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## THE EFFECT OF MEDIAL AND LATERAL FOOT LOADING ON THE MEDIAL KNEE CONTACT FORCE DURING WALKING

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### SUMMARY

Some gait modifications aim to reduce the medial knee joint force in order to prevent further progression or pain reduction of unilateral gonarthrosis. Controversial effects were reported for the use of passive methods like braces, laterally wedged shoes or insoles (Hinman et al. 2009, Segal 2012, Kutzner et al. 2011). The aim of this study was to actively shift the support onto the medial and lateral side of the foot. Three subjects with instrumented knee implants performed walking trials loading the foot normally, laterally, and medially. In order to facilitate this, acoustic feedback was given for the peak pressure in the shoe's insole. *In vivo* forces and moments were measured synchronously to determine the medial knee contact force  $F_{med}$ . The two peaks of the  $F_{med}$ , given in percentage of the body weight (%BW), were averaged intra-individually for both atypical conditions and compared to each subject's normal condition. Medial foot loading led to an *average* reduction of both force peaks by 11%. Foot support on the lateral side increased the first peak by 9% and the second peak by 14%. These data show that the knee force can effectively be influenced by an active movement. Further subjects and the evaluation of the underlying kinematics are needed in order to gain a better understanding of the biomechanics during gait modifications.

### INTRODUCTION

Knee osteoarthritis (OA) mostly affects the medial knee compartment (Ahlbäck, 1968). In order to reduce further progression of OA, gait can be modified to lower the external knee adduction moment and thus, the medial knee contact force  $F_{med}$ . Laterally wedged insoles or shoes showed only small reductions of  $F_{med}$  in only some of the investigated subjects (Kutzner et al., 2011). Instead of a passive intervention, the focus of this study was to actively roll the foot more medially and laterally to shift the center of pressure.

### METHODS

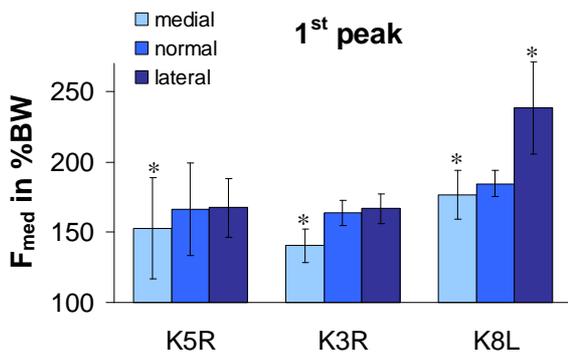
The study was approved by the local ethics committee. Three subjects (male, age: 63-75) with instrumented knee

implants (Heinlein et al., 2007) gave written informed consent to participate in this study. Each subject performed three sets of 40 consecutive gait cycles on a treadmill at 2.5km/h, loading the foot either normally, medially, or laterally. Acoustic feedback was given by a resistive pressure sensor (Interlink Electronics, Type FSR 402, 18mm diameter), embedded in an insole under the fifth metatarsal head. The patient first walked normally and the average peak pressure was determined. To enforce lateral loading of the foot, an acoustic signal was given at a 20% higher pressure level. The patient was then instructed to walk so that the signal was triggered for each step. To achieve a more medial load, the signal threshold was lowered to 20% below normal levels and the patient was instructed to avoid triggering the signal. The medial knee joint forces  $F_{med}$  were computed as percent of the patient's bodyweight (%BW). For each subject, the peak values of  $F_{med}$  from all gait cycles were averaged for the two gait modifications and compared to the forces during normal walking using a Student's-*t*-Test for unpaired samples.

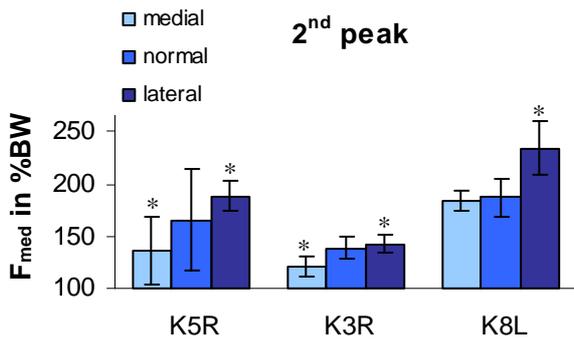
### RESULTS AND DISCUSSION

The medial knee contact force exhibited two peaks during the stance phase of gait. Both peaks of  $F_{med}$  were reduced by 11% (*average* of 3 subjects) in the medial loading conditions (Figure 1a). Lateral loads increased the first peak by 9% on average and the second one by 14% (Figure 1b).

These results show a tendency for medial knee load reduction when the foot is rolled more medially. Correspondingly, the medial knee force tends to increase when the foot is rolled laterally. In order to alter the foot loading, the subjects possibly increased their ankle pro- or supination and step width. Therefore, quantification of the lower body kinematics is needed in order to understand their effect on medial knee joint loading. Due to the small sample size, the significance of the preliminary data is limited and further subjects are currently being measured.



a



b

**Figure 1:** Peak medial knee joint force  $F_{med}$  in %BW during the early (Fig. 1a) and late stance phase (Fig. 1b) while rolling the foot normally, medially, and laterally. Significant differences to normal walking are indicated with \* ( $p < 0.05$ ). Data from the 3 subjects K3R, K5R, and K8L.

## CONCLUSIONS

Medial loading of the foot tends to reduce the medial knee force whereas lateral loading tends to increase it. Further evaluation of the lower body kinematics and the center of pressure is needed to understand the underlying mechanisms. The findings will enrich the understanding of how medial knee joint loading can be influenced by gait modifications.

## ACKNOWLEDGEMENTS

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