

## Narrative Review



# Ultrasonographic Imaging and Guided Intervention for the Superior Cluneal Nerve: A Narrative Pictorial Review

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**Background:** Ultrasound (US) has been widely used for the diagnosis and guided interventions of peripheral nerve disorders. Although superior cluneal nerve (SCN) entrapment is an important cause of lower back pain, a relevant review as to how US can be used for imaging and guided intervention for cases of SCN entrapment is still lacking.

**Objectives:** This review aims to revisit the anatomy and pertinent clinical issues of SCN entrapment, as well as the role of US regarding the diagnosis and subsequent management of relevant clinical scenarios.

**Study Design:** A narrative review.

**Methods:** Although the present article is a narrative review, we used a systematic approach to search the relevant literature. The combinations of key words, including SCN, ultrasound, and sonography, were used to search PubMed and Medline without restriction of languages or article types. The search period was from the earliest record through November 2021.

**Results:** Our included studies showed that high-resolution US and knowledge of sonoanatomy facilitated the visualization of individual branches of the SCN after emerging from the erector spinae muscles. However, the diagnostic block was needed for confirmation of SCN entrapment. Perineural US-guided injection was helpful in relieving the complaints of SCN entrapment; whereas, hydrodissection underneath the thoracolumbar fascia over the iliac crest seems to be a feasible approach for postsurgical analgesia.

**Limitations:** There was no clinical trial comparing the efficacy of different injection techniques and regimens.

**Conclusions:** US imaging is helpful for guiding injections of SCN entrapment and related clinical conditions. The evidence of US imaging in diagnosing SCN disorders remains insufficient, which requires more prospective studies to validate.

**Key words:** Low back pain, radiculopathy, sonography, neuropathy, injection

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Low back pain with a prevalence rate of 50.7% is one of the most common musculoskeletal complaints (1) observed in individuals aged > 65 years (2). The differential diagnosis of low back pain includes herniated nucleus pulposus, spinal stenosis, zygapophyseal joint arthropathy, spondylolisthesis, sacroiliac joint pain, nerve root compression, and myofascial pain syndrome (3,4). Superior cluneal nerve (SCN) entrapment is often overlooked as a cause and accounts for symptoms in 12%-14% of all patients with low back pain (5,6). A prospective study (5) performed in 2014 reported no significant gender-based differences (54.8% in women and 45.2% in men) among 113 patients with SCN entrapment.

Patients with SCN entrapment usually experience pain and dysesthesia in the gluteal region secondary to compression of the nerve between the thoracolumbar fascia and the posterior iliac crest (7). Diagnosis of SCN entrapment is conventionally based on evaluation of clinical symptoms, such as tenderness on palpation over the posterior iliac crest approximately 7 cm from the midline (5). Following technical advances in high-resolution ultrasonography (US) and knowledge of sonoanatomy, an increasing number of studies have investigated the clinical utility of US as a diagnostic imaging modality and as a useful interventional tool for SCN disorders. US facilitates direct visualization of the nerve fascicles and surrounding tissues, as well as enlargement of the cross-sectional area of the nerve proximal to the site of compression, which enables prompt and accurate hydrodissection of the entrapped nerve. In this narrative review, we discuss the anatomy of the SCN, the clinical manifestations of SCN entrapment, and the usefulness of US as an important diagnostic modality and interventional tool in specific clinical scenarios.

### Anatomy

The SCN originates from the lateral branches of the dorsal rami of the T11 to L5 spinal nerves. A cadaveric study of 10 specimens performed by Iwanaga et al (8) in 2019 showed that the T12 (10%), L1 (75%), L2 (90%), L3 (95%), L4 (45%), and L5 (10%) nerve roots contributed to the SCN. After coursing through the iliocostalis muscle or between the longissimus and iliocostalis muscles (Fig. 1A) (9), the SCN pierces the aponeurosis of the latissimus dorsi muscle (Fig. 1B) (9,10), and thereafter runs between the thoracolumbar fascia and the iliac crest toward the subcutaneous tissue of the gluteal region inferolaterally (11). The skin overlying the iliac crest and the superomedial portion of the

gluteus maximus muscle is innervated by the SCN (11) (Fig. 1C). Cutaneous sensation over the intermediate and inferior portions of the gluteus maximus muscle is provided by the middle and inferior cluneal nerves, respectively (11).

The SCN typically shows 3 terminal branches (medial, intermediate, and lateral) (12), although up to 6 branches have been reported (13). The medial branch crosses the iliac crest through a rigid osteofibrous tunnel formed by the inferior edge of the thoracolumbar fascia (14) and anastomoses with the middle cluneal nerve in the subcutaneous layer (10). In a cadaveric study of 50 specimens, Kuniya et al (6) observed that the mean length of the osteofibrous tunnel was 6.8 mm. In a study that included 10 cadavers, Tubbs et al (10) observed that the mean diameter of the medial branch ranged from 0.8 mm to 2.1 mm and that the mean length of the SCN was approximately 17 cm. The authors also observed that the lateral branch was the largest compared with the other terminal branches. The cadaveric study performed by Iwanaga et al (8) reported that the diameter of the medial, intermediate, and lateral branches of the SCN ranged from 0.70 mm to 2.69 mm, 0.57 mm to 2.96 mm, and 0.45 mm to 3.36 mm, respectively. The distance between the medial/lateral branches and the midline ranged from 52.6 mm to 86.2 mm and 54.8 mm to 102.5 mm, respectively. The distance between the medial/lateral branches and the posterior superior iliac spine ranged from 30.7 mm to 71.8 mm and from 45.9 mm to 91.6 mm, respectively (8). The cadaveric study performed by Kuniya et al (6) reported that the distance between the midline and the point at which the medial SCN pierced the thoracolumbar fascia was 67.4 mm. Figure 2 summarizes the measurement of locations of the SCN branches on cadavers in the aforementioned studies (8,9).

