

Managing Post-amputation Pain due to Battlefield Trauma with Non-invasive Peripheral Neuromodulation: One year Case series

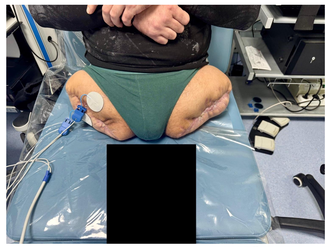
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BACKGROUND

The Russo-Ukrainian conflict has generated hundreds of thousands of casualties from drone strikes, artillery, blast and high-velocity ballistic trauma, with a substantial burden of traumatic upper- and/or lower-limb amputation. Sub-optimally controlled residual limb and phantom limb pain compromises quality of life, delaying rehabilitation and prosthetic ambulation. Opioid availability and invasive interventional analgesia remain constrained by ongoing hostilities. We present one-year update of a prospective study evaluating patented high-frequency non-invasive peripheral neurostimulation for post-amputation pain.






MATERIALS AND METHODS

160 patients presented with post-amputation syndromes. 18 of them had more than one limb amputated. 49.12% had their dominant side limb was amputated, and 8.77% had both limbs amputated. 2/3rd were lower limb amputees and over a third were upper limb amputees. Each received a single 30-minute session using a patented high-frequency neurostimulation device, delivered as peripheral nerve stimulation or peripheral field stimulation via surface electrode pads or bespoke electrode wraps applied to the residual stump. Electrode montage was configured to achieve paraesthesia coverage concordant with the topographical pain distribution, with amplitude titrated upwards until abolition of perceived antecedent pain—phantom limb pain, residual limb (stump) pain, or neuroma-related pain—while remaining subthreshold for discomfort. Follow-up assessments were undertaken at baseline, immediately after treatment, 24 and 48 hours, then monthly with ongoing treatment. Outcome measures comprised reduction in baseline pain scores, ease of mobilisation, prosthetic weight-bearing tolerance, and ambulation duration.

Longitudinal follow-up was conducted monthly via telephone until sustained analgesia was achieved; participants were advised to contact the clinic for additional support or treatments as needed. The study aimed to evaluate the immediate and short-term analgesic effects and functional outcomes associated with non-invasive peripheral neurostimulation in individuals with amputations or nerve injuries related to battlefield injuries.





RESULTS

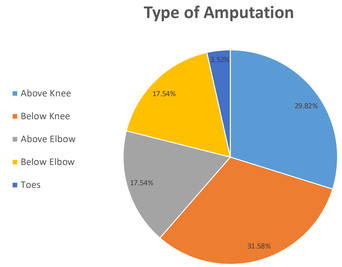
Total patients in the study population: 160
Among amputees, a substantial reduction in phantom-limb pain was observed after the initial treatment. Improved mobilisation with prosthetic devices was reported following treatment. Initial patient feedback indicated willingness to continue stimulation therapy for ongoing pain control and rehabilitation facilitation.
Patients with limb amputation made up 38% of the treated population and showed a strong response to high-frequency non-invasive neurostimulation. These results exceed those of the overall cohort (6.73 to 2.98, with 10.96 hours of relief), supporting the observation that post-amputation pain responds more favourably than other traumatic pain conditions.
However, patients with baseline pain above 6 points experienced recurrent pain episodes, including those in the repeat-treatment subgroup. Lower-limb amputations were the most common (63.38%), mostly below or above the knee. Upper-limb amputations accounted for 36.32% and were evenly divided between above- and below-elbow levels. Nearly half of the amputations involved the dominant side, and 8.77% of patients had bilateral amputations.

Pain Outcomes
Baseline VAS: 5.82
Post-treatment VAS: 1.91 (approximately 67% reduction)
Mean duration of relief: 13.9 hours
Recurrence: Observed in patients with baseline VAS >6, including those receiving repeat treatment

Amputated Limb
Leg: 63.38%
Arm: 36.32%

Level of Amputation
Below the knee 31.58%
Above the knee: 29.82%
Above the elbow: 17.54%
Below the elbow: 17.54%
Toes: 3.52%

Side of Amputation
Dominant: 49.12%
Non-dominant: 36.84%
Bilateral: 8.77%
Upper and Lower limb: 5.3%



DISCUSSION

A patented non-invasive neurostimulation therapy delivers alternating high-frequency electrical carriers through two independent electrodes. As the carriers pass through the skin and deeper tissues, nonlinear interactions generate intermodulation products, including lower-frequency components. These may create a local low-frequency electrical field beneath each electrode, potentially influencing nociceptive pathways, axonal excitability and synaptic transmission. The proposed analgesic mechanism is interference with nociceptive signal propagation, thereby reducing peripheral pain input to the central nervous system. The study included 160 patients, predominantly military personnel with severe limb trauma caused by blasts, shrapnel, drone strikes, artillery and high-velocity gunshots. Many required amputation and experienced neuropathic or phantom-limb pain that impaired prosthetic use, mobility and quality of life. Early intervention is being implemented among Ukrainian service members to reduce pain-related comorbidities, support mental health and facilitate rehabilitation. Planned expansion includes additional Ukrainian centres, professional training and comparisons with veteran populations in other countries. The approach may also be applicable to civilian traumatic amputations and amputations related to peripheral vascular disease or diabetes. Among amputees, phantom-limb pain was substantially reduced after the initial treatment, with improved prosthetic mobilisation reported. Initial feedback indicated willingness to continue stimulation for sustained pain control and rehabilitation. Amputees represented 38% of the treated population and appeared to respond more strongly than the overall cohort. Across the broader cohort, mean pain decreased from 6.73 to 2.98, with approximately 10.96 hours of relief. In the amputation subgroup, baseline visual analogue scale (VAS) pain declined from 5.82 to 1.91, representing an approximately 67% reduction, with mean relief lasting 13.9 hours.
Lower-limb amputations predominated (63.38%), comprising below-knee (31.58%), above-knee (29.82%) and toe amputations (3.52%). Upper-limb amputations accounted for 36.32%, divided equally between above- and below-elbow levels (17.54% each). Nearly half involved the dominant side, and 8.77% were bilateral. Patients with baseline pain above 6 commonly experienced recurrence, including some receiving repeat treatment. Overall, the findings support non-invasive neurostimulation as a potentially cost-effective adjunct for post-amputation analgesia, opioid and neuropathic-medication tapering, mobility and quality-of-life improvement.






CONCLUSIONS

This study evaluated a patented non-invasive neurostimulation therapy for post-amputation and neuropathic pain. The treatment alternates two high-frequency electrical carriers between independent electrodes. Nonlinear interactions within tissues generate lower-frequency intermodulation products, creating a local electrical field that may influence nociceptive pathways, axonal excitability and synaptic transmission. The cohort included 160 predominantly military personnel with severe blast, shrapnel or ballistic injuries sustained during conflict, including the Ukraine–Russia war. Many required amputation and experienced phantom-limb or neuropathic pain that impaired prosthetic mobilisation, rehabilitation and quality of life. Treatment goals included durable analgesia, improved mobility and reduction or tapering of opioid and neuropathic pain medications.

Pain recurrence was more common among patients with baseline pain scores above six, including some receiving repeat therapy.Early integration of this portable, non-pharmacological intervention may support rehabilitation in conflict-affected, remote and resource-limited settings. Its potential benefits include rapid analgesia, reduced medication burden, minimal adverse effects, scalability and improved functional recovery.

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