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Novel and Effective Use of Peripheral Nerve Stimulation to Treat Trauma-induced Chronic Shoulder Pain: A Case Report

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Background: Peripheral nerve stimulators (PNS) are an option when medications, injections, physical therapy, and transcutaneous electrical stimulation are not effective. Rotator cuff muscle disorders and acromioclavicular or glenohumeral joint pathologies commonly lead to chronic shoulder pain. However, this case report documents a PNS treating chronic shoulder pain following traumatic humeral fracture.

Case Report: Our patient presented years after her orthopedic team recommended nonoperative management for her traumatic humeral fracture. She described pain at rest (3-5/10), which was exacerbated by forward flexion and abduction (9/10). After her PNS, she noted greater than 80% pain relief (rating it a 3/10), as well as improved range of motion and improved pain with movement, 4/10 with movement.

Conclusion: This case is the first report of PNS use for traumatic humeral fracture, when the patient's clinical status precluded operative intervention. Our patient reported satisfaction with her pain relief and improved range of motion.

Key words: Peripheral nerve stimulation (PNS), neuromodulation, interventional pain, chronic shoulder pain, shoulder pain, chronic pain, humeral fracture, trauma

BACKGROUND

Peripheral nerve stimulators (PNS) are recommended when a patient's symptoms are refractory to conventional interventions, including oral medications, joint injections, physical therapy, and transcutaneous electrical stimulation (1). The use of PNS in the management of chronic neuromuscular pain is increasing, and previous literature documents efficacy of PNS in the treatment of shoulder pain of various etiologies (such as severe glenohumeral (GH) arthritis, post-stroke shoulder pain, post shoulder replacement chronic pain) (1,2). The most common causes of chronic shoulder pain are rotator cuff muscle disorders and acromioclavicular (AC) or GH joint pathologies (3). The following case report demonstrates an effective and novel use of PNS in treating chronic shoulder pain following A traumatic proximal humeral shaft fracture.

CASE REPORT

Informed consent was obtained from the patient for submission of a case report. As the case report is devoid of patient identifiable information, it is exempt from IRB review requirements as per University of Virginia policy.

A 78-year-old woman with a past medical history of stage III chronic kidney disease, type 2 diabetes mellitus, heart failure with reduced ejection fraction, interstitial lung disease on oxygen supplementation, atrial fibrillation, and orthotopic liver transplant on immunosuppression, experienced a ground level fall in 2016 related to orthostatic hypotension. She suffered a left humerus

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surgical neck fracture with posterior subluxation of the humeral head and anterior displacement of the humeral shaft. Orthopedic surgery recommended conservative management with outpatient follow-up. Her health status worsened over the following months, and orthopedic surgery continued to recommend nonoperative management due to her medical comorbidities. Plain films were obtained at the time of the fall (Fig. 1) and repeated 3 years later (Fig. 2), both showed an unchanged severely displaced and angulated proximal left humerus fracture. Despite conservative management, she developed chronic left shoulder pain and was ultimately referred to the Pain Management Clinic.

During her initial pain management consultation, she described the pain as intermittent when her arm was in a neutral position, with a severity of 3-5/10. Her pain was exacerbated by left upper extremity forward flexion and abduction to a severity of 9/10. The pain significantly interfered with her ability to sleep and perform activities of daily living.

Subsequent left suprascapular, axillary and lateral pectoral nerve blocks were performed with improvement, however due to difficulty with visualization because of the patient's anatomy, it was decided to not proceed with radiofrequency ablation. The patient then underwent cryoneurolysis of the left suprascapular nerve under ultrasound guidance with little to no improvement in her pain.

The patient then decided to pursue temporary peripheral nerve stimulation targeting the left suprascapular and axillary nerves. Under ultrasound guidance an introducer needle and stimulator probe was advanced to the suprascapular notch. Paresthesia was noted during sensory testing and a percutaneous lead was guided through the needle in vicinity to the suprascapular nerve. A second temporary lead was placed in a similar fashion at the axillary nerve motor points of the middle and posterior deltoid muscle. The suprascapular nerve was being stimulated at 100 Hz and stimulation of the axillary nerve branch of the middle and posterior deltoid muscle was set to 12 Hz.

