

Management of Pain in War-injuries with Non-invasive Peripheral Neurostimulation: Early Data from Unbroken Centre, Lviv, Ukraine

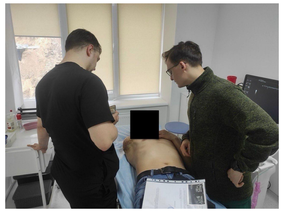
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National Rehabilitation Centre
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BACKGROUND

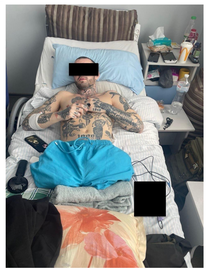
The ongoing armed conflict in Ukraine has yielded a high incidence of complex battlefield trauma, characteristically secondary to blast forces, primary fragmentation, and high-velocity ballistics that frequently necessitate emergency limb amputation. Post-amputation neuropathic sequelae—specifically phantom limb pain (PLP) and residual limb pain (RLP)—significantly impede physical rehabilitation, prosthetic integration, and long-term functional recovery. Non-invasive transcutaneous peripheral neurostimulation offers a target-specific, non-pharmacological strategy to attenuate post-traumatic neuropathic pain and comorbidity during subacute rehabilitation.



MATERIALS AND METHODS

The protocol followed at Ivano-Frankivsk was adopted at Lviv and ethical approval was formally granted by the Institutional Review Board on 30 June 2026. A cohort of 119 patients (selected from 156 presenting clinical candidates) with refractory neuropathic conditions most due to combat trauma was enrolled. Subjects underwent 30-minute therapeutic sessions utilizing a high-frequency neurostimulation device delivered as targeted peripheral nerve stimulation (PNS) or peripheral field stimulation (PFS) via customized hydrogel arrays or circumferential limb wraps. Current amplitude was titrated upward to individual sensory-tolerance thresholds to achieve localized conduction block, subjective paraesthesia, and regional analgesia. Pain intensity was quantified using the Visual Analog Scale (VAS) at baseline, immediately post-treatment, and at 24 and 48 hours. Functional prosthetic mobilization and biomechanical ease of movement were secondary endpoints. Patients residing in remote geographic locations were provisioned with portable neurostimulation units for self-administration, with longitudinal progress monitored via structured monthly telephone assessments.




RESULTS

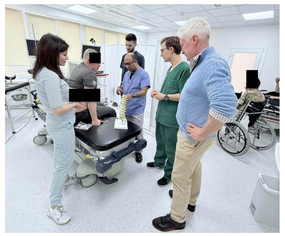
91.6% sustained battle-related injuries with half of them due to blast/missile injuries and landmine explosions; gunshot injuries being the third commonest cause. 83.2% subjects had amputations with 11 subjects having more than one limb amputated. All completed the stimulation protocol without adverse events; elevated stimulation thresholds were required in a subset of patients with dense post-traumatic sensory deficits. The cohort exhibited a mean baseline VAS score of 6.4. Mean VAS scores dropped sharply to 1.61 immediately post-intervention, with sustained analgesic effects recorded at 24 hours (VAS 2.91) and 48 hours (VAS 3.43). The mean duration of meaningful pain relief following a single application was 12.4 hours. Amputees reported rapid attenuation of PLP paroxysms following the index session, enhanced prosthetic compliance and gait re-education. 42% of all subjects required serial treatments, with mean duration of analgesic effect of 9.7 hours demonstrating consistent, non-tachyphylactic analgesic responses comparable to their index session.

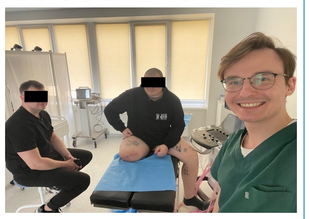
Type of Pain Syndromes

- Phantom pain – 39.48%
- Residual limb pain – 61.02%
- Peripheral neuropathic pain – 72.67%
- Lumbar radiculopathy – 9.1%
- Bone fracture – 4.66%
- Hyperalgesia – 6.22%
- Central neuropathic pain – 3.89 %
- Tourniquet syndrome – 62.34%
- Osteoarthritis/joint pain – 3.67 %
- CRPS – 2.61 %
- Midback pain – 32.56 %
- Cervical radiculopathy – 3.66 %
- Muscle pain – 0.19%
- Pelvic injury – 8.78%
- Post-traumatic headache – 41.8 %
- Axial low back pain – 52.11 %
- Other diagnoses – 7.56 %

