Influence of Functional Braces on the Kinetics of Anterior Cruciate Ligament-Injured Knees During Walking

Tung-Wu Lu, Yi-Cheng Hsieh, Gen-Jia Li, Hsiu-Chen Lin*, Horng-Chang Hsu+
Institute of Biomedical Engineering, National Taiwan University, Taipei 100, Taiwan
*School of Physical Therapy, China Medical College, Taichung 400, Taiwan
+Department of Orthopedics, China Medical College Hospital, Taichung 400, Taiwan

Introduction

Individuals with anterior cruciate ligament (ACL) injuries have been suggested to avoid quadriceps contraction with reduced extension moments during stance phase of gait to prevent excessive anterior tibial displacement (Andriacchi et al., 1993). Functional knee braces have been designed to provide necessary anterior/posterior stability (DeVita et al., 1997, DeVita et al., 1996) for these individuals. Therefore, studies on the kinetics of the knee with bracing have been on the changes of gait components in the sagittal plane, such as flexion and extension moments. Knowledge of their influence on the kinetics of the knee has not been available though with clinical significance. In the present study, a model of the lower limb combined with a specific marker system was developed and used to study the mechanics of the knee joint in individuals with ACL injuries without and with braces during gait.

Method

Ten ACL-injured subjects (mean age: 24.1, height: 168.9cm, weight: 66.1kg) were each fitted with suitable DonJoy Goldpoint braces (Smith & Nephew DonJoy Inc.) and walked at self-selected pace first without and then with braces in a gait laboratory equipped with a 7-camera motion analysis system (Vicon, Oxford Metrics, UK) and two force plates (AMTI, USA). A marker system was developed to enable the measurement of the bony landmarks around the knee joint while with braces. At least 3 successful trials for each condition were collected. A model of the lower limb was developed and used with inverse dynamics approach to calculate the forces and moments at the joints. Anthropometric data for the subjects were estimated using Dempster’s coefficients (Winter, 1990). Note that the model knee joint allowed translation on the tibial plateau, an important consideration for ACL-injured patients. Angular impulses at the knee in three planes were calculated as the areas enclosed by the moment curves and x axes. Peak values for each moment component were also obtained, Figure 1. Comparisons of the angular impulses and peak moments between the bracing conditions and between injured and normal knees were made using paired samples t-test with a significance level of 0.05

Results & Discussion

Without bracing, angular impulses and peak moments at the injured knees were smaller than at the normal knees (p<0.05). With braces peak adduction and internal rotation moments and impulses at the injured knees increased significantly (p<0.05) while those at the normal sides remained relatively unchanged, Figure 2. No significant increase in flexion impulses and peak flexion moments was found at the injured and normal knees with bracing. With bracing, impulses and peak moments for adduction and internal rotation at the injured knees were not significantly different from the normal ones while angular flexion impulses at the injured knees remained significantly lower than the normal sides.

Functional braces were shown to increase significantly the peak internal rotation and adduction moments and angular impulses at the injured knees, improving the bilateral kinetic symmetry in the frontal and transverse planes. Although knee braces were designed to improve sagittal plane stability for ACL-injured patients, no significant improvement was found in this plane in terms of rotational stability for the subjects studied. The present study suggests that knee braces may not be effective in increasing sagittal plane stability, both rotational and translational, in ACL-injured patients.
References

Figure 1: Knee moment curves from a typical subject during a gait cycle. The thick black lines are the moments for the with-brace conditions and the gray lines without-brace. The solid circles indicate the peak moments selected for statistical analysis.

Figure 2. Average changes of (a) the peak moments and (b) angular impulses at the knee after wearing braces. (* : p<0.05)