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Long Term Efficacy with Short Term Therapy with Peripheral Nerve Stimulation

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Board of Directors, World Academy of Pain Medicine United

Treasurer, New Jersey Society of Interventional Pain Medicine

Medical Expert, Medico-Legal Evaluations

Conflict of Interest

Boston Scientific

Biotronik

Guidepoint Consulting

Medtronic

Nervonik

Vivex

Outline

- Introduction
- Mechanism
- Indications
- Procedure
- Evidence

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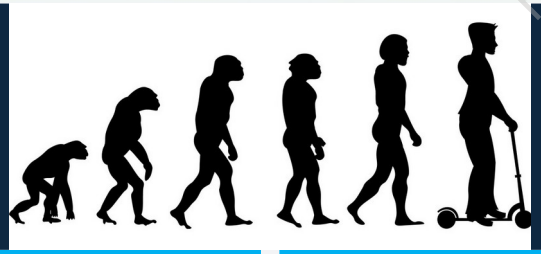
THEN

- Neurosurgical exposure/procedure
- Contact positioning critical
- Nerve injury/fibrosis concerns
- Focus on spinal cord stimulation
- Permanent and invasive
- Neuropathic focus
- Last resort therapy



NOW

- Percutaneous intervention
- Ultrasound guidance
- Leads and IPG meant for the periphery
- Remote lead placement
- Ease of use
- Low infection risk
- Durable relief following lead withdrawal
- *Applications beyond neuropathic pain*
- Early intervention

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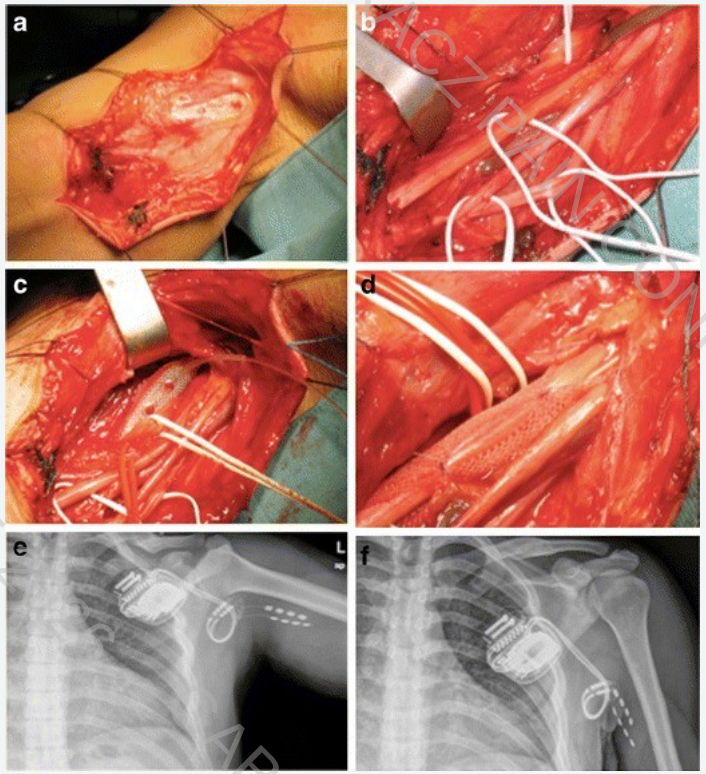
Historical "PNS" Implant

- Previous open cut down
- SCS leads and IPG
- Large incision
- Higher risk
- NOT minimally invasive



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Unique Considerations for PNS

- Lead design
- Tines, flexible, tightly spaced contacts, micro rather than macro stimulation
- Less tissue real-estate
- Lead length, I/EPG size / location
- Monopoloar vs Anode / Cathode
- Parallel vs Perpendicular
- High resolution ultrasound vs Fluoroscopy
- Do NOT cross joint lines

- One or two leads
- Transverse or Parallel
- Permanent vs Temporary
- Distal or proximal
- Fascial planes
- Better than conventional RFA given mixed motor nerves, pulsed RFA not covered

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PNS paradigms

- Trial followed by permanent implant
- Direct to permanent implant
- Short term treatment
- Same lead used for both trial and permanent implant

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Treatment Continuum

- Use of short term PNS early in the treatment continuum may:
  - Reduce chronic pain in patients who are not candidates for surgery
  - Reduce opioid use and pain that endures in patients post-operatively
  - Avoid tissue destruction (ie RFA)
  - Avoid advancement to permanently implanted systems when short term PNS delivers sustained pain relief
  - Reduce the likelihood of failed permanent system implants by improving the identification of delayed non-responders

References:
Ilfeld et al. 2021; Cohen SP, et al. 2020.; Naidu, et al., J Pain Res. 2022.

Indications

- Symptomatic relief of chronic, intractable pain, post-surgical and post-traumatic acute pain;
- Symptomatic relief of post-traumatic pain;
- Symptomatic relief of post-operative pain.

- Inclusion criteria: Healthy nerve proximal to the stimulation site, chronic pain along a named nerve,
- Exclusion criteria: Active infection, unable to operate device, requires MRI during treatment, recent ablation of the target nerve, secondary gain, adhesive allergy

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Short Term PNS Treatment

- 30-60 day treatment; not a trial, not a permanent implant
- Short term implant may obviate the need for permanent implant
- Stimulation parameters: frequency: 12 Hz; duty cycle: 50%; amplitude range: 0–30 mA; pulse duration range: 10–200μs; duration: 6-12 hrs / day
- Single and dual lead configurations
- External pulse generator
- Small lead

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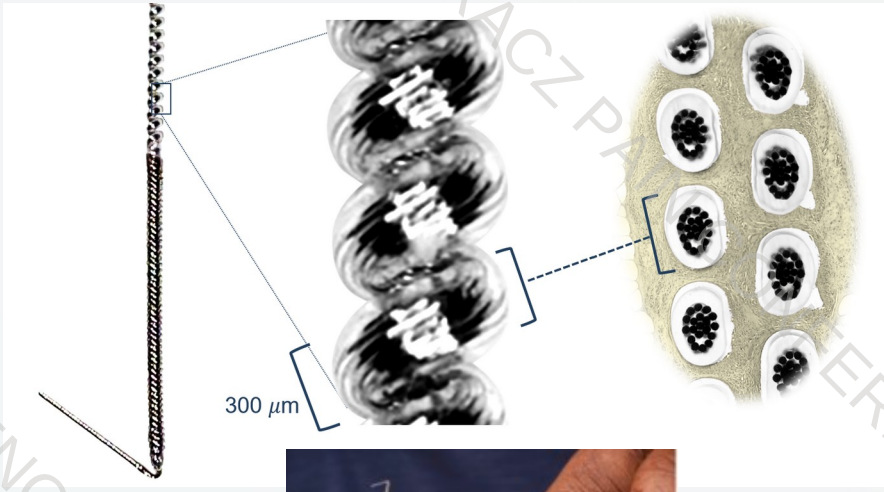
Lead Design

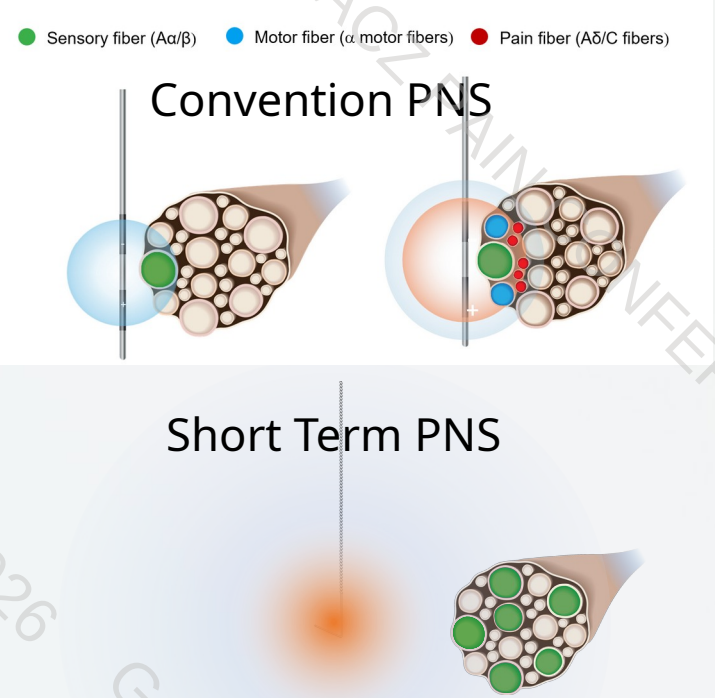
- The lead utilizes a multi-strand coiled wire
- ¼ the diameter of conventional neurostimulation leads
- Fibrotic ingrowth around the lead is intended to reduce pistoning and the ingress of contaminants
- Stretchy to prevent lead migration / fracture



References:
Ilfeld BM, Gabriel RA, Saulino MF, Chae J, Peckham PH, Grant SA, Gilmore CA, Donohue MC, deBock MG, Wongsarnpigoon A, Boggs JW. Infection Rates of Electrical Leads Used for Percutaneous Neurostimulation of the Peripheral Nervous
Pract. 2017 Jul;17(6):753-762. doi: 10.1111/papr.12523. Epub 2016 Nov 11. PMID: 27676323; PMCID: PMC5368033.

