

Advanced Interventions for Knee, Hip, and Shoulder Pain: PNS

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Disclosures

- Abbott – consultant, advisory board member, funded research
 - Boston Scientific – consultant, advisory board member
 - Medtronic – honoraria, funded research
 - Nevro – consultant, advisory board member
 - Saluda – consultant, funded research
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- This presentation does not contain off-label or investigational use of drugs or products.



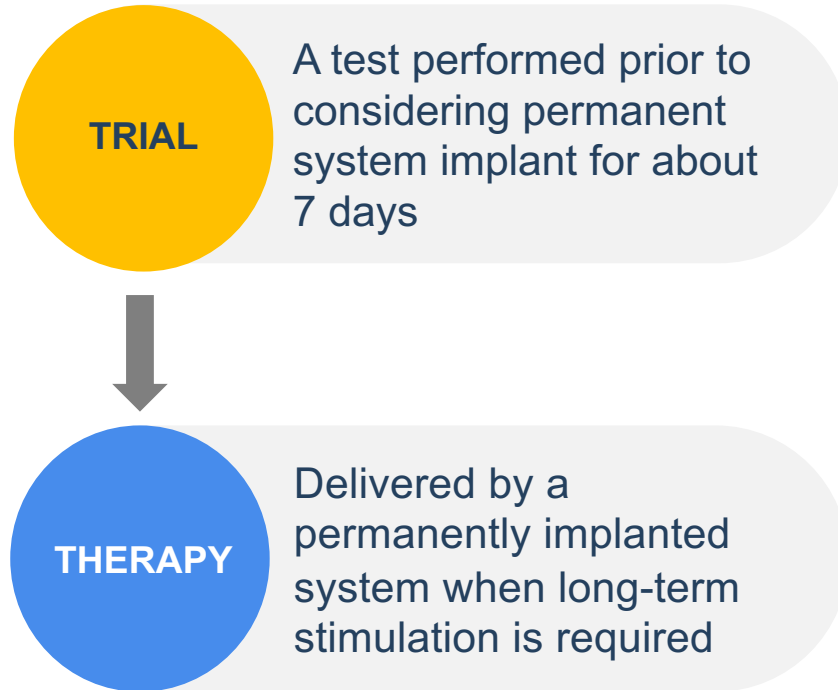
Learning Objectives

- After participating in this session, attendees should be able to:
 1. Describe appropriate peripheral nerve stimulation targets to treat appropriate knee, hip, and shoulder pain pathologies.
 2. Understand appropriate peripheral nerve stimulation candidates and where the best evidence exists.

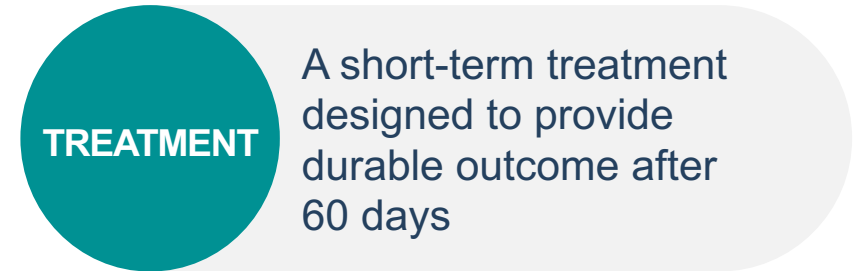


Types of PNS: Permanent vs 60-day Systems

Conventional PNS Systems



60-day PNS System



Knee Techniques

- Femoral Nerve
- Sciatic Nerve
- Saphenous Nerve



Femoral Nerve

Example Lead Placement Approach

ELECTRODE TARGET LOCATION:

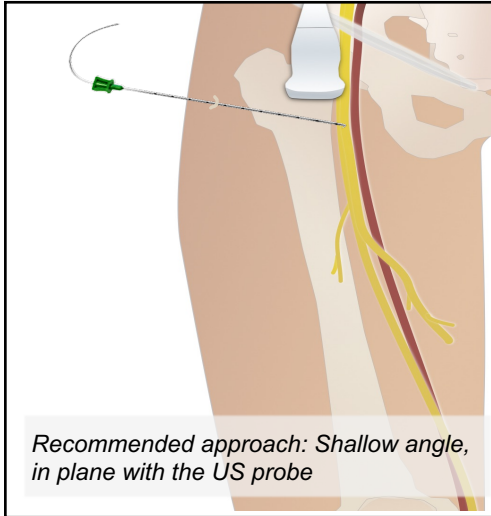
Superficial to the femoral nerve, between the fascia lata and fascia iliaca. The full electrode tip (~1 cm) should be inserted entirely under the fascia lata. Stimulation of saphenous branch may require more medial placement.

NEEDLE INSERTION:

~1-2 cm distal to the inguinal crease with a flat/horizontal trajectory passing superficial to nerve. Lead should be proximal to nerve branching, but far enough from inguinal crease to minimize impact of normal patient movements on lead. Insertion site should allow at least 4 cm of lead under the skin.

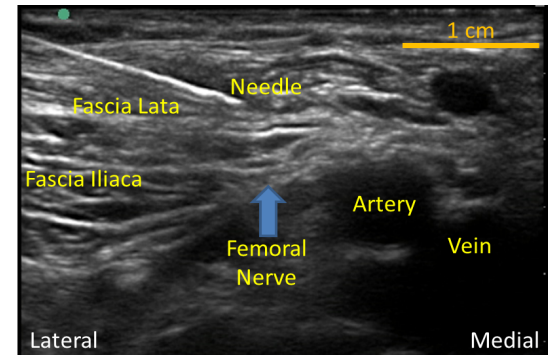
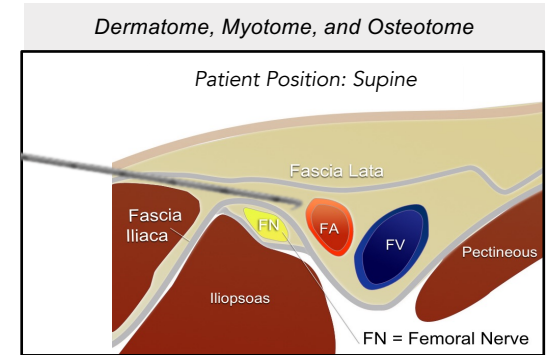
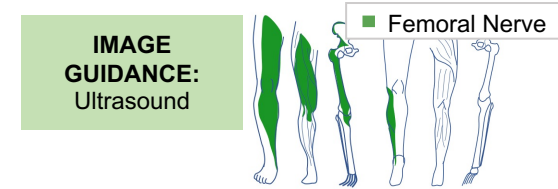
THINGS TO BE AWARE OF:

- Insertion directly at the inguinal crease may increase risk of future dislodgement.
- Always be aware of needle tip relative to femoral artery.



PLACEMENT CONFIRMATION:

Comfortable sensations should cover the region of pain. If distal discomfort (e.g., painful sensations, muscle contractions), you may increase nerve-electrode distance. If local discomfort, you may decrease nerve-electrode distance.



Sciatic Nerve – Transgluteal

Example Lead Placement Approach

ELECTRODE TARGET LOCATION:

~0.5-2 cm from the sciatic nerve as it runs deep to the gluteus maximus. The nerve may typically be visualized between bony landmarks on ultrasound.

