

IN-SILICO BIOMECHANICAL MODEL FOR AFFECTED MUSCLE IN TRANSTIBIAL AMPUTEES

Joseph M Dranetz[1], Sepehr Ramezani[1], Matthew Stock[2], Michael Carroll[3], Michael Varro[3], Hwan Choi[1*]

[1]Department of Mechanical and Aerospace Engineering, University of Central Florida, Orlando
[2]School of Kinesiology, University of Central Florida, Orlando
[3]College of Medicine, University of Central Florida, Orlando

Corresponding Author: Choi,Hwan <hwan.choi@ucf.edu>

ABSTRACT

The role of residual gastrocnemius in gait for transtibial amputees remains relatively unexamined. During the transtibial amputation surgery, the distal end of the gastrocnemius is typically wrapped around the distal end of the limb. As the apparent role of the muscle changes after an amputation, understanding the characteristics of the residual gastrocnemius and nature of these acquired functions can inform the development of surgical and rehabilitative strategies. Study of the electromyographic activations of the residual gastrocnemius during gait show that activation patterns vary greatly between but not within transtibial amputees. This suggests that transtibial amputees develop different strategies for their gastrocnemius during gait. Developing subject specific models that account for unique physiology of the residual gastrocnemius could better elucidate the character and function of the muscle given the variance observed in electromyographic data.

The goal of this study is to collect data to determine the physiological cross-sectional area, optimal fiber length, pennation angle, and muscle path contour of individual intact and residual gastrocnemii using EMG, Ultrasound, MRI, a human dynamometer, and a motion capture system in order to construct subject specific musculoskeletal models in OpenSim. From these models we can assess the character and function of the muscle. In this study we demonstrate that the contribution of the gastrocnemius muscles in knee flexion decrease in and amputated leg.

INTRODUCTION

Over 1.6 million people in the United States were living with limb loss in 2005. Individuals with transtibial amputation face multiple disadvantages in walking such as increased risk for chronic back or lower limb pain, degenerative joint diseases, and psychological conditions as well as an increased metabolic cost of movement[1]. Consequently, additional muscular effort from the residual limb or compensation of the intact limb may be required. As a result, individuals with transtibial amputation can expend 10 – 30% more energy when walking[2,3].

Among many other reasons, the absence of ankle plantarflexors chiefly contributes to these issues. Gastrocnemius and soleus muscles are the major ankle plantarflexors, and they play an important role in supporting and propelling the body forward[4,5]. While most plantarflexors are removed (including the