### Etiology

SCN entrapment is attributable to a variety of factors, including chronic stretching of the erector spinae muscles, compression by the hypertrophic thoracolumbar fascia, and surgery or injection-induced iatrogenic injuries. Surgeries that may potentially injure the SCN include pressure ulcer debridement, screw fixation of the sacroiliac joint, and spinal fusion through the iliocostalis muscle (9,14,15). Moreover, bone graft harvesting from the iliac crest is known to injure the SCN (16,17). Postoperative pain associated with SCN entrapment may occur in patients with SCN impingement caused by edema, irritation, or scarring of the overly-

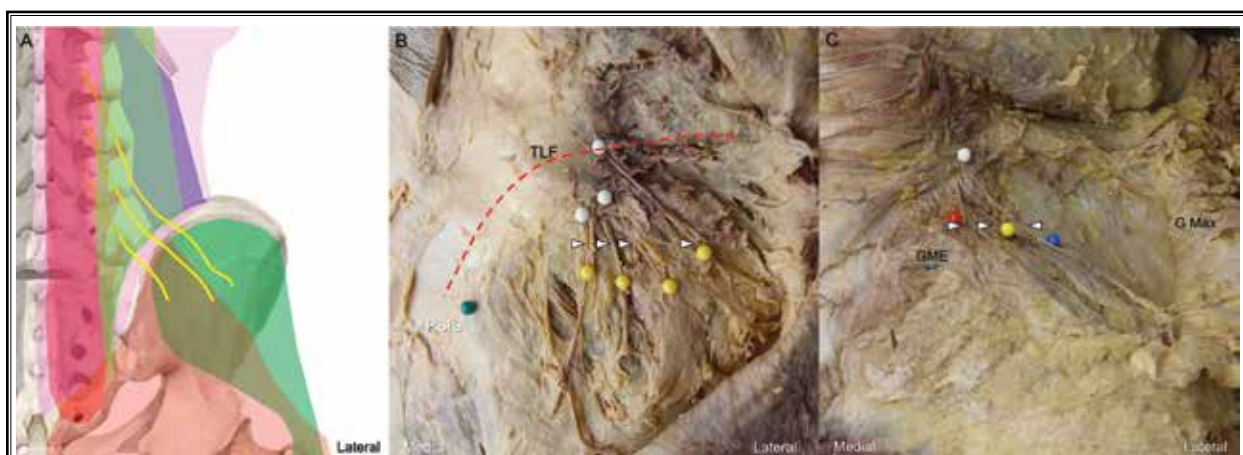


Fig. 1. Schematic drawing for the course of the superior cluneal nerve (A). Cadaveric models showing the branches of the superior cluneal nerve piercing the TLF over the posterior iliac crest (B) and providing the sensory innervation to the gluteal region (C). PSIS: posterior superior iliac spine; TLF: thoracolumbar fascia; GME: gluteus medius; G Max: gluteus maximus. Blue shade: quadratus lumborum muscle; grey shade: multifidus muscle; red shade: longissimus muscle; green shade: iliocostalis muscle; light purple shade: latissimus dorsi muscle and posterior thoracolumbar fascia; brown shade: gluteus maximus muscle; dark green shade: gluteus medius muscle; yellow line and white arrowhead: branches of the superior cluneal nerve; red dash line: posterior iliac crest.

ing tissues following the aforementioned procedures (18,19).

### Clinical Findings

Previous studies (20-23) have described erector spinae myofascial or iliac crest pain syndrome in patients with SCN entrapment. Gluteal pain and dysesthesia may be provoked by increased skin tension overlying the gluteus maximus muscle during excessive hip flexion (21,22). SCN entrapment can elicit leg symptoms, such as intermittent claudication (23) because of pain and limited range of motion, and this condition is also referred to as pseudo sciatica (13) or cluneal neuralgia (24). Walking endurance and distance decline without apparent lower extremity weakness (23). Notably, patients with parkinsonism tend to show symptomatic SCN entrapment caused by tightening of the thoracolumbar fascia secondary to an abnormal kyphotic posture (19).

### Diagnosis

Diagnosis of SCN entrapment is primarily based on clinical findings, including tenderness over the posterior iliac crest approximately 7 cm from the midline and 4.5 cm from the posterior superior iliac spine (5). However, owing to anatomic variations in the SCN (10), palpation alone may show limited diagnostic accuracy (6). In 2001, Ahn et al (25) performed an electrophysiological

study of the normal SCN and observed mean conduction velocity, amplitude, and peak latency values of 45.53 m/s, 4.07  $\mu$ V, and 2.02 m/s, respectively. To date, no electrophysiological study has reported findings in patients with SCN entrapment. Magnetic resonance imaging (MRI) may be useful to investigate SCN and adjacent soft tissues (Fig. 3). MRI may detect abnormal thickening of the thoracolumbar fascia; however, its low accessibility and high-cost limit the potential application of MRI as a diagnostic tool.

