

## Why Transfemoral Amputation Instead of Knee Disarticulation?

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### Abstract

The aim of this study is to determine gait patterns of the knee disarticulation (KD) and transfemoral (TF) amputee using microprocessor prostheses and compare to normal gait. Two amputees and eight healthy person (control group) participated in this study. Knee joint was a C-leg, while the foot was Axion foot in both prosthetic users. Three-dimensional gait analysis was performed via Vicon Nexus motion analysis system. Results of studied, asymmetries that differences in results between prosthetic side and sound side higher in knee disarticulation patients.

**Keywords:** Gait analysis, Knee disarticulation, Transfemoral amputee

### Özet

Bu çalışmanın amacı, diz dezartikülasyon (KD) ve transfemoral (TF) seviye ampute mikroişlemci protez kullanan hastanın yürüme patenlerini saptamak ve normal yürüyüş ile karşılaştırmaktır. Bu çalışmaya iki ampute ve sekiz sağlıklı kişi (kontrol grubu) katılmıştır. Her iki protez kullanıcısında Axion ayak ve C-leg diz eklemi vardı. Üç boyutlu yürüme analizi Vicon Nexus hareket analizi sistemi ile gerçekleştirilmiştir. Sonuç olarak, diz dezartikülasyonlu hastalarda protez tarafı ile sağlam taraf yürüme sonuçları arasındaki asimetri daha fazla bulunmuştur.

**Anahtar kelimeler:** Yürüme analizi, Diz dezartikülasyonu, Transfemoral ampute

### Introduction

To date, many surgical and biomechanical advantages mentioned on knee disarticulation (KD) less preferred than transfemoral (TF) amputation because of uncosmetic, prosthetic production difficulties and disproportional prosthetic knee centers other additional factor 'may KD cause the asymmetric gait?' raises the question on the agenda.

When compared with more distal amputations allowing for retention of vital muscularite and joints such as knee disarticulation or transtibial amputation, transfemoral amputation typically resulted in higher energy cost and asymmetric gait pattern (Highsmith et al., 2010, Jaegers et al., 1993). Gait analysis has shown that transfemoral amputees prefer to walk more slowly, with greater stride width and step length on prosthetic side. They also have a longer stance time and greater knee flexion on the sound side during stance. Sound limb increase the work done by its hip extensors and ankle plantar flexors to aid pelvic forward progression, prosthetic knee flexion, and prosthetic toe clearance (Nolan et al., 2003).

The purpose of this study was to describe gait patterns of the KD and TF amputee using microprocessor prostheses and compare to normal gait.

## Methods

Two amputees and eight healthy person (control group) participated in this study. One TF prosthetic user was male and adult amputee (Age: 20 yrs-old, Height: 175 cms, Mass: 68 kgs, Stump length: 73%, K-level 4) (Figure 1). The other KD prosthetic user was a male and adult amputee (Age: 24 years-old, Height: 177 cms, Mass: 63 kgs, K-level 4) (Figure 2). Knee joint was a C-leg, while the foot was Axion foot in both prosthetic users. Three dimensional gait analyses were done in Motion Analysis Laboratory via Vicon Motion Analysis System (Vicon Nexus, UK) with six infrared cameras at 240 Hz. gait records were obtained when the patient was with prosthesis. Kinematics and kinetics analyses were done in order to analyze the influence of prosthesis on amputee gait and compared with control group. We used Helen Hayes marker protokol in gait analysis.

## Results

Analyzing the temporo-spatial parameters, kinematics and kinetics results are shown in the Table 1. Asymmetry of the KD cadence, internal/external pelvic rotation degrees, internal hip rotation degrees and flexion/extension hip degrees were created by sound limbs (Figure 3.). These asymmetries were significantly higher than with TF prosthetic user.

