



The Feasibility of Percutaneous Peripheral Nerve Stimulators for Management of Persistent Postoperative Pain

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Introduction

Neurostimulation has been used for a long time as an analgesic modality for a wide variety of pain conditions with evidence of benefit. Technological limits, the invasiveness of lead placement, and cost of the procedure has significantly restricted its use. Recent developments in percutaneous peripheral nerve stimulation (pPNS) technology have allowed for the minimally invasive placement of percutaneous peripheral nerve stimulator leads under ultrasound guidance in a similar manner to continuous peripheral nerve catheters.[1] Like similar devices, pPNS provides electric stimulus to nerves to modulate peripheral and central pain responses. Unlike other devices currently in use, these leads are temporary, with therapy lasting only 60 days before lead removal.

A multimodal analgesic strategy, including the use of opioid analgesics, non-steroidal anti-inflammatories, acetaminophen, gabapentinoids, and regional anesthesia, can prove effective for chronic pain when used in an appropriate combination and dosage. However, opioid medications, most notably, have well-known detrimental side effects, risking dependence and potential addiction for patients. Research investigating pPNS as an alternative therapy has grown over the last decade. Several case series and proof-of-concept studies have been completed recently investigating the benefit of pPNS in the perioperative setting for a variety of surgical cases.[1] These studies have shown positive results with regards to pain reduction, opioid consumption, and functionality after total knee replacement, foot surgery, rotator cuff repair, and ACL reconstruction. Additionally, recent studies demonstrated the benefit of pPNS for a variety of perioperative and chronic pain pathologies to reduce pain levels and opioid use.[2]

While the current literature has focused on pPNS placement for either perioperative or chronic pain patients, there exists a population of pain patients who straddle those two groups. The incidence of persistent postoperative pain (generally greater than 6 months post-operatively) appears to range from five to 85 percent, depending on the surgery, with the median incidence being 20-30 percent.[3] pPNS treatment could provide an alternative option for patients with persistent postoperative pain whose only other options are continued ineffective traditional treatment methods or further surgeries to try to help ameliorate their pain. The goal of this feasibility study is to examine whether the patients with persistent postoperative pain who received pPNS placement from our Regional Anesthesia and Acute Pain Medicine (RAAPM) team achieved notable improvements in pain levels, and if so, were the reductions found comparable to those seen in the existing pPNS-related literature.

Methods

We received Penn State University IRB approval (STUDY00024034), to retrospectively examine the effects pPNS placement had on qualifying patients' self-reported pain levels, subjective functionality assessments (e.g. increased ability to perform ADLs, increased exercise tolerance, etc.), and use of prescribed pain medication (if applicable). A total of nine patients have received percutaneous peripheral nerve stimulator lead placement due to ongoing persistent pain that began after a surgical procedure. For the pPNS procedure, each patient was alert and able to give feedback about the sensation elicited and location of the sensation when the pPNS was placed to ensure this was reproduced in their areas of pain. Each lead was placed by a RAAPM team attending anesthesiologist. Prior to the pPNS procedure, informed consent was obtained from patients to use their de-identified information and data for scientific publications and presentations. Patients were contacted weekly by representatives from SPR Technologies to assess patient reported pain scores, pain medication use, and for any troubleshooting that was necessary. The patients then returned to the clinic to have pPNS removed after 60 days.

Results Table

Patient	Surgery Related to Persistent Pain	Nerve(s) Targeted	Highest recorded % Pain Relief	Self-Reported Change in Prescribed Pain Medication Requirements	Self-Reported Change in Quality of Life
1	Multiple Leg Surgeries in Short Period of Time Due to Traumatic Injuries	Sciatic (Popliteal)	95%	Not on chronic opioid medications	Minimally Improved
2 i	Knee Arthroscopy with Partial Medial Meniscectomy and Open Excision of Parameniscal Cyst	Saphenous	100%	Not reported	Not Reported
3	Total Knee Arthroplasty	Femoral	50%	Not on chronic opioid medications	Improved
4	Lateral Epicondylar Debridement, Radial Tunnel Decompression, Radiocapitellar Synovectomy	Radial	0%	No change	No Change
5	Tibiotalar Fusion	Sciatic (Popliteal)	100%	Not on chronic opioid medications	Improved
6 ii	Carpal Tunnel	Radial	35%	Not on chronic opioid medications	Minimally Improved
7	Tibiotalar Arthrodesis, Talocalcaneal subtalar fusion, Fibular Osteotomy	Sciatic	75%	Not on chronic opioid medications	Improved
8 iii	Total Knee Arthroplasty	Femoral	0%	No Change	None
9 iv	Subtalar Fusion and Ankle Arthrotomy	Femoral and Sciatic (Popliteal)	30%	Not on chronic opioid medications	N/A; still in treatment phase

i: Follow up difficult after week 1

ii: Removed prematurely by RAAPM team in week six due to patient request. Patient was not satisfied by level of efficacy.

iii: Removed prematurely by RAAPM team in week five due to patient request. Patient was not satisfied by level of efficacy.

iv: Only partial data as treatment still in progress for this patient.

Discussion

Neuromodulation has been investigated as an alternative non-pharmacologic form of analgesic treatment for patients with chronic pain. Percutaneous peripheral nerve stimulators have shown positive results in small studies and case reports for chronic lower limb pain of various etiologies.[4] Traditional medical therapies benefit many of these patients, allowing them to maintain semi-functional lives at minimum. However, mainstay pharmacological therapies for these patients rely heavily on opioid medications that have significant risks, side effects, and addiction potential. Often, patients with chronic postoperative pain undergo multiple follow up surgeries in an attempt to resolve the etiology of their pain, enduring great physical and financial costs in the process. pPNS could provide an alternative route for these patients to avoid further surgeries or provide hope for patients whose surgical options have been exhausted. Although the implant is temporary, there appears to be a sustained analgesic benefit from pPNS that significantly outlives the 60-day pPNS lead indwelling period.[5] Additionally, pPNS procedures are repeatable if analgesic effect wanes.

Over the last three years, our RAAPM team has developed a growing pPNS program in an attempt to reduce pain in patients with a variety of pain generating etiologies. Our aim with this project was to compare the pain reduction outcomes of our patients with persistent postoperative pain to the results seen in the other pPNS research involving patients with chronic extremity pain. Generally, pPNS studies involving chronic pain of peripheral limb nerves have shown a wide variety of reduction in pain scores, anywhere from 30-80% depending on the study and nerve(s) involved.4 Our limited results, while varying significantly patient-to-patient, seems to fit into the broader trend with other research studies. While narrow and from a small subset of patients, the results of our project indicate that pPNS could provide tangible benefit to patients dealing with debilitating pain secondary to persistent postsurgical pain. This feasibility project suggests a bigger prospective trial is warranted to evaluate the role of percutaneous peripheral nerve stimulators for these patients.

References

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