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Research Article

Peripheral Nerve Stimulation of the Suprascapular Nerve for Treatment of Shoulder Pain

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Abstract

Background: An 84-year old woman with a history of left shoulder replacement presented with chronic bilateral shoulder pain, resistant to conservative and procedural management. She is a candidate for right shoulder replacement, but wanted to avoid surgery and attempt less invasive measures to control her pain. After failing other treatment modalities, a suprascapular nerve block was performed as a predictor for peripheral nerve stimulation (PNS).

Objective: Evaluation of the efficacy of a minimally invasive wireless neuromodulation device to treat intractable shoulder pain.

Methods: She was implanted with bilateral wireless neurostimulators at the suprascapular nerve branches inferior to the suprascapular notch after successful nerve blocks. Pain scores at 3 months' post-implant were compared to baseline.

Results: Patient reported a decrease in pain scores from 8/10 to 3/10 on average, along with a reduction in pain medications and 60 % overall improvement in pain control at 3 months follow up.

Conclusion: This novel neuromodulation system, void of extensions and implantable battery, with a minimally invasive percutaneous technique, makes it suitable for Peripheral Nerve Stimulation (PNS). Peripheral nerve stimulation can be an effective and safe treatment for shoulder pain related to suprascapular neuropathy.

Keywords: Wireless neurostimulation; Suprascapular nerve; Shoulder pain

Introduction

Suprascapular neuropathy is an uncommon cause of shoulder pain and can be challenging to diagnose, since shoulder pain can have many sources, including rotator cuff, brachial plexus, and the cervical spine amongst others [1]. Suprascapular neuropathy can be diagnosed through physical examination and electro diagnostics after exclusion of other possible causes. Symptoms include: shoulder weakness, atrophy and aching or burning pain at the back of the shoulder in the scapular area [2]. Management of suprascapular nerve pain is challenging. Treatment options include pharmacological treatment including acetaminophen, Non-Steroidal Anti-Inflammatory Drugs (NSAIDs), anti-seizure medications and antidepressants. Non-pharmacological treatments include physical and occupational therapy. When both types of therapies fail, interventional procedures including steroid injections and surgical decompression (if there is a lesion) may be considered [3]. Pain control can be unsatisfactory with all of the above modalities.

When the pain remains resistant to these medications and interventions, PNS might provide an alternative. PNS involves electrical stimulation of a specific nerve that supplies a distinct area of the body. This can be achieved by a percutaneous method. However, conventional battery-dependent systems are not suitable for peripheral nerve stimulation due to the bulk and wiring of these systems. These device components are placed inside the patient's body and issues may arise when one of these components malfunctions. Complications related to the wiring between electrodes and the Implantable Power Generator (IPG) include dislocation, erosion, and infection. Additional issues may arise from the implantable battery. Displacement and pocket pain are common events [4,5].

The novel, wireless StimQ PNS System (Stimwave Technologies Incorporated, Pompano Beach, FL) is designed to mitigate these types of complications and challenges. The StimQ system relies on an external energy source to power the electrode arrays using an embedded micro-receiver. This eliminates the need for an IPG and its associated complications, and provides cosmetic advantages.

Medical History

The subject is an 84-year-old woman with a history of left shoulder replacement and bilateral shoulder pain. She is a candidate for right shoulder replacement, but, because of continued pain after the left sided surgery, she wanted to avoid surgery and attempt less invasive measures to control her pain. She tried oral opiates, physical therapy, and radiofrequency ablation with unsatisfactory pain control.

After failure of other treatment modalities, we discussed moving forward with suprascapular nerve blocks to be followed by a peripheral nerve stimulator trial and implant if the diagnostic injection produced good results. Patient reported 8/10 pain with medications and 10/10 without medications. A suprascapular nerve block was performed with significant, but temporary improvement in pain. Based on the results of the suprascapular nerve block, she was sent for psychological evaluation and agreed to proceed with a PNS trial.

Device Description

The StimQ stimulator has four contacts, a microprocessor, receiver, and antenna embedded within the body of the stimulator. The exterior of the stimulator is designed with fixation tines to secure the stimulator location. The implant is passive and powered by an external transmitter with antenna, which is worn over a thin layer of clothing.

Methods

Surgical description for the trial implant

A 13-gauge introducer needle was percutaneously inserted 4 inches medial to the axilla, near the inferior border of the scapula and was advanced under fluoroscopic guidance until the tip of the introducer was just inferior to the suprascapular notch on the right side; the needle stylet was removed, and an 8-contact, stimulator was placed through the introducer with the tip ending at the suprascapular nerve branches inferior to the suprascapular notch (Figure 1). The steering stylet was removed, and the receiver was connected to the system. The process was then repeated in identical fashion on the left side. The external tubing was fixated to the skin.