On postoperative day (POD) 10, the patient was seen for follow-up and reported some discomfort around the insertion site, but that her shoulder pain prior to the procedure had mostly resolved. The patient noted a range of motion difficulties due to atrophy, but was actively participating in physical therapy. On POD 30, the patient continued to report resolution of her pain. She noted improved range of motion and improved pain with movement, 4/10 with movement. The patient presented for lead removal on POD 67 and reported greater than 80% pain relief (rating it a 3/10) and

Fig. 1. Left shoulder x-ray obtained at the time of the patient's fall. Note the displacement of her humeral head.

Fig. 2. Left shoulder x-ray obtained 3 years after her fall. Note the continued humeral displacement and abnormal ossification of her injury.

continued improved range of motion. She noted the severity of her pain did not change with position or movement, in contrast to her exacerbating factors prior to PNS placement.

DISCUSSION

Common shoulder pathologies include osteoarthritis, joint instability, adhesive capsulitis, rotator cuff injury, labrum tears, and neuropathic conditions (2). Peripheral nerve stimulators (PNS) are an option when conventional treatment such as medication, joint injections, physical therapy, and transcutaneous electrical stimulation prove ineffective (1). Rotator cuff repair, total shoulder/reverse total shoulder arthroplasty are important interventional techniques to improve shoulder pain (3). However, premorbid conditions, previous repair, age, nicotine use, and more predict surgical success rate (3). Thus, PNS plays a role in improving pain for those who fail conservative management, cannot tolerate surgery, or choose not to have surgery.

The most common causes of chronic shoulder pain are rotator cuff muscle disorders, AC joint pathology, or GH joint pathology (3). Shoulder pain is commonly due to "wear and tear", as evidenced by its prevalence increasing with age (4). There are reports of patients who have found relief with peripheral neuromodulation in the setting of subacromial impingement syndrome, rotator cuff pathology, GH joint arthritis, AC joint arthritis, adhesive capsulitis, and biceps tendinopathy (2,3,5-10). Of the indications for PNS, treatment for post-hemiplegic stroke shoulder pain is the most well studied (2,10).

PNS for the shoulder focuses on 2 nerves, the axillary and suprascapular. The suprascapular nerve provides sensory innervation to the GH and AC joints and motor innervation to the supraspinatus and infraspinatus muscles (2,3). It can be targeted for intervention on its course from the brachial plexus (C5 and C6 nerve root origin) to the supra- or infraspinatus fossa, most commonly at the suprascapular notch (2). The axillary nerve provides sensory innervation to the posterior GH joint and superior lateral portion of the arm (2,3) and motor innervation to the deltoid and teres minor muscles. It also originates from the C5 and C6 nerve roots, coursing through the quadrangular space to the posterior humerus. It can be targeted anywhere along its course, most commonly at the posterior humerus (2). These nerves are the primary sensory nerves of the shoulder joint. Gofeld and Agur (11) described targeting the suprascapular and axillary nerve with PNS for shoulder pain, and other literature confirms these are common targets for PNS (3,5).

During our patient's diagnostic block, she noted improvement in pain on the lower part of her shoulder and minimal relief on the top of her shoulder. She noted relief at baseline and with motion/position with her PNS targeting her suprascapular and axillary nerves. While this corresponds with previous descriptions of the sensory innervation of the shoulder (11-13), her abnormal anatomy required a different approach for her axillary nerve. Approaching the posterior humerus or quadrangular space was not possible, thus, the decision was made to approach her axillary nerve at the mid deltoid, another option detailed by Gofeld and Agur (11). Laumonerie et al (13) describes a high density of mechanoreceptors (for the joint capsule) supplied by the axillary and suprascapular nerve. This mechanoreceptor component of pain explains her improvement with motion and position. Her attempted cryoablation, because of the narrow focus of the lesion, likely did not accomplish pain relief (14). Local anesthetic and electrical stimulus (15,16) can spread further, which could explain her improvement with these modalities. Her chronic pain likely has multi nerve involvement (as well as central sensitization [7]) based on her initial injury.

CONCLUSION

The literature shows PNS implantation improves pain in patients with shoulder pain after a stroke or a variety of "wear and tear" type injuries (2). This case is the first documented report of PNS use for traumatic humeral fracture, when the patient's clinical status precluded operative intervention. Our patient reported satisfaction with her pain relief and improved range of motion.

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