EFFECT OF A FATIGUING PROTOCOL ON MAXIMAL AND RAPID FORCE PRODUCTION IN PERSONS WITH PARKINSON'S DISEASE AND OLDER ADULTS

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Introduction

Persons with Parkinson's Disease (PD) experience neuromuscular disruption leading to resting tremor and bradykinesia (Figure 1). In comparison to non-impaired older adults (OA), they may exhibit a difference in muscle activation while performing maximal contractions[1-3].

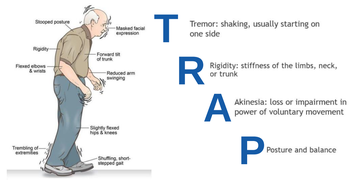


Figure 1. Description of symptoms of Parkinson's Disease

Individuals with PD exhibit fatigue resistance across repeated contractions[4-5], which could be due to substantial type-1 motor unit reorganization compared to age-matched OA[3]. Because of the potential shift in fiber type, peak torque and rate of torque development may be reduced in PD compared to OA[6]. Further, fatigue resistance may be observed in the PD compared to the OA.

The purpose of this study was to determine the effect of a fatiguing isometric knee extension protocol on maximal force and rapid force production in persons with PD and non-impaired older adults.

Methods

Twenty individuals (PD=11, OA=9) volunteered for this study. Following a warm-up and familiarization, participants performed two maximal isometric Contractions (MVIC) of the knee extensors. Following a recovery period, participants completed a fatiguing protocol that consisted of 5-sec maximal isometric voluntary contractions of the quadriceps femoris with 5-sec rest for a total of 30 contractions. During this fatiguing protocol, participants were instructed to push their leg against the cuff (activating their quadriceps muscles) as hard and as fast as they could.



Figure 2. Illustration of the Biodex and EMG placement

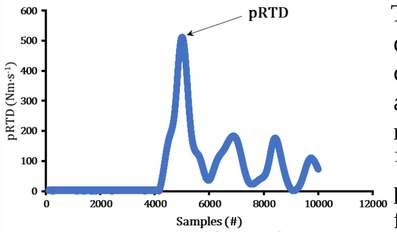


Figure 3. pRTD from first order derivative torque signal

The highest torque (Nm) achieved during the first, middle, and last contraction was calculated and defined as peak torque (PT). Additionally, peak rate of force development (pRFD; Nm/s^{-1}) was assessed as the highest positive peak using the first derivative of the force signal and determined as the highest rate of change in the force time curve (Figure 3). PT and pRTD were normalized (PTn and pRTDn, respectively) to the maximal PT and pRTD collected from the highest MVIC contraction. Fatigue in PT, PTn, pRTD, and pRTDn was calculated as a percent decline using the following equation: %decline=100–100(last Repetition/Initial Repetition). Independent samples t-tests were conducted to investigate the differences in %decline in the PD and OA groups. Separate 2 (Group) × 3 (Contraction) repeated measures ANOVA were run to investigate the differences in PT, PTn, pRTD, and pRTDn between the PD and OA group during the fatiguing knee extension protocol.

Results

Statistical analysis revealed a significant difference in %decline in pRTD (PD: 3.1±55.5 vs. OA: -150.3 ± 143.8, p = 0.017) but not in PT (PD: 31.5 ± 18.3 vs. OA: 33.7 ± 17.0, p = 0.611), PTn (PD: 13.9 ± 28.2 vs. OA: 13.3 ± 45.4, p = .195), pRTDn (PD: 26.6 ± 41.4 vs. OA: -27.7 ± 96.6 p = 0.950) (Figure 4).

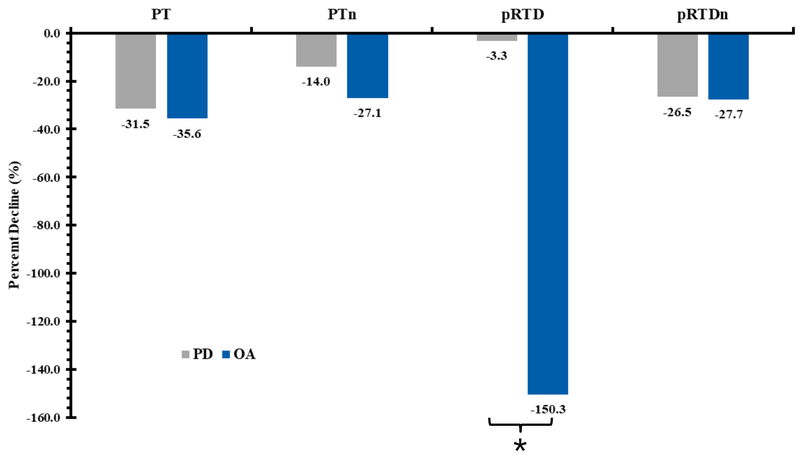


Figure 4. Percent decline in PT, PTn, pRTD, and pRTDn in Parkinson's Disease individuals and older adults. * = Significant difference between PD and OA (p≤0.05); peak torque (PT), normalized peak torque (PTn), peak rate of torque development (pRTD), normalized peak rate of torque development (pRTDn).