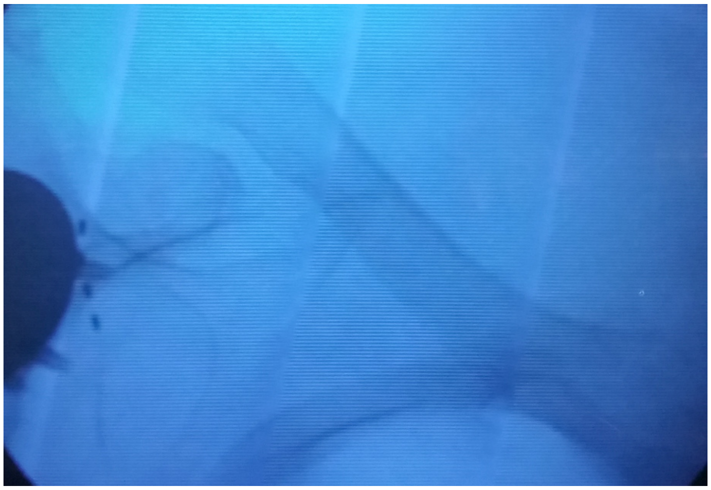

Figure 1: Image showing the four-contact neurostimulator electrode array at the suprascapular nerve branches inferior to the suprascapular notch.

During the 3-day trial, her average pain came down to a 3-4 out of 10 on the VAS scale. Given the excellent results of the trial, the patient agreed to move forward with the permanent implant.

Surgical description for the permanent implant

The trial stimulators were removed and replaced by a permanent 4-contact system with tines. Techniques and placement were similar to the trial procedure**.** Once the electrode arrays were placed bilaterally, beginning at the inferior angle of the scapula and running towards the suprascapular notch at a gentle angle on each side, a receiver pocket was created between the shoulder blades in the center of the back and the tails were tunneled medially and horizontally toward one another subcutaneously so that the tails were both in the receiver pocket and the area between the marker bands on each device overlapped in the middle of the back.

One anchor stitch was placed in the fascia and around each stimulator at the marker band. A knot was tied in the distal end of each stimulator in the receiver pocket. The stimulator was secured by passing anchor stitches through deep fascia in the receiver pocket and then through the stimulator itself. The receiver pocket was closed in layers.

Results

One external device with transmitting antenna was used to power both stimulators at the marker band region horizontally, between the shoulder blades where the stimulators overlapped beneath the skin. Stimulation parameters with pulse rate of 1.5 kHz and pulse width of 30 µs at 2 and 4 mA was tested and found effective. The patient tolerated the procedure very well. Improvement in pain scores was more then 60% from 8/10 to 3/10 on average. Subject had a reduced requirement in pain medications of 60% and noted overall improvement in pain control at 3 months follow up.

Discussion

The suprascapular nerve can be injured or irritated in several ways. Mechanical stress, compression, or injury from surgical procedures or trauma can cause serious damage and lasting pain [6,7]. Suprascapular neuropathy may lead to weakness in muscles supplied by the nerve including the supraspinatus and infraspinatus muscles. In addition, patients may complain of weakness in the shoulder during movement, which may, or may not, be appreciated on clinical exam [8,9].

Diagnosis overall can be challenging, as there are several other conditions that can paint a similar clinical picture including rotator cuff injury, cervical radicular pain, brachial plexopathy, bursitis and myofascial pain. A thorough history and exam are essential in finding the true source of the symptoms. Diagnostic nerve block for the suprascapular nerve is an important tool in diagnosing neuropathy. Imaging may be needed to establish the reason for the neuropathy and identify the compression area if present and can be useful in excluding other causes such as cervical radicular pain originating from separate pathology as well. Nerve conduction studies may additionally be considered if needed [10,11].

A prior case series on implantation of PNS for treatment of neuropathic pain conditions included a much more involved surgical procedure, not only for placement of the devices, but also in creating a large IPG pocket, requiring removal of a significant amount of tissue and extended time in the operating room. And while the technique was more complex using other systems, the patients still reported excellent improvement and efficacy of PNS for treating neuropathic conditions [12].

Placing a lithium ion battery in certain areas of the body (in the foot, for example) can be challenging, or even impossible, due to the lack of subcutaneous tissue, which makes the placement risky and likely to cause significant discomfort to the patient. The use of the StimQ PNS System has solved this problem, as there is no need for battery implantation. Thus, stimulators can be placed anywhere in the body, and an external soft antenna is used to send the power signal to the microprocessor embedded within the device through RF communication, instead of a direct physical connection to an IPG/power source. The surgery is done using a less than 1 cm incision for each stimulator placement and another small incision for a receiver pocket.

While PNS was used with success on the suprascapular nerve and other peripheral nerves in the body prior to the StimQ PNS System, the technique was tedious and required placement of a battery, formation of a large IPG pocket and extensive tunneling to place the battery in a location with enough subcutaneous tissue to be plausible. Efficacy has been proven in many studies and on various peripheral nerves, but PNS is now available in a much more practical and applicable form [12-15].

Conclusion

The presented case of PNS for suprascapular neuralgia resistant to other pain management modalities demonstrates that this patient achieved excellent pain relief after the procedure. This case confirmed the efficacy of PNS in treating suprascapular neuropathic pain specifically, which was described very few times in prior literature. In addition, it conveys the simplicity of the procedure and efficacy of the system used without the need for an implantable battery or aggressive tunneling and large incisions. PNS is an option that should be considered for patients with suprascapular neuralgia after failure of conservative management.

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