Monopolar Stimulation

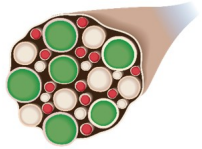
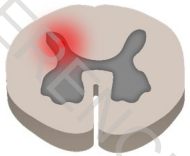
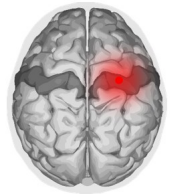
- Lead is placed distal to target
  - Allows for targeted A-beta fiber stimulation
  - Avoids unintentional A-delta and C fiber stimulation
  - Robust stimulation
  - Increased safety given distance from neural target



References:
1. Kuner and Flor, Nat Rev, 2017; 2. Devor, Exp Brain Res, 2009; 3. Latremoliere and Woolf, 2009; 4. Moseley and Flor, 2012; 5. Deer et al., 2021

Short Term PNS Proposed Mechanism of Action

Pathway to Chronic Pain

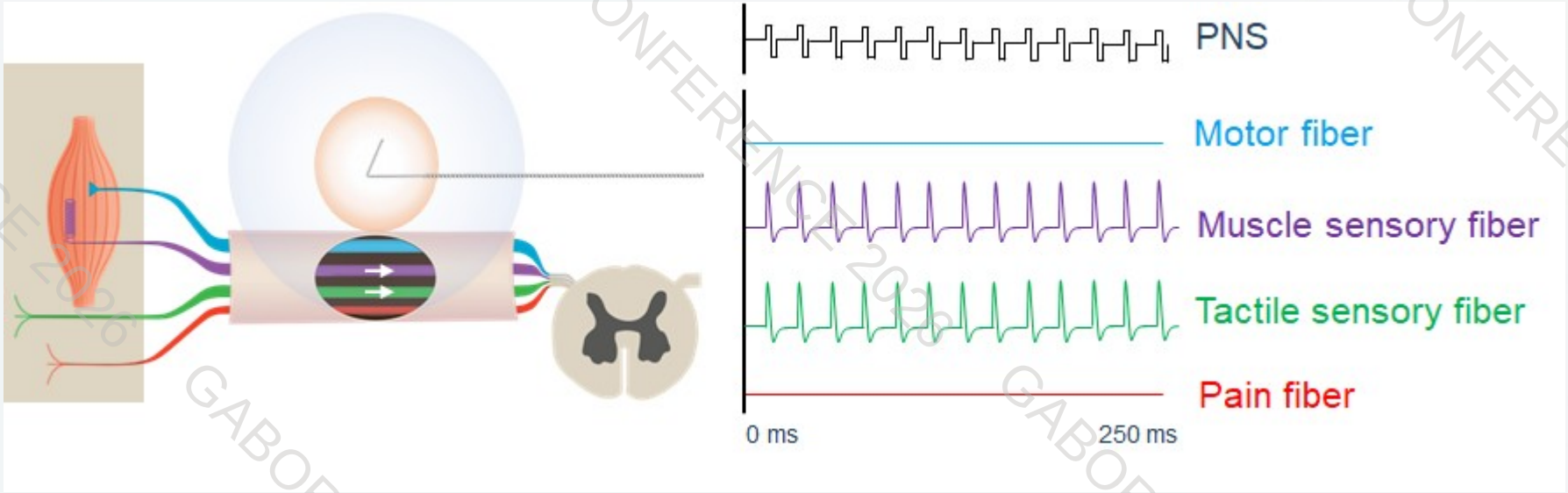
Inciting Event	***Neural Signaling Changes*** • *Increased abnormal and spontaneous afferent signaling* • *Pain that endures after normal tissue healing*	***Central Sensitization:*** • *Sustained changes in central pain processing* • *Hypersensitivity to normal inputs*	***Maladaptive Cortical Plasticity*** • *Unbalanced sensory inputs lead to cortical remapping* • *Imbalance in nociceptive processing*
			
Short Term PNS	**Improve Neural Signaling** • *INCREASE HEALTHY afferent signals in non-pain nerve fibers*	**Modulate Sensitization** • *MODULATE central pain processing* • *REDUCE hypersensitivity to normal inputs*	**Recondition Cortical Processing** • *REBALANCE sensory inputs to restore healthy cortical processing of nociceptive signals*

Peripherally Induced Reconditioning of the CNS

References:
(Kuner and Flor, Nat Rev, 2017; Devor, Exp Brain Res, 2009; Latremoliere and Woolf, 2009; Moseley and Flor, 2012)

Short Term PNS Proposed Mechanism of Action

- 100 Hz stimulation is intended to activate large diameter sensory afferents directly, with the goal of producing comfortable stimulation-evoked sensations in the target region of pain.



References:
1.. Deer et al., 2021

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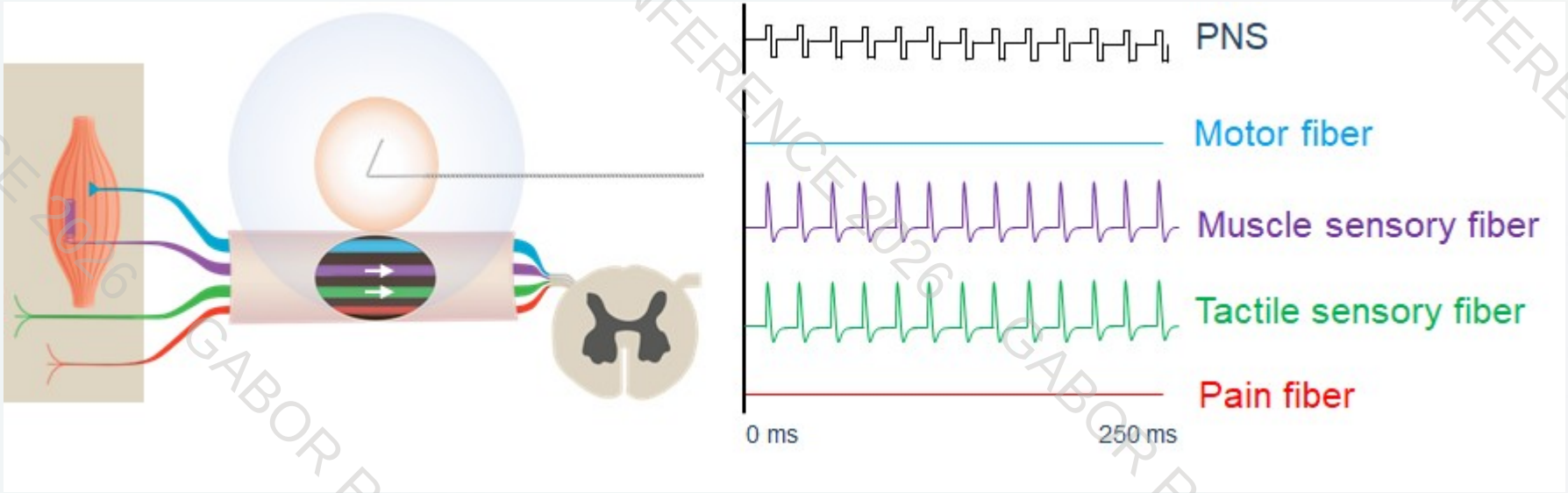
Short Term PNS Proposed Mechanism of Action

12 Hz stimulation is intended to activate large diameter sensory afferents both ***directly*** and ***indirectly*** through ***efferent fiber activation*** and resulting cycling muscle tension.[1]

- Efferent stimulation may use muscle as 'translator' to indirectly activate afferent fibers



References:
1.. Deer et al., 2021

Short Term PNS Proposed Mechanism of Action

Changes in inflammation

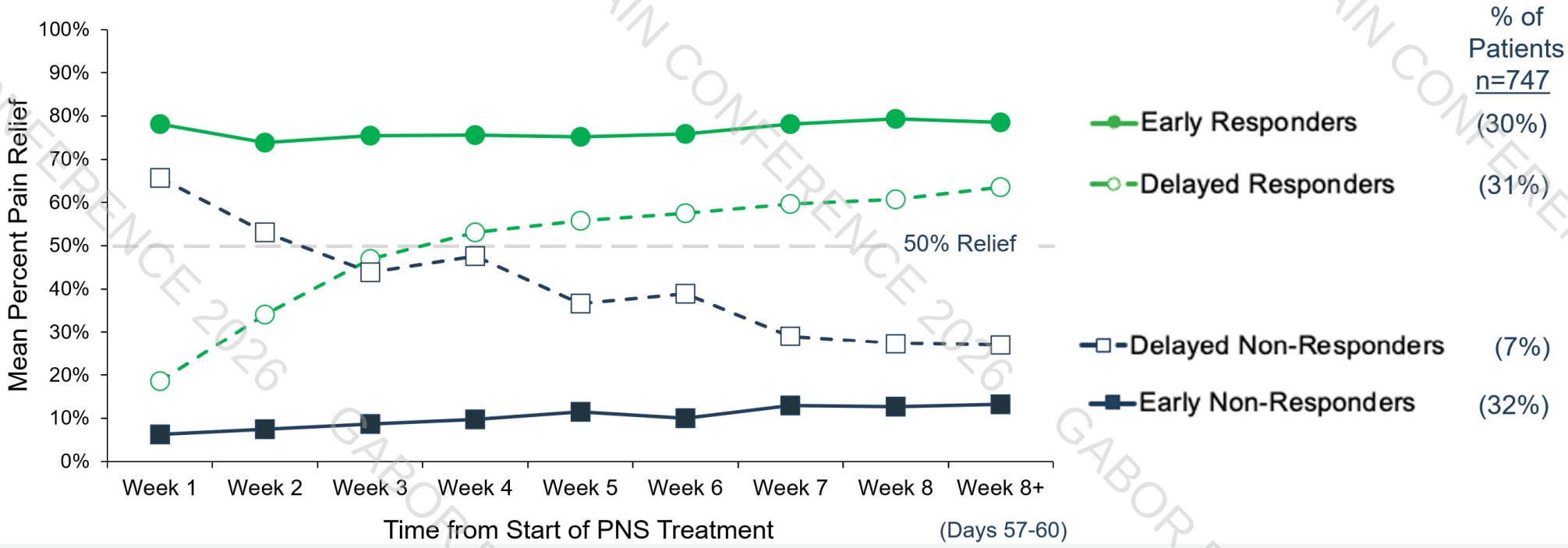
Table 1. Key Mediators with Regards to Anatomic Location, Waveform and Associated Cytokine Marker Elevation.