Etiology of Pain Syndrome

- Blast-missile injury – 31.13 %
- Landmine injury – 18.11%
- Fall – 3.2%
- Back pain – 3.7 %
- Gunshot (missile-type) wound – 7.1 %
- Exacerbation pre-existing condition 1.56 %
- Diabetes mellitus – 1.21%
- Motor vehicle collision – 3.27 %
- Cervical spine issues – 2.2%
- Trigeminal nerve neuropathy – 2.06%
- Back pain (recurrent) – 2.04%
- Heavy body armor – 3.09 %
- Joint problems – 3.11%
- Surgical intervention – 4.32 %
- Cumulative trauma – 1.3%
- Shrapnel wound – 11.4 %
- Other – 1.2%



DISCUSSION

The patented electrical stimulation therapy modulates cutaneous electrical delivery by alternating two high-frequency (HF) carriers, between two independent electrodes. As these carriers pass through the skin and deeper tissues, tissue polarization and the nonlinear electrodynamic properties of neuronal and muscular structures generate intermodulation products. The resulting frequency spectrum includes lower-frequency components arising from nonlinear mixing, effectively producing a low-frequency (LF) field beneath each electrode. Conceptually, this interaction zone forms a hemispherical region approximately three inches in diameter that encompasses local nociceptive pathways, potentially modulating axonal excitability and synaptic transmission. The proposed mechanism involves electrical field-based interference with nociceptive signal propagation, producing analgesia by reducing peripheral nociceptive input to the central nervous system. This cohort consists predominantly of military personnel who sustained shrapnel injuries from drone strikes, artillery shelling, and high-velocity gunshot trauma during the ongoing Ukraine–Russia conflict. These complex injuries frequently result in persistent neuropathic and post-amputation pain. Early intervention is being implemented to reduce comorbidity burden and to support mental health and overall well-being, because untreated pain can significantly impede rehabilitation and recovery. Plans are underway to expand the service to additional centres across Ukraine and to train health professionals in the delivery of non-invasive neurostimulation, building sustainable local capacity. The primary objective is to monitor patient progress, with a focus on improved mobility, durable pain relief, and the reduction or tapering of opioid and neuropathic pain medications. The team also intends to compare outcomes with analogous studies in veterans from other countries, placing these results within an international context. In addition, the team will explore whether this modality can benefit civilians undergoing amputation for peripheral vascular disease or diabetes, as well as those with traumatic amputations. This could extend the benefits of this approach well beyond the military setting. Findings will be disseminated in due course.

CONCLUSIONS

Battlefield injuries, including amputations, typically receive prompt initial care. However, post-amputation and other neuropathic pain remain undertreated in many settings. Contributing factors include limited healthcare resources, gaps in specialist expertise, supply chain disruptions, and the ongoing conflict. Together, these hinder timely rehabilitation, compromise mobilization, exacerbate mood disturbances, and sustain chronic pain. Combat-induced blast and ballistic injuries also cause complex neurovascular disruption, producing intractable neuropathic pain that obstructs functional prosthetic rehabilitation. Early integration of non-invasive peripheral neurostimulation into post-amputation pain protocols and broader neuropathic pain management may mitigate these challenges. This non-pharmacological option can be deployed at the point of care or in remote and low-resource environments. It offers potential for rapid analgesic benefit, reduced medication burden, and improved functional recovery. The modality is cost-effective, sustainable, scalable, and associated with minimal adverse effects, supporting continued engagement in rehabilitation and meaningful quality-of-life improvements. High-frequency non-invasive neurostimulation has demonstrated significant clinical utility within austere healthcare environments. It facilitates opioid-sparing analgesia, accelerated prosthetic acclimatization, and improved functional outcomes. Compared with the Ivano-Frankivsk site, the current site treats a greater number of amputees and patients undergoing active rehabilitation. This provides a valuable opportunity to evaluate the role of neurostimulation in prosthetic training and functional restoration. It also allows closer assessment of how effective pain control influences mobility, prosthetic fitting, and progression through rehabilitation programmes. initial patient-reported feedback indicated a clear willingness to continue neurostimulation therapy for both analgesia and rehabilitation support. This level of acceptance is encouraging, as patient engagement is essential to sustained recovery and long-term adherence to treatment.

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