

Available online at www.sciencedirect.com

SCIENCE @ DIRECT®

Gait & Posture xxx (2005) xxx–xxx

www.elsevier.com/locate/gaitpost

Hip and knee frontal plane moments in persons with unilateral, trans-tibial amputation

Todd D. Royer*, Carolyn A. Wasilewski

Department of Health, Nutrition, and Exercise Sciences, University of Delaware, Newark, DE 19716, USA

Received 11 October 2004; received in revised form 9 December 2004; accepted 1 April 2005

Abstract

Persons with unilateral, lower-extremity amputation are at risk of developing osteoarthritis in their intact limb. Among persons without amputation, knee osteoarthritis disease severity has been linked to elevated frontal plane knee moments. Therefore, the purpose of this study was to examine knee and hip frontal plane moments in persons with unilateral, trans-tibial amputation. We hypothesized that knee and hip internal abduction moments are greater in the intact limb compared to the prosthetic side. Three-dimensional gait mechanics were measured bilaterally from 10 persons with unilateral, trans-tibial amputation during walking to calculate lower-extremity joint moments. The intact limb knee and hip peak internal abduction moments were 46% and 39% greater, respectively, than on the prosthetic side. The intact side knee and hip peak internal abduction moments were 17% and 6% greater, respectively, than normal. Larger moments suggest joint loading is of higher magnitude on the intact side, which may be predisposed to premature joint degeneration, particularly knee osteoarthritis.

© 2005 Elsevier B.V. All rights reserved.

Keywords: Gait; Prosthesis; Kinetics; Joint moments; Walking

1. Introduction

Persons with unilateral, lower-extremity amputation are at a risk of developing osteoarthritis (OA) in the knee and/or hip of the non-amputated limb [1]. Melzer et al. [2] reported 65% of unilateral, lower-extremity amputee subjects had varying degrees of knee osteoarthritis in the intact limb, which was a significantly higher incidence rate than a group of healthy age and weight matched control subjects. Likewise, Lemaire and Fisher [3] reported a significantly greater incidence of knee joint OA in the unaffected limb of unilateral trans-tibial amputees over the age 65, who had used a prosthesis for at least 25 years. Conversely, Kulkarni et al. [4] reported a greater incidence of hip osteoarthritis in the amputated limb compared to the intact limb among World War II veterans.

Unilateral, lower-extremity amputees have asymmetrical gait. Most notably the prosthetic limb has a shorter stance phase, longer swing time, and smaller push-off force than the

intact limb [5]. These asymmetries may be due to a combination of muscle weakness, lack of sensory feedback, instability of the affected limb or to pain in the loading portion of the residual limb. This asymmetrical gait typically places greater demands on the intact limb [6,7]. Among unilateral, trans-tibial amputees the intact limb internal knee extensor moment is not only greater than that of the prosthetic side but exceeds the internal knee extensor moment in the limbs of control subjects [6,7]. This increased loading is problematic as greater joint loads may lead to joint degeneration [8].

Previous research fails to provide an understanding of the relationship between gait mechanics and osteoarthritis in amputees; however, previous findings on osteoarthritic gait [9–11] have demonstrated an important link between abnormal joint loading and knee OA. The internal knee abduction moment has been shown to reflect the force distribution between the medial and lateral compartments of the knee joint, where larger knee abduction moments correspond to greater loads on the medial knee compartment versus the lateral compartment [12]. Sharma et al. [9] reported a significant relationship between the knee

* Corresponding author. Tel.: +1 302 831 4351; fax: +1 302 831 3693.
E-mail address: royer@udel.edu (T.D. Royer).