Correlation between electromyographic activity of the forelimb and hand muscles and motor performance during a reach and grasp behavioral task.

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INTRODUCTION

Manual dexterity in humans is the result of a combination of recruitment of several hand and arm muscles. The aim of this study was to assess complex motor performance in normal human subjects combining two approaches: electromyographic (EMG) recordings from muscles involved in a unimanual reach and grasp task and the forces applied by the subject to fulfill this task.

In the context of brain injury affecting the motor cortex, this task allows the distinction between distal movements of the forelimb (grip force) and more proximal movements (load forces) and provides useful quantitative results about possible functional recovery.

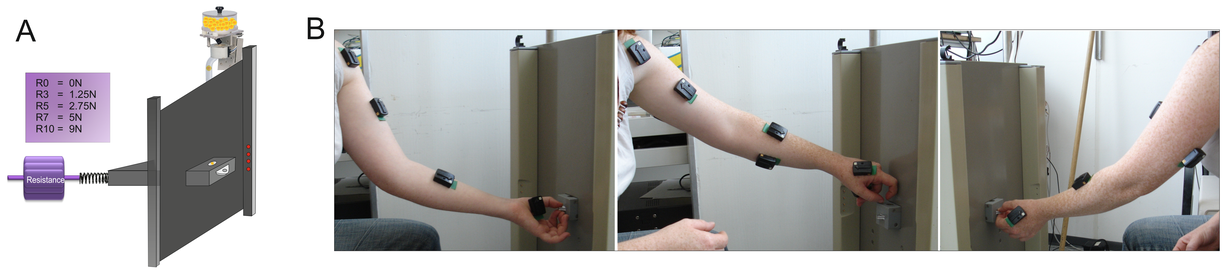


Fig.1:A. Drawing illustrating the reach and grasp drawer task setup with adjustable resistance (N) (extended from a previous version: Kazennikov et al., 1994, EJN). B.Pictures of a subject performing the drawer task with Trigno Wireless EMG System (DELSYS®).

METHODS

We recorded EMG activity from 6 arm and hand muscles simultaneously, together with the grip and load forces during 50 trials of the reach and grasp task consisting in pulling a drawer and retrieving small object inside the drawer.

The recorded muscles were: Thenar (Th), One Dorsal Interosseus (iDI), Palmaris Longus (PL), Extensor Carpi Radialis (ECR), Triceps Brachii and anterior part of the Deltoid (AD). The filtered and amplified EMG activity was acquired using Cambridge Electronic Device (CED), and analyzed using the Spike 2 software, in combination with continuous acquisition of the grip force (grasp of the knob) and the load force (pulling of the drawer).

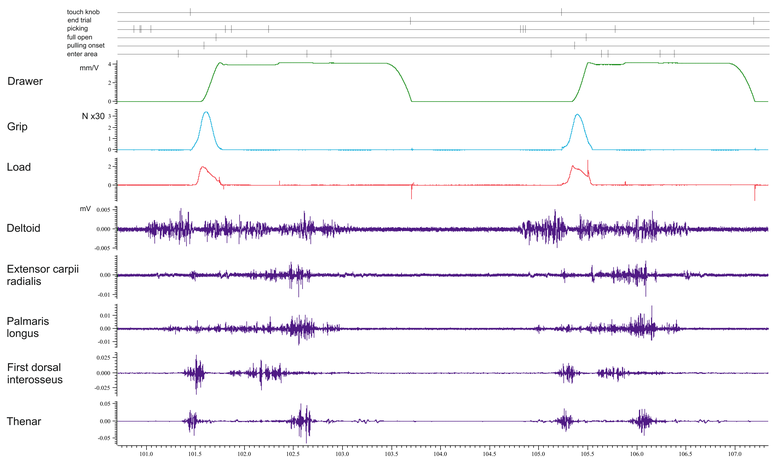


Fig.2: Example of online acquisition of the EMG activity of 5 muscles and two forces (grip force in blue and load force in red), and several timemarkers correlated to the unfolding of the reach and grasp drawer task.

