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Peripheral Nerve Stimulation with a High Frequency Electromagnetic Coupled (HF-EMC) Powered Implanted Neurostimulator with Receiver at the Suprascapular and Supraclavicular Nerves for the Treatment of Chronic Shoulder Pain: Case Report

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Background: Over 20% of adults are affected by chronic shoulder pain that can limit the use of the upper extremity and decrease the overall quality of life. Peripheral nerve stimulation (PNS) is an emerging treatment for refractory cases of chronic pain that has been receiving heightened attention in recent years with growing documentation of favorable results. This report discusses a case of chronic shoulder pain effectively managed with PNS.

Case Report: A 58-year-old man, with a history of cervical laminectomy presented with persistent pain of the left shoulder, radiating down the medial aspect of the left upper arm to the elbow, and pain along the upper trapezius between the neck and shoulder that did not ease after successful shoulder joint replacement. The pain averaged 8/10 and escalated to 10/10 with arm movement or lifting over 5 pounds. Once agitated, the pain would stay elevated for several hours. The patient eventually withdrew completely from social activities and stopped leaving his home except when absolutely necessary to avoid additional pain brought on by activity. Previous treatments, including physical therapy, opioids, nonsteroidal anti-inflammatory drugs (NSAIDS), and cervical epidural steroid injection, were unsuccessful in managing pain. The patient did, however, achieve relief with peripheral nerve stimulation. Pain scores at 3-month follow-up decreased from 8/10 without and 10/10 with activity to an average of 1/10 with increased activity, complete cessation of pain medication, and reported improvement in quality of life. These results have been maintained at 12 months post-implant.

Conclusion: Sub-threshold peripheral nerve stimulation with an externally powered system at the suprascapular and supraclavicular nerves was an effective treatment for a patient suffering from debilitating pain in the shoulder, upper arm, and upper trapezius after a successful, structurally sound shoulder replacement did not reduce persistent chronic pain.

Key words: Peripheral nerve stimulation (PNS), chronic pain, suprascapular nerve, supraclavicular nerve, mononeuropathy, upper limb pain, brachial plexus, disorder, shoulder replacement

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BACKGROUND

Chronic shoulder pain affects 20-33% of the general population(1). Often accompanied by muscle weakness and restricted movement, shoulder pain may also lead to the inability to work and perform daily activities, which impacts both the patient and society. Chronic shoulder pain may have a variety of causes, ranging from rotator cuff pathology and osteoarthritis (2) to pain that does not improve even after functional components of the shoulder have been replaced and repaired. Current management techniques include physical therapy, oral anti-inflammatory medications, oral corticosteroids, pain medications, intraarticular corticosteroids, nerve blocks, and surgery. However, pain does not always dissipate with these measures.

Oral anti-inflammatory agents, such as nonsteroidal anti-inflammatory drugs (NSAIDs), may be beneficial in acute settings; however, long-term use is not recommended due to associated side effects. In clinical practice, intraarticular corticosteroids have been reported to reduce pain in the short term, although the long-term benefit compared with local anesthetics is debatable (3). Suprascapular nerve blocks and ablation may be an effective treatment for chronic shoulder pain. However, cases of pneumothorax when spinal needles were used (4) have also been reported, and relief is often short-lived.

Adding to the complexity of treatment, Gofeld et al (2), discovered that any long-term continuous pain, irrespective of the preliminary cause, can become neuropathic over time through neurobiological transformation and modulation of nociceptive pain. This makes conservative treatment measures, such as anti-inflammatory drugs, physical therapy, and steroids, less effective the longer a condition persists.

This case report will discuss a patient with chronic shoulder pain, post-cervical laminectomy, and left shoulder replacement, diagnosed with nerve root and plexus disorders at the brachial plexus (affecting the suprascapular nerve) and mononeuropathy of the supraclavicular nerve. This patient was managed with peripheral nerve stimulation of the left suprascapular nerve at the brachial plexus and the supraclavicular nerve, reporting 75% pain relief after trial and 90% on a visual analog scale (VAS) scale at three months post-implant.