Therapy	Involved Cytokines	Role of Cytokines	Effect of Therapy
Tonic spinal cord stimulation	IL-15, IL-2, IL-12	Proinflammatory	Reduction in pro-inflammatory cytokines after SCS in CRPS patients (20)
	IL-4, IL-5, IL-10	Anti-inflammatory	Reduction in anti-inflammatory cytokines after SCS in CRPS patients (20)
Burst spinal cord stimulation	IL-10	Anti-inflammatory	Increase in level of IL-10 after burst SCS in back pain patients (22)
Dorsal root ganglion stimulation	IL-Iβ, TNF-α	Proinflammatory	Inhibition of pro inflammatory expression *in vitro* using light-induced injury model of microglia (31)
Vagus nerve stimulation	TNF, IL-1β, IL-8, HMGB1	Proinflammatory	Reduction in proinflammatory cytokines in cervical VNS in humans (50,51)
Peripheral nerve stimulation	IL-1B, IL-6, IL-1β	Proinflammatory	Reduction in proinflammatory cytokines with electroacupuncture in inflamed skin tissues (69)
TENS and subcutaneous electrical stimulation	IL-1, IL-6, TNF-α	Proinflammatory	Reduction in proinflammatory cytokines in a rat model (11)

References:
Chakravarty KV Neuromod 2019

Delayed Responders and Delayed Nonresponders

Real-world data from among 747 commercial patients with outcomes collected during treatment to assess response to PNS over time. Responders were defined as ≥50% pain relief.



References:
Naidu, et al., 2022, J Pain Res

Safety: Adverse Events in Clinical Studies (N=428 subjects)

- Skin irritation – 20.6%
- Pruritis – 9.9%
- Painful or uncomfortable stimulation – 4.7%
- Misc AEs - 2.6%
- Granuloma – 2.5%
- Pain at lead exit site – 2.0%
- Pain / Discomfort – 1.6%

References:
Data from Published Clinical Studies as of May 2026

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Procedure

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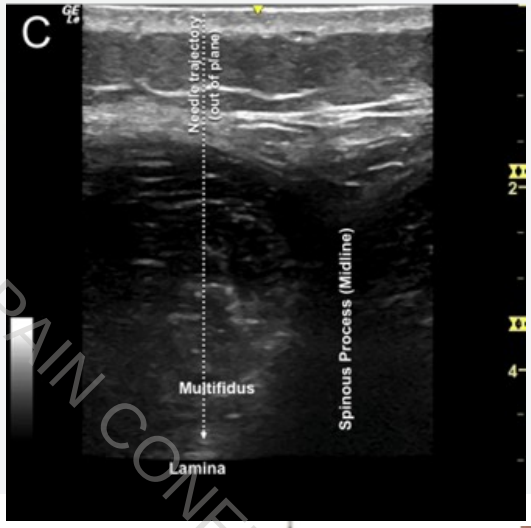
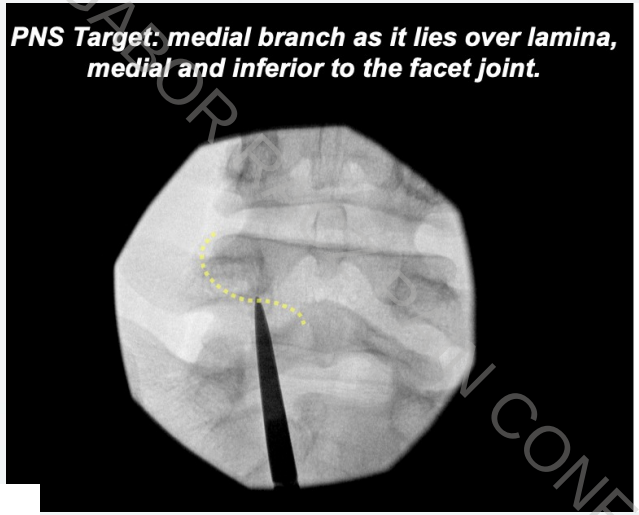
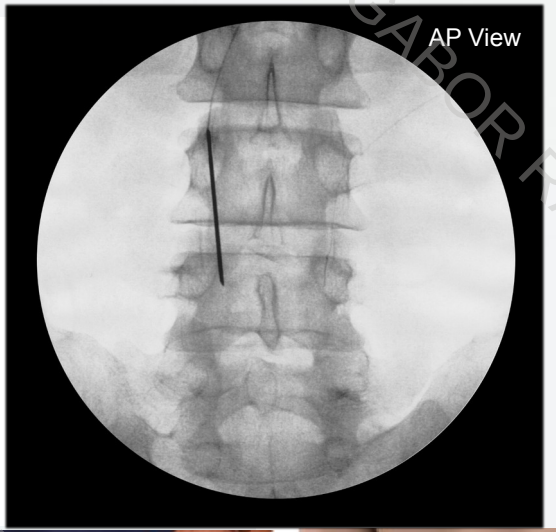
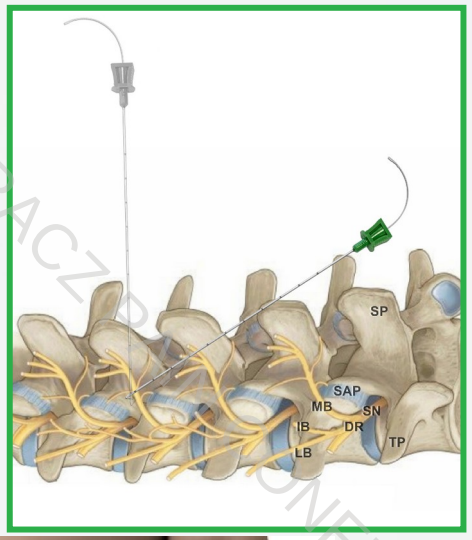
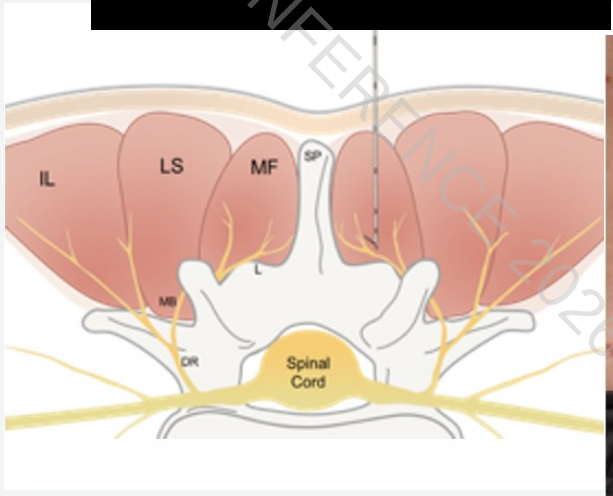
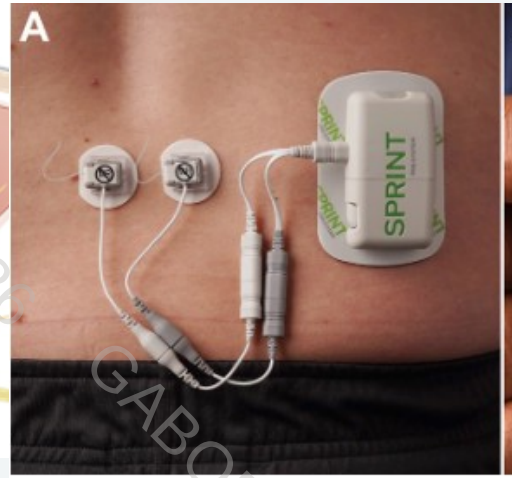

C
Needle trajectory (out of plane)
Spinous Process (Midline)
Multifidus
Lamina

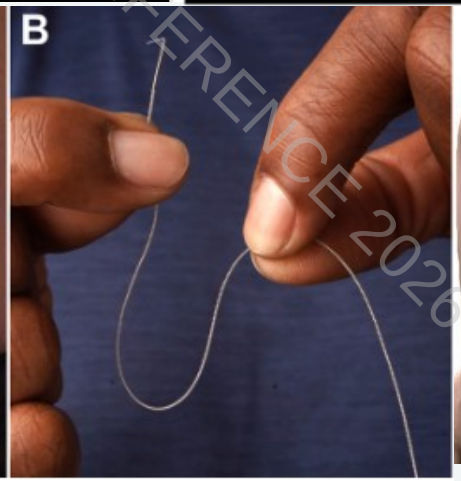

PNS Target: medial branch as it lies over lamina, medial and inferior to the facet joint.

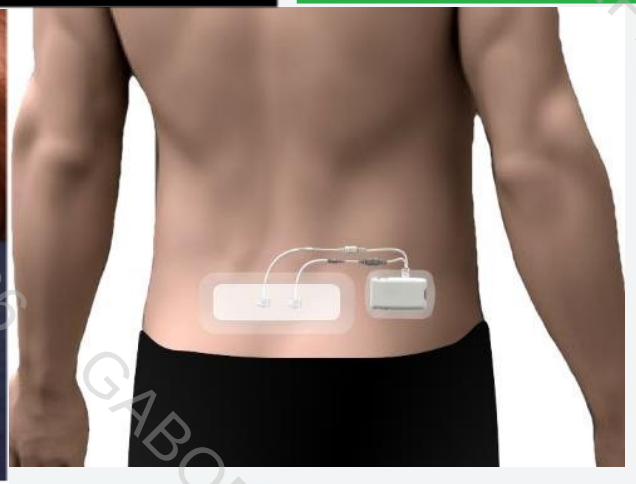

AP View


SP
SAP
MB
SN
IB
DR
TP
LB


IL
LS
MF
SP
L
MB
DR
Spinal Cord


A
SPRINT


B



Evidence for Lumbar Medial Branch

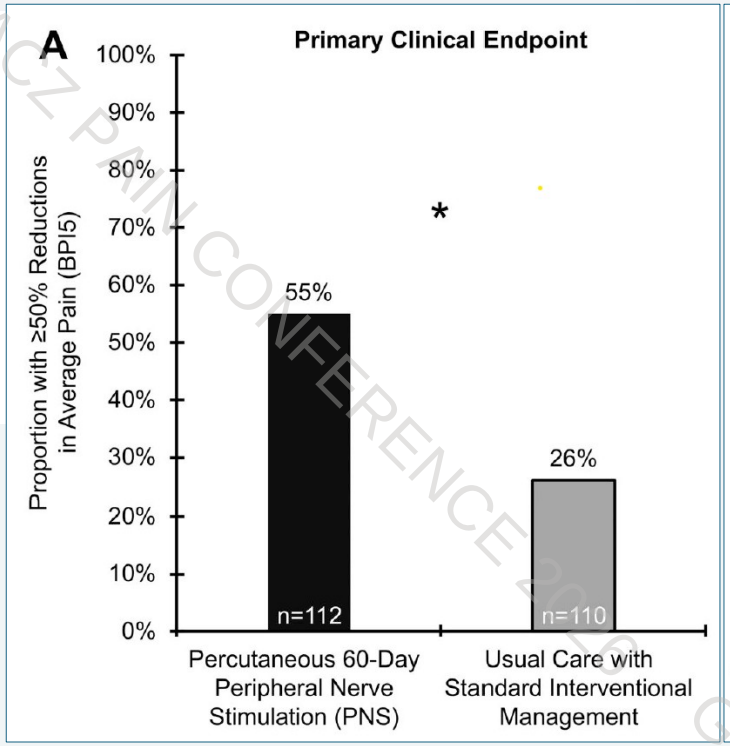
Pain Medicine, 2026, **27**, 462–473
https://doi.org/10.1093/pm/pnaf147
Advance access publication 25 October 2025
Original Research Article

