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Combined Wireless Spinal Cord Stimulation, Dorsal Root Ganglion Stimulation, and Peripheral Nerve Stimulation for Treating Low Back Pain

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Background: Neuromodulation has undergone significant advances over the past decade, particularly when the DRG and PNS modalities evolved to target conditions that are hard to cover by conventional SCS. The availability of a variety of stimulation modalities allows for a customized approach.

Case Presentation: A 49-year-old man presented with low back and buttock pain. The patient had a history of chronic lower back pain, L4/L5 and L5/S1 facet hypertrophy, a 3-mm left paracentral and foraminal disc protrusion minimally involving the left S1 nerve root, and right low back/buttock/hip pain after previous surgical removal of an episacroiliac lipoma on the right sacroiliac joint. Despite multiple therapies such as oral opioids, anticonvulsants, and physical therapy, the patient continued to experience right lower back and buttock pain.

Conclusion: The patient's pain scores decreased from a baseline score of 8 out of 10 without medication to a 1 out of 10 without medication. The wireless SCS and PNS significantly reduced pain scores for this patient suffering from lower back, buttock, and hip pain.

Key words: Dorsal root ganglion, low back pain, peripheral nerve stimulation, spinal cord stimulation

BACKGROUND

Spinal cord stimulation (SCS) has been a commonly used procedure for treating chronic pain since 1967. Currently, there are several systems available that provide different waveforms and capabilities, allowing physicians to choose between technologies to provide the best outcomes for different conditions, some of which may respond to one type of stimulation better than others (1,2).

While SCS is known to provide good pain relief, it can lack precision. Spinal cord stimulators will typically stimulate a large area or entire extremity rather than specifically targeting the desired dermatome.

The dorsal root ganglion (DRG) is located on the

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posterior root at every spinal level. It contains the cell bodies of primary sensory neurons and plays a very important role in modulating neuropathic pain (3). DRG stimulation was developed as a precise modality to target specific neuropathic pain at specific dermatomes (4-8). Its efficacy in treating low back pain is based upon the hypothesis that nociceptive information from the lumbar discs ascends in the sympathetic chain, entering the neuroaxis via the L2 DRG (9).

Furthermore, the evolution of peripheral nerve stimulation (PNS) provides the capability to stimulate peripheral nerves that otherwise would be challenging to target by spinal cord or DRG stimulation. With PNS, the target peripheral nerve is stimulated independently, providing the desired stimulation without stimulating any other structures.

We are presenting a unique case in which we utilized all 3 types of stimulation (SCS, transforaminal SCS to target the DRG, and PNS) using one wireless system to provide coverage of different painful areas, which enables a much easier implant in different anatomical locations when compared to "wired" traditional SCS.

CASE PRESENTATION

Our patient was a 49-year-old man with a history of low back pain, L4/L5 and L5/S1 facet hypertrophy (mildly involving the nerve roots), a 3-mm left paracentral and foraminal disc protrusion minimally involving the left S1 nerve root, and right low back/buttock/hip pain after the previous surgical removal of a right episacroiliac lipoma or "back mouse."

The patient presented to our clinic with low back pain on the right side. He had severe progressive pain that was poorly controlled. Over the years, the patient tried oral opioids, anticonvulsants, physical therapy, epidural steroid injections (both interlaminar and transforaminal), facet injections, medial branch blocks, sacroiliac joint injections, and radiofrequency ablation.

We were treating standard lower back pain with an additional concentration of pain surrounding the area where the lipoma was removed on the right lower back/upper buttock, just below the iliac crest. It was suspected that the superior gluteal nerve was damaged during the removal of the lipoma. We used SCS to target the low back pain and wanted to see whether transforaminal stimulation of the DRG or PNS of the superior gluteal nerve would be able to effectively cover the pain below the iliac crest.

We offered the patient a trial of combined spinal cord, peripheral (targeting right superior gluteal nerve), and DRG stimulation to see which of the 3, or which combination, would be most effective. The patient accepted this offer due to failure of all other modalities. He passed psychological evaluation before moving forward with the trial.

Surgical Description

Trial: Three stimulators were placed during the trial to find the best overall coverage of the low back as well as right upper buttock/hip pain. One stimulator was placed epidurally to stimulate the dorsal column of the spinal cord, using the needle entry point at T12/L1. A second stimulator was placed using a transforaminal approach to target the DRG at L2, with the needle entry point 8 cm lateral to the spine. A third stimulator was placed targeting the right superior gluteal nerve, with the needle entry point at the right sacroiliac joint.

