

# TOE OUT EFFECTS FRONTAL PLANE KNEE MOMENTS AND ANGLES IN PATIENTS WITH KNEE OSTEOARTHRITIS

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## INTRODUCTION

Knee osteoarthritis is a common problem facing the aging adult population. This condition is most prevalent in the medial compartment of the knee and is associated with increased varus (or adduction) alignment of the knee. Patients with medial knee osteoarthritis often exhibit increased medial joint space narrowing, increased external knee adduction moments, and increased compressive forces in the knee joint (Kaufman et al., 2001). It has been noted that patients may compensate for medial knee pain, associated with the knee osteoarthritis, by increasing toe out during gait. Although the correlation was not significant, Hurwitz et al. (2002) reported that as subjects increased toe out, the external knee adduction moment decreased. This may be related to decreasing the varus alignment of the knee during stance. However, the relationship between toe out and varus alignment during walking has not been assessed.

Therefore, the purpose of this study was to evaluate the relationship between toe out and frontal plane knee kinetics and kinematics in a group of patients with medial knee osteoarthritis. It was hypothesized that as toe out increases peak knee adduction and knee adduction excursion will decrease. It was also expected that an increased toe out would result in a

decrease in the peak external knee adduction moment.

## METHODS

This is an ongoing study of which eighteen subjects (11 women and 7 men) with medial knee osteoarthritis have been recruited. Subjects with knee osteoarthritis diagnosed by a Kellgren-Lawrence grade of 2-4 on an anterior-posterior flexed knee radiograph were included in the study. All subjects had a minimum of 3 on a 10 cm visual analog scale that rated pain during walking. 3D kinematics and kinetics were collected using a six camera VICON motion analysis system (sampling at 120 Hz) and a Bertec force platform (sampling at 960 Hz) as subjects walked across the 25 m runway at their comfortable walking speed. Data were collected on the limb with the greatest severity of knee osteoarthritis. Five trials were averaged for analysis.

The variables of interest included the toe out angle of the foot, peak knee external adduction moment, peak knee adduction angle, and adduction knee excursion (from foot strike to peak adduction) during the first half of stance. The toe out angle was calculated as the angle between the local anterior-posterior axis of the foot and the anterior-posterior axis of the lab coordinate system. Statistical analyses were performed using one way bivariate correlations with an alpha level of 0.05.

## RESULTS AND DISCUSSION

Toe out was significantly correlated to a reduction in both knee adduction moment (Fig. 1;  $p=0.05$ ) and peak knee adduction (Fig. 2;  $p=0.02$ ). Knee adduction excursion also decreased with toe out, but the correlation was not quite significant (Fig. 3;  $p=0.07$ ).

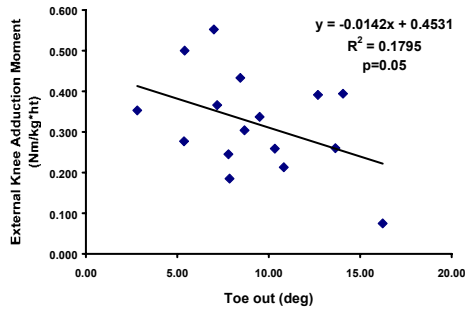


Figure 1. Correlation between Toe out and Frontal Plane Knee Moment

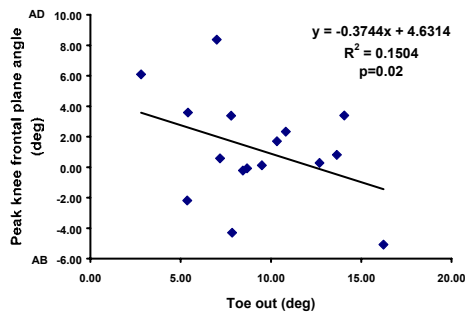


Figure 2. Correlation between Toe out and Peak Knee Adduction Angle

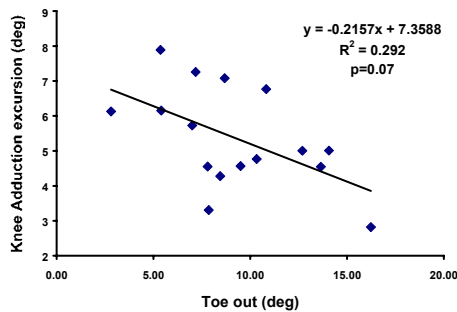


Figure 3. Correlation between Toe out and Knee Adduction Excursion

The results of our study are similar to those of Hurwitz et al. (2002) who observed a trend between the amount of toe out and the

first peak adduction moment in a group of patients with knee osteoarthritis. As the patients increase their toe out, they decrease the amount of adduction at the knee and therefore decrease the amount of contact at the medial compartment of the knee joint. Decreased knee adduction likely alters the position of the vertical ground reaction force vector thereby ultimately decreasing the external knee adduction moment.

Therefore it does appear that increasing toe out is related to decreased knee moments and decreased knee adduction motion. However only 15-30% of the variance in the knee variables was explained by toe out, suggesting that other factors influence knee mechanics as well. As additional subjects are added, these correlations may be strengthened.

## SUMMARY

The results of this study suggest that increasing toe out decreases the amount of peak adduction and adduction excursion that occurs at the knee joint this likely reduces the loading on the medial compartment of the knee joint. This may be a compensatory strategy in response to pain. Future studies might focus on training patients with knee osteoarthritis to walk with increased toe out to decrease peak knee adduction and external knee adduction moments. This may decrease compressive forces at the knee joint and slow the progression of knee osteoarthritis.

## REFERENCES

- Hurwitz et al. (2002). *J. Ortho Res.*, **20**, 101-107.
- Kaufman et al. (2001). *J. Biomech.*, **34**, 907-915.

## ACKNOWLEDGEMENTS

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