

Society of Engineering Science 51st Annual Technical Meeting

1–3 October 2014

Purdue University, West Lafayette, Indiana, USA

## Knee loading for abnormal gait

Hutchison, J., [jdhutchison@cedarville.edu](mailto:jdhutchison@cedarville.edu); Madsen, D.; Norman, T. L., Cedarville University, United States;  
Blaha, J. D., University of Michigan, United States

### ABSTRACT

The purpose of the study was to develop a mathematical model for determining knee loads for abnormal gait. Abnormal gait was defined as a person with varus, i.e. “bowleggedness”, or a person who had an external rotation of the femur (or the inability to internally rotate the femur) which caused an indirect varus in the forward positions of gait. Conditions such as these have been observed clinically to result in increased wear on the medial condyle of total knee replacements. This problem was approached by imposing static equilibrium on the femur. This allowed the loads at the knee to be calculated from the loading at the hip. In order to find the forces for abnormal gait, the assumption was made that the applied force magnitude for each position of gait at the hip was invariant for abnormal gait. The femur was then simulated to go through abnormal gait kinematics to find the relative change in angle when compared with the normal gait kinematics. The force vectors on the femoral head for each position of gait were then rotated according to the found relative changes in angle. The new force vectors were then used to find the loading at the knee for varus and external rotation of the femur cases using static equilibrium. The code written allowed a user to define the amount of varus and external rotation of interest. The user was then able to see a graphical representation of the loading through the gait cycle on the knee. In addition, the critical loading cases of gait at the knee were recorded and shown. The key result noted was an increase in adduction moment for the abnormal gait cases in comparison with the normal gait, consistent with clinical findings of increased wear on the medial condylar component. Understanding knee loading for abnormal gait will help design engineers understand the range of loading conditions of knee implants in vivo.