

# BILATERAL INTERMITTENT CLAUDICATION AFFECTS JOINT POWERS DURING GAIT

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## INTRODUCTION

Peripheral arterial disease (PAD) affects over 10 million people in US and is a manifestation of atherosclerosis leading to decreased blood flow to the legs. Claudication is the primary PAD symptom resulting in a cramping pain in the legs that significantly limits the ability of these patients to walk resulting in significant disability. Our previous work suggested that ground reaction forces, joint kinematics, and joint moments are altered in patients with unilateral PAD as compared to controls (Scott-Pandorf et al, 2007; Chen et al, 2008). These gait alterations are present even before the onset of claudication and variably worsen with the onset of claudication pain. The present investigation extends this previous research work to the evaluation of joint powers in patients with bilateral PAD. We hypothesized that the joint powers of these patients will be different compared to healthy matched controls and that they would become worse after the onset of claudication pain.

## METHODS AND PROCEDURES

Thirteen (age:  $64.46 \pm 8.47$  years) patients with bilateral PAD and ten healthy gender-height-age matched (age:  $67.23 \pm 12.67$  years) controls walked on a 10 meter walkway over an embedded Kistler force platform while kinetics and kinematics were recorded using a Motion Analysis system. Five trials were captured for each leg during pain free PAD-

PF (prior to claudication onset) and pain induced PAD-P (after claudication onset) conditions. The PAD-PF condition was acquired first. During this condition, rest periods were required between trials. Then, claudication was induced by having patients walk on a treadmill set at 10% grade and 0.67 m/s until the onset of pain. At this point the patients were moved immediately back to the walkway, where the PAD-P condition was collected with no rest between trials. Hip, knee, and ankle joint powers were calculated from the ground reaction forces and kinematics during the stance phase. The maximum power absorption and generation were identified for the hip, knee, and ankle joints. T-tests were used to compare the PAD-PF and PAD-P conditions to the healthy controls, and between the PAD-PF to PAD-P conditions.

## RESULTS

Patients in both PAD-PF and PAD-P conditions showed significantly ( $p < 0.05$ ) less power generation at the ankle at terminal stance, less power generation at the knee at midstance and less power generation at the hip at early stance, as compared to controls (Fig. 1). In the PAD-P condition, patients showed significantly less power generation at the ankle at terminal stance, less power absorption at the knee at late stance and more power generation at the hip at late stance, as compared to the PAD-PF condition.

## DISCUSSION

Our data demonstrate that PAD patients have insufficient ankle muscular strength to push off during late stance and this weakness worsens after onset of claudication pain. The current findings may be the result of the myopathy and neuropathy described in PAD limbs at the cellular level due to chronic and repetitive ischemia (Pipinos et al, 2008). The combined changes observed in the three joints provide a better understanding for the instability of the PAD patients. Several of these alterations (such as the reduction of knee power generation and the joint power redistribution after onset of claudication) but not all (reduced hip power generation at early stance) are similar to those observed in elderly individuals (DeVita et al, 2000 and Kerrigan et al, 1998). The similarity of the aging and PAD gait may be attributed to a similar neuromuscular deterioration in the lower limbs or heretofore unrecognized incidence of PAD in the elderly population. Such an association makes further evaluation of gait in elderly patients with and without PAD extremely important, and is the object of research work currently in progress in our laboratory. Furthermore, we are also exploring what adaptations are present in unilateral PAD patients (only one leg with atherosclerotic occlusions) and patients with unifocal and multifocal disease. This research will provide the foundation for the development and evaluation of the treatment methodologies currently used for PAD.

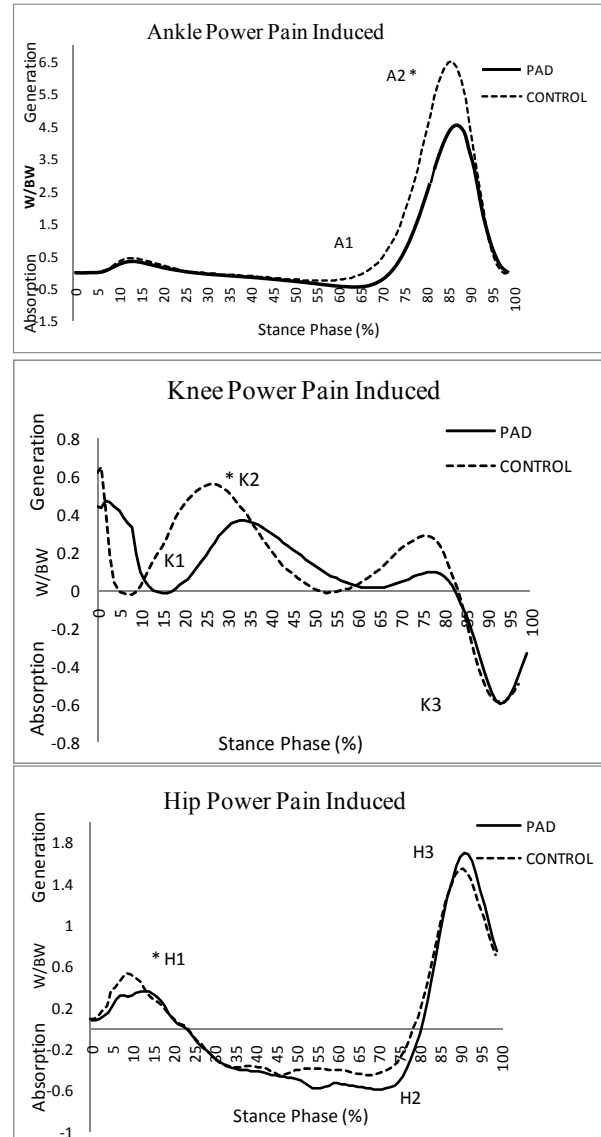
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**Figure 1.** Mean ensemble joint power curves for the ankle, knee and hip for the Controls and the PAD group in the pain condition.