During the trial, the stimulators were each tested alone and in every possible combination with one another. The best relief was found using the traditional SCS stimulator in combination with the PNS stimulator. The SCS system was oriented superior to inferior; the superior gluteal stimulator was inserted medially to laterally, and the tail of the PNS system was gently angled upward so that the areas between the 2 marker bands on each stimulator ended up parallel and close enough together to be placed on a single antenna.

The patient experienced 70% improvement throughout the 7-day trial. Pain scores were reduced from 8 out of 10 preprocedure (without medication) to 1 out of 10 (without medication) at the end of the trial. The best combination was found using the SCS and PNS leads together.

Permanent Implant: The patient was positioned prone and the low back was sterilely prepped and draped. An 8-contact SCS wireless epidural electrode array was placed with an entry point at T12/L1 using the loss-of-resistance technique, and the top (1) electrode was positioned at T7 (Fig. 1). The second 8-contact stimulator (PNS) was placed at the right superior gluteal nerve with a needle entry point at the posterior superior iliac spine and the electrode array covering the branches of the superior gluteal nerves (Fig. 2 and Fig. 3). The receivers were inserted into the inner lumen of the electrode arrays, and stimulation was tested with good coverage of the painful areas reported. The SCS stimulator was anchored using the injectable Sandshark anchor

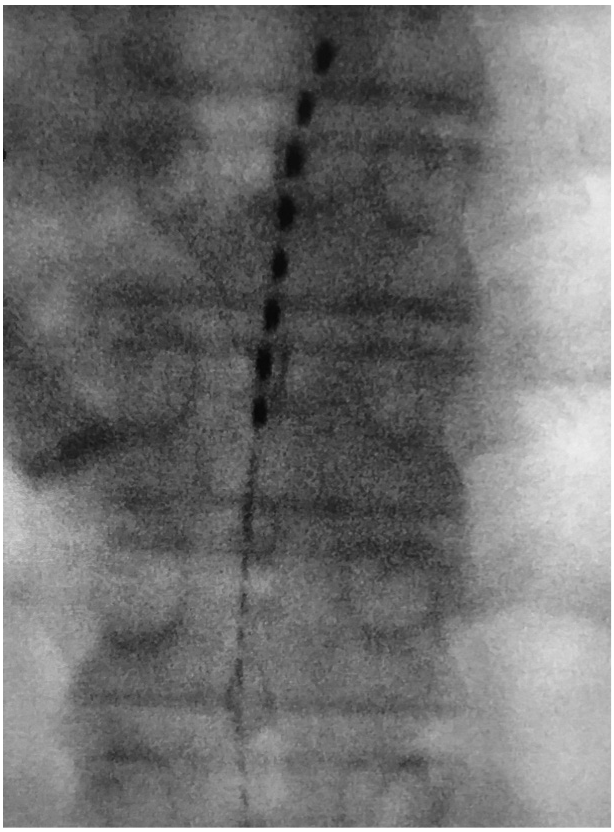

Fig. 1. Image showing AP of permanent placement 8-contact electrode array epidurally between T8 and T10 for SCS
Abbreviations: AP, anterior posterior; SCS, spinal cord stimulation.

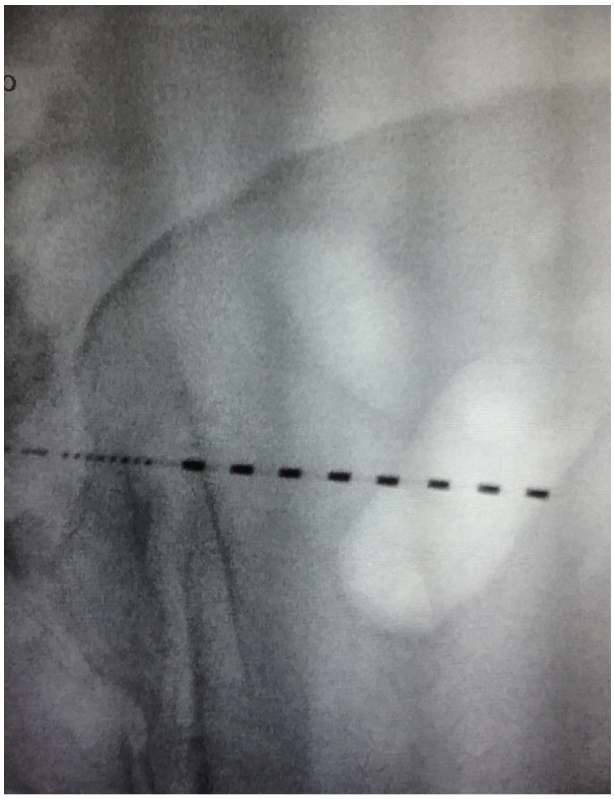

Fig. 2: Image showing permanent 8-contact electrode array targeting the right superior gluteal nerve.

