INTERACTION BETWEEN MASS AND ALIGNMENT ON KNEE ADDUCTION MOMENT IN PATIENTS WITH KNEE OSTEOARTHRITIS

[1]Rebecca Moyer, [1]Trevor Birmingham, [1]Crystal Kean, [1]Ian Jones, [1]Thomas Jenkyn, [1]Bert M Chesworth, [1]J Robert Giffin
[1]Wolf Orthopaedic Biomechanics Laboratory, Fowler Kennedy Sport Medicine Clinic, University of Western Ontario, London, ON
Email: rmoyer@uwo.ca

INTRODUCTION

Knee osteoarthritis (OA) is a leading cause of pain, disability and health care use. The need to better understand risk factors, and their mechanisms, for progression of the disease is paramount. There is some evidence to suggest that the effect of BMI on the development and/or progression of knee OA depends on lower limb alignment [1,2,3].

Although the results of clinical studies evaluating this potential interaction have been inconsistent, authors have consistently suggested that the likely mechanism is due to increased focal loading of the medial compartment of the knee.

The external adduction moment about the knee during walking is a valid proxy for the dynamic load on the joint's medial compartment [4]. The magnitude of the knee adduction moment (KAM) is a potent risk factor for progression of OA [5]. Body mass and varus alignment of the lower limb contribute to the KAM and are the targets of various treatment strategies.

The purpose of the present study was to evaluate the interaction between mass and alignment when predicting the KAM in patients with knee OA. We hypothesized that the effect of body mass on the KAM would be moderated by the extent of limb malalignment.

METHODS

354 patients with knee OA were recruited from a cohort of patients being screened for participation in a prospective study of osteotomy procedures. Patients underwent 3-D gait analysis using an 8-camera motion capture system and modified Helen Hayes markers set (Eagle EvaRT; MAC, Santa Rosa, CA) synchronized with a single floor-mounted force plate (AMTI, Watertown, MA).

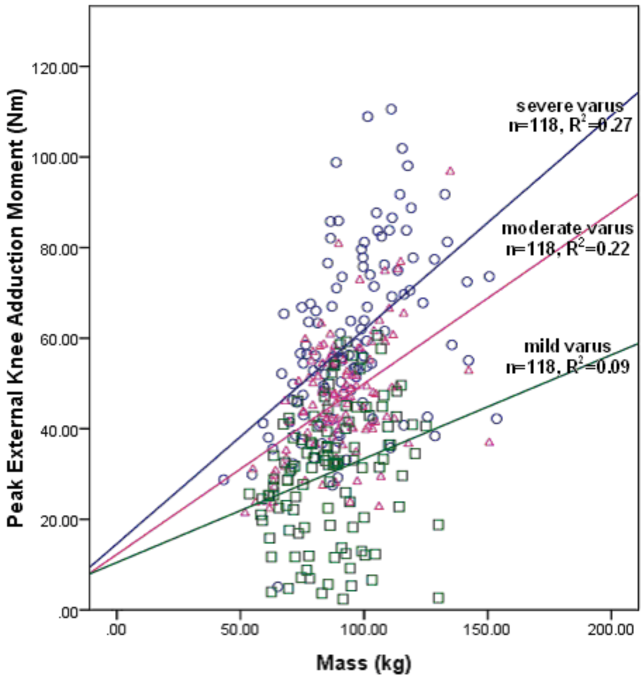

Figure 1: Scatterplot illustrating the relationship between mass and knee adduction moment for patients with different extents of malalignment.

The peak KAM (Nm) was calculated from the kinematic (60Hz) and kinetic (1200Hz) data using commercial software (Orthotrak 6.2.4; MAC, Santa Rosa, CA) and custom post-processing techniques. Gait speed, toe out and lateral trunk lean were also determined. Body mass (kg) and height (m) were measured prior to gait testing. Frontal plane alignment was quantified using the mechanical axis (hip-knee-ankle) angle (deg) measured from standing long-cassette radiographs.

We tested for effect modification by entering the interaction term (mass*mechanical axis angle) into a linear regression model predicting peak knee adduction moment (Equation 1).

(Equation 1)

KAM = height + speed + toe-out + trunk-lean + mass + alignment + mass*alignment

We then split the sample into three subgroups based on tertiles for mechanical axis angle and evaluated the relationship between mass and knee adduction moment for each subgroup using simple linear regression.

RESULTS AND DISCUSSION

The interaction term (mass*mechanical axis angle) significantly ($p=0.04$) contributed to a model predicting the KAM while controlling for height, gait speed, toe out, trunk lean, mass and mechanical axis angle (Total $R^2=0.67$). In patients with severe varus alignment (≥9deg) KAM increased 0.47 Nm for every 1kg increase in mass. In patients with moderate varus alignment (4.80 to 8.99deg) KAM increased 0.38 Nm for every 1kg increase in mass. In patients with mild varus alignment (≤4.79deg) KAM increased 0.23 Nm for every 1kg increase in mass (Figure 1, Table 1).

CONCLUSIONS

These findings illustrate that there is a significant interaction between mass and alignment when using these two variables to predict medial compartment loading during walking in patients with knee OA. As we hypothesized, the effect of body mass on the KAM depends on the extent of limb malalignment. Those with greatest malalignment exhibit the greatest association between mass and peak knee adduction moment. Individuals with both increased mass and increased malalignment may benefit most from earlier intervention strategies intended to decrease dynamic knee joint loads.

REFERENCES

1. Felson DT, et al. *Arthritis and Rheumatism* **50**(12), 3904-3909, 2004.
2. Sharma L, et al. *Arthritis and Rheumatism* **43**(3), 568-575, 2000.
3. Niu J, et al. *Arthritis and Rheumatism* **61**(3), 329-335, 2009.
4. Andriacchi TP and Mundermann A. *Current Opinion in Rheumatology* **18**, 514-518, 2006.
5. Miyazaki T, et al. *Annals of the Rheumatic Diseases* **61**, 617-622, 2002.

Table 1: The un-standardized regression coefficient values with 95% confidence intervals for each of the three subgroups.

Alignment (deg)	β	95% CI
Severe Varus (n=118)	0.47	0.33-0.62
Moderate Varus (n=118)	0.38	0.25-0.5
Mild Varus (n=118)	0.23	0.09-0.37