The ElectroSacroGram (ESG): a point-of-care electrophysiological method for transforming neuro-sacral assessment following spinal cord injury/lesion (SCI/L)

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Objectives

To develop a point-of-care method for quantitative assessment of the neuro-sacral function combining key elements of the digital rectal examination (DRE) using a handheld portable surface EMG (s-EMG) device providing live results, termed ElectroSacroGram (ESG). We also assessed its content/concurrent validity in 101 neuro-sacral assessments completed among a cohort of 65 individuals suspected with acute SCI/L.

Method

A cross-sectional prospective cohort study was performed (2022-2023) in a single Level 1 specialized trauma center. The ESG method was first developed in a cohort of 8 neurologically intact participants to quantify motor response's amplitude of the external anal sphincter (EAS) resting tone, maximal voluntary anal contraction (maxVAC) and bulbocavernosus (BCR) reflex. In addition, sacral sensory sparing was assessed using electrical perceptual threshold (EPT) at S4-5 sensory key points. Concurrent and content validity, reliability as well as sensibility/specificity were assessed to measure how well the ESG distinguishes between neurologically impaired and neuro-intact individuals, as opposed to the current gold standard (DRE done by a SCI expert).

Results

Healthy participants presented with a mean anal resting tone of $2.15\pm0.49\mu V$, maxVAC of $21.46\pm7.29\mu V$, BCR of $4.80\pm2.49\mu V$ and EPT of $3.50\pm2.22mA$. The ESG showed an excellent content validity (>95%), as rated by experts who agreed on its relevance for neuro-sacral assessment. Concurrent validity was very good to excellent with Kappa Cohen coefficient $\kappa=0.887$ and 0.908 for maxVAC and EPT, respectively. Each component of the ESG had excellent intra-rater reliability (ICCs: 0.964-0.989) and good-to-excellent inter-rater reliability (ICCs: 0.808-0.968) and well as good-to-excellent sensitivity and specificity to detect neurologically impaired individuals. Moreover, the ESG identified contractions undetected by experienced clinicians in 3% and 15% of cases for maxVAC and BCR.

Conclusions

The ESG is a valid and reliable point-of-care precision tool providing for the first time a live quantitative assessment of the neuro-sacral function following suspected SCI/L. The ESG is accessible has the potential to transform the assessment of SCI/L for clinical and research purposes.