(Stimwave LLC, Pompano Beach, FL) with the wings deployed below the supraspinous ligament. A receiver pocket was made distal to the last (cut) marker band of the SCS stimulator and a Tuohy needle was used to tunnel from the receiver pocket to the original needle entry point. The distal end of the stimulator was pulled through the needle, burying the system completely under the skin. The distal end was knotted and then coiled in the receiver pocket and secured to the fascia using silk sutures. A second receiver pocket was made adjacent to the first (channel) marker band of the SCS stimulator, and the PNS stimulator tunneled beneath the skin and directed to the second receiver pocket, gently angled so that the area between the marker bands was parallel to the area between the marker bands on the SCS stimulator. A knot was tied in the distal end of the stimulator, which was coiled, and silk sutures were used to anchor the system securely to fascia in the receiver pocket. The fascia was closed over the distal end of the

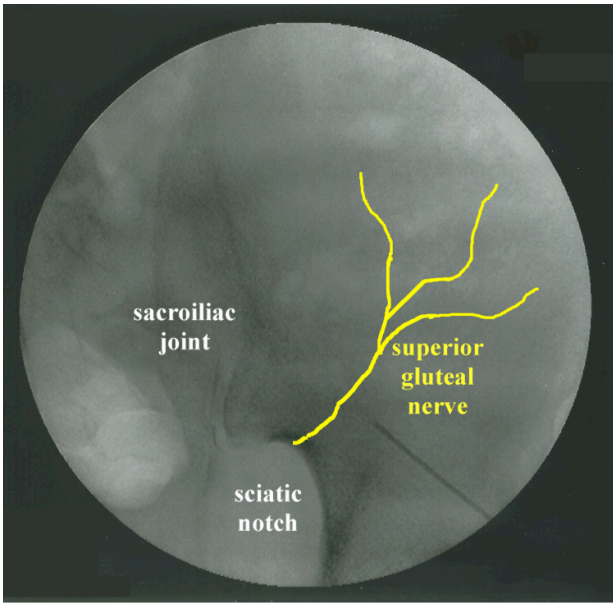

Fig. 3: Fluoroscopic location of the superior gluteal nerve.
(Image courtesy of Andrea Trescot, MD)

stimulators in both receiver pockets. The skin was closed in layers. Stimulation was again performed with good coverage. The back was cleaned and the patient was moved to recovery.

The patient noted 75% improvement during the follow-up 8 months post implant. Pain scores were reduced from 8 out of 10 preprocedure to 1 to 1.5 out of 10 at the last follow-up.

DISCUSSION

Neuromodulation has undergone significant advances over the past decade, particularly as the DRG and PNS modalities evolved to target conditions that are hard to cover by the standard SCS.

The presence of this variety of stimulation techniques allowed us to provide good coverage for our patient. The SCS was placed to provide coverage for the low back neuroaxial pain. We tried transforaminal SCS targeting the DRG as well as PNS, and found that the PNS provided the patient with better coverage for the superior gluteal nerve, which was hard to target by SCS.

PNS has been used to treat different peripheral neuropathic pain conditions, targeting nerves from head to toe (10,11). SCS provides coverage for large areas (e.g., low back and legs), which will provide stimulation to areas far from the nerve of interest. PNS, on the other hand, can precisely target a certain nerve and provide the coverage required without stimulating other parts of the body.

Our case is unique in that we used a single stimulator brand that could provide all of those modalities (SCS, transforaminal, and PNS). In addition, the system is wireless, which allowed us to place stimulators both in the epidural space and over the targeted peripheral nerves without the implantation of a battery, by instead using an external antenna and generator. Both stimulators were programmed to deliver different forms of stimulation, due to the different nature of their use.

CONCLUSION

We presented a case with challenging low back pain in the midline and laterally. We placed one epidural SCS and a PNS at the superior gluteal nerve to provide PNS. The combination of both modalities provided excellent pain relief for our patient. In addition, the use of wireless systems can prevent the complications associated with battery implant.

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