Therapeutic potential of transcutaneous electrical spinal stimulation on upper extremity functions in cervical spinal cord injury

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Methods

Introduction

- Transcutaneous electrical stimulation is a non-invasive strategy to modulate spinal circuitry and induce neuroplasticity
- Electrical neuromodulation of spinal networks below the injury facilitates volitional motor control in both lower and upper extremities

Goals:

- Determine the therapeutic potential of non-invasive spinal stimulation for functional restoration of hand and arm
- Quantify the sustained benefits to hand and arm function that persist beyond the period of spinal stimulation

Subject:

- 62 y/o male, C3 central cord syndrome, ASIA D, 2 years post-injury

Interventions: 4-5 times/week

- Stimulation + physical therapy: 4 weeks (Figure 1)
- Physical therapy only: 4 weeks
- Stimulation + physical therapy: 1 weeks

Outcome Measures:

- Graded Redefined Assessment of Strength, Sensibility and Prehension (GRASSP) test
- International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI) assessment
- Hand strength

Results

Transcutaneous stimulation improved arm and hand functions measured by GRASSP test

Pinch force 2- to 7-fold greater after stimulation

Figure 1. Transcutaneous stimulation via electrodes placed midline at C3-4 and C6-7 as cathodes. (Inset) Biphasic, rectangular, 1 ms pulses at a frequency of 10Hz. Stimulation intensity between 10 and 200mA.

Figure 2. A) – GRASSP score increased 52 points following only 4 weeks of stimulation
B) – Water pouring (prehension) and 9 hole peg tasks (dexterity) were unsuccessful at the baseline and at first week when stimulation was off.
C) – After 4 weeks of stimulation, left hand prehension & dexterity improved dramatically
D) – One additional week of stimulation lead to further improvement in hand function.

Figure 3. During stimulation treatment, lateral pinch force improved 2 and 7 fold in left and right hands, respectively. PT alone did not further improve pinch force, but the gains were maintained throughout the 3-month follow-up period.

Discussion

- Concurrent application of transcutaneous electrical spinal cord stimulation and PT restored strength, dexterity and sensation
- The magnitude of improvements exceeded previous reports of activity-dependent interventions after SCI

Conclusion

- Our results provide evidence that non-invasive electrical spinal cord stimulation:
  - Confers both immediate & sustained benefit
  - Restores functional use of the hands after SCI

References

5. Gad et al. J Neurotrauma 2018
6. Inanici et al., IEEE TNSRE in press