Original Article

COMPARING FOUR ELECTRICAL STIMULATORS WITH DIFFERENT PULSES PROPERTIES AND THEIR EFFECT ON THE DISCOMFORT AND ELICITED DORSIFLEXION

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ABSTRACT

Objective: To test the perceived comfort and efficiency of four functional electrical stimulators (FES). **Design:** The stimulators were applied over the dorsiflexors (DF) of 28 healthy volunteers. Electronic goniometers monitored changes in electrically-induced DF. Stimulus intensity was increased until full DF occurred or until the subject requested the stimulation stop before full DF. All data were stored on an oscilloscope. Subjects marked on visual analog scales their perceived amount of tingling, pins-needles-burning sensation, and muscle cramping. Data analyses were applied to the amount of dorsiflexion (deg), phase charge (μC), tingling perception, pins-needle-burning perception and muscle cramps perception. Significant differences were accepted at $p<0.05$. **Results:** Group means DF were 19.9±13.5 deg (Focus), 19.5±15.3 deg (300PV), 20.0±13.1 deg (L300), and 24.5±14.6 deg (GMES II) and statistically similar ($F=1.627$, $P=0.189$). The phase charge needed to elicit dorsiflexion yielded significant differences among the stimulators ($F=54.61$, $P=2.09E^{-19}$). Post-hoc comparison indicated that GMES II phase charge was significantly lower than the other stimulators. Similarly, the GMES II was perceived as having respectively 39.1%, 34.2%, and 28.1% less pins-needle-burning discomfort than Focus ($p=0.0003$), 300PV ($p=0.0001$), and L300 ($p=0.006$). **Conclusion:** Shortening the phase duration resulted in a more comfortable and more efficient stimulation that may lead to designing a lower profile, lighter weight, and more cosmetic FES.

KEY WORDS: Electrical stimulation; Comfort; Dorsiflexion; Phase charge.

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INTRODUCTION

Non-invasive functional electrical stimulation (FES) has been used in clinical practice for many years.[1] Essentially, FES uses a battery powered stimulator to generate pulses of sufficient electric charge to depolarize peripheral nerves.[2,3] The excited motor nerves propagate their action potentials to the muscles causing the muscles to contract.

Researchers frequently focus their efforts to improve the perceived comfort of stimulation and simplify the operation of FES systems for patients with deficits in the musculo-skeletal, and/or neurological systems. In addition, miniaturization of wearable FES systems increases compliance, ease and comfort of use and appears important for patients who wear the FES throughout the day by enhancing their functional ability.[4]