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METHOD

Peripheral Nerve Stimulation for the Treatment of Superior Cluneal Neuralgia: A Cadaver Demonstration of a Novel Technique for Lead Placement

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Abstract: Superior cluneal neuralgia (SCN) is a distinct cause of lower back and/or leg pain related to pathology of the superior cluneal nerve. When assessing a patient with low back pain (LBP), superior cluneal neuralgia is frequently misdiagnosed. The pathophysiology of SCN ranges from myofascial compression brought on by aberrant muscle tone to direct iatrogenic injury or trauma. In this technical report we will discuss the anatomy of superior cluneal nerve, superior cluneal neuralgia, current treatment modalities, and a novel approach to peripheral nerve stimulation (PNS) lead placement via a cadaver demonstration for SCN.

Keywords: superior cluneal nerve, low back pain, peripheral nerve stimulator, superior cluneal neuralgia

Introduction

The superior cluneal nerve is a relatively small but important sensory nerve in the human body. It is a branch of the dorsal rami of the upper lumbar spinal nerves, typically arising from the dorsal rami of L1, L2, and L3, though there can be some variation in its origin.[1] The distinct cause of low back pain with symptoms affecting the groin and/or legs was first identified as superior cluneal neuralgia (SCN) in 1957. Nicknamed pseudo-sciatica, SCN is a commonly missed diagnosis due to its vastly overlapping symptoms.[2]

This nerve plays a crucial role in innervating the skin and soft tissues of the lower back, specifically the upper buttock area and the skin overlying the posterior superior iliac spine (PSIS).[1] Treatment modalities include conservative management, radiofrequency ablation, and decompressive surgery. The use of peripheral nerve stimulation has been described for the treatment of SCN. However, the traditional approach to PNS lead placement is technically challenging in the transverse plane limiting its effectiveness.[3] Herein, we present a novel interventional minimally invasive approach using peripheral nerve stimulation of the superior cluneal nerve for SCN. We will demonstrate this technique utilizing a cadaver model.

Superior Cluneal Nerve Anatomy

The superior cluneal nerve is part of a group of nerves known as the cluneal nerves, which includes the superior, middle, and inferior cluneal nerves. These nerves branch off from the posterior rami of the lumbar spinal nerves. The superior cluneal nerve is further divided into superior, intermediate, and lateral branches.[1]

The cluneal nerve typically originates from the dorsal rami of the lumbar spinal nerves L1, L2, and L3, but the exact level of origin can vary between individuals. The neural contribution can include T11-L5 nerve roots, although multiple anatomical studies have demonstrated that there is a considerable variation.[2,3] The spinal nerve roots

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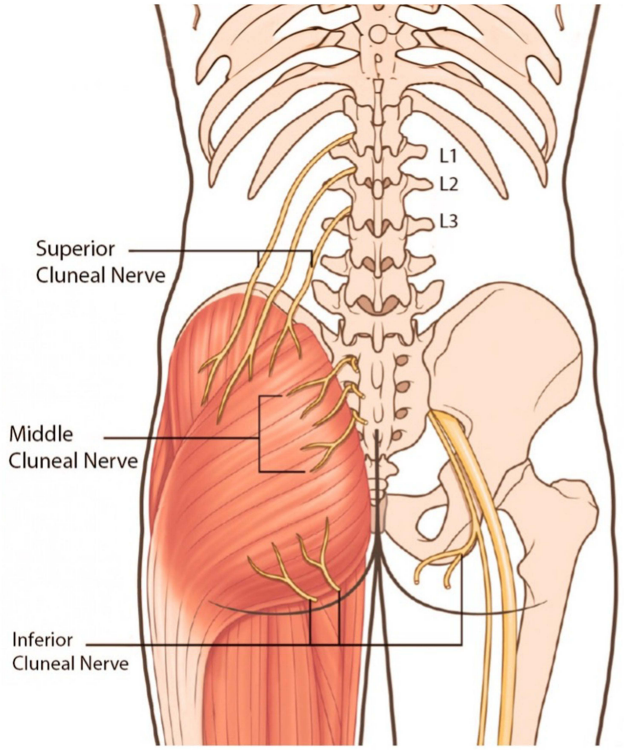

Figure 1 Superior, middle, and inferior cluneal nerves. Superior cluneal nerves as they cross over the iliac crest. (Image created by Michael Gyorfi).

emerge from the body and pass through the paraspinal and psoas major muscles before arriving at the quadratus lumborum muscle in the posterior region. The spinal nerve roots then approach the iliac crest by passing through the thoracolumbar fascia. The thoracolumbar fascia forms the anterior wall of the osteofibrous tunnel, which the SCN may pass through as it crosses over the posterior iliac crest.[2] Note the superficial nature of the superior cluneal nerves as they cross over the iliac crest (Figure 1).