### Treatment

Nonoperative treatments for SCN entrapment include administration of topical nonsteroidal anti-inflammatory drugs or physical modalities, such as transcutaneous electrical nerve stimulation (26). Injections of local anesthetics may be considered for patients with severe symptoms in whom a rapid analgesic effect is desired (15). In a study performed in 2018, Inklebarger et al (27) treated 2 patients using palpation-guided injections with 12.5% dextrose combined with phenol, glycerine, and lidocaine. In another study, Mahli et al (17) used alcohol neurolysis to successfully treat 4 patients with SCN entrapment following bone graft harvesting from the iliac crest.

Decompression of the thoracolumbar fascia can be considered in patients who respond poorly to conservative management. Morimoto et al (18) observed

that thoracolumbar fascia excision can relieve radiating pain elicited on palpation. The authors identified the SCN intraoperatively using a nerve stimulator; posterior

bulging of the SCN indicated successful decompression (18). Reportedly, indocyanine green video angiography can confirm improved regional blood flow following complete decompression of the SCN (28).

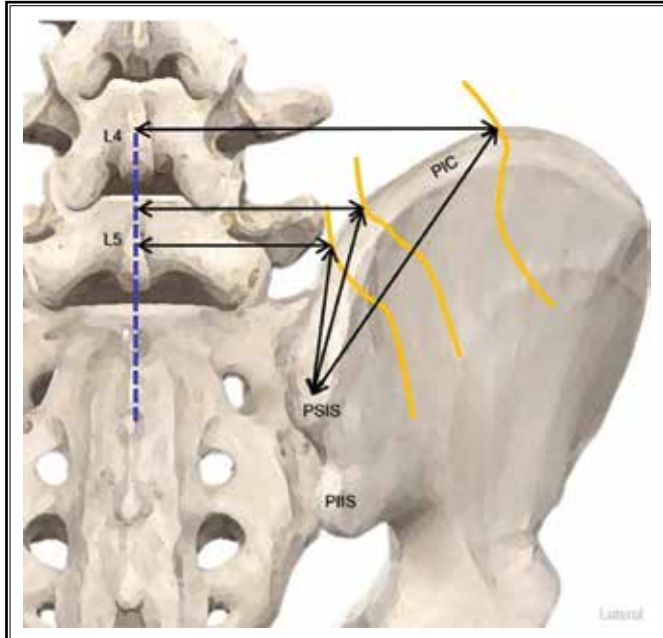


Fig. 2. Illustration for the measurement of the distance between the PSIS and the midline and medial, intermediate, and lateral branches of the superior cluneal nerve crossing the PIC. PIIS: posterior inferior iliac spine; PSIS: posterior superior iliac spine; PIC: posterior iliac crest.

### Literature Search

In this article, we present a narrative review and pictorial essay; however, we also performed a systematic literature search. We searched the PubMed and Medline databases using combinations of the following key words: "superior cluneal nerve," "ultrasound," and "sonography," without restriction of language or article type. We searched the literature from inception until November 2021. Table 1 summarizes the details of each study included in this research.

### Ultrasonographic Evaluation

In a study of 14 cadaveric specimens, Bodner et al (14) reported US-based identification of the SCN using a caudal-to-cranial approach from the sacral attachment of the gluteus maximus to the insertion of the gluteus medius muscle on the posterior gluteal line of the ilium (Fig. 4). However, the authors did not provide details regarding accurate identification of the segment of the SCN that crosses the posterior iliac crest. In 2017, Chang et al (29) reported placement of the transducer at the posterior inferior iliac spine and movement of this

