**The Resistance of a Knee Joint to Externally Imposed Movement in Patients with Cerebral Palsy**

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## Introduction

The velocity dependence of stretch reflexes is a most common feature of human spasticity. The clinical tests used to evaluate the resistance of a joint are subjective, especially in children. The application of the complex, torque devices to quantify spasticity in clinical settings is limited. The aim of this study was to determine whether (1) the hand-held force transducer and an electrogoniometers can be used to measure the resistance of a knee joint in patients with cerebral palsy at different velocities and (2) the different types of resistance can be differentiated with the methods.

## Statement of Clinical Significance

The clinical criteria for treatment selection in patients with spasticity are subjective and the treatment is often not effective. The abnormal tone in patients may be affected by the increased short and long latency reflexes, dystonia, rigidity and/or the joint's dynamics. The complex torque devices [1,2] used to quantify the resistance has limited application in the clinical settings. The simple measurement method shows potential not only in the quantification of resistance, but also to differentiate the different types of abnormal tone. Different gait patterns [3] were reported in children with cerebral palsy, however their link to the changes at the structural level of a knee joint has not been reported in patients with cerebral palsy with quantitative methods. The treatment may be more effective if its choice is based on the more precise, neurophysiological criteria.

## Methodology

The lower leg of a subject sitting on a special table was pulled in knee flexion and next extension, with a hand-held force transducer, while knee motion was measured with the electrogoniometer at different velocities ranging from 0.2 to 8 rad $s^{-1}$. EMG signals from the rectus femoris and medial hamstrings muscles were collected with surface electrodes. The relations between velocity and: the resistance at the beginning of motion, work done to move a limb, and maximum activation of the rectus femoris and hamstrings muscles were calculated. The characteristic points of the Tardie test were also calculated. The data were collected in 17 patients with cerebral palsy and in 20 able-bodied subjects.

## Results

The regression equations and correlation between the velocity of passive flexion are shown in Table 1 and the distribution of different types of abnormal resistance in Fig. 1.

## Discussion

The differences between resistance and work between patients and controls found in our study were similar to the differences reported with the application of complex torque devices [1,2]. Our study showed that the EMG parameters differentiate better than stiffness and work for patients vs. controls. Not only Ashword, but also the Tardie scale can be quantified with the simple measurement method. The small differences of biomechanical parameters between

Table 1. The relation between the biomechanical and EMG parameters of resistance as a function of velocity v of a passive knee flexion

| | Controls | | Patients | |
|---|---|---|---|---|
| | Regression | Correlation | Regression | Correlation |
| Stiffness | -1 + 3 v | 0.8 * | 0.34 + 3.4 v | 0.58 * |
| Work | 0.34 + 0.08 v | 0.63 * | 0.48 + 0.08 v | 0.71 * |
| Catch | 1.58 + 0.14 v | 0.14 | 1.42 + 0.04 v | 0.28 * |
| Tq_catch | 0.014 + 0.31 v | 0.78 * | 0.83 + 0.12 v | 0.32 * |
| R2 | 1.6 + 0.14 v | 0.74 * | 1.39 + 0.14 v | 0.62 * |
| Tq_R2 | 0.44 + 0.08 v | 0.33 * | 0.99 + 0.006 v | 0.002 |
| RecFem | 5.6 – 0.12 v | -0.06 | 32.7 + 3.2 v | 0.14 * |
| Hams | 14.5 – 0.91 v | -0.19 | 41 – 3v | 0.23 * |

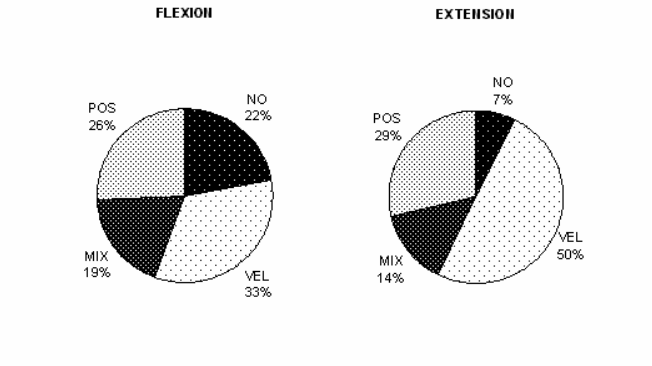


Figure 1. The distribution of four types of resistance in patients with cerebral palsy

VEL - velocity dependent muscle activation
POS - position dependent muscle activation
MIX - neither velocity nor position dependent activation
NO - no muscle activation

patients vs. controls may be related to the large variability of the data in patients. The nonhomogenity of the patients with cerebral palsy has been confirmed by the identification of different types of abnormal resistance. The different types of abnormal resistance have not been previously reported in patients with cerebral palsy. The velocity and position dependent activation of the antagonist muscle which was most commonly observed in our patients (Fig. 1) was previously reported in patients with other types of spasticity [4], but it was not found in patients with cerebral palsy [5].

It seems that different types of resistance at the structural level of a knee joint may affect differently knee motion during walking. The contribution of different types of resistance to different walking patterns [3] in patients with cerebral palsy is now under investigation in a larger population of patients.

**References**

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