NEEDLE INSERTION:

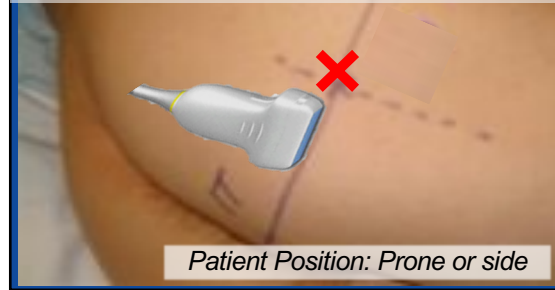
Nerve can typically be identified running perpendicular to line connecting ischial tuberosity and greater trochanter, approx. halfway along the line. Needle is usually inserted in-plane to US probe, lateral to medial.

THINGS TO BE AWARE OF:

- A curvilinear probe is recommended.
- Stimulation coverage may be maximized by passing over nerve rather than pointing needle directly at it (may not be possible in larger patients due to depth of nerve).

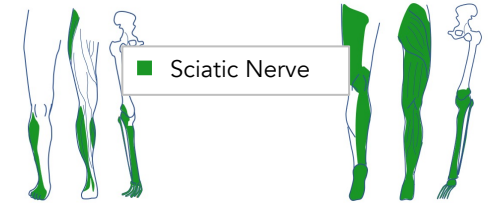
IMAGE GUIDANCE: Ultrasound

Image showing insertion location to target the sciatic nerve as it lies halfway between the ischial tuberosity and greater trochanter.

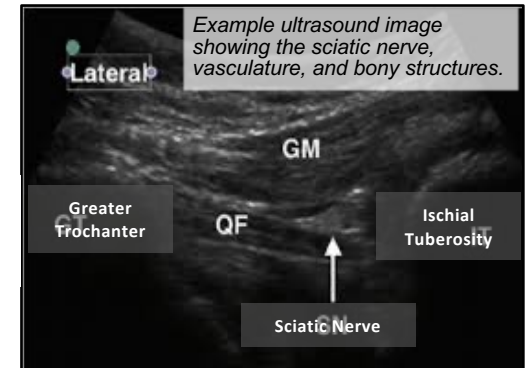
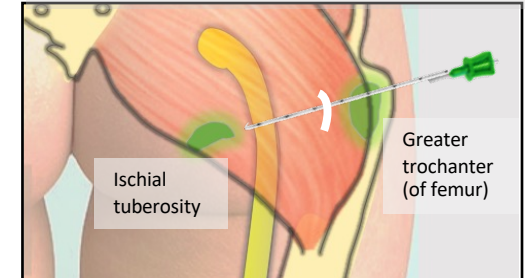


PLACEMENT CONFIRMATION:

Comfortable sensations should cover the region of pain. If distal discomfort, (e.g., painful sensations, muscle contractions) you may increase nerve-electrode distance. If local discomfort, you may decrease nerve-electrode distance.



Dermatome, Myotome, and Osteotome



Sciatic Nerve – Subgluteal

Example Lead Placement Approach

ELECTRODE TARGET LOCATION:

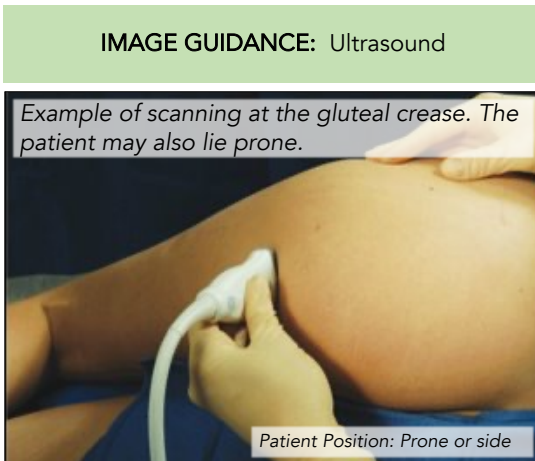
~0.5-2 cm from the sciatic nerve at, above, or below the subgluteal crease. The nerve may lie in connective tissue near the biceps femoris muscle.

NEEDLE INSERTION:

Locate the sciatic nerve at the gluteal crease. If having difficulty, trace the nerve from a distal location on the leg where the nerve is more superficial. Needle insertion should be lateral to medial, in-plane with the ultrasound probe.

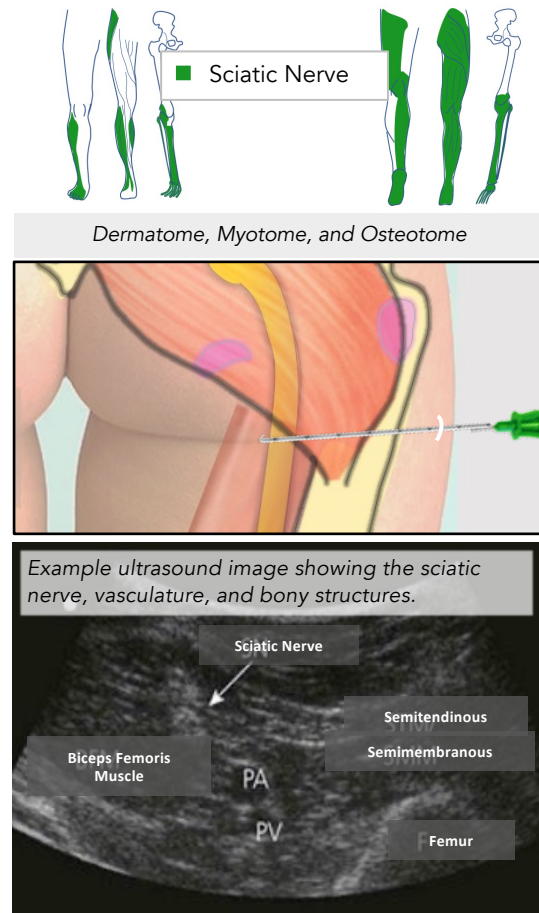
THINGS TO BE AWARE OF:

- A curvilinear probe is recommended
- Stimulation coverage may be maximized by passing over nerve rather than pointing needle directly at the nerve



PLACEMENT CONFIRMATION:

Comfortable sensations should cover the region of pain. If distal discomfort, (e.g., painful sensations, muscle contractions) you may increase nerve-electrode distance. If local discomfort, you may decrease nerve-electrode distance.



Sciatic Nerve – Popliteal

Example Lead Placement Approach

ELECTRODE TARGET LOCATION:

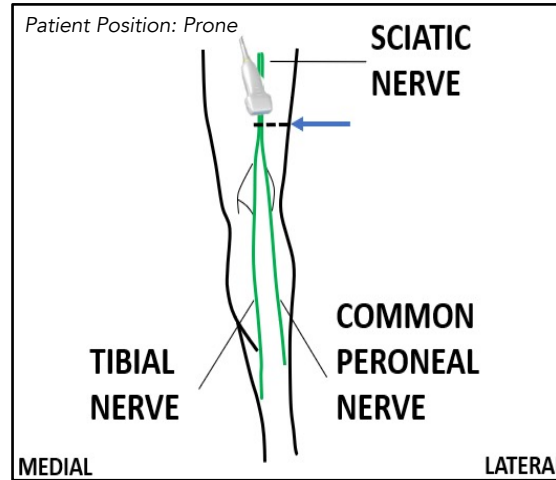
~0.5-1 cm superficial to the nerve. Alternative locations include deep, lateral, or medial to the nerve. Placement proximal to the sciatic branching into tibial/common peroneal nerves may stimulate a larger proportion of the leg.