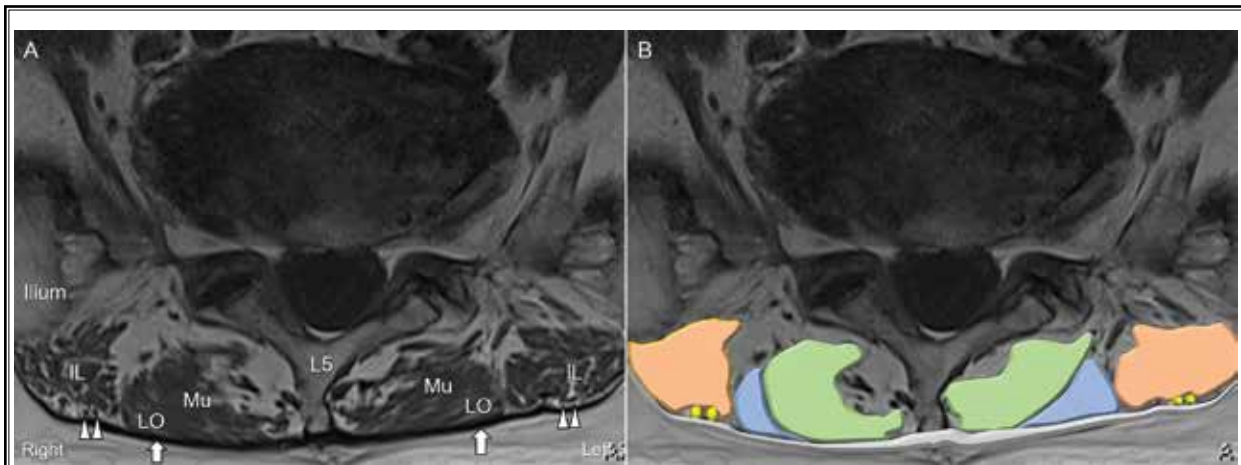


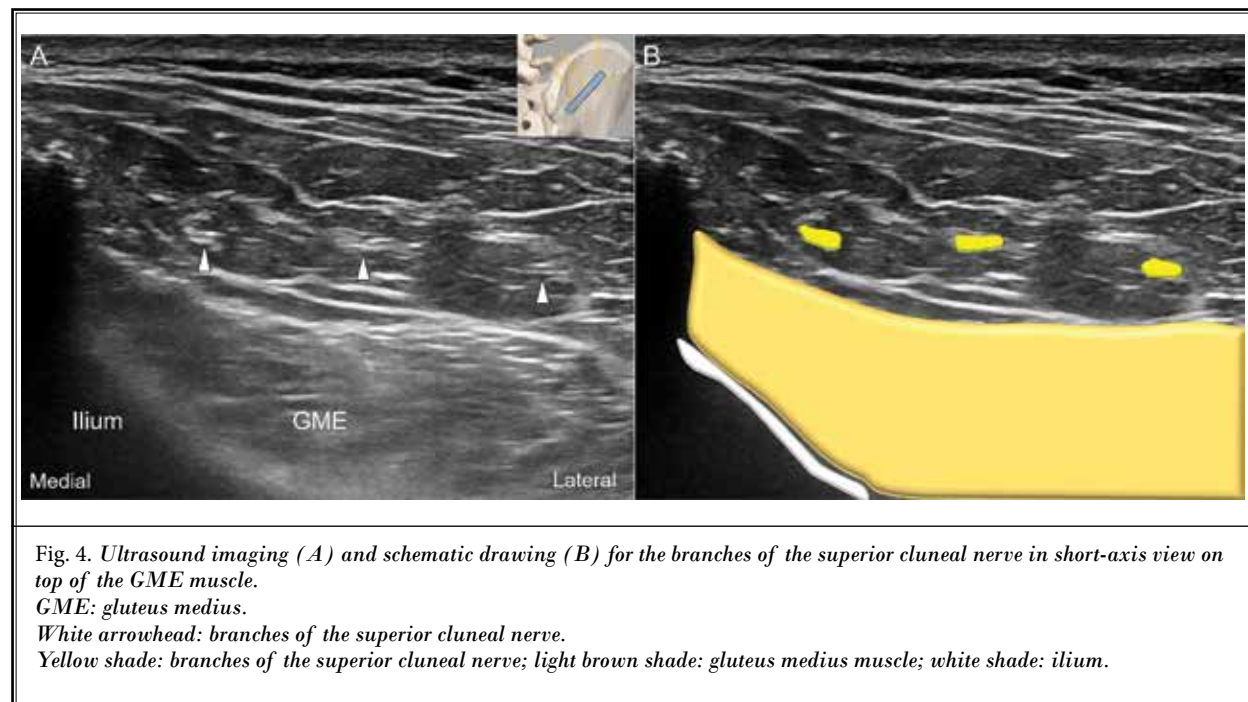
Fig. 3. Magnetic resonance imaging (A) and schematic drawing (B) for the branches of the superior cluneal nerve on top of the fifth lumbar vertebral level. IL: iliocostalis muscle, light orange color; Lo: longissimus muscle, light blue color; Mu: multifidus muscle, light green color. White arrowhead and yellow dots: branches of the superior cluneal nerve; white arrow and grey shade: thoracolumbar fascia.



Table 1. Summary of the articles on ultrasound imaging and guidance for the superior cluneal nerve. pathologies/interventions

Author (y)	Study Type	Number of Patients	Diagnosis	Details of Imaging and Intervention	Main outcome
Bodner et al 2016	Case Series	9	SCN Entrapment	US-guided SCN block through an in-plane approach for the short axis of the SCN with 2 mL of 1% lidocaine.	Decrease in numbness within the presumed territory of SCN after the SCN block.
Chang et al 2017	Case Report	1	SCN Entrapment	US-guided injection on the medial branch of the SCN in its long axis through a cranial-to-caudal in-plane approach with hydrodissecting the segment crossing the posterior iliac crest using 4 mL of 5% dextrose and 1% lidocaine.	80% of pain relief after a total of two injections.
Nielsen et al 2019	Step 1: Cadaver Study. Step 2: Randomized Controlled Trial	Step 1: 6 cadavers; Step 2: 20 patients	Step 2: Healthy Volunteers	Step 1: US-guided injection with 10 mL methylene blue into the posterior thoracolumbar fascia. Step 2: US-guided SCN block on the lateral border of the erector spinae muscle where the lumbar intramuscular aponeurosis fuses with the thoracolumbar fascia, using 15 mL of 0.375% ropivacaine.	Step 1: All branches of the SCN in all cadaver sites were stained. Step 2: Anesthesia after the procedure was successful in 18 of the 20 (90%) active sites and in none of the placebo sites ( $p < 0.001$ ).
Ricci et al 2019	Case Report	1	SCN Entrapment	US imaging of the posterior iliac crest for the SCN and application of transcutaneous electrical nerve stimulation on the entrapped segment.	Significant reduction in the low back pain and dysesthesia.
Fan et al 2021	Case Report	1	Not Mentioned	US-guided SCN block on top of the iliac crest and gluteus maximus muscle parallel to the transverse process of L5, using 15 mL of 0.5% ropivacaine.	Relief of pain in the cutaneous region.

Abbreviations: SCN: superior cluneal nerve; US: ultrasound.



device cranially along the medial border of the iliac crest. Disappearance of the gluteus maximus and visualization of the gluteus medius muscle enabled clear identification of the SCN in its short axis between the thoracolumbar fascia and the iliac crest (Fig. 5). In 2019, Ricci et al (26) reported that the medial branch of the SCN was clearly identifiable within an osteofibrous tunnel that appears as a notch at the medial edge of the posterior iliac crest.

