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Fixating the pelvis in the horizontal plane affects gait characteristics

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Abstract

In assistive devices for neuro-rehabilitation, natural human motions are partly restricted by the device. This may affect the normality of walking during training. This research determines effects on gait of fixating the pelvis translations in the horizontal plane during treadmill walking. Direct effects on the motion of the pelvis and external forces acting on the pelvis were measured. Several gait descriptors (step parameters, trunk angles and a ground reaction force parameter) were defined and measured to indicate changes. We observed the effect of the pelvis fixation on these parameters while varying gait velocity (0.35, 0.60 and 0.90 m/s). It was shown that the fixation caused a reduction of step width by 33%, and an increase of step length of 19%. Sagittal and coronal trunk rotations changed with +68% and −54% respectively. The fixation also significantly changed the effect of speed on most descriptors. It can therefore be concluded that a fixation of the pelvis severely affects gait dynamics and that it should be avoided if natural walking should be possible during training.

Keywords: Gait; Treadmill Walking; Rehabilitation; Devices

1. Introduction

In the last decade several gait training robots were developed [1]. These devices offer safety and support during gait training. Due to design considerations often concessions are done to the normality of walking during training. A typical limitation that might disturb walking is a fixation of pelvis translations in the horizontal plane [2,3]. Avoiding a fixated pelvis would demand additional degrees of freedom, leading to a mechanically more complex design. Both for designing robotic devices and training practice, it is relevant to know what the effects of such a fixation are.

Literature on pelvis function in gait generally focuses on body-internal pelvis rotations [4,5]. These are however not the focus of this paper. Blocking the pelvis translations in global space comes down to changing body dynamics in both forward and sideways direction. In the sagittal plane it causes the pelvis to move (relatively to the treadmill surface) exactly with the constant velocity of the treadmill, thus opposing the natural fluctuations in velocity and the forward fall that is utilized for propulsion. In the frontal plane the cyclic lateral sway towards the weight-bearing foot is obstructed. In fact the instability of the body is completely omitted, making actions for maintaining the bodies' vertical stance superfluous.

Recently, Israel and colleagues [6] showed that the metabolic costs during standing with fixated pelvis, were significantly smaller than during unassisted standing. They argued that this decrease was caused by a decreased need for muscular work for stabilization in the frontal and sagittal

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always reported in gait research, it is clear they have an important role in gait, like maintaining the full body balance and increasing efficiency [4]. Leg, pelvis and trunk motions are closely interrelated during gait [5].

Returning to the goal of this study, we can conclude that a fixation of the pelvis should be avoided. In the first place several sub-tasks of gait are omitted from the training, such as the need to generate propulsion as well as keeping lateral balance. In the second place important gait characteristics of spontaneous walking of healthy subjects change so much that it is very likely that the transfer of ability may be affected The normalization of certain gait parameters, that could be realized by a fixation, is in case of a training robot not important as a device will offer other options to alter parameters like step-length, that do not disturb the whole gait function [13].

Conflict of interest statement

There are no financial interests nor any other conflict of interest of any author of this paper.

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