FORCE OUTPUT IS MORE VARIABLE IN PATIENTS WITH PERIPHERAL ARTERIAL DISEASE

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INTRODUCTION

Peripheral arterial disease (PAD) is a major vascular disease affecting 8 to 12 million people in the United States. This disease is characterized by atherosclerosis in the lower extremity arteries and pain in the legs known as claudication. Patients with PAD have altered baseline gait as compared to healthy controls [1]. Walking is a complex interaction between nervous, muscular, and cardiovascular systems. In patients with PAD, the cardiovascular system is compromised due to lower extremity arterial blockages that reduce blood flow to the muscles in the legs. Previous studies have shown abnormal ankle moment and power in patients with PAD [2-6]. These altered parameters may be caused by insufficient ability of the plantarflexors to generate muscle force. Thus, the purpose of this study was to investigate muscular strength profiles in patients with PAD as compared to healthy age-matched controls.

Patients with PAD have poorer physical functioning than healthy controls, which coincides with reduced muscular strength and power at the ankle, knee, and hip [2-6]. Patients with PAD also have reduced cross-sectional area of muscle tissue, reduced nerve conduction velocity [6], and a decrease in type II (fast twitch) muscle fibers, which could lead to decreased muscular strength [7]. While much work has been done investigating muscular strength, there is little work that looks past peak maximal muscular strength. Walking however, is not a task requiring maximal effort. Therefore, this study investigated more comprehensive variables of muscular function including average, timing, and variability measures of force profiles. These measures were compared to healthy controls.

METHODS

Eight patients with PAD (age: 67.0 ± 7.0 yrs; height: 175.1 ± 9.0 cm; mass: 87.9 ± 13.6 kg) and eight age-matched controls (age: 66.9 ± 7.1 yrs; height: 176.0 ± 3.1 cm; mass: 86.7 ± 14.5 kg) performed isometric plantarflexion and dorsiflexion testing using a dynamometer (System 3.0; Biodex Medical Systems, Shirley, NY). Two maximal repetitions of isometric plantarflexion were performed for a duration of ten seconds for each repetition. Strength of patients with PAD was captured while they experienced claudication pain. To induce claudication, patients with PAD walked until the onset of claudication pain on a treadmill set at 0.67 m/s and 10% incline. Dependent variables during strength testing included peak torque, time to peak torque, average torque, and standard deviation of torque during the linear region. Average and standard deviation were calculated for the linear region of each trial as shown in Figure 2. Significant differences between patients with PAD and healthy controls for each variable were determined using independent t-tests (α = 0.05).

RESULTS AND DISCUSSION

Significant differences between controls and PAD patients were discovered at peak torque (76.6 ± 17.4 ft*lbs and 56.9 ± 18.2 ft*lbs, p = 0.04), average torque during the linear region (72.5 ± 17.3 ft*lbs and 52.4 ± 18.9 ft*lbs, p = 0.04), and standard deviation of torque during the linear region (1.36 ± 0.5 ft*lbs and 2.6 ± 1.3 ft*lbs, p = 0.02, Figure 1). Patients with PAD were not able to generate as much maximum force during isometric plantarflexion as healthy controls. Furthermore, during the linear region, patients with PAD generated lower and more variable torque.
There was no significant difference between controls and patients with PAD in time to peak torque (6.1 ± 3.2 s and 5.7 ± 2.8 s, p = 0.82).

The finding that healthy controls are able to generate more force than patients with PAD is consistent with the literature [2-6]. However the key finding from this study shows that patients with PAD demonstrate more variable force output during plantarflexion as shown by an increased standard deviation. This finding may explain why patients with PAD have altered ankle moment and power during walking [2-6].

CONCLUSIONS

The present study shows that patients with PAD cannot generate peak plantarflexor force similar to healthy controls. In addition their force output is significantly decreased and more variable than controls during the linear region. Overall, strength profiles are consistent with gait alterations seen in patients with PAD, specifically reduced ankle moment values and power generation compared with age-matched healthy controls.

REFERENCES