CASE PRESENTATION

Informed consent was obtained and CARE Guidelines were followed for this report.

A 58-year-old man, with a history of left shoulder replacement and cervical laminectomy presented to our institution with pain in the left shoulder joint radiating down the medial aspect of the left upper arm to the elbow and along the upper trapezius between the neck and shoulder. It was suspected that the pain might have been originating in the cervical spine. X-ray imaging of the spine was performed and cervical epidural steroid (CESI) was completed. When the CESI did not relieve the symptoms, a block of the suprascapular nerve was performed, which helped the pain in the shoulder joint, but did not provide relief for the pain radiating into the arm. Attempting to reproduce the arm pain by compressing the brachial plexus was successful. After that, a brachial plexus block was performed relieving the shoulder and arm pain, and confirmed involvement of the brachial plexus.

At that point the patient was diagnosed with nerve root and plexus disorders at the brachial plexus and mononeuropathy of the supraclavicular nerve. Average pain was rated 8/10, which elevated to 10/10 when driving or lifting objects over 5 pounds with the left arm. Once escalated, pain levels would remain at 10/10 for several hours. The patient began avoiding social activities, leaving his residence only when necessary to prevent agitation and increased pain. Previous treatments, including physical therapy, opioids, NSAIDS, and cervical epidural steroid injection, failed to provide significant improvement and nerve blocks offered only temporary relief.

The patient agreed to a trial peripheral nerve stimulation of the left suprascapular and supraclavicular nerves. The neurostimulators were placed with fluoroscopy guidance and secured in a sterile fashion. The patient was sent home for the trial period. The patient wore the antenna assembly on the upper arm and used subthreshold stimulation at 0.2-0.4 mA. After the trial, the patient reported approximately 75% relief. The neurostimulators were subsequently removed in the office without any complications.

Device Description

The Freedom® PNS System (Curonix LLC, Pompano Beach, FL) uses high-frequency electromagnetic coupling (HF-EMC) technology to power an implanted neurostimulator with receiver (Fig. 1). Each electrode array has 4 or 8 contacts (1.3 mm in diameter, 4 mm spacing) with embedded electronics and a separate receiver. A small, external rechargeable transmitter

connected to a transmitting antenna worn in the clothing or a fabric sleeve, supplies the energy to power the implanted device through the skin. The device uses pulsed electric current to create an electrical field that acts on nerves to inhibit the transmission of pain signals to the brain.

Procedure Methods

The path of the suprascapular nerve was mapped along the anterior pathway as part of the brachial plexus, and a needle entry point and trajectory were planned using palpation and fluoroscopy. The 4 contact, tined electrode array was placed on the skin for planning purposes with the top of the device at the suprascapular nerve in the brachial plexus near the left clavicle with the electrodes running medially and the remainder of the lead running horizontally and laterally toward the shoulder. A marking pen was used to map out the trajectory. The skin and deeper tissues at the needle entry point were anesthetized, and a first stab incision was made. A 13-gauge introducer needle was passed through the subcutaneous tissues towards the suprascapular nerve target. The electrode array was inserted through the needle and advanced to the suprascapular nerve near the left clavicle at the brachial plexus. The electrode placement was confirmed with fluoroscopy (Fig 2).

The path of the lateral branch of the supraclavicular nerve was mapped along the posterior pathway using palpation and fluoroscopy and the needle entry point was planned. The skin and deeper tissues were anesthetized, and a first stab incision was made. A 13-gauge introducer needle was passed through the subcutaneous tissues toward the supraclavicular nerve target. The four contact, tined electrode array was inserted through the introducer and placed at the lateral branch of the supraclavicular nerve at the upper trapezius. Electrode placement was again confirmed with fluoroscopy (Fig. 2).