NEEDLE INSERTION:

Superior to the popliteal fossa, in plane with the ultrasound probe, lateral to medial. Scan up and down the thigh to determine where the nerve branches.

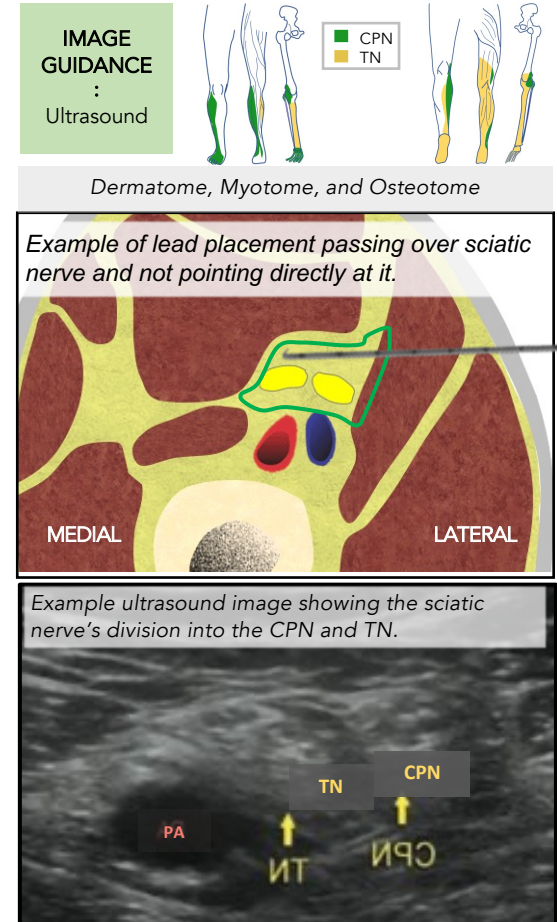
THINGS TO BE AWARE OF:

- Medial placement may preferentially target TN (tibial nerve) distribution.
- Lateral placement may preferentially target CPN (common peroneal nerve) distribution.



PLACEMENT CONFIRMATION:

Comfortable sensations should cover the region of pain. If distal discomfort, (e.g., painful sensations, muscle contractions) you may increase nerve-electrode distance. If local discomfort, you may decrease nerve-electrode distance.



Saphenous Nerve

Example Lead Placement Approach

ELECTRODE TARGET LOCATION:

Deep to the Sartorius Muscle on the medial side of the thigh. Ideally, the full electrode tip (~1 cm) should lie entirely in the fascial plane (see image on right) running parallel to the edge of the muscle but can be placed in the vastus medialis or sartorius muscles if needed.

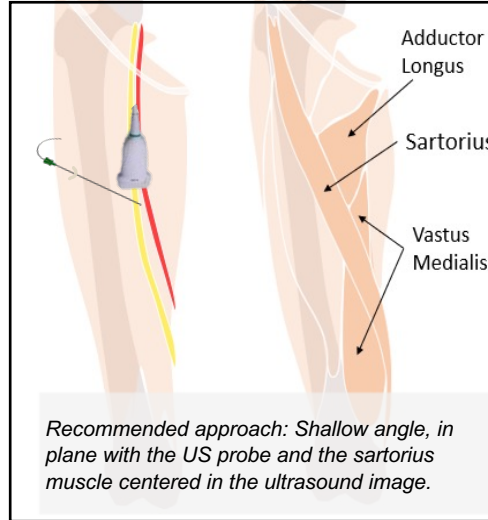
NEEDLE INSERTION:

~1 cm distal to where the saphenous nerve and femoral artery diverge on ultrasound.

Note that the femoral nerve and artery diverge when scanning more distally down the thigh.

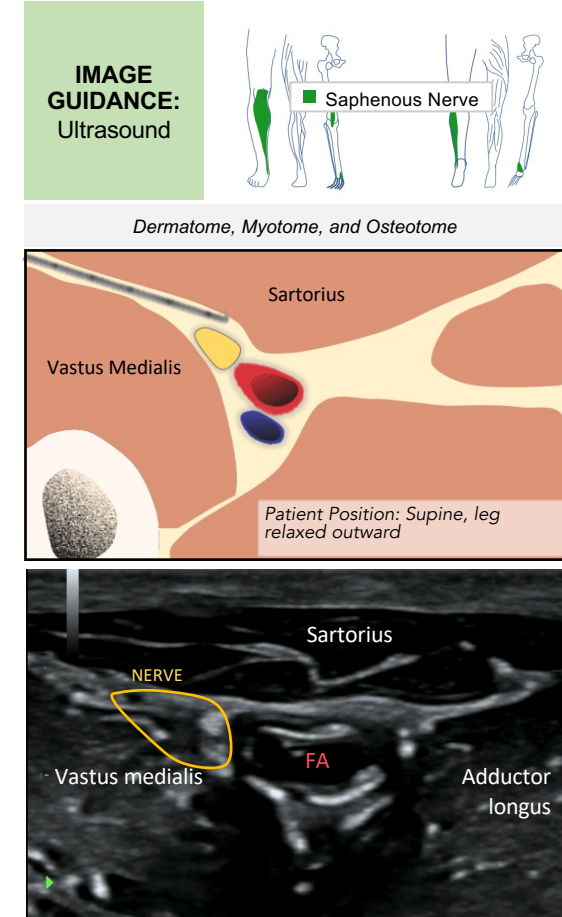
THINGS TO BE AWARE OF:

- Insertion site should allow at least 4 cm of lead under the skin.
- Always be aware of needle tip relative to femoral artery.



PLACEMENT CONFIRMATION:

Comfortable sensations should cover the region of pain. If distal discomfort (e.g., painful sensations, muscle contractions), you may increase nerve-electrode distance. If local discomfort, you may decrease nerve-electrode distance.



Hip Techniques

- Lateral Femoral Cutaneous Nerve
- Superior Gluteal Nerve (not included)
- Subcutaneous Field Stimulation (not included)



Lateral Femoral Cutaneous Nerve

Example Lead Placement Approach

ELECTRODE TARGET LOCATION:

~0.5-1 cm from the LFCN just distal to inguinal ligament and ASIS. Place the ultrasound probe immediately inferior to the ASIS, parallel to the inguinal ligament. The nerve lies between the tensor fasciae latae muscle and sartorius muscle.

NEEDLE INSERTION:

- Needle is inserted in a lateral-to-medial orientation.
- A fascial "pop" may be felt as needle enters appropriate plane between the muscles.

THINGS TO BE AWARE OF:

- Ensure at least 4 cm of lead is inserted to avoid dislodgement.



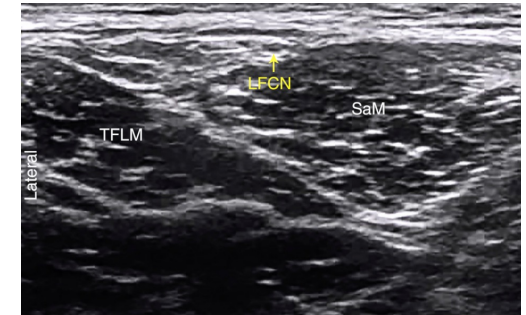
PLACEMENT CONFIRMATION:

Comfortable sensations should cover the region of pain. The expected distribution of coverage is the anterolateral thigh. There is a large variation in the sensory coverage between patients due to the variable anatomy of the LFCN.