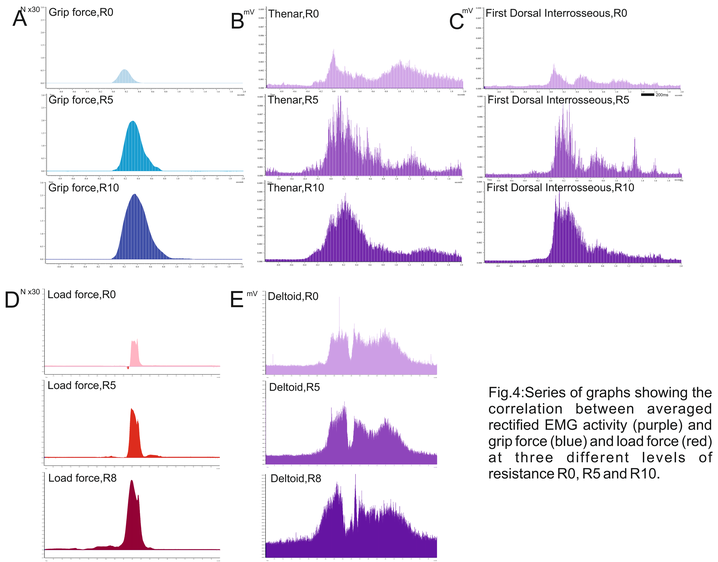


Fig.4:Series of graphs showing the correlation between averaged rectified EMG activity (purple) and grip force (blue) and load force (red) at three different levels of resistance R0, R5 and R10.

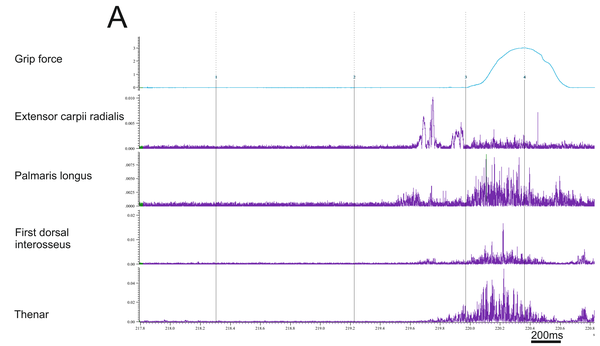
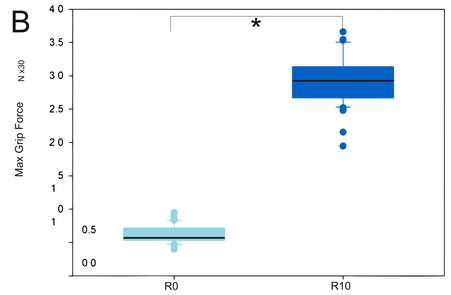
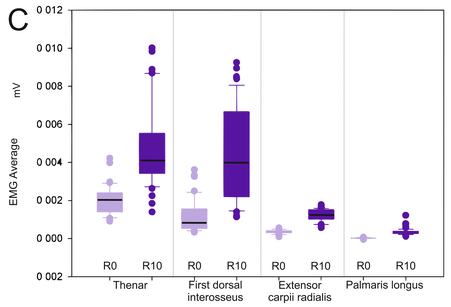


Fig.5 Quantification of maximal grip force and EMG activity:
Panel A: Methods of measurment:Averaged EMG activity between onset and max grip force corrected to background activtiy.
Panel B: Boxplot showing significant increase of maximal grip force at R0 (left) and R10 (right)
Panel C: EMG activity recorded in four muscles involved in the grip force at R0 (left) and at R10 (right)





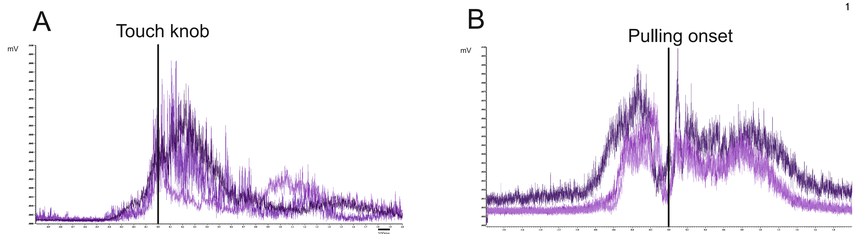


Fig.3: Superimposition of EMG activity recorded in distal muscle (Panel A) and in proximal muscle(Panel B) at three different levels of resistance. The preshaping activity is fairly constant despite the increase of resistance, particularly in Panel A.

RESULTS

Preliminary results show, as expected, a correlation between the increase of force required when the resistance to pulling was increased and the amplitude of the rectified EMG activity of the hand muscles used in the precision grip task.

Quantification of EMG activity shows a significant increase (Mann and Whitney $p<0.001$) of EMG activity in covariation with a significant increase of maximal grip force.

CONCLUSIONS

The present results provide a validation of the reach and grasp drawer task associated to EMG recordings, which is thus pertinent to assess effects of an inactivation of the primary motor cortex, performed either in human subjects (using transcranial magnetic stimulation) or in macaque monkeys (using GABA-A agonist inactivation).