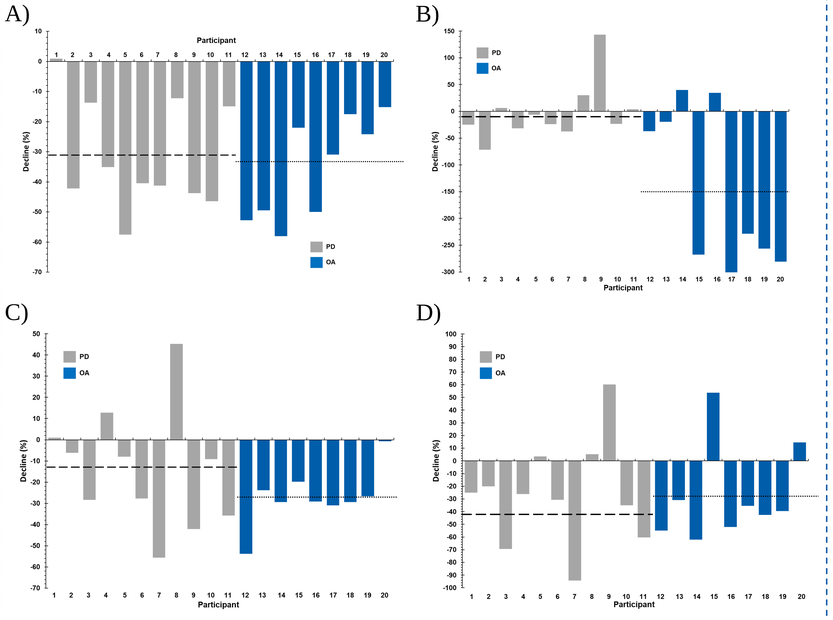


Figure 5. Individual percent decline in PD (gray) and OA (Blue) in **A)** PT, **B)** pRTD, **C)** PTn, and **D)** pRTDn across the thirty repetitions; peak torque (PT), normalized peak torque (PTn), peak rate of torque development (pRTD), normalized peak rate of torque development (pRTDn). Black dashed line represents the average decline in PD and the black dotted line represents the average decline in OA.

There was no group × time interaction for PT (p=0.806), PTn (p=0.774), pRTD (p=0.871), or pRTDn (p=0.945). However, a significant main effect for time was revealed in PT (First rep: 135.1 ± 40.9 Nm vs. Middle rep: 116.8 ± 32.6 Nm vs. Last rep: 102.9 ± 26.8 Nm, p=0.001), PTn (First rep: 1.1 ± 0.5 Nm/MVIC vs. Middle rep: 0.9 ± 0.4 Nm/MVIC vs. Last rep: 0.8 ± 0.4 Nm/MVIC, p ≤ 0.001), pRTD (First rep: 795.9 ± 624.3 Nm/s^{-1} vs. Middle rep: 535.1 ± 413.5 Nm/s^{-1} vs. Last rep: 497.6 ± 396.2 Nm/s^{-1}, p = 0.015), and pRTDn (First rep: 7.1 ± 3.2 Nm/s^{-1} vs. Middle rep: 4.9 ± 5.8 Nm/s^{-1} vs. Last rep: 4.5 ± 5.3 Nm/s^{-1}, p = 0.024) (Figure 6).

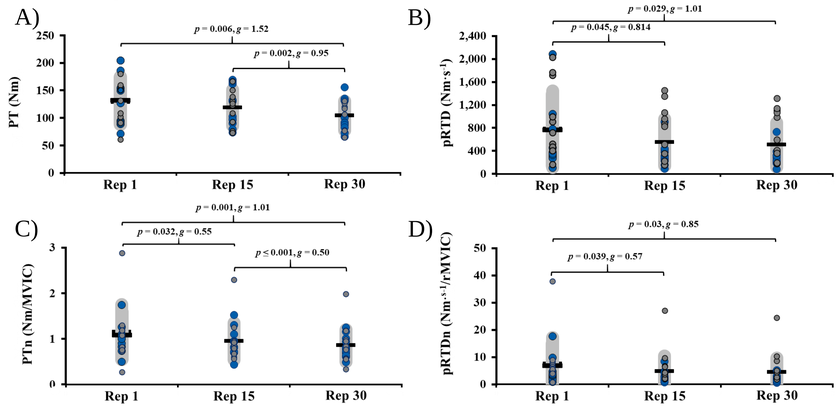


Figure 6. Paired samples t-tests between Rep 1, Rep 15, and Rep 30 in **A)** PT, **B)** pRTD, **C)** PTn, **D)** pRTDn; peak torque (PT), normalized peak torque (PTn), peak rate of torque development (pRTD), normalized peak rate of torque development (pRTDn). Gray dots represent OA. Blue dots represent persons with PD.

Conclusions

These data demonstrate a significant difference in pRTD fatigue between the PD and OA groups. However, the difference is negated when pRTD is normalized to account for PT (pRTDn). The elimination of the differences in pRTDn could be due to the PD having an impaired capacity for rapid torque production compared to OA. These data suggest that the potential fiber type shift in the PD group may contribute to fatigue resistance[5]. The % decline in PT is similar in PD compared to the OA. However, pRTD % decline is greater in the PD compared to the OA suggesting that PD may influence RTD to a greater extent than PT production.

Practical Applications

Coaches, clinicians, and practitioners may use the reduction in the rate of torque production in older adults and persons with Parkinson's Disease following a fatiguing protocol to improve exercise programing.

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