IMAGE
GUIDANCE
:
Ultrasound



Ultrasound of anatomy of the intermuscular area.



Shoulder Techniques

- Suprascapular Nerve
- Axillary Nerve
 - Quadrangular Space
 - Trans-deltoid



Suprascapular Nerve

Example Lead Placement Approach

ELECTRODE TARGET LOCATION:

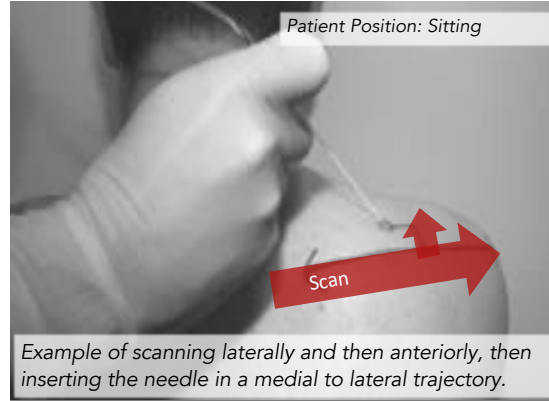
~0.5-1 cm from the suprascapular nerve as it enters the groove at the suprascapular notch.

NEEDLE INSERTION:

Place the ultrasound probe over the spine of the scapula, then scan out to the distal 3rd of the spine. From there, scan anteriorly to find the suprascapular notch.

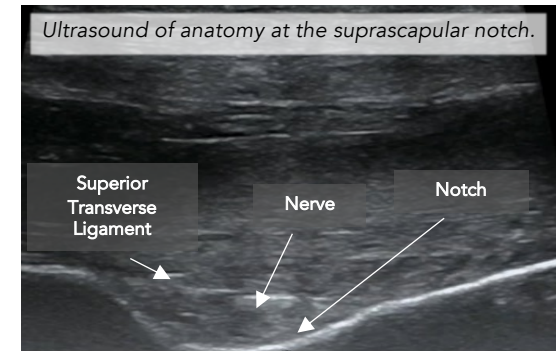
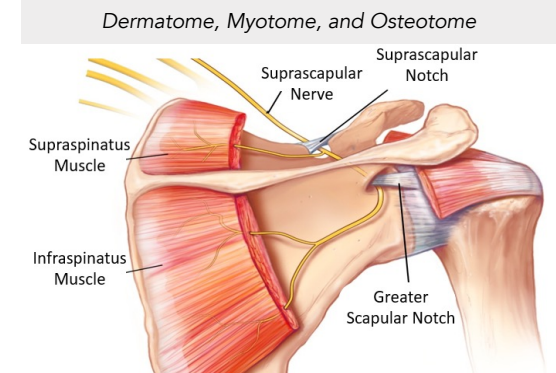
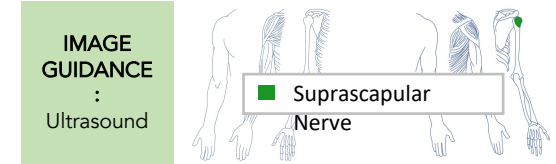
THINGS TO BE AWARE OF:

- Lead is often placed through (i.e., beneath) the superior transverse ligament into the suprascapular notch.
- Avoid inserting needle too deep to avoid puncturing the pleural cavity



PLACEMENT CONFIRMATION:

Comfortable sensations should cover the region of pain. However, response may be different compared to other nerves because the suprascapular nerve doesn't innervate skin. If distal discomfort (e.g., painful sensations, muscle contractions), you may increase nerve-electrode distance. If local discomfort, you may decrease nerve-electrode distance.



Axillary Nerve – Quadrangular Space

Example Lead Placement Approach

ELECTRODE TARGET LOCATION:

~0.5-1 cm from the axillary nerve as it passes through the quadrangular space and spreads to the head of the humerus.

NEEDLE INSERTION:

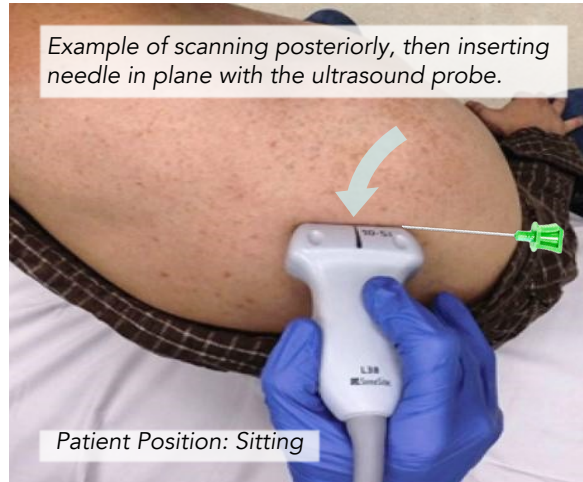
Start with the ultrasound probe on the posterior-lateral humeral head. Scan posteriorly along the bone until the quadrangular space and axillary nerve come into view. See image to right.

THINGS TO BE AWARE OF:

- The circumflex artery runs near the axillary nerve as it passes through the quadrangular space.
- The cross-section of the nerve will be visible on the ultrasound.

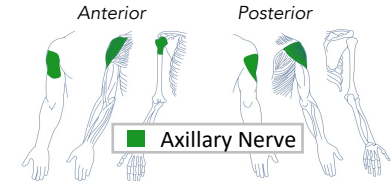
IMAGE GUIDANCE: Ultrasound

Example of scanning posteriorly, then inserting needle in plane with the ultrasound probe.

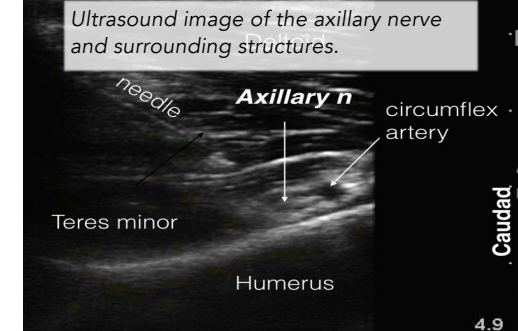
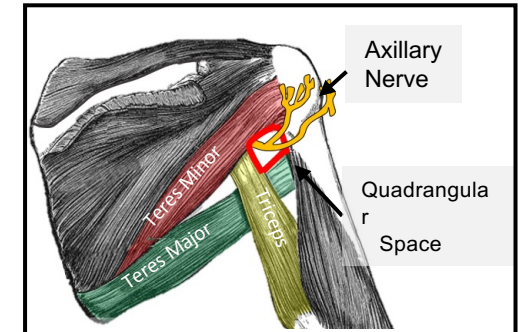


PLACEMENT CONFIRMATION:

Comfortable sensations should cover the region of pain. If distal discomfort (e.g., painful sensations, muscle contractions), you may increase nerve-electrode distance. If local discomfort, you may decrease nerve-electrode distance.



Dermatome, Myotome, and Osteotome



Axillary Nerve – Deltoid

Example Lead Placement Approach

ELECTRODE TARGET LOCATION:

Placed in the middle of the deltoid muscle. Although the muscle is relatively thin, adequate lead (~3 cm) should be seated beneath the skin to encourage tissue ingrowth.