The steering stylets were removed, and separate receivers were connected to the electrode arrays. An anchor stitch with 3-0 silk was used to secure both neurostimulators at the needle entry points. A receiver pocket was created with a second incision on the upper arm, and the stimulators were tunneled beneath the skin from the first incisions to the receiver pocket. A knot was tied to connect the separate receivers and electrode arrays permanently. The distal portions of the neurostimulators were coiled and secured to the fascia within the receiver pocket. The pocket was then

Fig. 1. Freedom SCS/PNS systems

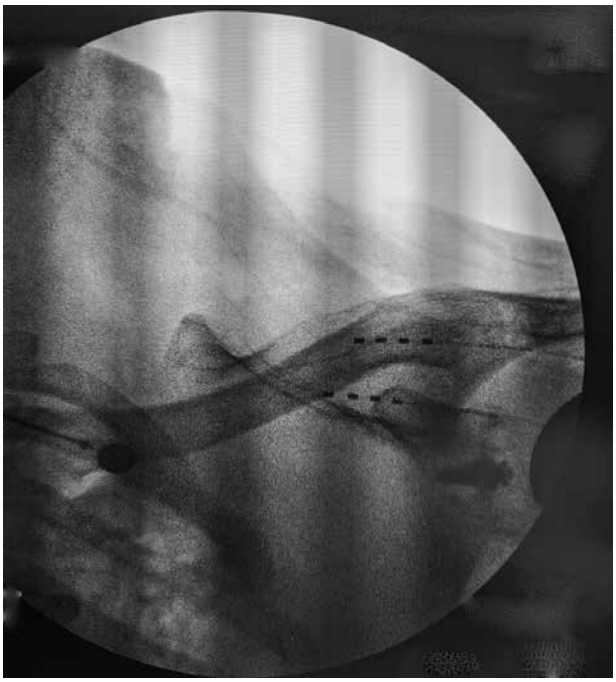

Fig. 2. AP of device placement at the suprascapular and supraclavicular nerve.

closed with subcutaneous and subcuticular sutures and covered in a dermal adhesive.

RESULTS

At 2 weeks post-implant, pain scores had reduced to 2/10; by 3 months, the patient reported an average of 1/10. The patient was able to cease all medication, sleep more soundly without specific positioning, lift normal household items, and drive without increased pain. The patient has resumed participating in social activities and is no longer restricted to the confines of his home. The patient feels he can now lead a much more normal and fulfilling life. These results remain consistent through 12 months post-implant. No adverse events were reported.

DISCUSSION

Although etiology varies, chronic shoulder pain accounts for 20-50% of all musculoskeletal issues. Traditional conservative measures and even repair and replacement of the joint and surrounding structures do not always resolve pain and accompanying symptoms. Peripheral nerve stimulation may be a promising option for patients with refractory pain.

In this case, a middle-aged man with a history of shoulder replacement complained of persistent pain even after the joint was replaced and structurally sound. Conservative measures, including physical therapy, opioids, NSAIDS, and cervical epidural steroid injection, did little to provide relief and left the patient essentially homebound.

Peripheral nerve stimulation offers an exciting opportunity for chronic pain management when conventional methods have been exhausted. It has been stated that approximately 25% of patients experience negative effects from pain medications (5), meaning that even if successful in controlling pain, they need to be discontinued, leaving patients searching for effective alternatives.

The Freedom PNS System (Curonix LLC, Pompano Beach, FL) was used in this case on the suprascapular and supraclavicular nerves. The patient reported approximately 75% pain relief following the trial and 90% pain relief by 3 weeks post-implant, along with complete cessation of pain medications and significantly improved quality of life, which have all been maintained through the one-year mark.

CONCLUSION

While available studies on PNS for management of chronic shoulder pain are limited, this report highlights a case in which conservative measures and joint replacement failed to effectively reduce chronic pain. However, sub-threshold peripheral nerve stimulation with an externally powered system at the suprascapular and supraclavicular nerves has proven a safe and effective therapy in this case in providing sustained relief.

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