In 2019, Nielsen et al (15) reported that the fascicles of the SCN may appear as several hypoechoic bubbles on the surface of the erector spinae muscle covered by the posterior layer of the thoracolumbar fascia, following placement of a high-frequency linear transducer at the lateral border of the erector spinae muscle. However, the authors did not provide details regarding the method to trace the SCN distally toward the distal subcutaneous layer. Chang et al (30) described a tracking technique, which facilitated identification of the SCN in the subcutaneous layer overlying the gluteus medius muscle. Thereafter, the SCN courses back to the level of the iliac crest and thoracolumbar fascia (Fig. 6). Finally, the nerve can be visualized as it enters the longissimus or iliocostalis muscles; it is difficult to follow its intramuscular path owing to the steep and undulating course (14). The SCN can be fully delineated along its long axis after rotating the transducer to the oblique sagittal plane (Fig. 7). This technique focuses on the subcutaneous course of the

SCN; therefore, the transducer should be placed gently on the skin to avoid unnecessary compression of the subcutaneous tissues (30).

### Ultrasonographic Diagnosis

Nerve entrapment is ultrasonographically characterized by enlargement of the cross-sectional area of the nerve and a positive sono-Tinel sign (31). Our literature search yielded only one article that described the US findings of SCN entrapment in its long axis in a patient who underwent posterior lumbar interbody fusion surgery (14). The nerve appeared as a fusiform hypoechoic lesion with a narrow segment confined by the thoracolumbar fascia and the posterior iliac crest. Although the authors reported normal US findings in the remaining 8 patients, all patients experienced complete pain relief and resolution of numbness over the SCN-innervated territory after diagnostic nerve blocks (14).

The SCN is small in size; therefore, in our opinion, a longitudinal view of the nerve may be useful to detect the site of entrapment. The diagnostic performance of US may be limited by the following factors: (a) Owing to increased adiposity in patients with obesity, the subcutaneous layer may appear more hyperechoic, and it may be difficult to distinguish the epineurium of the SCN from the surrounding structures. (b) Clear visualization of the SCN also depends on the echotexture of the adjacent muscles, which may be atrophic in patients

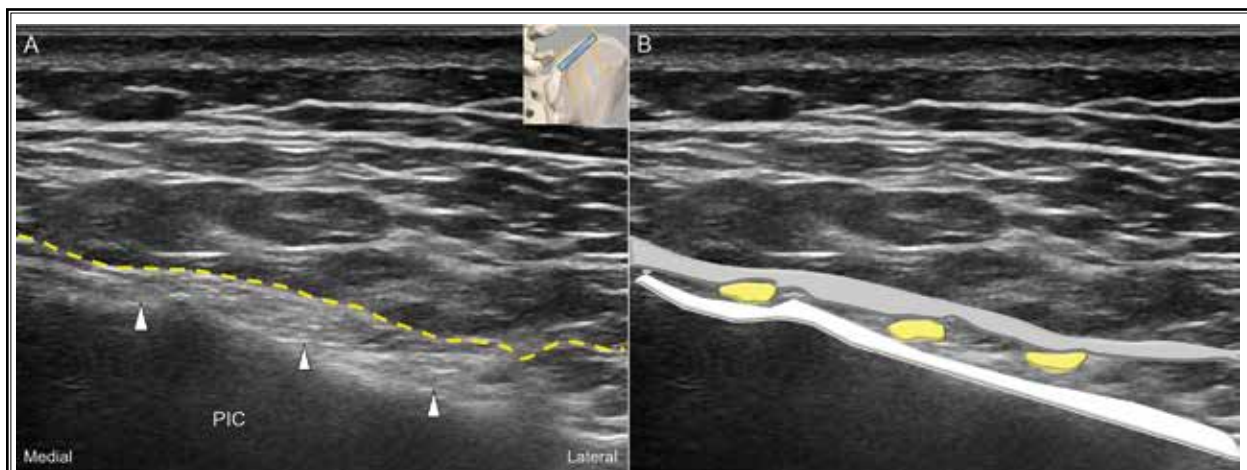


Fig. 5. *Ultrasound imaging (A) and schematic drawing (B) for the branches of the superior cluneal nerve in short-axis view between the thoracolumbar fascia and the PIC.*

*PIC: posterior iliac crest.*

White arrowhead: branches of the superior cluneal nerve; yellow dash line: thoracolumbar fascia.

Grey shade: latissimus dorsi muscle and posterior thoracolumbar fascia; yellow shade: branches of the superior cluneal nerve; white shade: posterior iliac crest.

with low back or gluteal pain (32). Therefore, a favorable response to a perineural injection is considered the gold standard for diagnosis of SCN entrapment, based on US imaging (19,26).