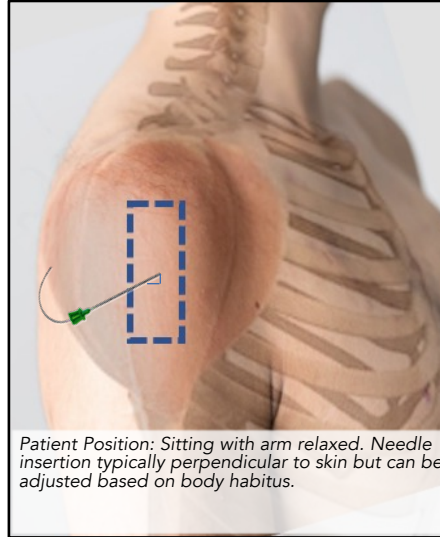
NEEDLE INSERTION:

3 finger widths, or 6 cm, below the acromion, within the middle third of the deltoid muscle bounded on the bottom by the insertion of the deltoid muscle into the fold of the axilla (see rectangle in image to right).

THINGS TO BE AWARE OF:

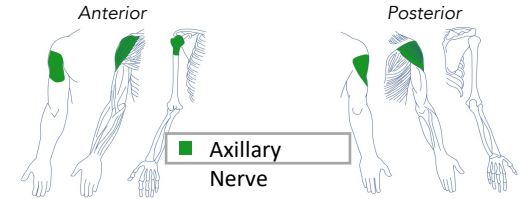
- A neurovascular bundle runs along the inferior part of the deltoid muscle.
- A perpendicular insertion angle is typical but may be adjusted based on body habitus to ensure adequate lead length seated beneath the skin.

IMAGE GUIDANCE: Optional

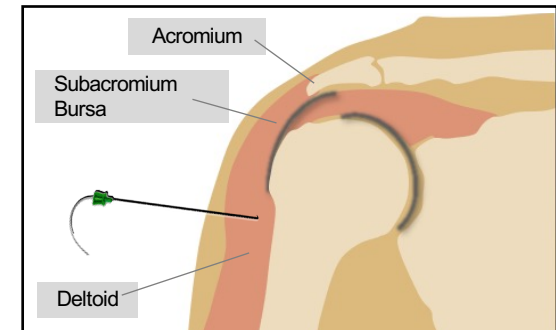
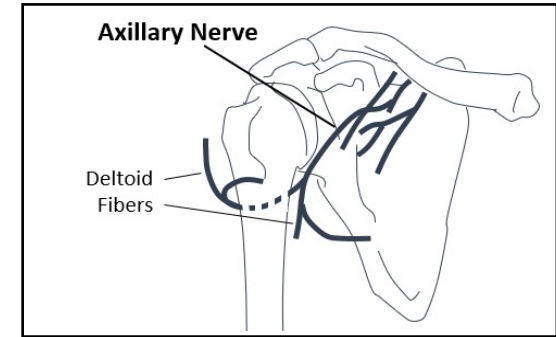


PLACEMENT CONFIRMATION:

Stimulation should elicit comfortable sensations. Confirm activation of the Axillary Nerve by observing the deltoid muscle held in tension.



Dermatome, Myotome, and Osteotome



Clinical Evidence



Knee, Hip, Shoulder PNS Pathology

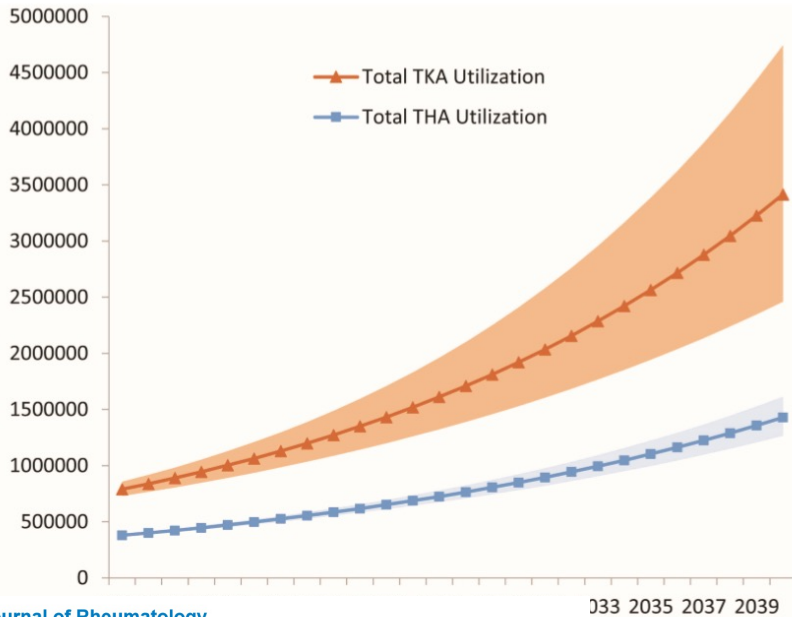
- Knee
 - Post-TKA
 - Post-amputation
- Hip
 - Post-THA
 - Meralgia Paresthetica
- Shoulder
 - Hemiplegic Shoulder Pain
 - Impingement Syndrome



Knee Evidence

Joint Replacement in the USA

THA and TKA are high volume procedures; but satisfaction is much higher in THA



The Journal of Rheumatology

Rates of Total Joint Replacement in the United States: Future Projections to 2020–2040 Using the National Inpatient Sample

Jasvinder A. Singh, Shaohua Yu, Lang Chen and John D. Cleveland

In the United States:

9.3M US adults complain of chronic knee pain

0.9M – 1.2M TKAs projected by 2030

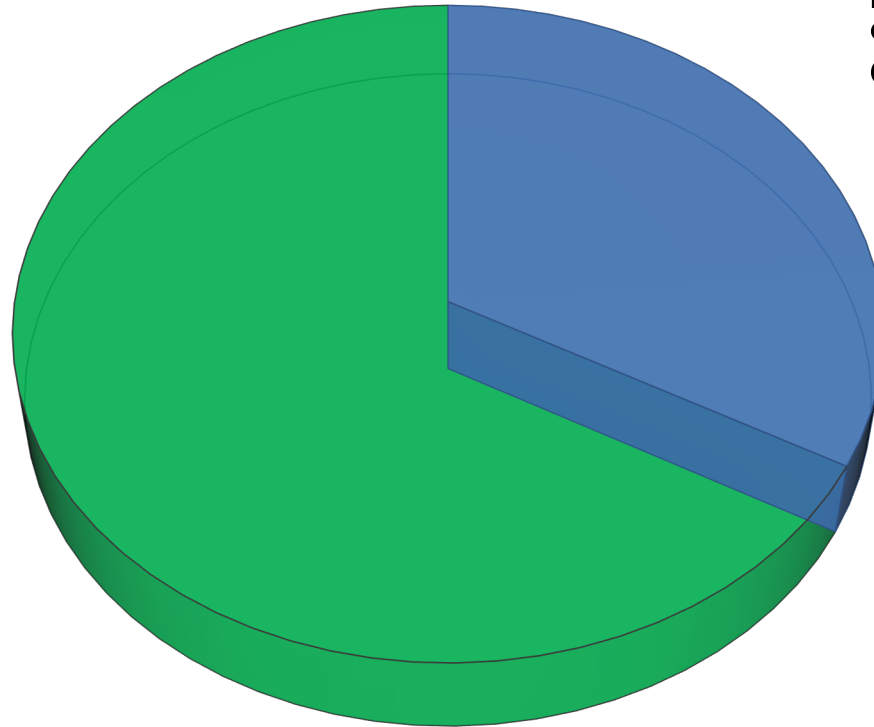
~20% of TKA patients are not satisfied

~10% of TKA patients undergo revision

OA and Post-TKA Pain Can Be Neuropathic

Approximately 1/3 of patients with OA pain present with a neuropathic component. Pre-operative neuropathic pain is often associated with CPSP after TKA.

