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Centre of pressure displacements in trans-femoral amputees during gait

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Abstract

The aim of this study was to describe and quantify centre of pressure (CoP) displacement during walking in 12 unilateral trans-femoral amputees who had worn a prosthesis for at least 10 years. All subjects wore the same type of prosthesis and seven healthy subjects acted as controls. The CoP was acquired by an F-scan system and the displacements along the longitudinal axis of the foot versus time were quantified. An asymmetry of both temporal and spatial parameters of CoP patterns occurred between the sound and the prosthetic foot. The double support time and the time during which the CoP remained in the heel and mid-foot region were longer for the prosthetic limb. Conversely, the stance phase was longer for the sound limb, as was the time spent by the CoP in the forefoot. There was a redistribution of the time during which the CoP remained within the different zones of the sound foot with respect to the normal feet of the control subjects. The asymmetry seen in trans-femoral amputee stance is due not only to an abnormal spatio-temporal distribution of the CoP under the prosthetic leg, but also to a modification of the spatio-temporal distribution of the CoP under the sound foot compared to the normal foot. We conclude that an adaptation occurs in the control of the stance phase on the sound side during amputee gait.

Keywords: Centre of pressure; Amputee gait

1. Introduction

Several studies have investigated the gait of trans-femoral and trans-tibial amputee subjects [1,2]. Some authors have studied amputee gait by paying attention to biomechanical characteristics of different components of modular prostheses to improve their performance. Many studies have compared different prosthetic feet. In particular, the traditional SACH foot was compared with the so-called energy storing feet (flex-foot) [3–5]. The performance of different prosthetic knees for trans-femoral prostheses has also been investigated [6–8].

Other papers have concentrated on the gait of lower limb amputee subjects [2,9–15] to investigate kinematics and kinetics and compare this with normal subjects. The most important result, highlighted in many studies, was an asymmetry of amputee gait [16–22]. Generally, lower limb amputees remain in stance for a longer percentage of the gait cycle on their sound limb, compared to the prosthetic limb and to the healthy subjects [17,23]. The double limb support (DLS) time, measured from heel strike of the amputated leg until toe-off of the sound leg, has also been found to be longer than that of the contralateral leg [18]. Nolan and Lees [19] have shown that amputees compensate for the loss of one or more joints, by increasing net joint moments and power output at their intact limb, compared to able-bodied subjects. Amputee asymmetric gait also implies a difference in load supported by the two legs. The vertical ground reaction force and its impulse acting on the sound limb are greater for the sound limb than the prosthetic limb [23].

To date, however, relatively few papers have looked at centre of pressure (CoP) patterns during amputee gait. During walking, the CoP controls the forward progression of the whole body centre of mass [26]. Impaired CoP displacements in amputees could lead to difficulties in adequately controlling dynamic equilibrium. Zernicke et al. [24] studied

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