**Ultrasound-Guided Interventions**

Our literature search showed that US guidance may be useful for treatment of SCN entrapment, for regional

gluteal blocks, and postoperative analgesia following operations in proximity to the iliac crest. Bodner et al (14) performed a diagnostic block via an in-plane approach for the short axis of the SCN using 2 mL of 1% lidocaine on top of the posterior iliac crest (Fig. 8). In 2017, Chang et al (7) reported a case of parkinsonism accompanied by SCN entrapment secondary to a kyphotic posture. A US-guided injection was performed along

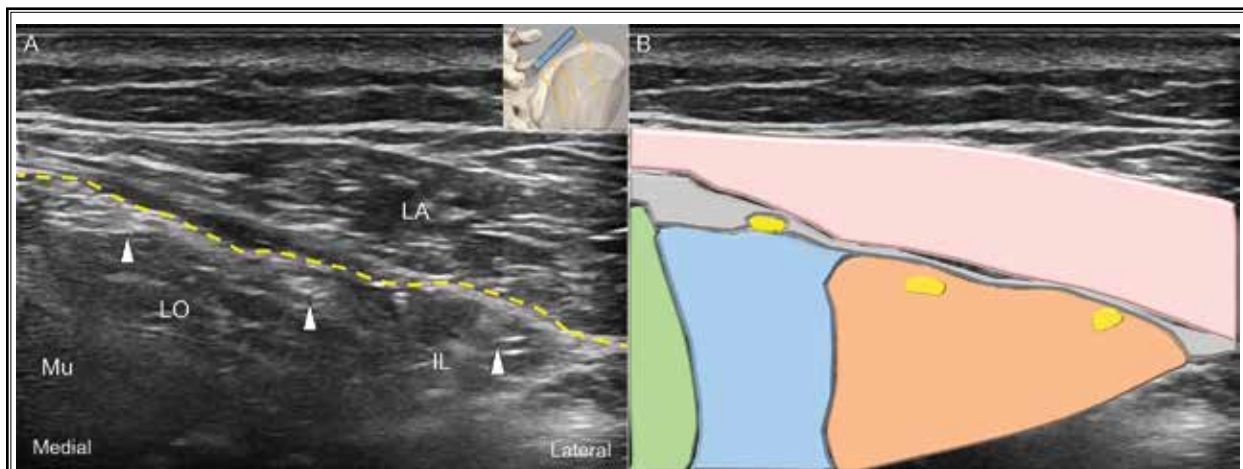


Fig. 6. *Ultrasound imaging (A) and schematic drawing (B) for the branches of the superior cluneal nerve between the thoracolumbar fascia and the erector spinae muscle.*  
 IL: iliocostalis muscle (light orange shade); LA: latissimus dorsi muscle (light pink shade); LO: longissimus muscle (light blue shade); Mu: multifidus muscle (light green shade).  
 White arrowhead and yellow shade: branches of the superior cluneal nerve; yellow dash line and grey shade: thoracolumbar fascia.

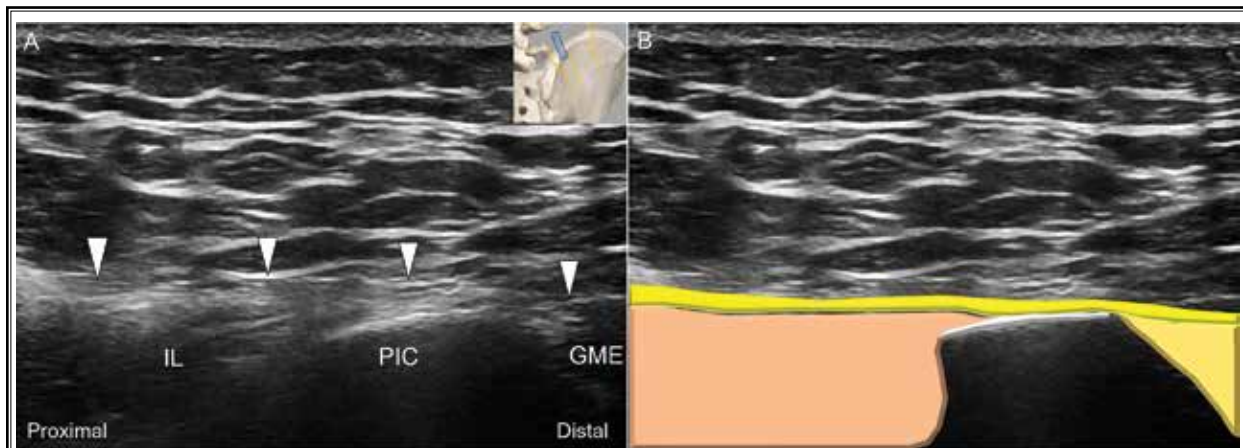


Fig. 7. *Ultrasound imaging (A) and schematic drawing (B) for the intermediate branches of the superior cluneal nerve in long-axis view.*  
 White arrowhead: branches of the superior cluneal nerve.  
 IL: iliocostalis muscle (light orange shade); GME: gluteus medius muscle (golden shade); PIC: posterior iliac crest (white shade); yellow shade: superior cluneal nerve.

the long axis of the medial branch of the SCN through a cranial-to-caudal in-plane approach using hydrodissection of the segment that crosses the iliac crest (Fig. 9). The authors injected 4 mL of 5% dextrose and 1% lidocaine, a common combination used for perineural injections (33). The patient reported 80% pain relief following 2 injections.

In a cadaveric study of 6 specimens performed by Nielsen et al (15), 10 mL of methylene blue was injected under US guidance into the posterior thoracolumbar fascia at the L3 level. The injections stained all branches of the SCN in all 6 cadavers. The authors also recruited

20 healthy volunteers to determine the effects of regional anesthesia after the SCN block. The patients were randomized into a group (n = 10) that received 15 mL of 0.375% ropivacaine on the right side and an injection of the same volume of saline on the left side and another group (n = 10) that received the active injection on the left and placebo on the right side (15). US-guided injections were performed through an in-plane approach into the lateral border of the erector spinae muscle at the site of fusion of the lumbar intramuscular aponeurosis and thoracolumbar fascia (Fig. 10, Video 1). Postprocedural anesthesia was suc-