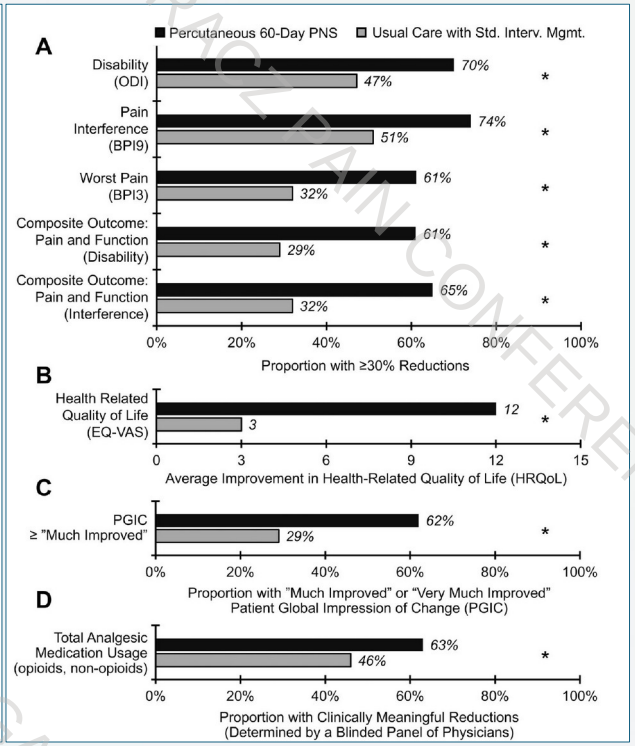
OXFORD

NEUROMODULATION & MINIMALLY INVASIVE SURGERY SECTION

Comparison of percutaneous 60-day peripheral nerve stimulation of the lumbar medial branches to usual care with standard interventional management for chronic low back pain—a multicenter pragmatic randomized controlled trial (RESET)

- Level I evidence: Prospective, multicenter pragmatic randomized controlled trial demonstrating the effectiveness of 60-day PNS for chronic low back pain.
- More than doubled the responder rate: 55% of patients achieved ≥50% pain relief versus 26% with standard interventional management ($P < 0.001$).
- Improved function—not just pain: Significant improvements in disability, pain interference, quality of life, and reduced analgesic utilization.
- Durable benefit beyond treatment: Clinical improvements were maintained through 6 months after completion of the temporary 60-day therapy, supporting a lasting neuromodulatory effect after lead removal.





Evidence for Lumbar Medial Branch

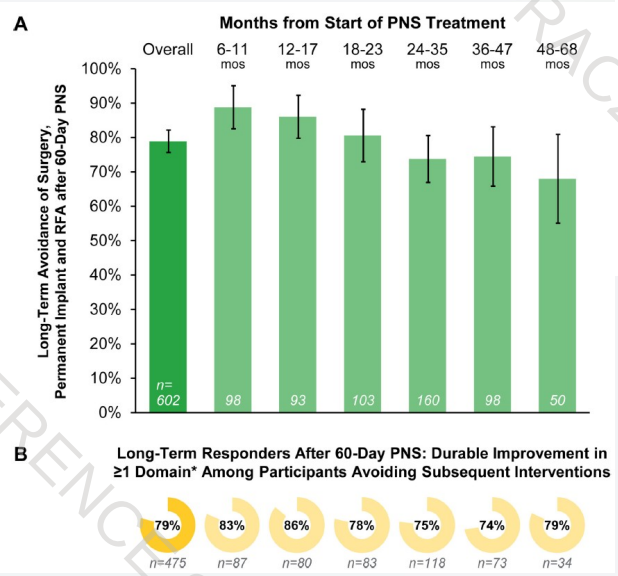
Pain Ther
https://doi.org/10.1007/s40122-026-00858-3

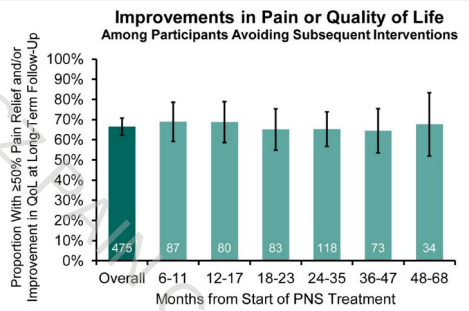
ORIGINAL RESEARCH

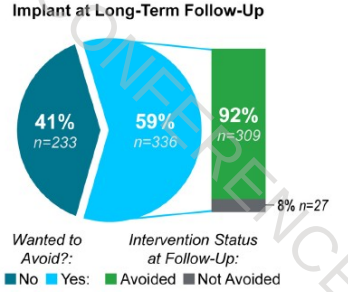
Durable Outcomes and Intervention Avoidance in Low Back Pain Up to 5 Years After Percutaneous 60-Day Peripheral Nerve Stimulation

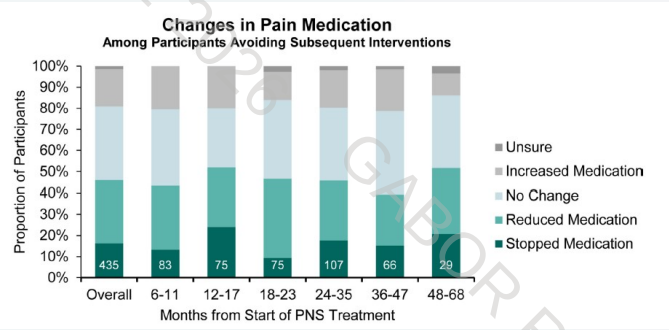
Samir J. Sheth · Denise D. Lester · Jauqlat Mahmood · Sarah E. Trampota · G. Lawson Smith · Raheleh Rahimi Darabad · Brandon D. Swan · Meredith J. McGee · Joseph W. Boggs

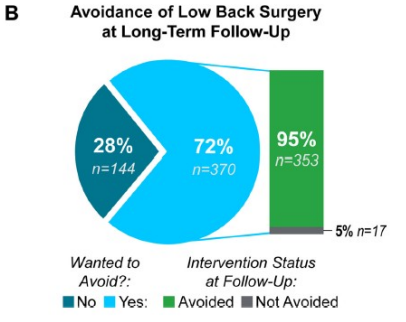
- 602-patient real-world cohort with follow-up extending to 68 months
- 79% avoided RFA, permanent implant, and lumbar surgery
- 53% average sustained pain relief among long-term responders
- 92% avoided permanent implants and 95% avoided lumbar surgery
- Clinically meaningful improvements in function, quality of life, mood, and sleep persisted for years
- Supports 60-day PNS as a disease-modifying neuromodulation strategy, not simply a temporary analgesic treatment.



