THE ANALYSIS OF GAIT IN INDIVIDUALS WITH TRANSFEMORAL AMPUTATION USING A BIONIC KNEE DESIGN: A CASE STUDY

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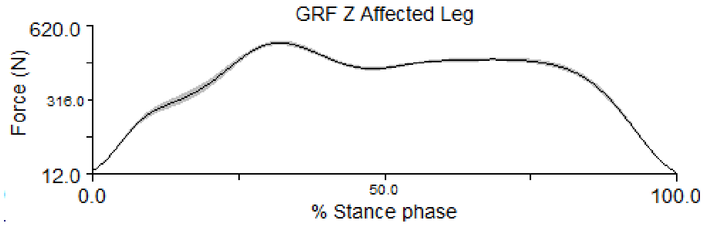
KEYWORDS: biomechanics, gait, amputees, prosthesis, kinetic analysis, kinematic analysis.

INTRODUCTION: Walking is the body´s natural means of moving from one location to another. It is also the most convenient means of traveling short distances (Perry, 1992). Approximately 4500 new amputations of lower extremities are performed annually in the Czech Republic. Worldwide, 200 – 500 million major amputations are performed each year. Major limb amputations of lower extremities account for approximately 85% of all cases of amputations (Ellis, 2005). The loss of a lower extremity causes the inability to walk without a prosthetic aid. Biomechanics has an important place in the multidisciplinary team, which is essential for the complex care of amputees (Janura, Svoboda, Kozakova, & Birgusova, 2006). New prosthetic designs may enable people with transfemoral amputation perform sports (running) activities in the future. However, it is necessary to master walking with a prosthesis first. The aim of our study is to describe the selected biomechanical parameters of gait in patients with a two-year experience with a bionic knee.

METHOD: One female (age – 45, height – 1.62m and weight – 64 kg) with transfemoral amputation participated in the study. The amputation was on the left side, it was executed 30 years ago, and she had been using a bionic knee for 2 years. She was a good walker who used her prosthesis on a regular basis and led a normal active life. The participant visited the laboratory on two separate occasions. On both occasions, the proband performed fifteen attempts to walk across two Kistler force plates (model 9286AA) embedded in the floor. For the purpose of the kinematic analysis, motion measurement markers were placed on the proband's body. We used lower body marker set. Objective gait measurements were acquired with a computerized video motion analysis system utilizing seven infrared cameras (Qualisys). Capture frequency was 247 Hz. Marker data were processed using Visual3D software (C-motion, Rockvile, MD, USA). Using Visual3D, all lower extremity segments were modeled as frustra of cones. The local coordinate system of the thigh, leg and foot was derived from the standing calibration trial. The lower extremity 3-D joint angles were calculated using a Xyz Cardan rotation sequence.

RESULTS:



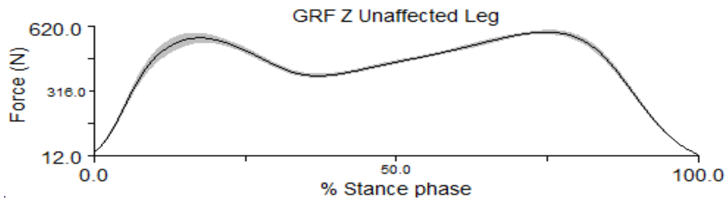


Figure 1. Vertical ground reaction force during the stance phase of the subject with Bionic knee design (n=1, 15 attempts). The gray area displays the standard deviation.

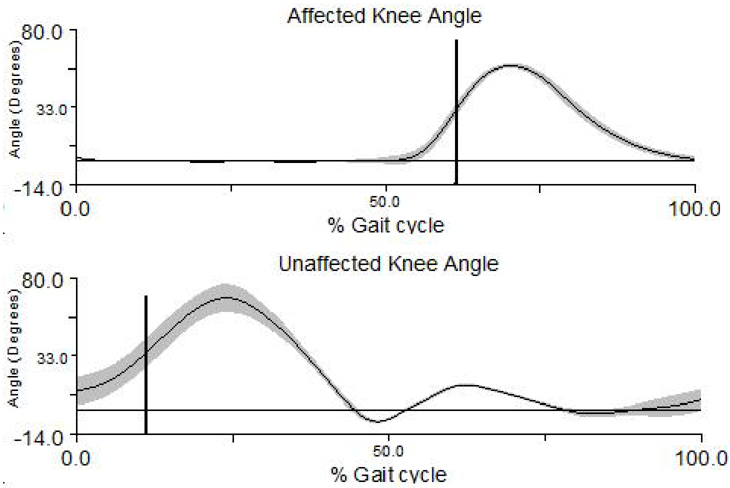


Figure 2. Knee angle during the gait cycle of the subject with Bionic knee design (n=1, 15 attempts). The gray area displays the standard deviation. Each graph begins and ends at initial contact and therefore represents one gait cycle. The vertical line represents toe off for each condition.

The first flexion (Figure 2) typical for normal walk does not occur in the bionic prosthetic knee. This fact also influences the course of the vertical ground reaction force in the healthy extremity in relation to the stance phase. Figure 1 shows that the active propulsion takes place from 30 to 80% of the stance phase on unaffected leg.

DISCUSSION: The purpose of this study was to describe the selected biomechanical parameters of gait in patients with a two-year experience with a bionic knee. Valmassy (1996) states the active propulsion time from 50 to 80% of the stance phase in normal population. Our finding is that the active propulsion during the stance phase on unaffected leg is by almost 20% longer in the stance phase as against normal gait. The phase of active propulsion therefore starts earlier, as Figure 1 shows. The non-existence of flexion in the prosthetic knee joint during the swing phase remains a great problem of walking with transfemoral prosthesis. This fact complicates the possibility of changing the walk to running in patients with a transfemoral amputation.

CONCLUSION: During the gait measurement, there was no flexion during the swing phase in the afflicted extremity of the patient with a two-year experience with a bionic knee joint. This fact also affected the active propulsion during the stance phase of the healthy extremity. These deviations from normal gait complicate changing the walk to running.

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Acknowledgement

This research was supported by the SGS Grant of the University of Ostrava 6108/2010