The relationship between the SCN, thoracolumbar fascia, and posterior iliac crest was examined anatomically in fifteen cadavers. Although the SCN's lateral and intermediate branches penetrated or went through a fissure in the fascia, the SCN's medial branches seemed to be stuck between the superior rim of the iliac crest and the taut thoracolumbar fascia fibers.[3]

The primary function of the superior cluneal nerve is to provide sensory innervation to the skin and soft tissues of the lower back, particularly the upper buttock region. It carries sensory information from these areas to the central nervous system, allowing individuals to perceive touch, pressure, temperature, and pain in this region.[3]

Superior Cluneal Neuralgia

The superior cluneal nerve can play a significant role in the experience of lower back pain. When it becomes irritated or compressed it is classified as superior cluneal neuralgia (SCN). SCN can lead to referred pain in the lower back, upper buttock, and posterior iliac crest region. This referred pain can be misinterpreted as lower back pain, even though the source of the problem may be the nerve itself.[4]

Irritation or compression of the superior cluneal nerve can result from various factors, including mechanical stress, poor posture, or injury to the lower back. Prolonged sitting, repetitive activities, or occupational factors that involve bending and twisting at the waist can contribute to the development of this condition.[5]

Identifying and addressing issues related to this nerve can be essential for diagnosing and managing certain cases of lower back pain. The clinical presentation of SCN typically manifests as chronic, burning, stabbing, or shooting pain in

the lower back and upper buttock region. The pain may radiate down the back of the thigh or around the hip area. It is often described as sharp or electric shock-like and may be associated with numbness, tingling, or hypersensitivity in the affected area.[4,5]

Diagnosis of superior cluneal neuralgia is primarily clinical, based on a thorough medical history and physical examination. Imaging studies such as X-rays, MRI, or CT scans may be conducted to rule out other potential causes of pain, such as lumbar disc herniation or spinal stenosis. Diagnostic nerve blocks, where a local anesthetic is injected into the superior cluneal nerves, can help confirm the diagnosis by providing temporary relief from pain.[5]

SCN Treatment

An early and accurate diagnosis of SCN is crucial for improving the prognosis. A prompt diagnosis enables healthcare providers to initiate appropriate treatment and reduce the risk of chronic and debilitating pain. Conservative treatment is the first line of management. This may include physical therapy, postural correction, and lifestyle modifications to alleviate pressure on the superior cluneal nerves.[5,6]

Medications like non-steroidal anti-inflammatory drugs (NSAIDs) and neuropathic pain medications can provide relief from pain and reduce inflammation. These medications can be effective in managing symptoms and may contribute to an improved prognosis for some patients.[6]

In cases where conservative treatments and medications are ineffective or provide only temporary relief, surgical interventions may be considered. Nerve decompression surgery involves releasing entrapped superior cluneal nerves. However, surgery carries its own set of risks, and it is typically reserved for cases where other treatments have failed.[6]

A less invasive treatment option involves injection of local anesthetic to reduce the pain and inflammation around the superior cluneal nerve. Diagnostic nerve blocks can confirm the diagnosis and provide temporary pain relief. The response to diagnostic nerve blocks can guide treatment decisions. If a patient experiences significant relief from the blocks, it suggests that more targeted interventions such as radiofrequency ablation may be affective.[7]

More recently, PNS has been investigated as a treatment option for refractory SCN. Abd-Elsayed demonstrated successful utilization of wireless PNS systems on five patients with various neuralgias, including cluneal neuralgia. The evidence that PNS can be effectively used for patients with LBP due to SCN is strengthened by this report.[8]

Peripheral Nerve Stimulation for SCN

Peripheral nerve stimulation is a relatively new treatment modality for numerous chronic pain conditions. Several studies have demonstrated the effectiveness of peripheral nerve stimulation in managing acute post-surgical pain in orthopedic procedures such as total knee arthroplasty, anterior cruciate ligament surgery, as well as chronic knee pain.[9] A retrospective review of 57 patients concluded that PNS is a safe and effective treatment modality with sustained pain relief for up to 24 months.[10]

Peripheral nerve stimulation leads are responsible for directing an electric current to the afferent neurons, which are responsible for sensory input in the painful region. The idea behind this method is that the electric current applied to the peripheral nerve will affect the larger, myelinated afferent nerve fibers, which can disrupt the processing of pain signals in the spinal cord by smaller, non-myelinated afferent fibers.[9]