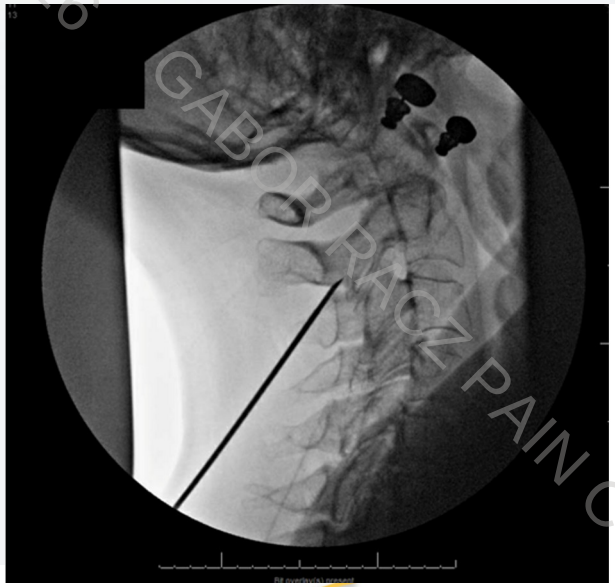


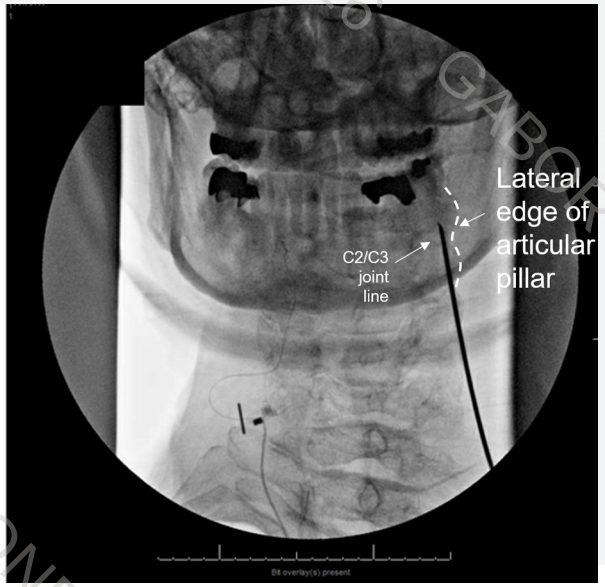


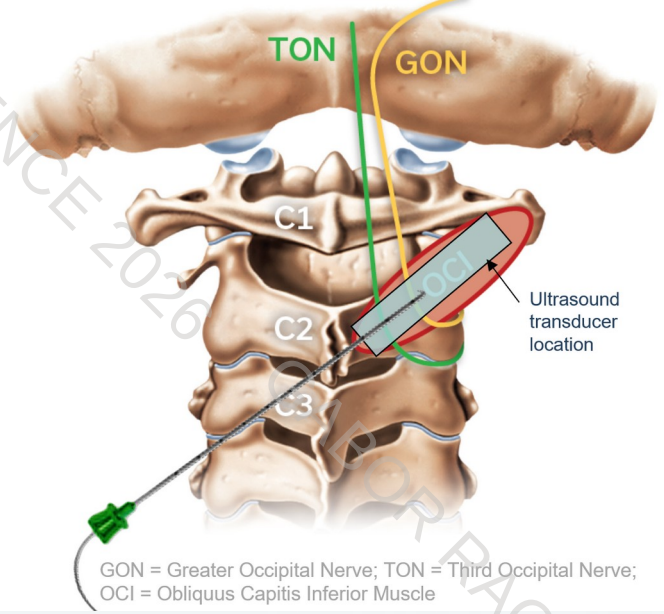




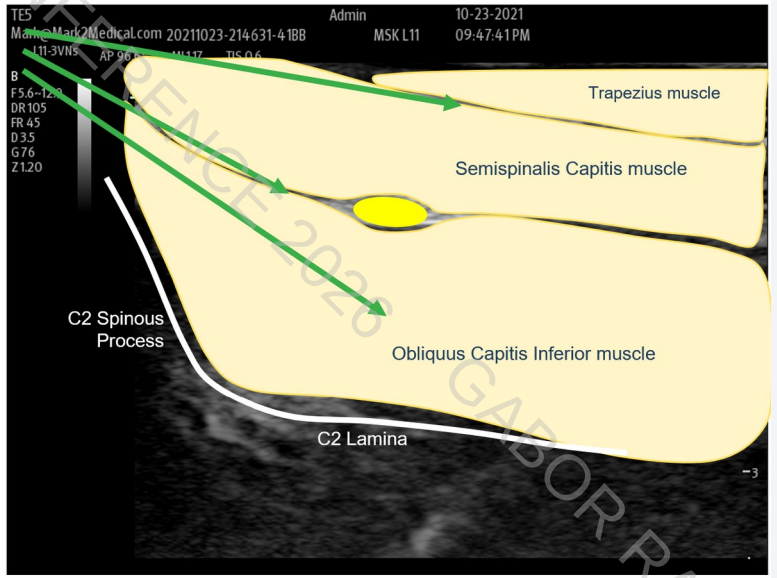
References:
Naidu, et al., 2022, J Pain Res







GON = Greater Occipital Nerve; TON = Third Occipital Nerve;
OCI = Obliquus Capitis Inferior Muscle



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Evidence for Occipital

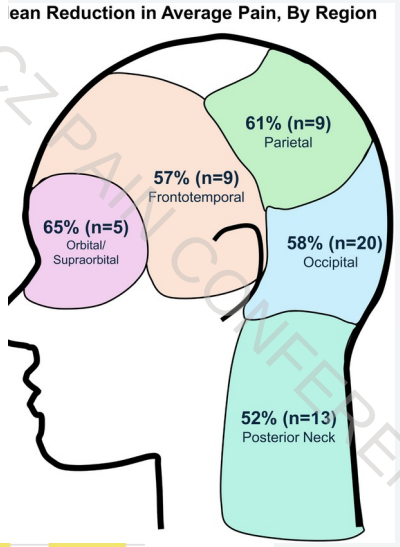
Clinical Trial > Headache. 2025 Nov-Dec;65(10):1776-1787. doi: 10.1111/head.14948.
Epub 2025 May 20.

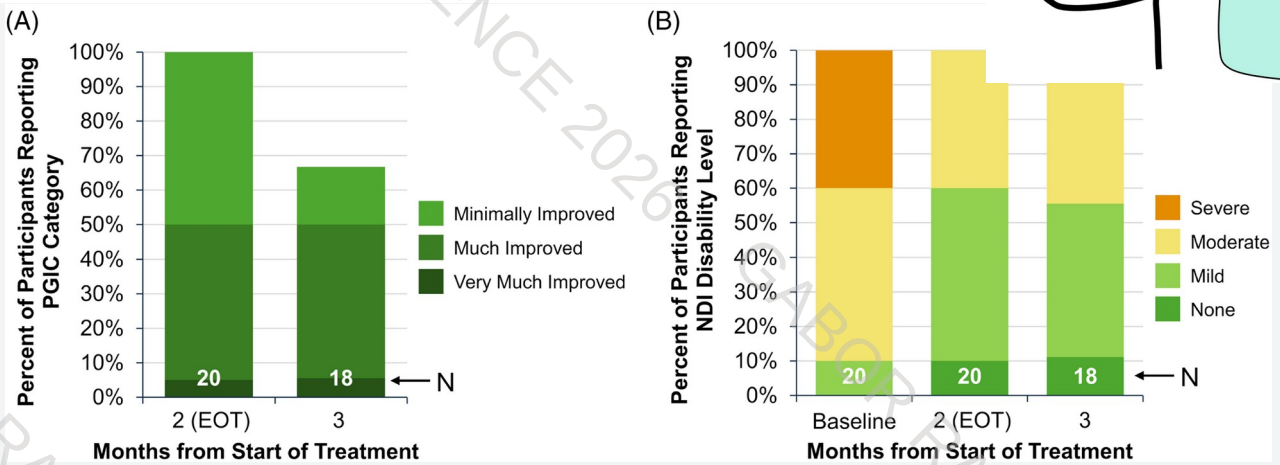
A multicenter, prospective, single-arm study of 60-day peripheral nerve stimulation of the occipital nerves for the treatment of headache

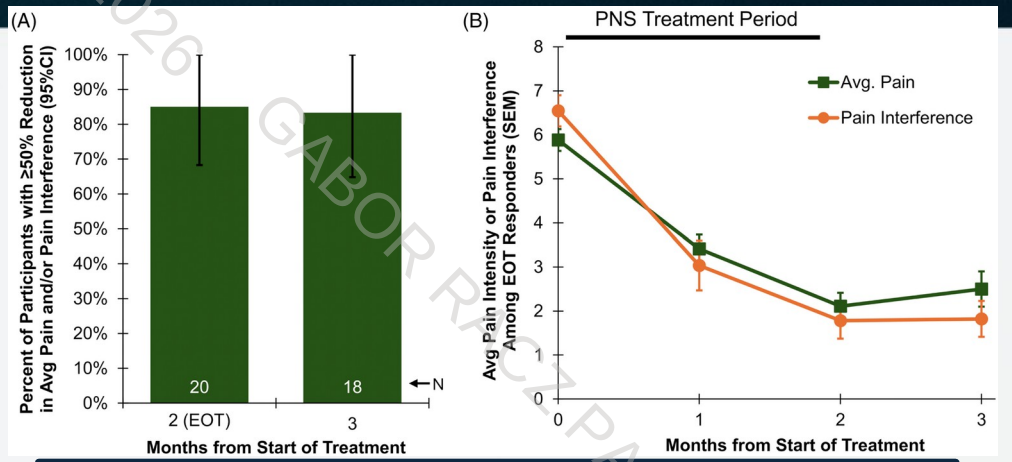
Genaro G Gutierrez [1], Zachary L McCormick [2], Mitchell P Engle [3], Christopher A Gilmore [4], Matthew J Pingree [5], Jason E Pope [6], David J DiBenedetto [7], Narayan R Kissoon [5 8], Puneet K Sayal [3], Claire A Zurn [9], Nathan D Crosby [9], Joseph W Boggs [9]