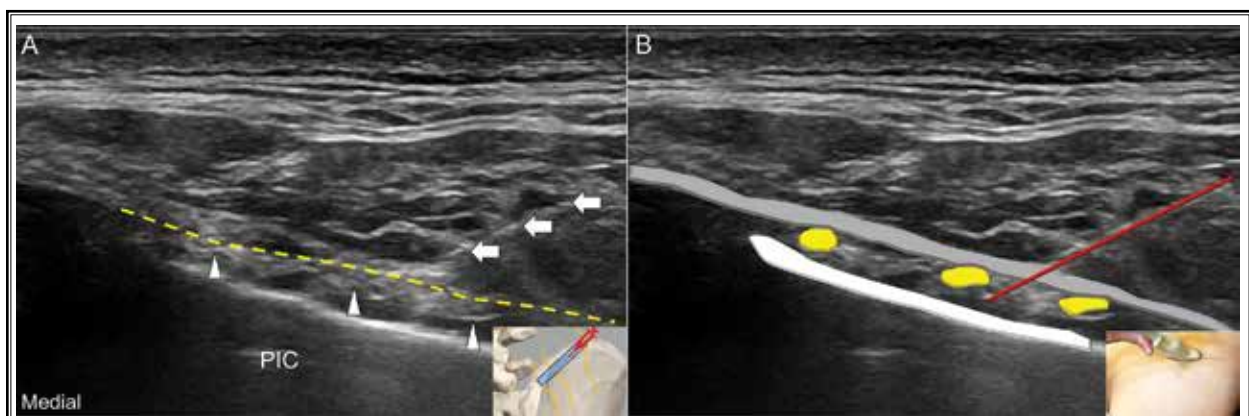


Fig. 8. *In-plane (lateral to medial) approach to target the superior cluneal nerve (in short-axis view) between the thoracolumbar fascia and the PIC (A). Corresponding schematic drawing (B).*

White arrowhead: branches of the superior cluneal nerve; white arrow: needle (red shade).

Thoracolumbar fascia: yellow dashed line and grey shade; branches of the superior cluneal nerve: yellow shade; PIC: posterior iliac crest (white shade).

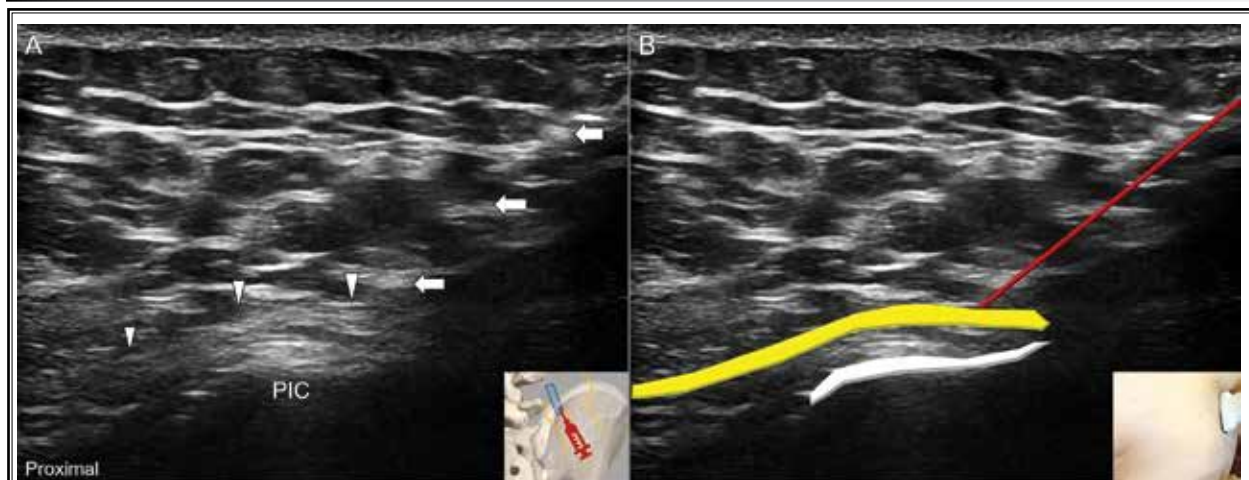


Fig. 9. *In-plane approach to target the superior cluneal nerve distally in the long axis view (A). Corresponding schematic drawing (B).*

White arrowhead: branches of the superior cluneal nerve (yellow shade); white arrow: needle (red shade).



cessful in 18 of the 20 (90%, 95% confidence interval 68.3%-98.8%) active injection sites and in none of the placebo injection sites ( $P < 0.001$ ) (15).

Fan et al (32) reported a novel method for post-operative analgesia after total hip arthroplasty. The curved transducer was placed at the midline of the sacrum and moved cranially in the transverse plane. After identification of the spinous and transverse processes of the L5 vertebra, the transducer was moved laterally to the top of the iliac crest at the site of attachment of the gluteus maximus muscle (Fig. 11). A total of 15 mL of 0.5% ropivacaine was injected beneath the

thoracolumbar fascia. This technique does not require localization of the SCN, which serves as an advantage.

