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Peripheral Nerve Stimulation with High-Frequency Electromagnetic Coupling (HF-EMC) at the Ilioinguinal and the Superior Gluteal Nerve in the Treatment of Mononeuropathy

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Background: Peripheral neuropathy is a difficult-to-treat condition. Peripheral nerve stimulation has shown to be an effective option but systems with an implantable battery are inappropriate due to its form factor. Complications and cosmetic concerns need to be considered when using conventional systems. Instead, externally powered peripheral nerve stimulation technology should be considered.

Case Report: A 62-year-old woman presented with pain in the right posterior superior iliac spine (PSIS) and the right upper buttock, radiating into the right posterior thigh. In addition, she began experiencing pain in the right lateral hip and the right inguinal crease and groin. The patient was diagnosed with right ilioinguinal and superior gluteal mononeuropathy and was offered a trial of an externally powered peripheral nerve stimulator.

Conclusion: The patient had a successful trial and opted to have a permanent neurostimulator (electrode array and separate receiver). At 4 months after the permanent implant, the patient is reporting approximately 100% pain relief with improved quality of life. Peripheral nerve stimulation was a successful treatment option for a patient suffering from chronic, debilitating hip and groin pain.

Key words: Groin, hip, ilioinguinal, mononeuropathy, peripheral nerve stimulation, PNS, posterior superior iliac spine, superior gluteal, thigh

BACKGROUND

Peripheral mononeuropathy is a common neurological disorder of the peripheral nervous system. This occurs when a superficial nerve is damaged due to trauma or entrapment. The overall prevalence of peripheral neuropathy is 2.4% but increases to 8% in individuals above 55 years of age (1).

Hip pain can be caused by superior gluteal or femoral nerve injury. Damage to the superior gluteal nerve can result in pain, numbness, weakness, and paresis of the lower extremity, hip, and groin (2).

Groin pain often emerges when the ilioinguinal nerve becomes injured during lower abdominal or pelvic surgeries (3). Neuropathy of the ilioinguinal nerve can cause severe pain and disability that may prove challenging to diagnose. The peripheral distribution of the nerve is over the inguinal ligament and the base of the

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scrotum or labia, which overlaps with presenting pain patterns of many other primary sources (4).

For regional pain disorders such as chronic hip and groin pain, a targeted approach is required in order to effectively treat the individual structures (5).

Peripheral nerve stimulation (PNS) is commonly used to target localized pain. The hardware previously used for PNS, however, has been designed for spinal cord stimulation and is inappropriate for PNS due to the presence of an implantable battery, as is illustrated by complication rates and cosmetic concerns (6). Externally powered PNS technology has the potential to reduce complication rates and allow for optimal cosmesis while effectively treating chronic pain.

CASE

A 62-year-old woman presented to the Texas Institute of Pain and Spine with pain in the right posterior superior iliac spine (PSIS) and the right upper buttock. The pain radiated into the right posterior thigh, and it began in 2003 after surgery because of a coccygeal fracture. The bone fragment was removed, but the pain persisted. In addition, she began experiencing pain in the right lateral hip and the right inguinal crease and groin. She was diagnosed at our center with right ilioinguinal and superior gluteal mononeuropathy. The patient underwent an intrathecal pump implant in 2009, which was removed in 2016 due to marginal efficacy. She also had a spinal cord stimulator (SCS) implant in 2016 with placement between T8 and T11. The SCS system remains implanted, but the patient no longer utilizes it as it has proven to be ineffective as well. Additional prior treatments including physical therapy and analgesics (hydrocodone-acetaminophen 10-325 mg and morphine sulfate extended-release 15 mg every 12 hours) failed to provide adequate relief. Reported pain scores were an average of 8 of 10, and the patient was only able to sleep approximately 4 hours per night.

The decision was made to proceed with a PNS trial of the right ilioinguinal and superior gluteal nerves. The procedure was performed in the office using ultrasound guidance and fluoroscopy. Two electrode arrays were placed and temporarily secured in a sterile fashion and the patient was sent home for a 7-day trial period. The patient wore the wearable antenna assembly on the lateral hip using a Stashband™. Preferred stimulation settings were recorded at 1499 Hz and .5 to .7 mA. At the conclusion of the trial, the patient reported 100% relief. The electrodes were subsequently removed in the office without any complications.

Device Description

The Freedom PNS System (Curonix, Distributor for Stimwave Technologies Freedom PNS system, Pompano Beach, FL) uses high-frequency electromagnetic coupling technology to power the implanted neurostimulator (Fig. 1). Each stimulator is comprised of an electrode array(s) with 4 or 8 contacts and and the electrode array is connected to a separate implanted receiver(s). A small, external rechargeable transmittersupplies the energy and data to the implanted neurostimulator through the skin. The device uses pulsed electrical current to create an electrical field that acts on nerves to inhibit the transmission of pain signals to the brain.