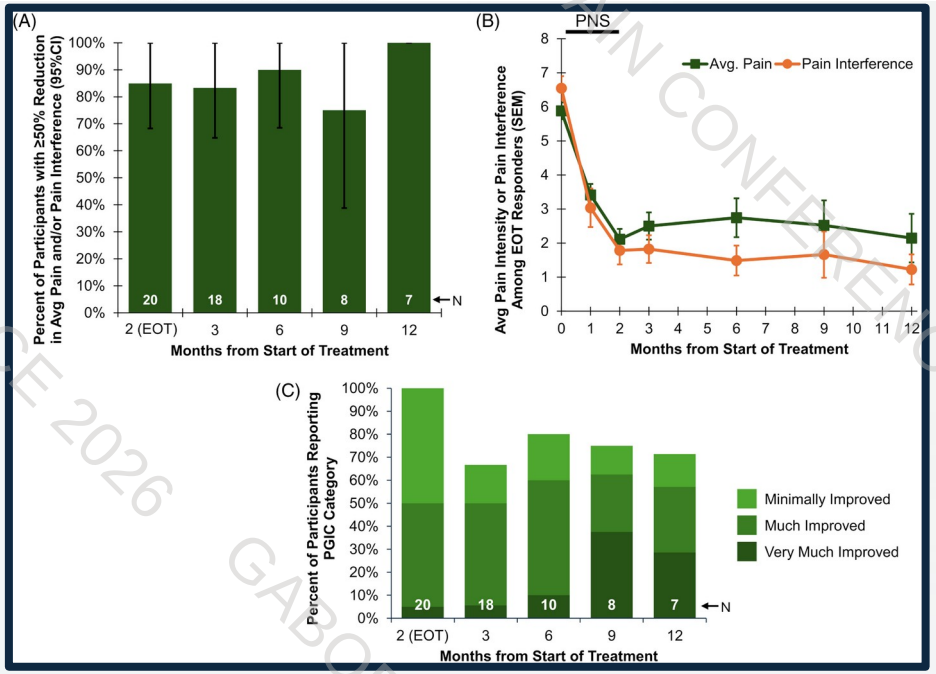
Affiliations + expand

PMID: 40391557 PMCID: PMC12638517 DOI: 10.1111/head.14948



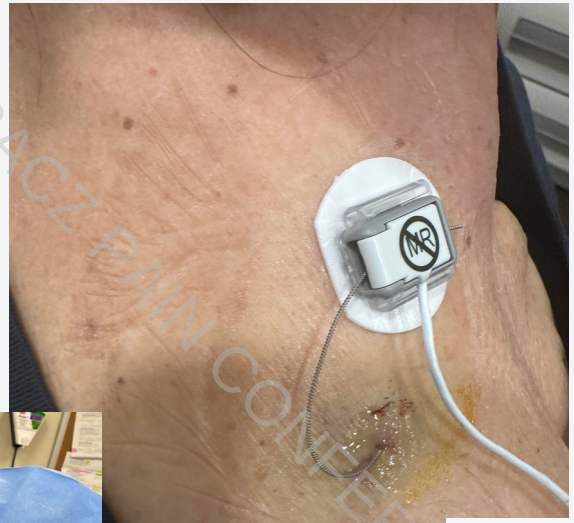


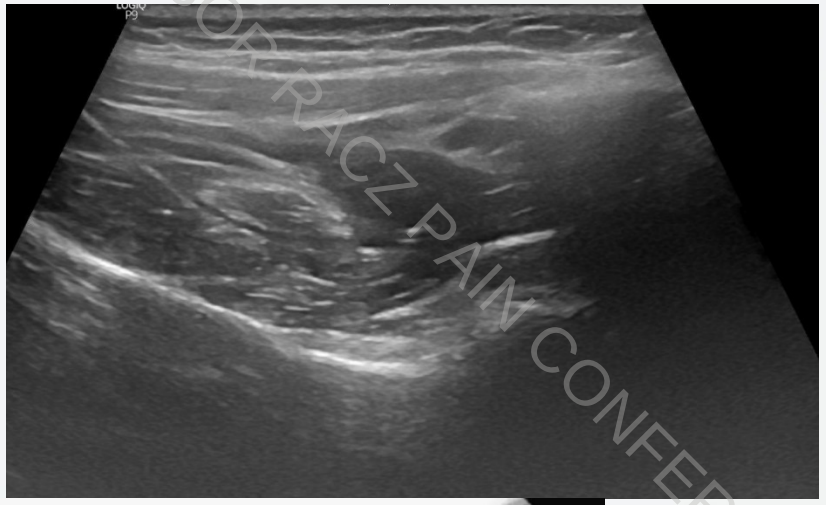


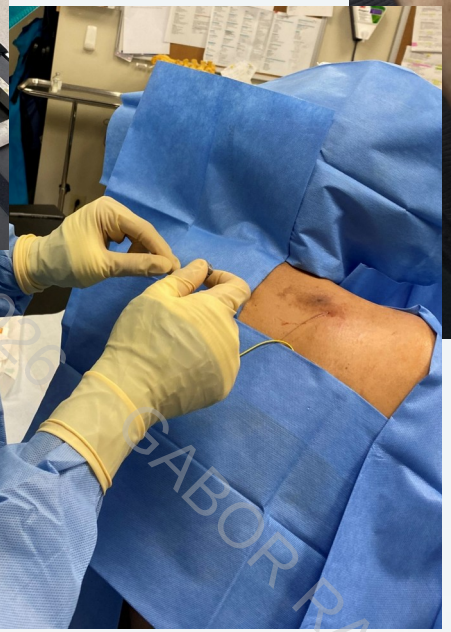


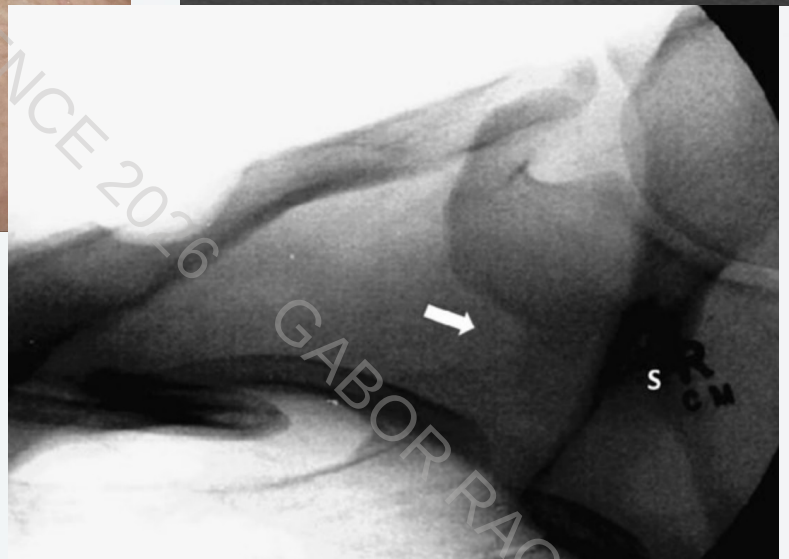
Reference:
Gutierrez GG, McCormick ZL, Engle MP, et al. A multicenter, prospective, single-arm study of 60-day peripheral nerve stimulation of the occipital nerves for the treatment of headache. Headache. 2025; 00: 1-12. doi:10.1111/head.14948

Shoulder









GABOR RACZ PAIN CONFERENCE 2026

Evidence for Shoulder

Randomized Controlled Trial > Am J Phys Med Rehabil. 2005 Nov;84(11):832-42.
doi: 10.1097/01.phm.0000184154.01880.72.

Intramuscular electrical stimulation for hemiplegic shoulder pain: a 12-month follow-up of a multiple-center, randomized clinical trial

John Chae [1], David T Yu, Maria E Walker, Andrew Kirsteins, Elie P Elovic, Steven R Flanagan, Richard L Harvey, Richard D Zorowitz, Frederick S Frost, Julie H Grill, Zi-Ping Fang

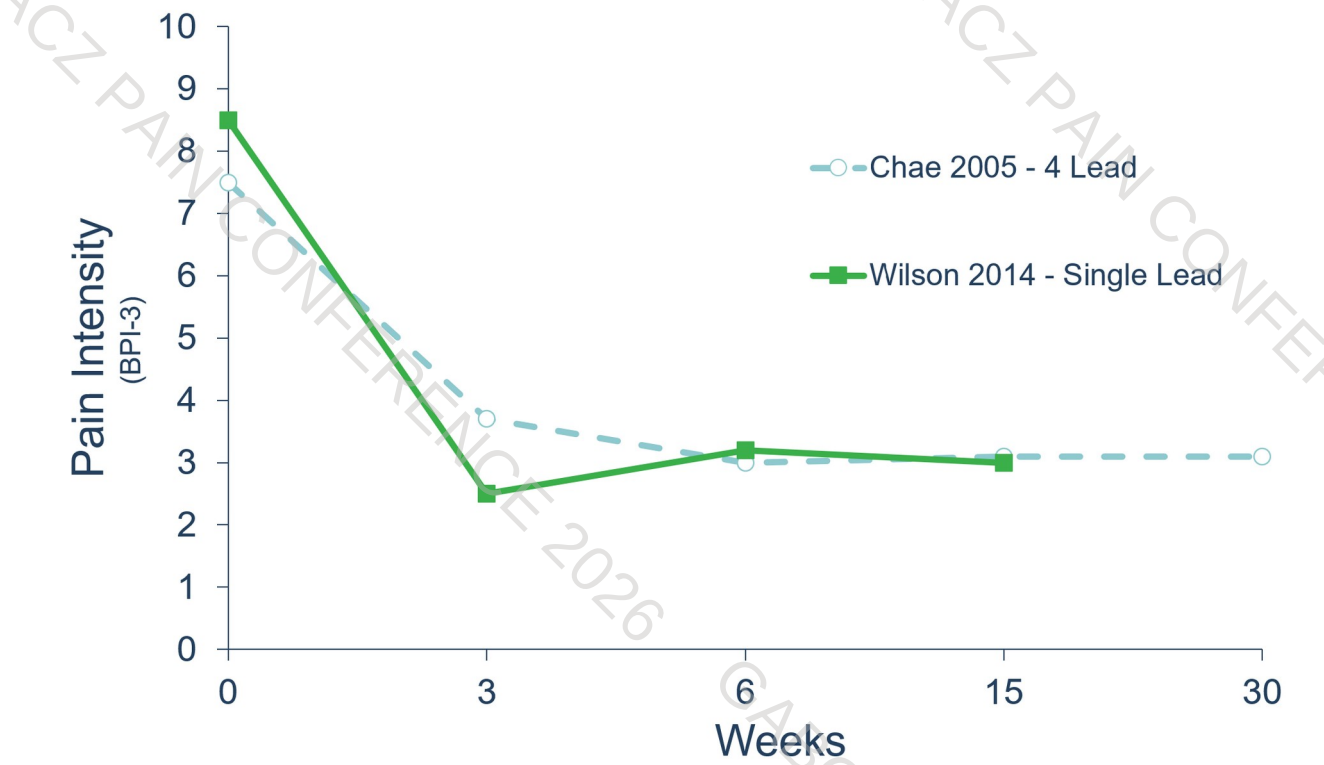
Neuromodulation Technology at the Neural Interface ins International Neuromodulation Society

Case Series

Percutaneous Peripheral Nerve Stimulation for Chronic Pain in Subacromial Impingement Syndrome: A Case Series

