

KNEE COMPRESSION FORCES IN TRANSFEMORAL AMPUTEES USING C-LEG AND 3R60 PROSTHESIS

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INTRODUCTION

Previous studies investigating knee compression forces in normal subjects have found forces of 3-4.6 times body weight during normal walking [1,2]. The purpose of the present study was to quantify the knee compression forces in transfemoral amputees and to investigate the effect of two different prostheses (C-leg vs. 3R60) on this parameter. Transfemoral amputees depend heavily on the function of the sound side, and they have an increased incidence of osteoarthritis [3]. Therefore, we hypothesized that the knee compression forces on the sound side in transfemoral amputees were increased when compared to normal subjects.

METHODS

Five unilateral transfemoral amputees who had the microprocessor controlled knee prosthesis C-leg as their daily prosthesis completed the entire study, which consisted of two gait analyses with a one week acclimation period between the two tests. The first gait analysis was performed on C-leg, and the second test was performed on the hydraulic 3R60 knee prosthesis. Walking speed was controlled to be 1.1 m/s. Vicon 460 was used to collect kinetics and kinematics. The link segment model used for inverse dynamics did not include the changed properties due to the prosthesis.

Compression forces for each of the five subjects were calculated by a simple model, which was described by [4]. Compression forces for one subject were also calculated by the use of an AnyBody model (AnyBody Technology, Aalborg, Denmark).

RESULTS AND DISCUSSION

The time course patterns of the knee compression force were similar to previous studies with a heel strike transient and two peaks at 25% and 75% stance phase, which corresponds to the peaks of the vertical ground reaction force (Figure 1). Two subjects had a higher than normal heel strike transient. Furthermore, two subjects had a higher peak at 25% stance phase than normal subjects. No significant difference was observed between the prostheses when the first peak was tested.

The size of the highest peak was similar to values obtained in earlier studies. Thus, the mean peak value at 25% stance was 2.8 times body weight when the simple model was used. Four out of five subjects had an increased heel strike transient compared to normal subjects.

Two different muscle models were used in the AnyBody modeling. Both models showed the heel strike transient and the two peaks, which were also observed by the use of the simple model (Figure 2). The magnitude of the compression forces were higher in the AnyBody model than in the simple model which is probably due to allowance of co-contraction and that the hip joint was included in this model. However,

the size of the heel strike transient was not different between the simple model and the AnyBody model.

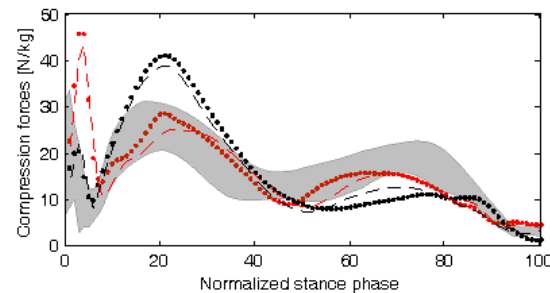


Figure 1: Knee compression forces for two subjects (red and black) calculated by the simple model. Dotted lines indicate C-leg. Dashed lines indicate 3R60.

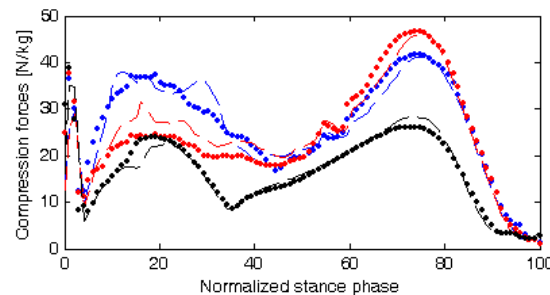


Figure 2: Compression forces for one subject calculated by a simple model (black), a simple AnyBody model (blue), and an advanced AnyBody model (red). Dotted lines indicate C-leg. Dashed lines indicate 3R60.

CONCLUSIONS

Both models led to the same pattern and reliable results of the compression forces. However, the AnyBody model was time-consuming, and this model is only relevant if other parameters than compression forces should be investigated simultaneously.

The knee compression forces on the sound side were similar to or lower than the knee compression forces in normal subjects which is in contrast to our hypothesis. This might be due to a lower gait speed in this study than in previous studies. However, the results indicate that transfemoral amputees walk with increased knee joint loading at heel strike which may explain why these subjects have an increased incidence of osteoarthritis. The different prostheses used in the study did not affect the compression of the knee.

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