## Discussion

Asymmetric gait is common in individuals with lower limb amputation and can lead to serious health complications. Abnormal gait generally lacks a smooth, symmetric gait pattern, sometimes causing an increase in the vertical and lateral displacement of the center of mass resulting in increased energy demand (Blanc and Borens, 2004). Met et al. found no significant differences between KD and TF levels, but the identification of variables/ confounders to prosthetic ambulation was poor and hence the results cannot be directly attributed to amputation levels (Met et al., 2008). Variables that influence prosthetic rehabilitation are advancing age, presence of comorbidities (including mental diseases), premorbid functional/ambulatory level, condition of contralateral limb, presence of oedema and psychosocial factors (Met et al.,2008, Taylor et al.,2005). These factors will have to be part of a multivariate analysis together with the level of amputation to determine whether any amputation level has an independent influence on prosthetic ambulation. Our study resulted that asymmetries that differences in results between prosthetic side and sound side higher in knee disarticulation patients. Pelvic motion plays a decisive role in determining the amputee gait pattern, and exaggerated movements of the upper body and pelvis including excessive lateral shift and transverse rotation are common (Nolan et al., 2003) Pelvic motion and rotation increased TF and KD patient, but differences of movement between prosthetic and sound side more in KD patients.

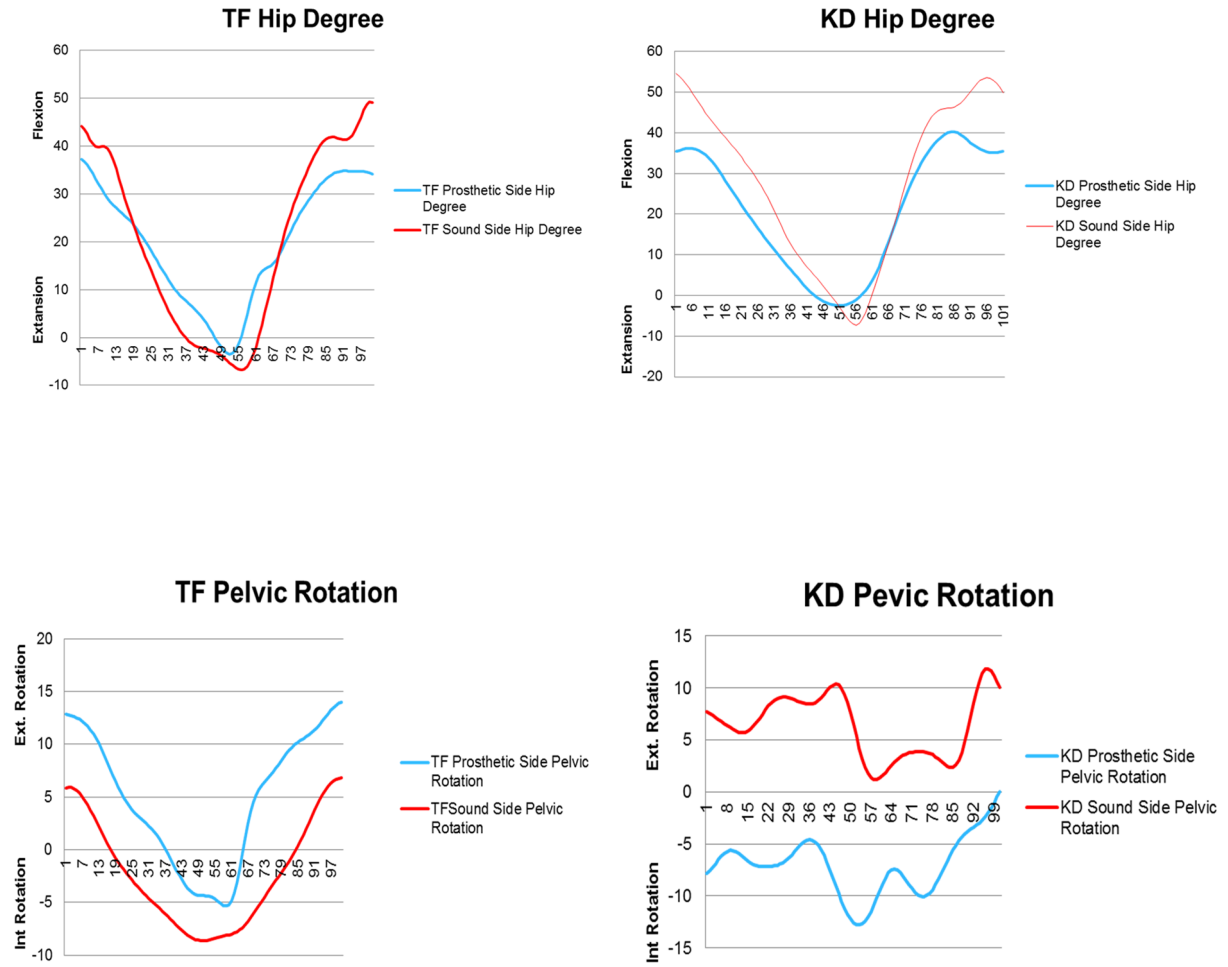
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**Table 1.** Kinetic and kinematic gait analysis results of transfemoral and knee disarticulation patient.