Im HJ, et al. *Pain Pract* 2014
Valdes AM, et al. *Semin Arthritis Rheum* 2014
Wright A, et al. *Clin Orthop Relat Res* 2015

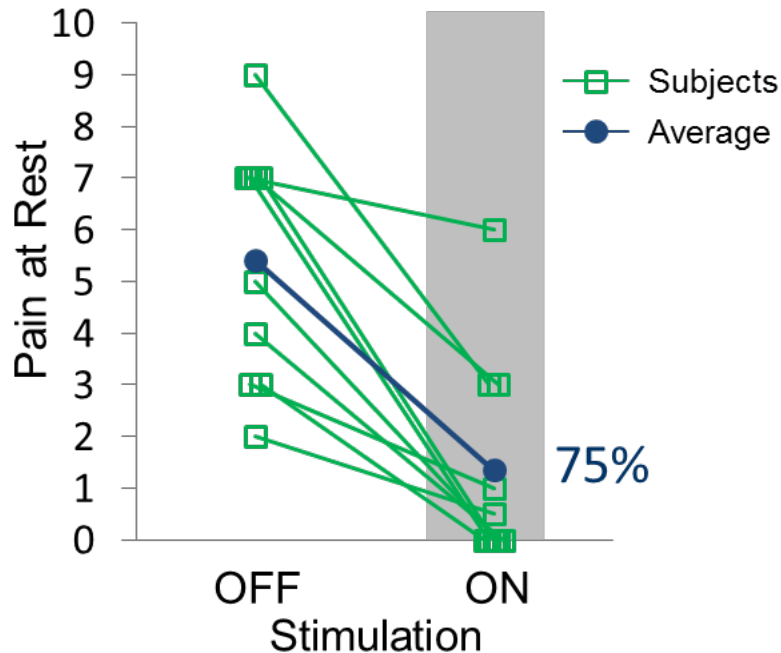


Neuropathic pain after TKA affects 6% - 11% of patients.

Borsook D, et al. *Ann Surg* 2013
Deumens R, et al. *Ann Surg* 2013
Phillips JR, et al. *Bone Joint J* 2014
Lavand'homme PM, et al. *Clin Orthop Relat Res* 2014
Wylde V, et al. *Pain* 2011
Haroutiunian S, et al. *Pain* 2013

PNS for Postoperative TKA Pain

60-day PNS has demonstrated significant pain relief among patients following significant orthopedic trauma (e.g., total knee replacement)



Ten subjects enrolled after undergoing TKR surgery

- N=6: early/acute phase (6-13 days after TKR)
- N=4: postacute phase (40-100 days after TKR)

Immediate and substantial reductions in postop pain

- Average pain relief: 75%
- Immediate highly clinically significant reductions in pain ($\geq 50\%$) in 9 subjects (90%)
- Stimulation OFF: 70% of subjects had pain ≥ 4
- Stimulation ON: 10% of subject had pain ≥ 4
- Complete (100%) pain relief in 50% of subjects

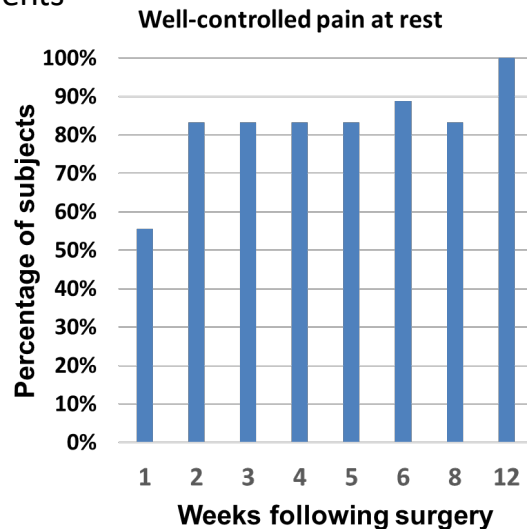
60-Day PNS for Postoperative TKA Pain

Postoperative pain

- 83% (n=15/18) had mild & well-controlled pain (<4/10) at 1 month
- 100% had pain <4/10 at 3 months

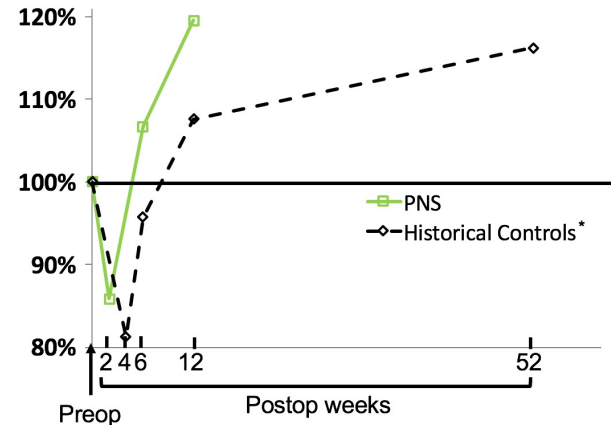
Historical controls

- Persistent & disabling pain (≥ 3 months after TKR) typically reported in 10-20% or more of patients



Six-minute walk test (6MWT)

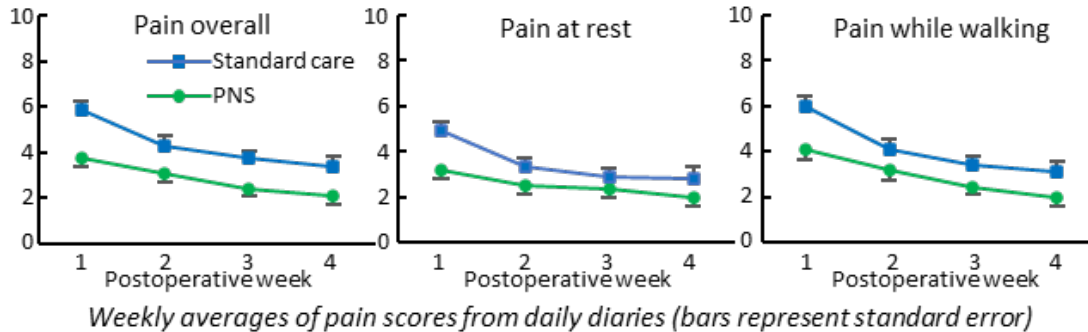
- 3 months after TKR: average distance = 120% of preoperative distance.



