Evaluation of control modalities and functional impact of a self-piloted grasp neuroprosthesis in stroke patients: preliminary results from a multi-crossover N-of-1 randomized controlled study
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Evaluation of control modalities and functional impact of a self-piloted grasp neuroprosthesis in stroke patients: preliminary results from a multi-crossover N-of-1 randomized controlled study

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Introduction

Stroke is the leading cause of acquired motor deficiencies in adults. Improving prehension abilities is challenging for individuals who have not recovered active hand opening capacities post-stroke. Functional electrical stimulation (FES) applied to finger extensor muscles to restore grasping abilities in daily life, called grasp neuroprosthesis (GNP), remains confidential in post-stroke population. Thus, we developed a GNP and control modalities adapted to the characteristics of this population and assessed its impact on functional restoration of grasping abilities.

Methods

A GNP prototype was designed with specific control modalities (voice control, foot and head movements). A software allowing configuration and monitoring, interprets user commands through input signals from sensors (IMUs and microphone) and triggers a pre-programmed external electrical stimulator. Over 5 days, the users tested and selected a preferred control modality before training with the GNP to perform unimanual and bimanual tasks in a seating position. Its functional impact was assessed in a blinded evaluation multi-crossover N-of-1 randomized controlled trial (clinicaltrials.gov: NCT04804384), followed with a QUEST questionnaire.

Results

Preliminary results from eight subjects (1 to 17 years post-stroke; Fugl-Meyer motor upper-extremity score 21 to 48/66) showed a preference for non-paretic foot triggering (7/8). All subjects selected the key-pinich task as the primary outcome and the palmar grasp task as secondary outcome. All subjects successfully completed from 83\% to 100\% of the tasks using the GNP (100\% for 5 subjects; khi2: p<0.001), while none of them could complete the task without GNP activation. QUEST ranged from 29 to 35 (median of 33/40).

Conclusion

These preliminary results attest that the GNP prototype and its control modalities are well suited to the post-stroke subjects in terms of self-triggering, while allowing to restore grasping capabilities. A wearable version of this device is being developed to improve prehension at home in daily life.