Torque-angle curves in patients with neurological motor impairment: a preliminary study

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Summary

Torque-angle curves are poorly described in patients with neurological motor impairment. In the current study, shoulder internal-external rotation and elbow flexion-extension isokinetic torques were recorded at 30°/s in concentric and eccentric modes in patients with subacute or chronic stroke (n=5) or multiple sclerosis (n=2), with spasticity ≤3/4 and muscle strength ≤3/5, on the Ashworth and MRC scale, respectively. Joint amplitude restrictions were observed unsystematically in spastic patients. Torque amplitudes seemed largely dependent on MRC grades. Unexplained inter-patient optimal angle differences were observed. Eccentric torques were usually greater than concentric torques.

Introduction

Upper limb motor impairments due to neurological conditions are common and can lead to dependency. Evidence is emerging that force training on isokinetic ergometers, i.e. at a controlled speed over a joint's full range of motion (ROM), improves patients' isometric peak torques and functional abilities (1). However, existing literature rarely describes torque-angle curves in patients (2), while specifying patients' needs could open up prospects for therapeutic improvement. The goal of this study is to describe torque-angle curves depending on patients' clinical spasticity and muscle strength.

Methods

After approval from the ethics committee (2024-A01007-40), the first 7 of 60 planned patients (5 females, 2 males, 55.7±16.6 years, 163.6±9.8 cm, 62.9±9.2 kg), hospitalized at one rehabilitation center for subacute or chronic stroke (n=5) or multiple sclerosis (n=2) were included. The selection criteria were spasticity ≤3/4 on the Ashworth scale and muscle strength ≤3/5 on the Medical Research Council (MRC) scale.

Maximal torques were measured using a Con-Trex® ergometer during 5 repetitions of shoulder internal-external rotation at 45°in the scapula plane, then 5 repetitions of elbow flexion-extension. The ROMs were explored at an angular speed of 30°/s successively during concentric, then eccentric muscle contractions. Patients' positioning, stabilization, as well as resting procedures were standardized according to the ergometer's manual guidelines.

Data were processed using MATLAB software v. R2023b. Equivalence between angles displayed by the ergometer and joint angles was established by goniometric measurement of the joint angle at a known ergometer position. Torques were filtered using a 4th-order Butterworth filter in the angle domain, first with a band-stop filter (cutoff frequencies 0.153-0.173/° and 0.316-0.336/° to remove a known ergometer's geometric artifact) and then with a low-pass filter (cutoff frequency 0.5/°, 15 Hz equivalent). The ergometers' default gravity correction was applied and the residual offset resulting from ergometer friction was corrected.

Results and Discussion

Ashworth 2 spastic patients had joint amplitudes close to those of non-spastic patients, or restricted by up to 2/3. (e.g., Figure 1). Most curves were ordered similarly to the MRC grade, with amplitudes varying from simple to triple for the same grade. Most curves were convex, with unexplained differences in optimum angle. As in healthy subjects, eccentric torques were usually greater than concentric torques.

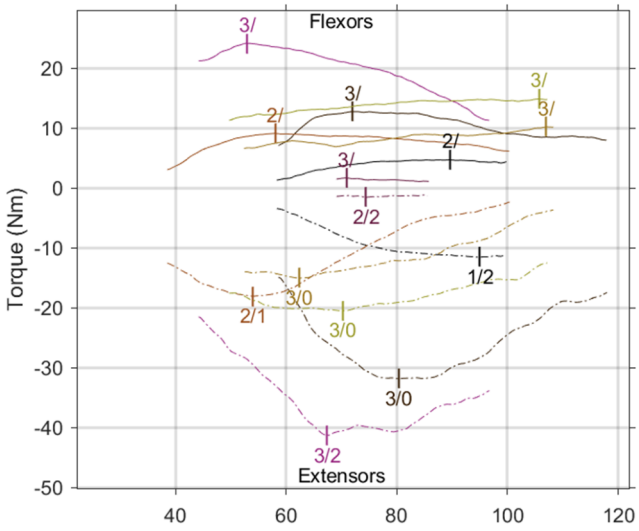

Figure 1: Torques generated during elbow flexion, during active concentric (solid lines) or eccentric (dotted lines) contractions. Each color represents a patient. Vertical bars: optimum angles. Labels: MRC grade/antagonist muscles' Ashworth grade when available

Conclusions

Curve of different ROM, shape and amplitude were observed for similar clinical spasticity and strength grades. It would be interesting to work on our full dataset to better describe the links between ergometric and clinical assessments.

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References

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