Although peripheral nerve stimulation has been demonstrated as effective in treating several chronic pain conditions there is minimal documentation trialing PNS as a potential refractory SCN treatment modality. Dr. Abd-Elsayed demonstrated a successful utilization of a wireless PNS system in five patients with different types of neuralgias, including cluneal neuralgia in 2020.[8] This was followed by two separate single case studies in 2022. One performed by Soteropoulos and the other Chauhan. They both demonstrated a refractory SCN case that was successfully treated with PNS.[11,12]

Novel Approach to PNS for SCN

In this section we will demonstrate a novel approach to placing a peripheral nerve stimulator for the superior cluneal nerve using a cadaver model and compare this new method to the current standard. This was a cadaveric study where placement was performed on a cadaver using fluoroscopic guidance with saving images to demonstrate all steps for placing a peripheral nerve stimulator introducer and lead. The University of Wisconsin ethics committee approves of our cadaveric research.

The medial, intermediate, and lateral branches are the three main branches of the SCN, as was previously mentioned. An appropriate length of lead contacts is required to achieve stimulation of all three branches, if that is the clinical goal. The lead placement should ideally follow the superior edge of the bone in order to achieve maximum contact over the superior edge of the iliac crest.

Traditionally this is achieved via a transverse approach. This involves placing the introducer and lead from medial to lateral over the iliac crest in an AP view. The problem with this technique is that it does not account for the angle of the iliac crest which can significantly differ between patients. The anatomy of iliac crest is not completely transverse but instead follows an angle. Using the transverse placement approach may cause the lead to cross the iliac crest without being on top of it along the length of the lead

Our novel technique for placing a super cluneal peripheral nerve stimulator involves positioning the fluoroscope in a contralateral oblique position and using a coaxial approach to advance the introducer. This allows you to align your view with the anterior angle of the iliac crest.

The patient is first put in the prone position. Using fluoroscopy and a marking pen, the patient's anatomic landmarks were identified. Notably when obtaining the appropriate view with fluoroscopy a contralateral oblique angle is needed. The Iliac crest is not transverse so a transverse image will be deceiving. Once the patient and fluoroscopy are in the correct position a finder needle is then utilized (Figure 2).

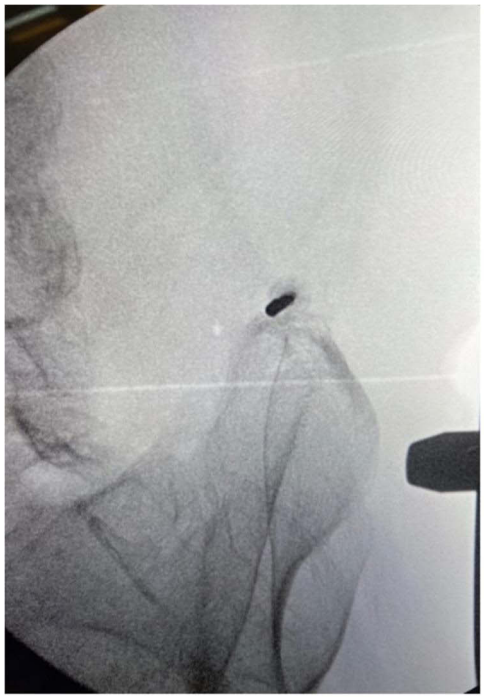

Figure 2 Finder needle placed with fluoroscopy to identify anatomic landmarks (30-degrees).

After placing the introducer above the iliac crest in the contralateral oblique approach, it is advanced over the iliac crest until it reaches the desired location, then an AP view can be taken to confirm final placement. This is then to be followed by removing the introducer stylet and placing the peripheral nerve stimulator lead through the introducer to its desired location. (Figures 3–6).

