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Validation of an online reflex activity measure for use in feedback training and clinical decision making

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1. Introduction

Many people with neurological impairments experience increased resistance in joints, which is caused by velocity dependent stretch hyperreflexia (spasticity), increased background muscle activity and/or altered tissue properties [1]. Medicines and surgery are often used to decrease hyperreflexia, but are invasive and often have limitations. Hyperreflexia may be decreased non-invasively using training, in which feedback is provided on reflex magnitudes [2,3]. For this purpose, a system identification (SI) method has been developed to quantify hyperreflexia online [4,5]. The SI method can additionally be used to separate hyperreflexia from the other components of increased joint resistance, which is essential information for clinical decision making [6]. This study aims to add to the validation of this SI method for use in training and clinical decision making.

2. Research Question

Can reflexes be quantified in real-time using system identification?

3. Methods

Twelve healthy participants (7 male, 21.3 ± 2.0y) participated in this study. Participants were seated in a chair with their right foot connected to a single axis actuator by means of a footplate. Ramp-and-hold perturbations of the ankle towards dorsiflexion (0.035 rad, max. 2.74 rad/s) were applied during three seated control conditions and two conditions known to enhance reflexes: experienced pain and Jendrassik manoeuvre (JM) [7]. The SI method [3] was used to quantify reflexes of the ankle joint, as well as intrinsic ankle joint resistance. Within-session repeatability was assessed by comparing SI outcomes from the three control conditions. Validity was analyzed by comparing SI reflexes with EMG reflexes, quantified as peak gastrocnemius lateralis EMG activity [5]. Likewise, correlation between SI intrinsic resistance and background EMG activity was analyzed [5]. In addition, construct validity was analyzed by assessing the effect of pain and JM using paired-samples t-tests.

4. Results

Both SI and EMG reflexes were significantly higher during the pain

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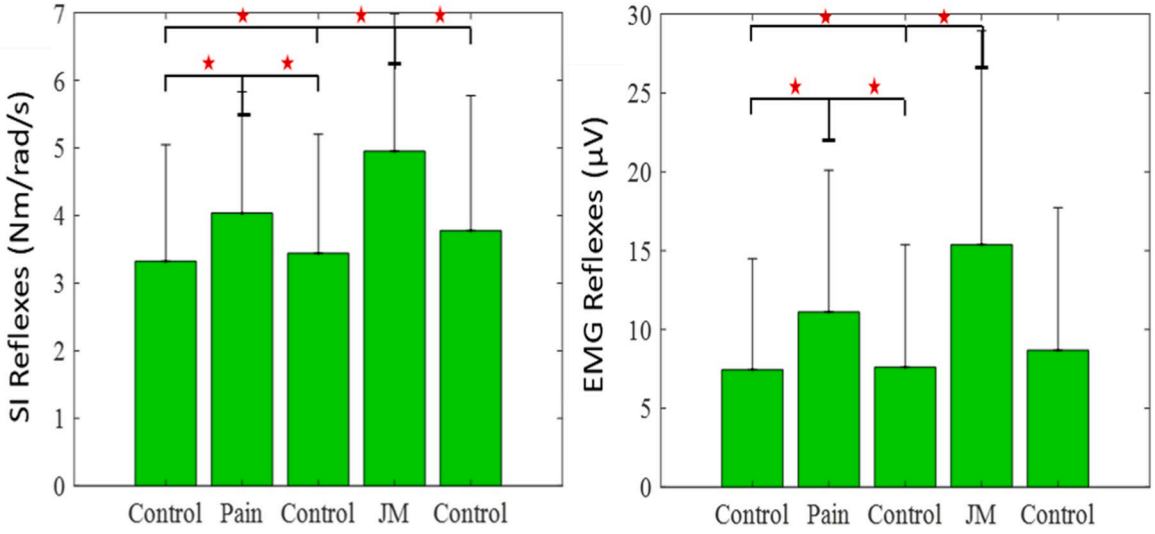
and JM condition compared to control conditions (see figure). SI reflexes showed moderate-high correlations with EMG reflexes (r = 0.84), as well as high within-session repeatability (r = 0.97). SI intrinsic resistance showed moderate-high within-session repeatability (r = 0.86), but no significant correlation with EMG background activity.

Picture 1 - "Flux_Esmac"



5. Discussion

The SI method appears valid for use in training, since it can detect differences in reflex magnitude within-sessions and shows a high within-session repeatability. Intrinsic resistance consists of tissue properties and background activity and was therefore expected to correlate with background EMG. Contradictory, this correlation was absent, which is in contrast with previous findings [5]. Further research should study the distinctive possibilities between hyperreflexia and intrinsic resistance, for example by including conditions which influence tissue properties and conditions with different levels of background activity. Furthermore, a reliability study should be performed to assess repeatability of the SI method in patient populations, before it can be decided to use in clinical decision making or training evaluation.

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