Validation of Online Intrinsic and Reflexive Joint Impedance Estimates using Correlation with EMG Measurements

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Background

Two state-of-the-art research lines towards voluntary modulation of reflexive activity in order to reduce spasticity:

EMG-based:
- Reduce muscle hyperreflexia
- Constant background activity
- Participants with spasticity

System Identification-based:
- Modulation reflexive impedance
- Constant intrinsic impedance
- Able-bodied participants

Can the system identification-based paradigm also be used by participants with spasticity? Potential improvements w.r.t. EMG:
- Participant comfort
- Target multiple muscles
- Faster training effects

Aim

Investigate linear association between the independently measured EMG- and system identification-based paradigms:

- Background EMG activity ⇔ Intrinsic joint stiffness
- Reflex EMG activity ⇔ Reflexive activity

Methods & Results

Protocol

• 3 male able-bodied subjects
• 1-DOF perturbations in sagittal plane of ankle joint

Consecutive 60s periods with constant subject behavior show the following associations:

- Background EMG Soleus ⇔ Intrinsic stiffness
- Reflex EMG Soleus ⇔ Reflexive gain

Normalisation per subject

Conclusions

Valid to use system identification-based approach in training paradigm to reduce muscle hyperreflexia give the large linear association between independent system identification and EMG measures.

Future Research

Recommendations for using system identification measures in training to reduce muscle hyperreflexia:

- Neutral torque task
- Focus on calf muscles

95% confidence intervals computed for four lower leg muscles and two torque target, via non-parametric bootstrap, show:

- Up to 86% shared variance for intrinsic pathway
- Up to 87% shared variance for reflexive pathway

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