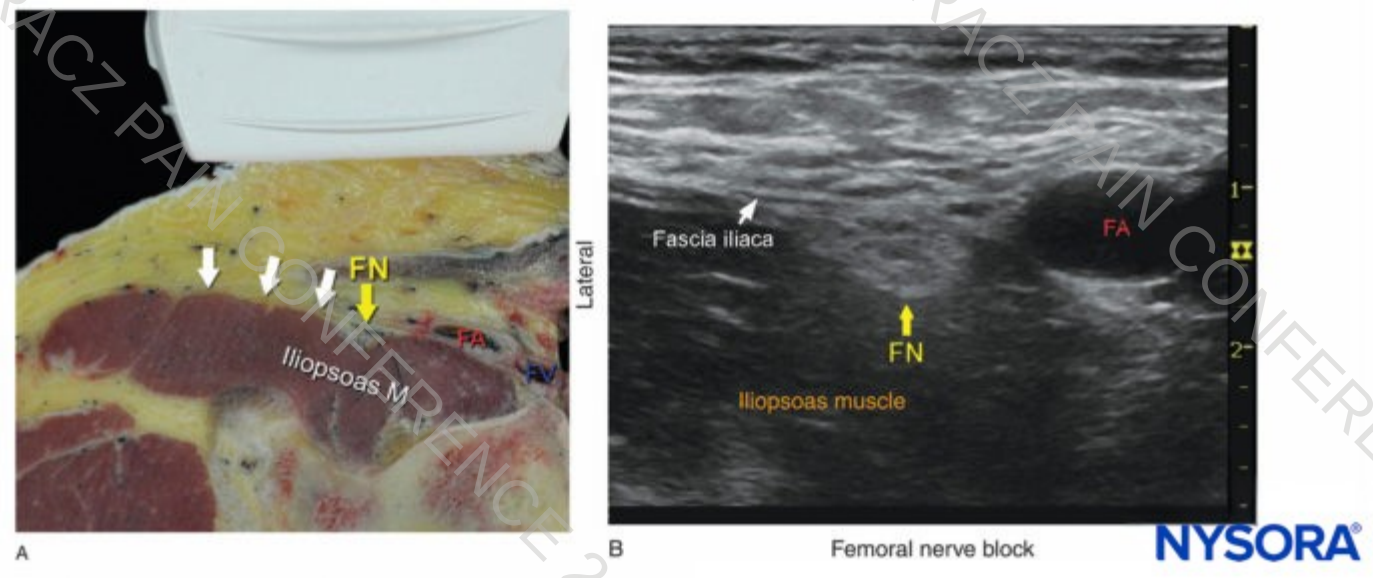
Richard D. Wilson MD, MS, Michael A. Harris MD, Douglas D. Gunzler PhD, Maria E. Bennett MS, John Chae MD

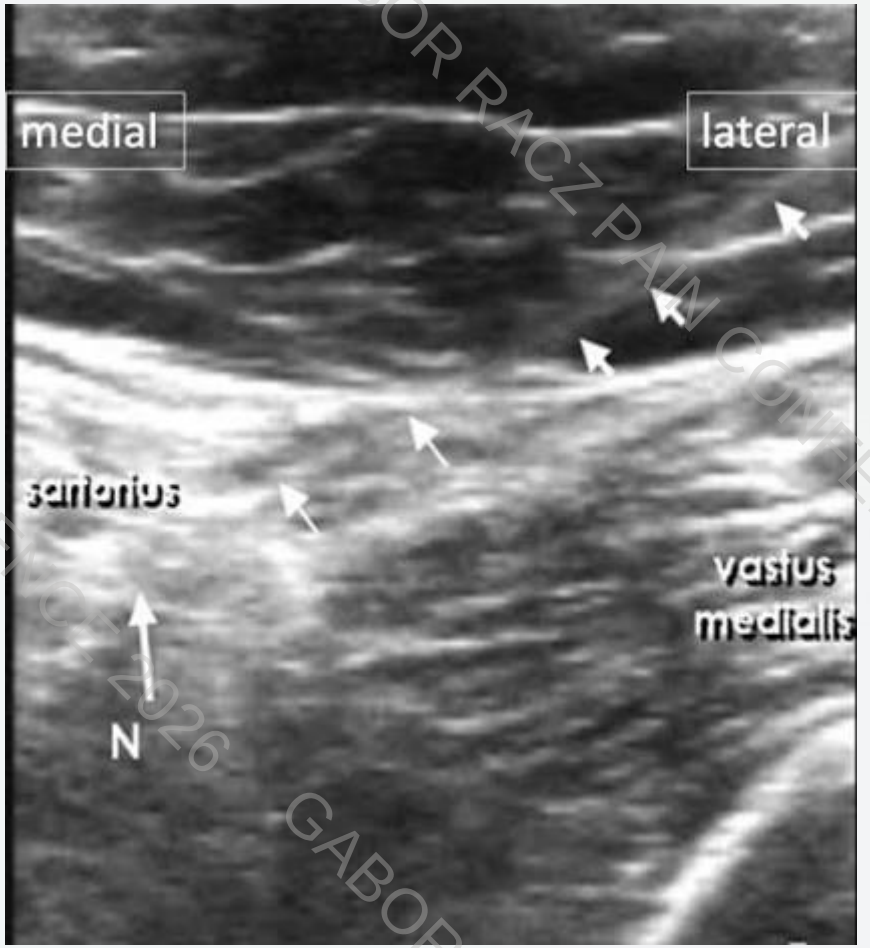
First published: 11 February 2014 | https://doi.org/10.1111/ner.12152 | VIEW METRICS



Reference:
1. Chae J, Yu DT, Walker ME, Kirsteins A, Elovic EP, Flanagan SR, Harvey RL, Zorowitz RD, Frost FS, Grill JH, Fang ZP. Intramuscular electrical stimulation for hemiplegic shoulder pain: a 12-month follow-up of a multiple-center, randomized clinical trial. Am J Phys Med Rehabil. 2005 Nov;84(11):832-42. doi: 10.1097/01.phm.0000184154.01880.72. PMID: 16244520.
2. Wilson R, Harris M, Gunzler D . Percutaneous Peripheral Nerve Stimulation for Chronic Pain in Subacromial Impingement Syndrome: A Case Series Neuromodulation, 17, 771-776

Knee



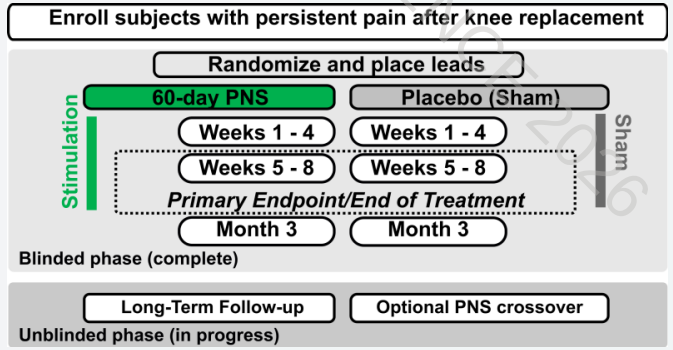


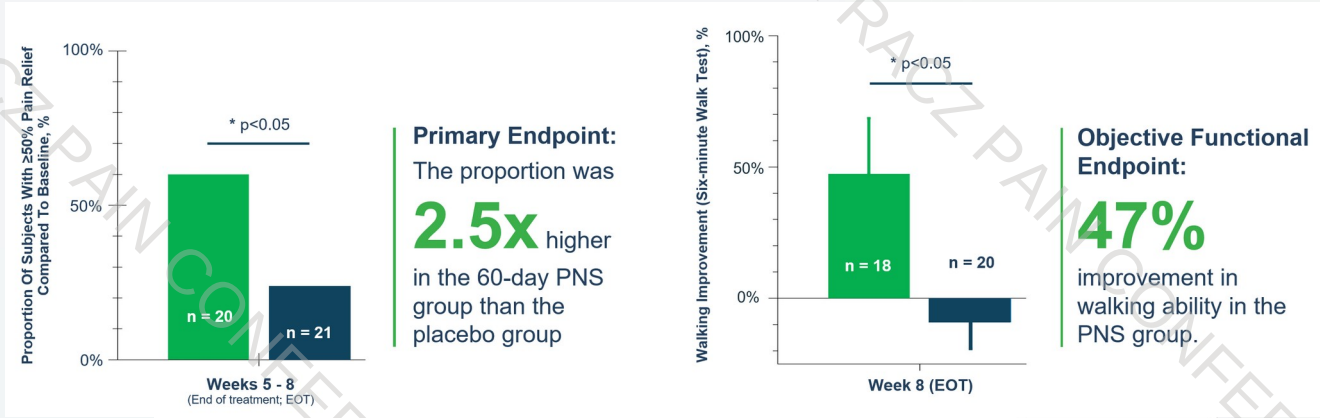
GABOR RACZ PAIN CONFERENCE 2026

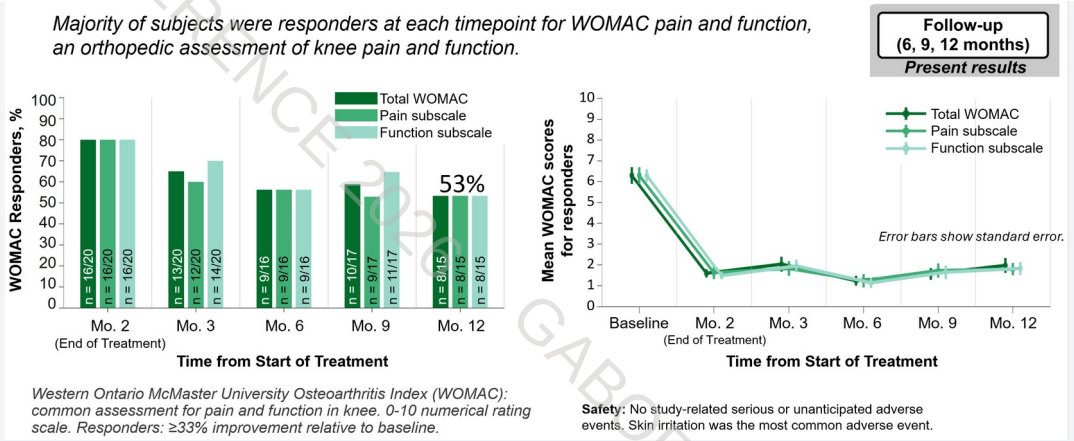
Evidence for Knee

Randomized Placebo-Controlled Trial of 60-Day Percutaneous Peripheral Nerve Stimulation Treatment Indicates Relief of Persistent Postoperative Pain, and Improved Function After Knee Replacement

Johnathan H. Goree, MD[1]; Stuart A. Grant, MD[2]; David M. Dickerson, MD[3,4]; Brian M. Ilfeld, MD[5]; Yashar Eshraghi, MD[6]; Sandeep Vaid, MD[7]; Ali K. Valimahomed, MD[8]; Jarna R. Shah, MD[1]; G. Lawson Smith, MD[1]; John J. Finneran, MD[5]; Nirav N. Shah, MD[3,4]; Maged N. Guirguis, MD[6]; Maxim S. Eckmann, MD[9]; Ajay B. Antony, MD[10]; Brian J. Ohlendorf, MD[11]; Mayank Gupta, MD[12]; John E. Gilbert, PhD[13]; Amorn Wongsarnpigoon, PhD[13]; Joseph W. Boggs, PhD[13]







