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► **To cite this version:**

Ronan Le Guillou, Mathilde Couderc, Margot Morin, Camille Cormier, Christine Azevedo Coste, et al.. 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. FES Workshop 2022 - International Workshop on Functional Electrical Stimulation, Sep 2022, Innsbruck, Austria. hal-03923987

**HAL Id: hal-03923987**

**<https://inria.hal.science/hal-03923987>**

Submitted on 5 Jan 2023

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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-pinch 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.