Procedure Methods

Two neurostimulators (electrode arrays and separate receivers) were placed, one at the ilioinguinal nerve and the other at the superior gluteal nerve. The path

Fig. 1. Freedom SCS/ PNS systems.

of the ilioinguinal nerve in the lower abdomen was visualized, and a needle entry point and pathway were planned using palpation, ultrasound, and fluoroscopy. The electrode array was laid on the skin with the distal electrode placed at the ilioinguinal nerve. Using a skin marker, a 1-cm sagittal line was marked over the needle entry location. The skin and deeper tissue were anesthetized using a mixture of 1% lidocaine and 0.25% bupivacaine with epinephrine. A #10 blade was used to make a first stab incision. A 13-gauge PNS introducer needle was passed through the subcutaneous tissues toward the ilioinguinal nerve. The needle was advanced subcutaneously in the fascial plane. The electrode array was inserted through the needle and advanced to the ilioinguinal nerve. The electrode placement was confirmed with fluoroscopy and ultrasound.

The path of the superior gluteal nerve in the buttocks was visualized and a needle entry point and pathway were planned using palpation, ultrasound, and fluoroscopy. The second electrode array was laid on the skin with the distal electrode placed at the superior gluteal nerve with the remainder of the electrode array running laterally. The incision site was marked, the skin and deeper tissues were anesthetized, and a first stab incision was made. A 13-gauge PNS introducer was passed through the subcutaneous tissues towards the superior gluteal nerve. The needle was advanced and the electrode array was subsequently inserted and advanced to the superior gluteal nerve in the buttock. The electrode placement was again confirmed with fluoroscopy and ultrasound (Fig. 2). The steering stylets were removed, and separate receivers connected to the electrode arrays. Receiver pockets were created using a second incision, and the stimulators were tunneled beneath the skin from the first incision to the receiver pockets. A knot was tied to permanently connect the separate receivers and electrode arrays. The distal portion of the neurostimulators were coiled, sutured to itself while eliminating any sharp ends, and then the coil was sutured to the fascia within the pockets to prevent migration. All incisions were copiously irrigated. The receiver pockets were closed with 2-0 Vicryl and the Zip skin closure system, and then Telfas and Tegaderms were applied.

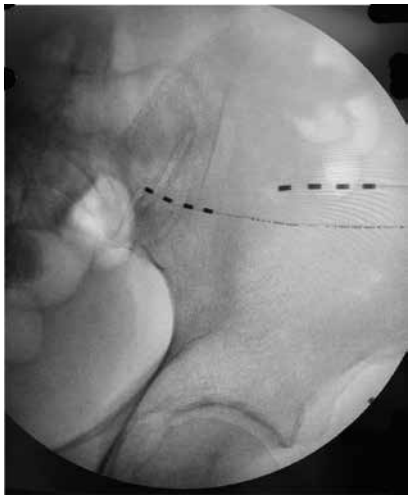

Fig. 2. Oblique view of device placement.

RESULTS

At one month after the permanent procedure, the patient reported drastically reduced pain scores with 100% relief, increased activity, and better quality of life. At 4 months post operation, the patient is able to sleep 8 hours per night on average, and pain medication usage has reduced by 50%. Prior to implant, the patient would have to lie down and rest after 15 minutes of walking, standing, or sitting. She can now do any of these activities as long as she would like without hip or groin pain. These results remain consistent 4 months after the permanent procedure, and the patient would not require any pain medication were it not for her unrelated back pain. No adverse events were reported.

DISCUSSION

Chronic groin and hip pain can be difficult pathologies to treat, as several peripheral nerves may have to be targeted to fully address the symptoms. Use of conventional stimulation systems, with an implanted battery for PNS, should be discouraged due to high complication rates and protrusion risk, discomfort, and cosmetic concerns.

Externally powered systems should be considered for the treatment of chronic pain as the result of mononeuropathy in peripheral locations. These devices are less invasive and eliminate complications and concerns associated with traditional, implanted battery systems. They also have the flexibility to combine multiple nerve targets to address challenging pain patterns and to choose placement based upon patient anatomy and individual needs, making them a more appropriate choice for peripheral nerve stimulation.

CONCLUSION

Subthreshold PNS with an externally powered system at the ilioinguinal and superior gluteal nerves was a successful treatment option for a patient suffering from chronic, debilitating hip and groin pain as a result of nerve damage following a surgical procedure.

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