PNS creates potential to:

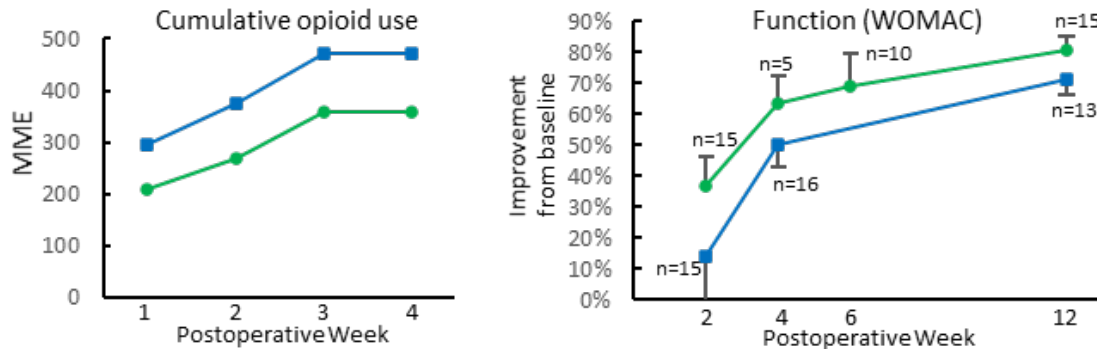
- Accelerate recovery
- Increase proportion of patients who fully recover

Post-TKA pain: preoperative lead placement (60-day PNS)



Analysis of 2 studies

- Subjects receiving preoperative (>1 day) femoral & sciatic leads implant and standard care (e.g., preop nerve blocks) compared favorably to standard care alone



60-Day Percutaneous PNS in Management of Post-Amputation Pain

Results from a successful double-blind, placebo-controlled RCT

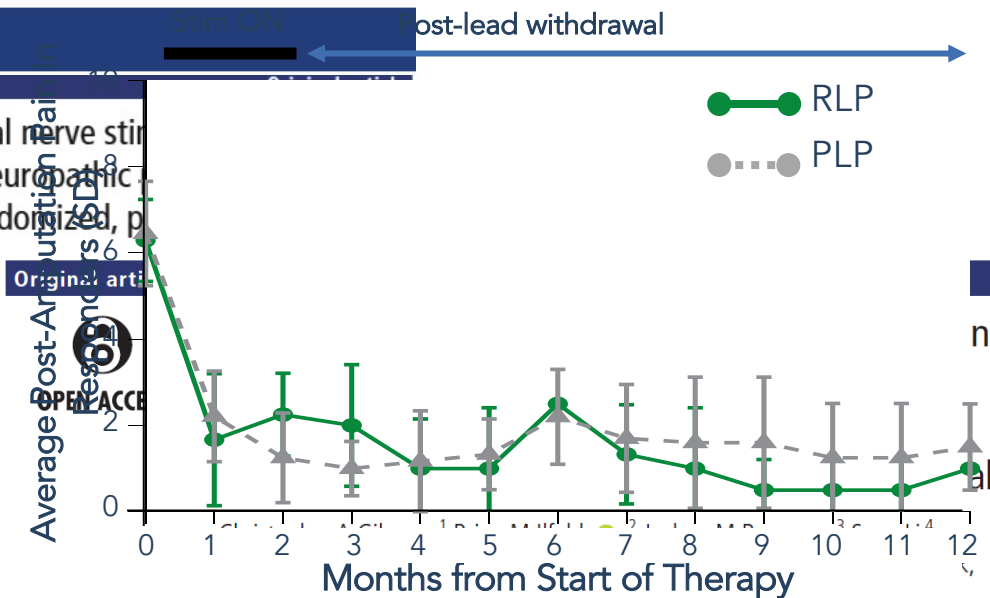
BMJ Journals

Regional Anesthesia & Pain Medicine



Percutaneous peripheral nerve stimulation treatment of chronic neuropathic pain: a multicenter, randomized, parallel, double-blind, placebo-controlled trial

Christopher Gilmore,¹ Brian Ilfeld,² Corey Hunter,⁶ Richard Rauck,¹ Leonid Steven Cohen,⁸ Nathan Crosby,⁹ et al.



n=12 (PNS Group), n=14 (Sham Group)

Hip Evidence

Limited Evidence

PERIPHERAL NERVE STIMULATION OF THE LATERAL FEMORAL CUTANEOUS AND SUPERIOR GLUTEAL NERVES FOR TREATING PROXIMAL NEUROPATHY HIP PAIN


Matthias Wiederholz, MD¹
Alaa Abd-Elsayed, MD²
Niek Vanquathem, BA³

WISCONSIN MEDICAL JOURNAL

Treatment of Intractable Hip Pain after THA and GTB Using Peripheral Nerve Field Stimulation: A Case Series

Alexander E. Yakovlev, MD; Beth E. Resch, APNP; Sergey A. Karasev, MD

Peripheral Nerve Stimulation: A New Treatment for Meralgia Paresthetica

Brendan Langford , MD* and William D. Mauck, MD[†]

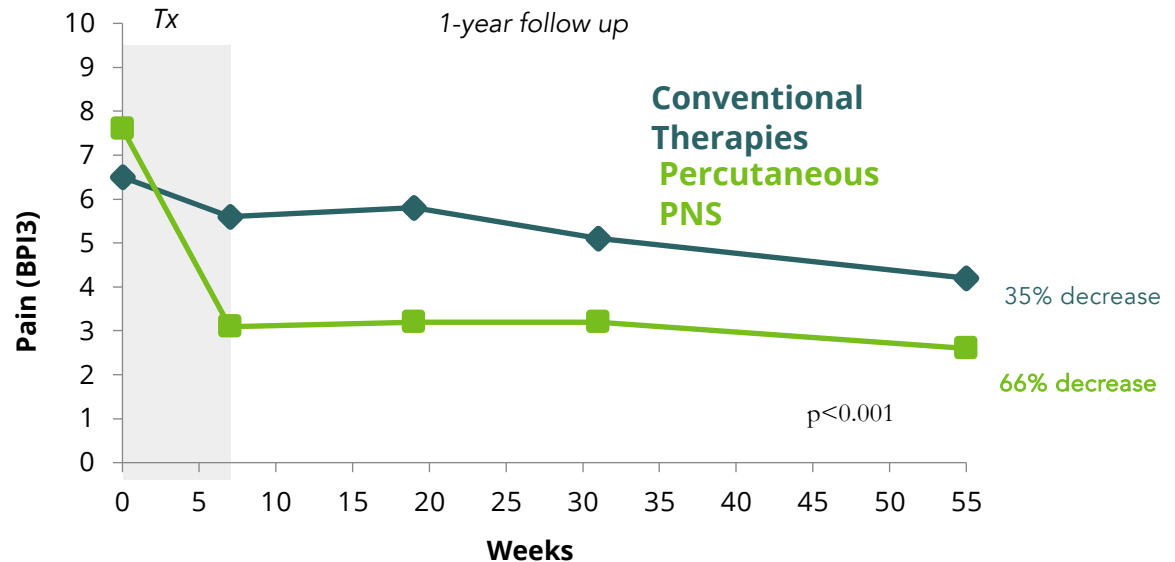
Shoulder Evidence

6-week Percutaneous PNS vs Conventional Care for Hemiplegic Shoulder Pain

First Percutaneous PNS Randomized Controlled Trial...First demonstration of Sustained Pain Relief

