

The Relationship between Hip and Knee Kinematics to the Knee Adduction Moment in Asymptomatic Individuals with Genu Varum

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INTRODUCTION

Medial knee osteoarthritis (OA) is a common and disabling condition, affecting millions of Americans. It has been shown to be associated with genu varus (GV) alignment, as well as an increased knee adduction and a high knee adduction moment (KEAM) during gait (Sharma et al, 2001; Baliunas et al, 2002). It was recently reported that adults with genu varus (GV), but with otherwise healthy knees, are at a two-fold increased risk for later developing medial knee OA (Brouwer et al., 2007). It is possible that these individuals, like those with medial knee OA, also exhibit mechanics associated with a high KEAM. GV alignment is likely to be associated with hip abduction (or reduced hip ADD) and external rotation (ER) and knee adduction (ADD) and ER. These motions, in turn, may be associated with the KEAM. Understanding these mechanics may lend insight into the increased risk of developing knee OA. However, the gait mechanics of these individuals have not been studied.

Therefore, the purpose of this study was to assess the relationship between the frontal and transverse plane motions of the hip and knee with KEAM. The focus of this study is on individuals with GV, but no evidence of knee OA. We hypothesized that since the KEAM is a frontal plane moment, frontal plane kinematics would be more closely related to it than the transverse plane kinematics.

METHODS

To ensure that the individuals with GV were asymptomatic, they completed the Sports and

Recreational Activities subscale of the Knee Injury and Osteoarthritis Outcome Score Knee Survey (KOOS) (Roos et al., 1998). A score of $\leq 2/20$, where 0/20 means no symptoms and 20/20 means extreme symptoms, was needed to qualify for the study. To be classified with GV, the frontal plane mechanical axis of the tibia was measured using a caliper-inclinometer device (Hinman et al., 2006). A value of $\geq 11^\circ$ from vertical was needed to qualify for the study.

To assess gait mechanics, retro-reflective markers were placed on the lower extremity with greater GV. Three-dimensional motion analysis was performed as the subject walked at a controlled speed at 1.46 m/s ($\pm 5\%$) along a 25 m walkway. Kinematic data were captured using an 8-camera VICON motion analysis system (120 Hz). Kinetic data were captured using a Bertec force platform (1080 Hz). Five usable trials were collected for each subject. Data was processed and analyzed using Visual 3D and custom Labview software. The frontal and transverse plane hip and knee kinematics at the time of the first peak of the KEAM (Figure 1) were extracted for each trial, and then averaged for each subject. These four variables were then correlated to the KEAM.

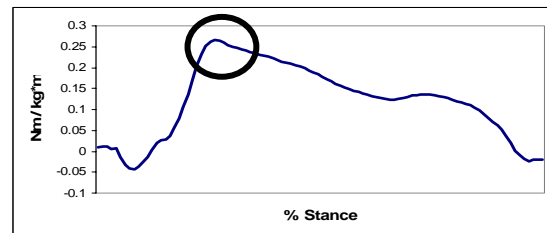


Figure 1 The KEAM peak during the 1st half of stance

RESULTS

This is an ongoing study, of which seven (two female, 5 male) asymptomatic subjects have been recruited, to date (Table 1).

Table 1 Demographic data for seven subjects

Variable	Mean (SD)
Age (years)	23.9 (3.7)
Height (m)	1.73 (0.1)
Mass (kg)	70.2 (10.3)
KOOS-S (0-20)	0.4 (0.8)
Tibial Mech. Axis (°)	101.4 (0.5)

The mean peak KEAM value for the group was 0.363 (0.06) Nm/ht*wt. Knee ADD was most strongly correlated with peak KEAM (Figure 2). A moderately strong correlation was seen for hip IR, and a moderate correlation for knee ER. A poor relationship was seen for hip ADD angle.

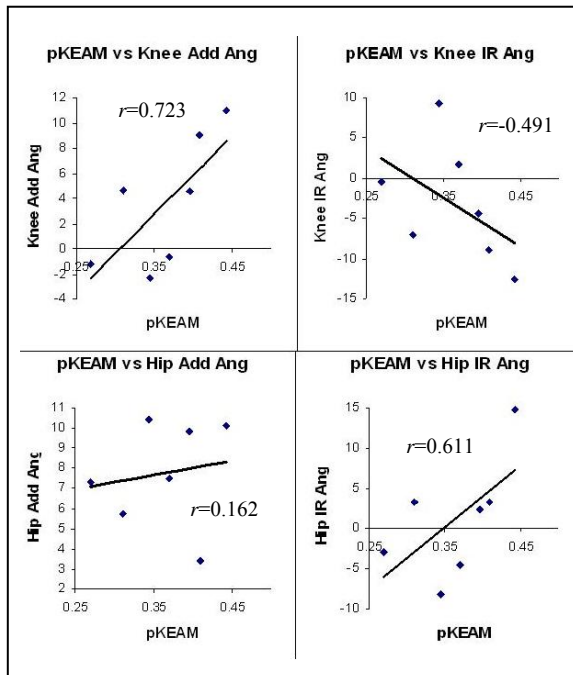


Figure 2 Scatterplots depicting the relationships between the kinematic variables (in degrees) and peak KEAM (in Nm/ht*wt).

DISCUSSION

Young, asymptomatic individuals with GV appear to ambulate with elevated KEAM values (0.363 Nm/ht*wt) that are similar to

those with medial knee OA (0.379 Nm/ht*wt) (Butler et al., 2007). This may explain their increased risk of later development of medial knee OA. Understanding the kinematic patterns that produce this high KEAM may be particularly valuable to researchers and clinicians aiming to reduce medial joint loading in this population. These preliminary data suggest that the knee ADD angle was most closely related to the peak KEAM. This is not surprising as they are both frontal plane knee mechanics. In addition, as expected, knee ER was moderately correlated with the KEAM. Surprisingly, hip IR, and not ER, was correlated with the KEAM.

These findings, if supported at the conclusion of this study may indicate that altering the knee adduction angle may be helpful in reducing medial compartment loading. This may help to delay or prevent the onset of medial knee OA in these individuals with GV.

SUMMARY

The frontal plane knee angle at the time of peak KEAM is strongly related to the magnitude of the peak KEAM during the first half of stance in asymptomatic individuals with GV.

REFERENCES

- Sharma et al. (2001). *JAMA*, 286:188-195.
- Baliunas et al. (2002). *Osteoarth Cart*, 10:573-579.
- Brouwer et al. (2007). *Arth & Rheum*, 56:1204-1211.
- Zhao et al. (2007). *J Orthop Res* 25:789-97.
- Roos et al. (1998). *JOSPT* 78(2): 88-96.
- Hinman et al. (2006). *Arthr & Rheum*, 55:306-313.
- Butler et al (2007). *J Orthop Res* 25:1121-1127.

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