LARGE KNEE ADDUCTION MOMENTS DURING GAIT ARE RELATED TO WEAK KNEE EXTENSORS IN PARTIAL MENISCECTOMY PATIENTS

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INTRODUCTION

Mechanical joint loading is believed to contribute to the development of osteoarthritis (OA) (Radin, 1982). Larger than normal knee adduction moments during the stance phase of gait would generate large loads on the medial articular surfaces of the tibiofemoral (TF) joint (Schipplein & Andriacchi, 1991), and have been shown to accelerate progression of TF OA (Miyazaki et al., 2002). Although knee strength has been correlated with sagittal plane knee loading, the contribution of muscular strength to frontal plane knee loading during gait is undetermined. This study aimed to investigate variations in walking gait patterns in a population of people at increased risk of TF OA, and determine the influence of knee strength on knee joint loading in the frontal plane. It was hypothesised that arthroscopic partial meniscectomy (APM) patients would have reduced muscular strength about the knee that would be associated with large knee adduction moments.

METHODS

Three-dimensional gait analysis, using a 50 Hz VICON motion analysis system, was performed on 107 patients who had recently undergone APM, and 49 healthy controls (CON), walking at a freely-chosen velocity. Gait data included: lower limb joint and segment motion; ground reaction forces (GRFs); lower limb joint moments, powers and work. Three-dimensional kinematics and kinetics were calculated using a custom seven-segment lower limb model. Knee range of motion (ROM) was calculated as the difference between the knee angle at heel strike and the peak knee angle during midstance. External joint moments were normalised to individual's height*weight, then analysed over the stance phase of gait. Subjects also underwent knee strength testing on a Biodex isokinetic dynamometer. Isometric knee flexion and extension strength was tested at 75 and 45 degrees of knee flexion, respectively. Weak knee extension strength was defined as less than one standard deviation below the mean of CON knee extension strength. Data were statistically tested using two-way repeated measures ANOVA, Bonferroni corrected for multiple comparisons, with a p value of 0.05.

RESULTS AND DISCUSSION

Gait velocity was not significantly different between APM and CON groups. Knee flexion strength was similar between groups, while APM subjects displayed weaker normalised knee extension strength compared to CON ($p<0.04$). The APM group also had larger knee adduction moments than CON ($p<0.05$), whilst knee flexion moments were similar between groups ($p=0.08$). Twenty-five percent of the APM group were categorised as weak, compared to 15% of CON.

Subjects categorised as weak, with respect to knee extension strength, had significantly higher stance-phase knee adduction moments ($p<0.05$), particularly during early stance (Figure 1), which cannot be accounted for by GRFs, as these were not different between weak and normal groups. Larger knee adduction moments are likely to place larger loads on the medial compartment of the TF joint and may require increased muscle activity for joint stabilisation.

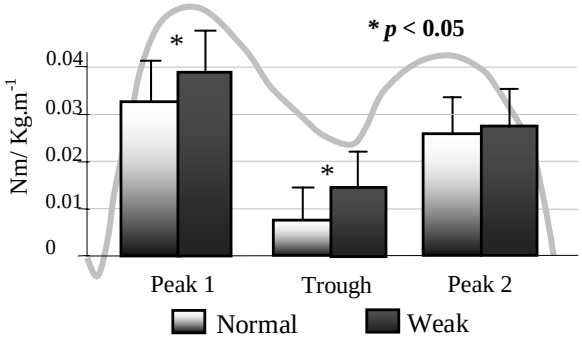

Figure 1: Stance phase knee adduction moments in subjects with "Normal" and "Weak" knee extension strength

Subjects with weak knee extension strength also had reduced ROM at the knee ($p<0.02$), which may be characteristic of a 'stiff' walking gait. The knee adduction moment was negatively correlated with the knee ROM measure, particularly at midstance ($r=0.324$). Limited knee flexion during weight acceptance would provide less shock attenuation at the knee and perhaps contribute to a varus 'buckling' response. This requires further investigation.

SUMMARY

This study demonstrates a negative relationship between knee extension strength and knee adduction moments over stance phase of walking gait. The data suggest a post-APM population experience larger knee adduction moments while walking, particularly those with weak knee extensors who have reduced knee ROM during stance phase. As the knee adduction moment tends to transfer more of the TF joint reaction force onto the medial compartment, these patients might be at increased risk of degenerative joint disease.

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