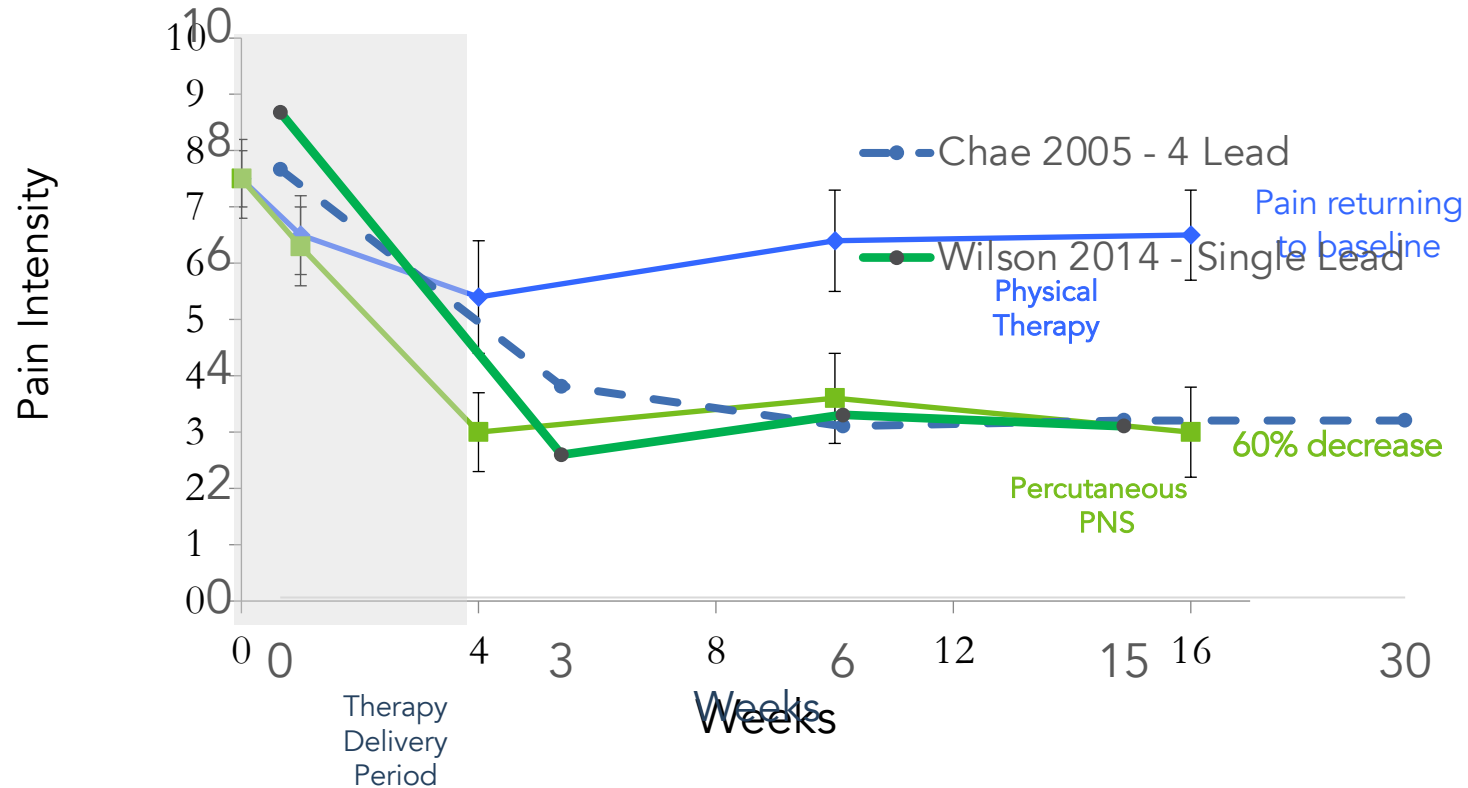
This RCT utilized a 4-lead approach to activate the muscles surrounding the shoulder joint (SS, PD, MD, Trap)

78% Reported Relief 12 months after Treatment



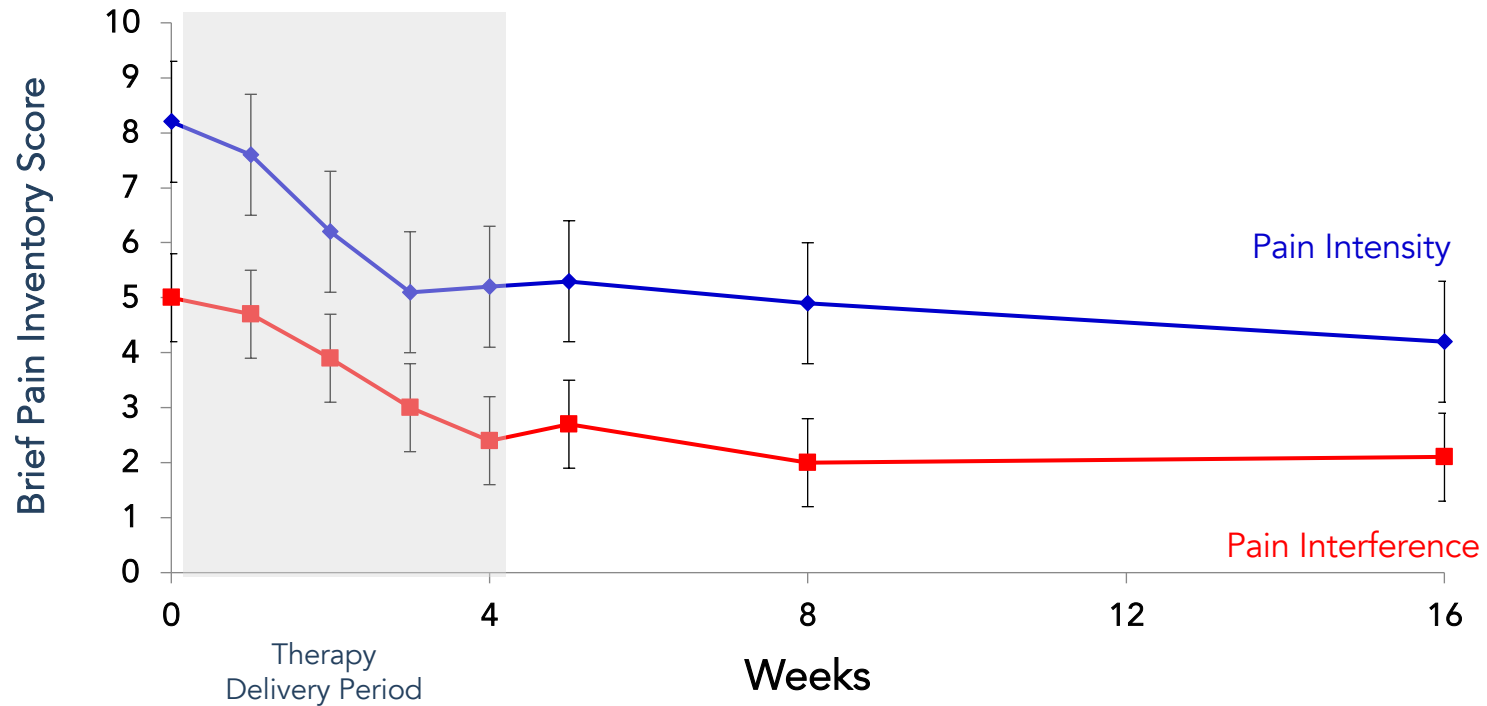
Chae Results Replicated in Single Lead RCT

3-week Percutaneous PNS vs PT in the Management of Hemiplegic Shoulder Pain



Results Replicated in Other Types of Shoulder Pain

Percutaneous PNS in the Management of Shoulder Impingement Syndrome



Conclusion

- Peripheral nerve stimulation is a growing neurostimulation technique
- Evidence is limited compared to other neurostimulation methods, but research is on-going
- There is good evidence for use of PNS in post-amputation pain and hemiplegic shoulder syndrome. Small studies suggest PNS is useful in post-TKA pain.