"CALIBRATION METHODS FOR 2-DOF HAND-WRIST CONTROL"

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INTRODUCTION
Commercial prostheses often only control a single degree of freedom at a time (e.g. hand or wrist). Proportional, simultaneous and independent control of two degrees of freedom is desired [1]. Studies have related EMG to multiple degrees of freedom (DOFs) [2], primarily in able-bodied subjects. Advanced EMG-force models incorporate subject-specific and task-specific dynamics and are calibrated with durations upwards of 1-2 minutes. Additionally, high density electrode arrays that are often used in these studies are not practical for commercial use. Reducing the calibration duration and/or number of electrodes makes EMG-force modelling more feasible for commercial applications. In this study we focus on calibration duration as well as the relationship of the number of electrodes on EMG-force estimation error for two DOF (2-DoF) hand-wrist contractions.

METHOD
Subjects: 9 able-bodied subjects (5 males, 4 females aged 20-49 years), all underwent informed consent.

Apparatus: 16 conventional bipolar electrodes mounted circumferentially about proximal forearm, hand secured to three-axis load cell to measure wrist forces/movement. Fingers of the same hand secured to second single-axis load cell to measure hand open/close force.

Procedures: EMG-force data collection: measure maximum force in dominant arm using four different DoF wrist/hand motions; record 50% MVC and rest trials for EMG processing calibration; and four trials targeting random moving object on computer screen (2 training/2 testing).

RESULTS
Training from 1- and 2-DoF trials had the best performance for both 1-DoF and 2-DoF testing. There are many possible combinations but generally hand open/close coupled with wrist flexion/extension provided best results. Error progressively increased as training duration decreased, especially for durations less than 30 seconds. It was feasible to decrease the number of electrodes from 16 to 6 and trial durations as short as 38 seconds (per DoF) to keep %MVC error to a minimum.

DISCUSSION
Additional testing with limb-absent subjects is warranted and planned. Optimal electrode site location and down-selection requires further investigation, especially for limb-absent subjects [3].

CONCLUSION
Two-DoF control demonstrated similar error levels when compared to 1-DoF control. Two-DoF prostheses control with as few as 4 or 6 electrodes may be feasible. Calibration of 38 seconds per DoF required.

CLINICAL APPLICATIONS
Advanced calibration techniques could offer additional degree of freedom control for prostheses users.

REFERENCES

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