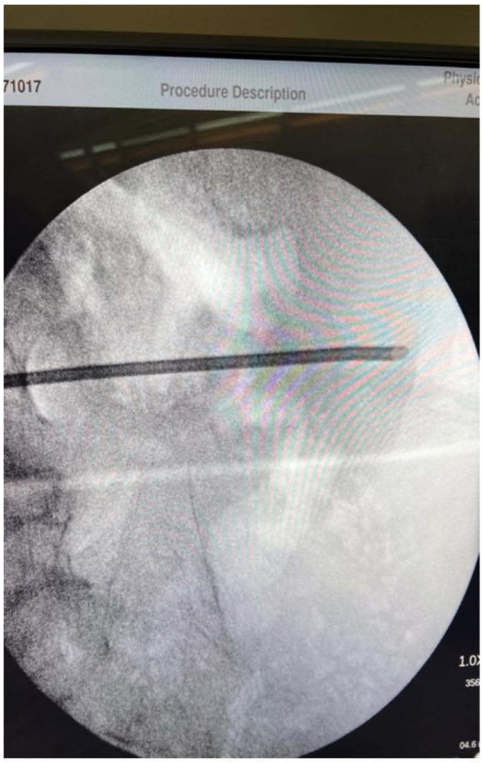

Figure 3 6-inch, 13-gauge introducer Tuohy needles placed over the iliac crest via fluoroscopy (30-degrees).

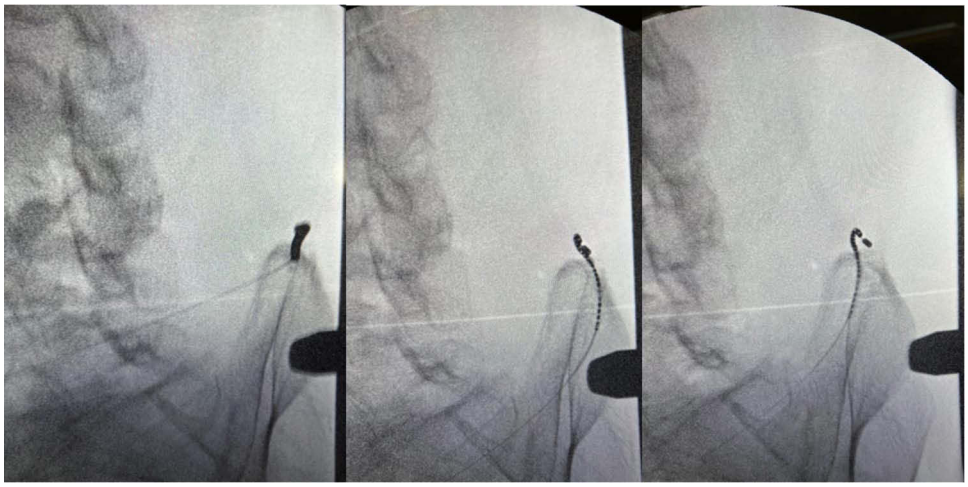

Figure 4 Peripheral nerve stimulator lead placed via the contralateral oblique technique over the left iliac crest (30-degrees).

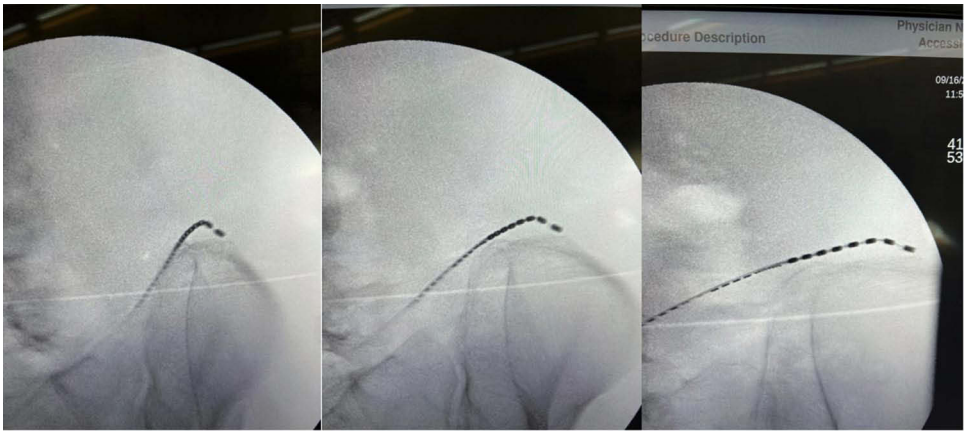

Figure 5 Peripheral stimulator lead placement demonstrated at 30-degrees, 15-degrees, and transverse.

Figure 6 Final view of placement (30-degrees).

Conclusion

We present a novel technique for placing peripheral nerve stimulation lead/s for stimulating the superior cluneal nerve. We demonstrated each step via a cadaver model. Our approach guarantees accurate placement of the PNS lead parallel to the iliac crest no matter the angle or tilt which guarantees close proximity between the lead and the superior cluneal nerves. Further studies will be needed to compare both PNS lead placement techniques in terms of physician satisfaction and patient outcomes.

Disclosure

Dr Alaa Abd-Elsayed reports is a consultant for Curonix. The authors report no other conflicts of interest in this work.

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