| Amputated /<br>Sound Limb                      | Transfemoral<br>Amputated<br>Side | Transfemoral<br>Sound Limb | Knee<br>Disarticulation<br>Amputated<br>Side | Knee<br>Disarticulation<br>Sound Limb | Control Group<br>(n=8) |
|--|-----------------------------------|----------------------------|--|---------------------------------------|------------------------|
| <b>Gait Parameters</b>                         |                                   |                            |  |                                       |                        |
| Cadance (step/min)                             | 116                               | 116                        | 98   | 114                                   | 117.7 ± 9.6            |
| Walking Speed (m/s)                            | 1.51                              | 1.45                       | 1.49   | 1.43                                  | 1.2 ± 0.2              |
| Stride Length (m)                              | 1.48                              | 1.52                       | 1.82   | 1.50                                  | 1.2 ± 0.1              |
| Max. Posterior Pelvic Tilt (°)                 | 10.86                             | 10.88                      | 17.87  | 21.69                                 | 7.6 ± 3.5              |
| Max. Anterior Pelvic Tilt (°)                  | 26.07                             | 25.9                       | 24.42  | 16.34                                 | 9.9 ± 3.7              |
| Max. Pelvic Rotation – External (°)            | -6.04                             | -8.62                      | -12.81                                       | 1.19                                  | -3.8 ± 1.8             |
| Max. Pelvic Rotation – Internal (°)            | 8.63                              | 6.8                        | 0.02   | 11.82                                 | 5 ± 1.9                |
| Max. Hip Extension (°)                         | -0.53                             | -6.7                       | -5.7   | -2.4                                  | -12.4 ± 6.5            |
| Max. Hip Flexion (°)                           | 37.7                              | 45.3                       | 54.9   | 40.2                                  | 30.5 ± 3.5             |
| Max. Hip Rotation – External (°)               | -6.4                              | -29.33                     | 5.22   | -16.28                                | -17.6 ± 4.9            |
| Max. Hip Rotation – Internal (°)               | 9                                 | 7.44                       | 23.5   | 29.03                                 | 6.7 ± 9.1              |
| Max. Knee Extension (°)                        | -4.6                              | -9.5                       | 4.5  | -4.1                                  | -0.6 ± 3.5             |
| Max. Knee Flexion (°)                          | 70.2                              | 57.05                      | 73.9   | 54.6                                  | 54.3 ± 6.2             |
| Max. Ankle Plantarflexion (°)                  | -0.96                             | -24.1                      | 6.39   | -30.11                                | -14.8 ± 4.6            |
| Max. Ankle Dorsiflexion (°)                    | 10.6                              | 13.6                       | 15.5   | 11.6                                  | 13.3 ± 1.5             |
| <b>HM1</b>                                     |                                   |                            |  |                                       |                        |
| Maximum Hip External Flexion Moment (Nmm/kg)   | 0.55                              | 1.08                       | 0.81   | 1.04                                  | 0.84 ± 0.25            |
| <b>HM2</b>                                     |                                   |                            |  |                                       |                        |
| Maximum Hip External Extension Moment (Nmm/kg) | -1.72                             | -5.2                       | -2.18  | -2.16                                 | -0.83 ± 0.2            |

*Figure 1.* Patient with transfemoral prosthesis*Figure 2.* Patient with knee disarticulation prosthesis



**Figure 3.** Transfemoral and knee disarticulation sound and prosthetic side hip flexion/extension, pelvic rotation degrees graphics.