), where amputation remains the patient’s perceived last and only therapeutic option. In our view, amputation for pain or function in CRPS should only be considered in exceptional circumstances, unless more supportive evidence becomes available. Specialist, multidisciplinary Pain Medicine services also providing advanced neuromodulation competence, and specialized prosthesis services must work together in such considerations.

**Acknowledgements:**

AG, SL, RP and MS contributed to the management described in this case report, and wrote, reviewed and approved the manuscript. All authors had access to all case-report data.

Conflict of interest: AG declares having received support to attend a workshop by Nevro; the UK CRPS Guidelines Group, which AG chairs, has received unrestricted educational grants by several companies, including companies producing neuromodulation equipment. SL, RP, MS have no conflicts of interest to report.

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 **Figure Legends**

**Figure 1.** *Periprocedure fluoroscopic images.* **A:** percutaneous trial lead during attempted conventional spinal cord stimulation to treat CRPS recurrence after limb amputation for CRPS. Trial stimulation, including after proximal, or distal re-positioning of the trial lead (not shown) did not recover paraesthesia in the stump. Spinal cord stimulator paddle lead from the unsuccessful surgical trial, *which preceded* amputation is seen left in situ. **B**: dorsal root ganglion stimulation lead in situ at L4 level.

**Figure 2.** *Socket development to achieve prosthesis tolerance with effective dorsal root ganglion stimulation in place*. **A**: one of the early sockets with the lower leg freely suspended and a thigh corset and shoulder straps; **B**: final socket with full enclosure; **C:** lateral view