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Title : Soft Exosuits Increase Walking Speed and Distance after Stroke

Background & Purpose : Portable exoskeletons are the state of the art in wearable robotics[1]. These remarkable machines have enabled individuals who are unable to walk, to walk again. However, for those that retain the ability to walk following neurological injury, such as the majority poststroke, rigid systems may not be necessary to restore more normal walking behavior[2]. Our group has developed soft wearable robots (exosuits) made from garment-like, functional textiles. As previously described[3], mechanical power generated by actuators are transmitted to the wearer's paretic ankle during walking via the interaction of cable-based transmissions and the exosuit's functional textiles. In previous studies, we demonstrated that exosuits can actively assist the paretic limb during walking and improve ground clearance, increase propulsion symmetry, and reduce the metabolic burden of hemiparetic gait after stroke[4,5]. The present study extends this work and evaluates the effects of a portable exosuit on short- and long-distance walking function.

Subjects : Six subjects >6 mo poststroke.

Methods : Participants completed 2 days of overground gait testing to evaluate the effects of wearing an exosuit unpowered versus their baseline walking (day 1) and powered versus unpowered (day 2). Importantly, formal training on how to walk with the exosuit was not provided as participants' natural response to the exosuits was the focus of this study. On day 1, participants' baseline walking was evaluated using the 10-meter walk test (10mWT)—which measured walking speed capacity—and the 6-minute walk test (6MWT)—which measured long-distance walking function. Subsequently, participants completed both walking tests with the exosuit worn, but unpowered. Following baseline testing, participants donned the exosuit and a ~4 kg, waist-mounted, bodyworn actuator and were provided < 12 minutes of exposure to walking with the exosuit powered and delivering assistive forces, but no instruction. On day 2, participants completed the 10mWT and 6MWT with the exosuit unpowered and then with the exosuit powered.

Results : When walking with the exosuit worn but unpowered, participants did not walk slower compared to their baseline walking ($P > 0.05$). In contrast, when walking with the exosuit powered, participants walked 0.12±0.02m/s faster during the 10mWT and 30±12m farther during the 6MWT ($Ps < 0.05$). The 30m average gain in total walking distance during the 6MWT was driven by a sustained increase in long-distance walking speed per minute of the test of 0.08±0.03m/s.

Conclusions : Through targeted assistance of the paretic ankle, soft exosuits can increase the walking speed of individuals with poststroke hemiparesis in a manner that can be sustained over long distances.

Clinical Relevance : Exosuits have the potential to enable physical therapists to target the specific biomechanical deficits contributing to walking-related disability after stroke in overground walking contexts.

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