### Future Perspectives

Few studies have investigated the diagnostic performance of US for SCN disorders. Technological progress and the availability of high-frequency transducers, including those with a frequency of 20 MHz-24 MHz, enable clearer visualization of fascicles of the SCN and it is easier to distinguish between the healthy nerve and SCN entrapment. Although the prevalence of SCN entrapment is not low, no clinical trial has compared the

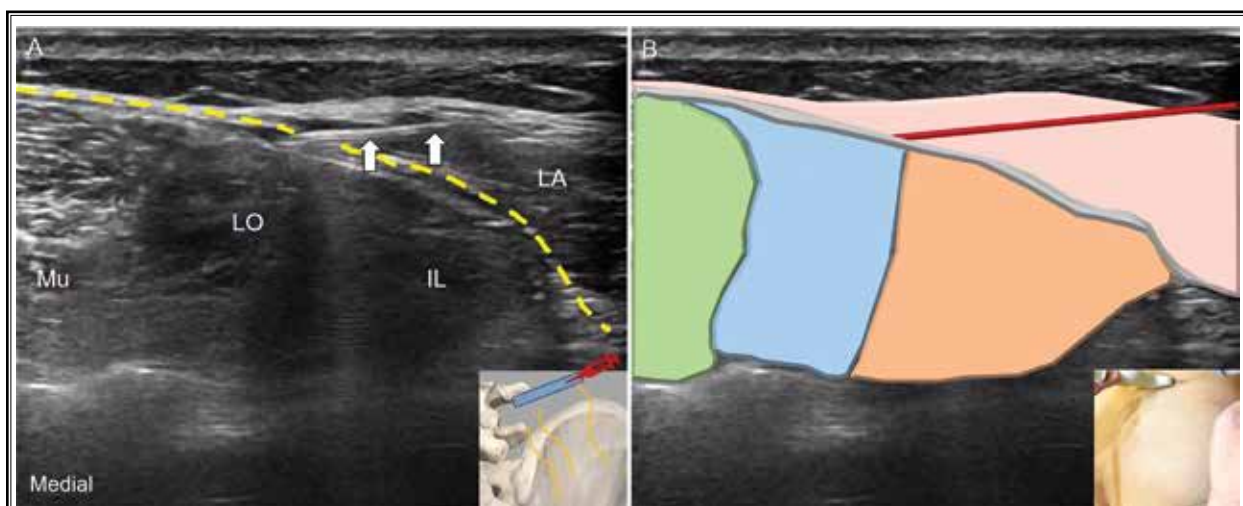


Fig. 10. *In-plane (lateral to medial) approach to target the thoracolumbar fascia (A). Corresponding schematic drawing (B).* IL: iliocostalis muscle (light orange shade); LA: latissimus dorsi muscle (light pink shade); Lo: longissimus muscle (light blue shade); Mu: multifidus muscle (light green shade). Thoracolumbar fascia: yellow dashed line and grey shade; white arrow: needle (red shade).

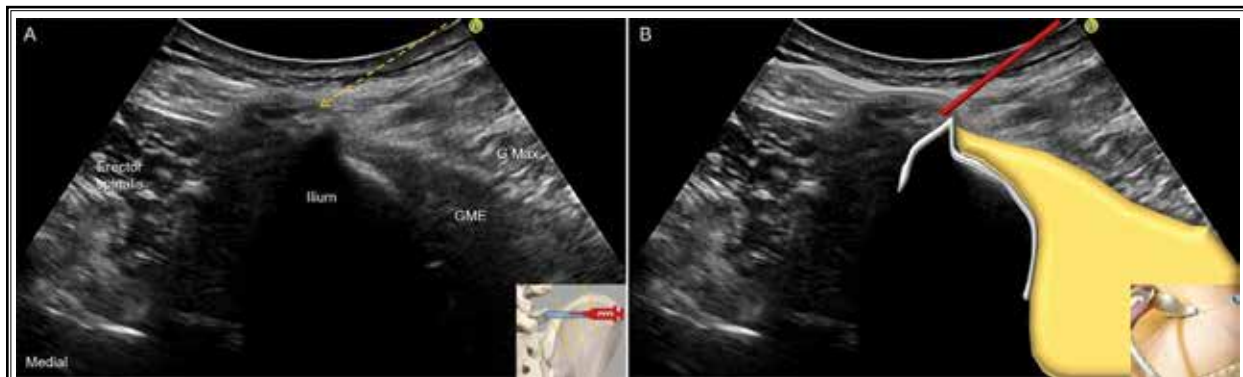


Fig. 11. *In-plane (lateral to medial) approach to target the superior edge of the iliac crest (A). Corresponding schematic drawing (B).* GME: gluteus medius; G Max: gluteus maximus. Yellow dash-line arrow: trajectory of the needle. Grey shade: posterior thoracolumbar fascia; light brown shade: gluteus medius muscle; white shade: ilium; red shade: needle.

efficacy of different injection techniques and regimens for this condition. Studies are warranted to definitively establish the efficacy of perineural injection vs blunt hydrodissection (beneath the thoracolumbar fascia) in such cases. US evaluation may indisputably be useful to guide clinical decision-making regarding the optimal intervention in a specific case. Further studies are warranted to determine the feasibility of US-guided radiofrequency ablation of the SCN.

## CONCLUSIONS

High-resolution US facilitates clear visualization of individual branches of the SCN after it emerges from the erector spinae muscles. However, it is challenging to detect enlargement of the cross-sectional area

of the nerve in cases of SCN entrapment; therefore, a diagnostic block is important for confirmation. US-guided perineural injection may relieve symptoms of SCN entrapment, and hydrodissection of the nerve beneath the thoracolumbar fascia over the iliac crest appears to be feasible for postsurgical analgesia. Administration of local anesthetics deep to the superficial fascia of the iliocostalis muscle from its lateral edge is a potential adjuvant procedure for regional anesthesia of the buttock region. Future prospective studies and randomized controlled trials are warranted to gain a deeper understanding of the role of US imaging and US-guided interventions in the management of SCN disorders.

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