Reference:
1. Goree J, Grant S, Dickerson D ... Randomized Placebo-Controlled Trial of 60-Day Percutaneous Peripheral Nerve Stimulation Treatment Indicates Relief of Persistent Postoperative Pain, and Improved Function After Knee Replacement . Neuromodulation, 2024; 27, 847-861

Real World Outcomes of Short Term PNS Treatment

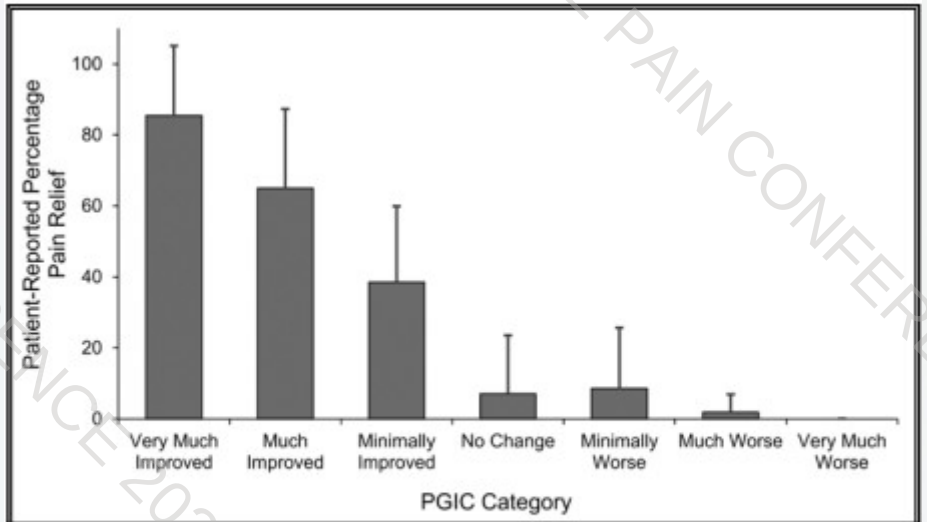


Fig. 3. *Patient-reported percentage pain relief by Patient Global Impression of Change (PGIC) response at end of treatment. The mean patient-reported percentage pain relief is stratified by PGIC response at the end of treatment. Error bars = SD.*

References:
Huntoon MA, Slavin KV, Hagedorn JM, Crosby ND, Boggs JW. A Retrospective Review of Real-world Outcomes Following 60-day Peripheral Nerve Stimulation for the Treatment of Chronic Pain. Pain Physician. 2023 May;26(3):273-281. PMID: 37192232.

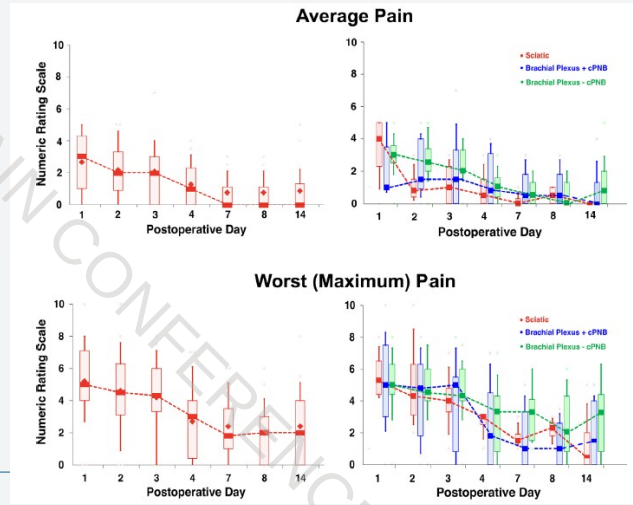
Emerging Tech: Combine Chemical and Electrical Neuromodulation

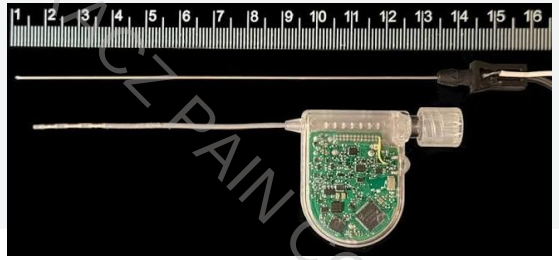
Brief technical report

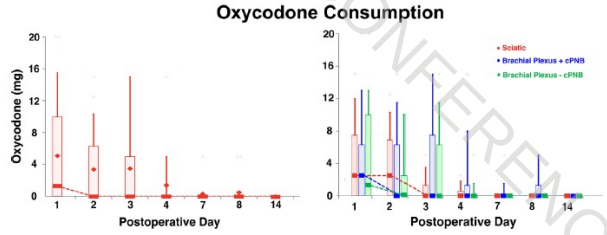
OPEN ACCESS

Percutaneous analgesic device enabling both local anesthetic delivery and electrical stimulation (neuromodulation) of peripheral nerves: a pilot feasibility study (case series)

Brian M Ilfeld [1,2], Engy T Said [1], Brian H Park,[1] Sanjay K Sinha,[3] Bryan Leek,[4] Matthew J Meunier,[4] Ian M Foran,[4] Andrew Hurvitz,[4] William T Kent,[4] Alexandra K Schwartz,[4] Baharin Abdullah,[1] Rafael Alkabalan,[5] Nathan Lau,[5] John J Finneran [1,2]



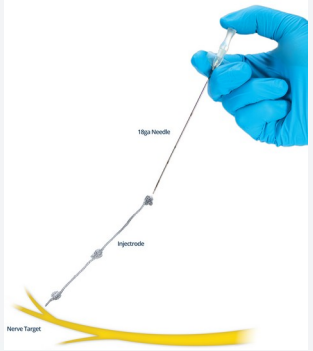


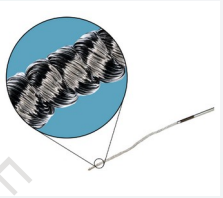


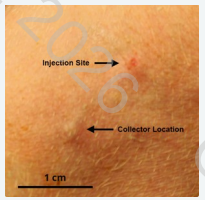
- Low postoperative pain:
  - Median average pain score was only 2/10 (IQR 0–3) during the first postoperative week. After POD1, median daily average pain remained ≤2/10, while worst daily pain declined to ≤5/10.
- Limited opioid requirements:
  - Median cumulative oxycodone consumption was 43 mg (IQR 18–73 mg) during the first postoperative week despite patients undergoing moderate-to-severe pain orthopedic procedures.
- Majority avoided severe pain:
  - Over the entire 14-day study:35% experienced only mild pain (NRS <4)50% experienced moderate pain (NRS 4–7)Only 15% experienced severe pain (NRS >7) at any point
- .Minimal pain-related functional interference (BPI)
  - Day 3: median 2/10 (IQR 0–4)
  - Day 7: median 0/10 (IQR 0–7) suggesting rapid recovery in pain-related function.

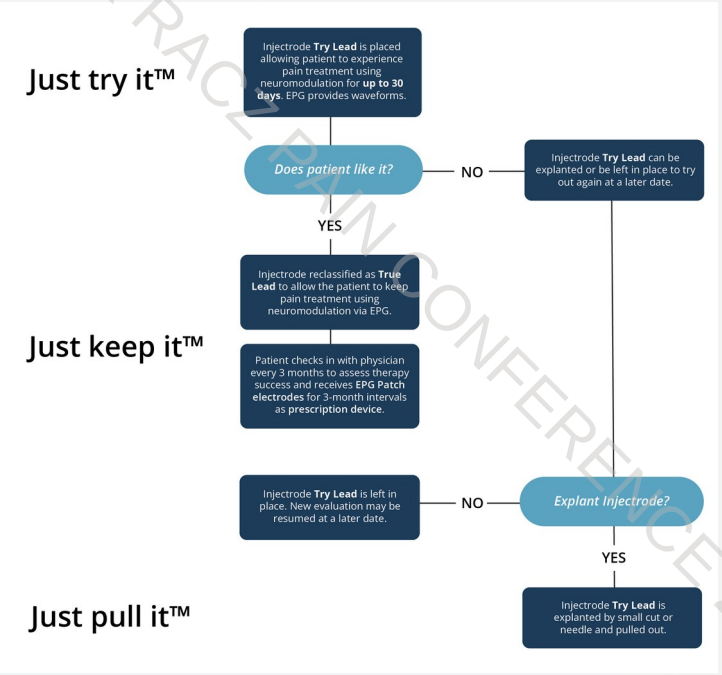
Emerging Tech: Injectable System

- Flowable pre-polymer, and upon injection, cures to form a compliant neural electrode in vivo
- Minimally invasive
- No visible scars
- No need to change wound dressing
- Simple procedure
- Can trial 30 days, if respond keep device, if do not respond remove
- Earlier intervention
- Further study needed









References:
Trevathan J.K., Baumgart I.W., Nicolai E.N., Gosink B.A., Asp A.J., Settell M., Polaconda S.R., Malerick K.D., Brodnick S.K., Zeng W., et al. An Injectable Neural Stimulation Electrode Made from an In-Body Curing Polymer/Metal Composite. Adv. Healthc. Mater. 2019;8:e1900892. doi: 10.1002/adhm.201900892.

Summary

- Short term PNS offers a treatment that is:
  - Non-opioid, non-ablative
  - Easily reversed or repeated
  - May reduce the need for a permanent implant
- Studies with short term PNS have demonstrated:
  - Most patients have experienced clinically meaningful relief1
  - Short term PNS treatment can produce sustained pain relief
  - Consistent pain relief has been observed across different pain areas, including low back and headache and neck pain

References:
Pritzlaff, et al, Pain Management. 2024; McCormick, et al, Pain Medicine. 2025; Huntoon, et al, Pain Physician. 2023. Gutierrez, et al. Headache. 2025

29th Annual Gabor Racz Advanced Interventional Pain Conference and Workshop
Budapest, Hungary August 24-26, 2026

Thank you!

Ali Valimahomed, MD