

Peripheral Nerve Stimulation for Hemiplegic Shoulder Pain: A Systematic Review

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OBJECTIVE

- We present a systematic review of the safety and efficacy of peripheral nerve stimulation (PNS), a promising new neuromodulation modality for refractory hemiplegic shoulder pain (HSP).

METHODS

- A systematic review involving a comprehensive search of relevant literature was performed in six major databases. We considered clinical trials published between January 1970-June 2024 which assessed PNS for pain relief in chronic stroke survivors suffering from hemiplegic shoulder pain with or without shoulder subluxation.

RESULTS

- After removal of 46 duplicates, 129 titles and abstracts were screened and a total of 3 clinical trials were identified (Table 1).
- In a clinical trial with 15 stroke survivors, the motor points of the supraspinatus, posterior deltoid, middle deltoid, and trapezius muscles were stimulated for 6 hours/day for 6 weeks.² A significant decrease in pain intensity (NRS) was observed post treatment (7.15±1.62 versus 1.54±1.28; p<0.0001) with sustained pain relief noted at six month follow up.¹
- In a multicenter RCT 61 stroke survivors were randomized to a six-week four-lead PNS therapy (n=32) or usual care with hemi sling (n=29).³ The intervention group experienced greater improvement in pain scores (BPI 12) than the control group at the end of the six-week treatment (difference 3.7; p=0.001), at 3 months (difference 3.3; p=0.001), and at 6 months (difference 2.3; p=0.006). No significant group differences were observed for shoulder biomechanics.²

RESULTS CONTINUED

- In a subsequent RCT comparing a three-week single-lead PNS therapy (n=13) with PT (n=12), the mean pain severity (BPI 9) at baseline was 7.5±0.7 and 7.6±0.7 for PNS and PT, respectively, which improved to 3.2±0.7 and 6.1±0.8 at 6 weeks after treatment, and to 3.0±0.7 and 6.1±0.8 at 12 weeks after treatment.³
- None of the reviewed clinical trials reported major procedure-related adverse events.

DISCUSSION

- HSP has a reported incidence of 10%-22% and results from a diverse set of pathologies including impaired motor control of the shoulder girdle muscles, rotator cuff tendinopathies, as well as central sensitization.⁴
- While treatment modalities such as PT allow for proper positioning of the paretic limb and improvements in shoulder subluxation, the association between post stroke shoulder subluxation and HSP is not well established.⁵
- PNS is a safe, minimally invasive therapy for HSP and may offer greater pain reduction than conservative management. PNS induced analgesia may be achieved despite lack of effect on shoulder biomechanics.
- It is postulated stimulation of myelinated primary afferents leads to reduced response of dorsal horn neurons to unmyelinated nociceptors.⁵ In addition, there may be neuroplasticity changes induced by sensory modulation that alter the pain experience.
- Single-lead implantation between the middle and posterior deltoid muscles may offer less technical difficulty and post procedural discomfort than a four-lead approach with comparable efficacy.

REFERENCES:
1. Renzenbrink GJ, Ijzerman MJ. Percutaneous neuromuscular electrical stimulation (P-NMES) for treating shoulder pain in chronic hemiplegia. Effects on shoulder pain and quality of life. Clin Rehabil. 2004;18(4):359-365. doi:10.1191/0269215504CR759OA
2. Yu DT, Chae J, Walker ME, et al. Intramuscular neuromuscular electric stimulation for poststroke shoulder pain: a multicenter randomized clinical trial. Arch Phys Med Rehabil. 2004;85(5):695-704. doi:10.1016/j.apmr.2003.07.015
3. Wilson RD, Gunzler DD, Bennett ME, Chae J. Peripheral nerve stimulation compared with usual care for pain relief of hemiplegic shoulder pain: a randomized controlled trial. Am J Phys Med Rehabil. 2014;93(1):17-28. doi:10.1097/PHM.0000000000000011
4. Anwer S, Alghadir A. Incidence, Prevalence, and Risk Factors of Hemiplegic Shoulder Pain: A Systematic Review. Int J Environ Res Public Health. 2020;17(14):1-21. doi:10.3390/IJERPH17144962
5. Maxwell AMW, Nguyen VQC. Management of Hemiplegic Shoulder Pain. Curr Phys Med Rehabil Rep. 2013;1(1):1-8. doi:10.1007/s40141-012-0001-y/TABLES/1



Table 1. Clinical Trials Assessing Peripheral Nerve Stimulation for Hemiplegic Shoulder Pain

Author, Year Published	Study Design	Sample Size	Intervention	Stimulation Parameters	Control	Results
Renzenbrink et al, 2004 ¹	Non-RCT	15 stroke survivors with hemiplegic shoulder pain and subluxation	Intramuscular electrodes placed near motor points of posterior deltoid, middle deltoid, upper trapezius, supraspinatus Treatment Duration: 6 hrs./day for 6 wks. (total treatment time 252 hrs.)	Current: 20 mA, Frequency: 12 Hz, Pulse width: 10-200 μs to provide optimal joint reduction	None	A significant decrease in pain intensity (NRS) at the end of treatment. Pain relief persisted at six month follow up.
Yu et al, 2004 ²	RCT	61 stroke survivors with hemiplegic shoulder pain and subluxation PNS: 32, C: 29	Four intramuscular electrodes placed near motor points of posterior deltoid, middle deltoid, upper trapezius, supraspinatus Treatment Duration: 6 hrs./day for 6 wks. (total treatment time 252 hrs.)	Current: 20 mA, Pulse width: 10-200 μs to provide optimal joint reduction	Hemi sling	PNS group with significantly greater improvements in pain severity (BPI 12) and pain interference (BPI 23) scores compared to controls at end of treatment, at 3 months, and at 6 months. No group differences in shoulder subluxation, spasticity, pain free external rotation, or motor impairment.
Wilson et al, 2014 ³	RCT	25 stroke survivors with hemiplegic shoulder pain with or without subluxation PNS: 13, C: 12	Single percutaneous electrode placed near axillary motor points of middle and posterior deltoids Treatment Duration: 6 hrs./day for 3 wks. (total treatment time 126 hrs.)	Current: 20 mA, Frequency: 12 Hz, Pulse width: 40-200 μs	Physical Therapy (8 hrs. of outpatient physical therapy over 4 wks. + daily home exercise)	PNS group with significant reduction in pain severity (BPI 3) compared to controls at 6 wk. and 12 wk. follow ups after treatment. No group differences in pain interference, or QOL.



Our systematic review indicates PNS is a safe, minimally invasive therapy for hemiplegic shoulder pain and may offer greater pain reduction than conservative management.