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GAIT AND TRUNK MOVEMENT PATTERNS OF LOW BACK PAIN PATIENTS AND HEALTHY VOLUNTEERS DURING SUPPORTED AND CONVENTIONAL TREADMILL WALKING

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SUMMARY

This study investigates the effects of body weight supported and conventional treadmill walking on gait and trunk motion of asymptomatic people and low back pain (LBP) patients. Forty participants, 19 LBP patients and 21 asymptomatic individuals were recruited. Significant differences were found in gait and trunk kinematic parameters between the two walking conditions, in both participant groups.

INTRODUCTION

Treadmill walking has been extensively used as means of rehabilitation in a wide variety of neurological as well as musculoskeletal conditions [1,2,3]. It has been previously shown that overground and treadmill walking have similar kinetic and kinematic characteristics [4]. However, the use of supported treadmill walking may have an effect on the kinematic and temporospatial parameters of diseased and asymptomatic population. It is recognized that different harness designs may have a different effect on gait and trunk movements.

Thus, this study investigates the effects of supported treadmill walking on gait and trunk movements when a 40% of body weight support is applied through an under arm fitted harness (fig. 1).

METHODS

This study was granted ethical approval from both the University and NHS ethics committees. The current paper contains results from 21 healthy individuals (age 38±8, height 1.78±0.06m, and mass 78±11 kg) and 19 LBP patients (age 47±9, height 1.74±0.06m, and mass 81±13 kg) (mean ± SD).

Participants walked on the treadmill (Cosmos Stellar 4, Germany) at their self selected walking speed. All measurements reported here obtained after a 30 minutes familiarization period. The application of 40% of body weight support was randomly counterbalanced between two sessions. A pneumatic apparatus was used along with an under arm harness (fig. 1). All data, trunk movements, lower limb kinematics and temporospatial gait parameters are average values over five gait cycles (fig. 2).

A six motion analysis camera system (VICON, Oxford, UK) was used at 100Hz to capture motion during treadmill walking. Trajectories were filtered with a 4^{th} order Butterworth filter with a cutoff frequency of 7 Hz. Vicon cameras were positioned in a semicircular manner, 2-3 meters behind the treadmill. For the gait analysis the Vicon Plug-in-Gait marker configuration was utilized, using 14mm reflective markers. Lower body angles were calculated using the clinical Plug-in-Gait model. Relative trunk movements in respect to the pelvis were calculated about all three axes.

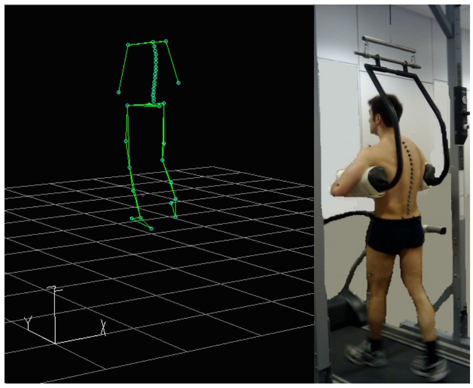

Figure 1: Vicon workplace interface and body weight support system.

Code was written in Vicon BodyBuilder (V3.6) in order to define two local coordinate systems on the pelvis and thorax respectively. For the statistical analysis, parametric tests (paired samples t-tests) were used since data were normally distributed. A significance level of 5% was chosen for the observed differences between walking conditions.

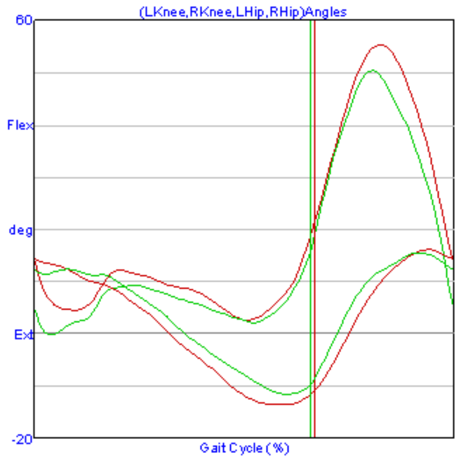

Figure 2: Right/left knee and hip angles, lines represent averages of five gait cycles (red = left, green = right).

RESULTS AND DISCUSSION

The main findings of this study were that the majority of the trunk kinematics and gait parameters showed significant changes during the partial body weight supported treadmill walking in both participant groups. No significant asymmetries were documented between left and right lower limbs in both groups. Direct comparisons between participant groups were not attempted since the mean self-selected walking speed was different and this can be a differentiating factor for both the gait parameters and trunk kinematics. Double support was significantly higher and the single support was significantly lower during conventional walking in both groups (Table 1). This effect in the gait support times may be a direct result of the 40% upward force and the harness which was restricting the body motion along the progression line. Also, it may be an indirect effect caused by the neuro-musculoskeletal system adaptations due to the decreased demand for balance maintenance. Also, there was a significant decrease of knee flexion angles which is an indication of decreased vertical amplitudes of the body centre of mass. In addition, the stepping frequency and length was significantly modified during supported walking by the healthy participants while remained unchanged in the LBP patient group. This may indicate decreased adaptability of LBP patients in altered walking conditions.

The trunk movement patterns found in this study was similar to those reported elsewhere [5]. A significant decrease was found in the trunk rotation in the coronal and transverse planes during the supported walking, in the both groups, while motion in the sagittal plane remained unchanged (Table 2). This may have implications in people with spinal pathologies. Thus, although it has been documented that overground and treadmill walking are essentially similar [4], this study shows that external support alters significantly gait parameters and trunk movements of healthy and with LBP people.

CONCLUSIONS

To sum up, this study shows that 40% of body weight supported treadmill walking alters significantly the majority of the gait and trunk kinematic characteristics in both asymptomatic and with LBP people. Supported walking seems to significantly affect the double/single support gait parameters and trunk rotation in the coronal and transverse planes in both groups. Knee flexion is also significantly reduced in both groups which indicate decreased body movement in the vertical direction. These findings should be taken into consideration from people planning to use this type of exercise for rehabilitation or other purposes.

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Table 1: Temporospatial characteristics of patients and healthy participants during normal and supported treadmill walking [mean (SD)].

	LBP patients			Controls		
	Supported	**Normal**	***p***	**Supported**	**Normal**	***p***
Cadence (step/min)	97.8(12.4)	99.7 (10.3)	.33	95.5 (8.4)	98.4 (6.7)	**.01**
Walking speed (m/s)	0.93 (0.23)	0.93 (0.23)	-	1.04 (0.16)	1.04 (0.16)	-
Stride time (s)	1.25 (0.16)	1.21 (0.13)	.23	1.27 (0.14)	1.22 (0.08)	**.01**
Opposite foot contact (% cycle)	50.4 (2.1)	50.2 (2)	.69	50.4 (1.4)	50.5 (1.4)	.75
Double support (%)	27.5 (7.7)	30 (4.6)	**.02**	23.9 (3.2)	29.9 (2.7)	**.00**
Single support (%)	36.4 (4)	32.2 (2.7)	**.01**	37.8 (1.9)	35.5 (1.7)	**.00**
Est. stride length (m)	1.14(0.25)	1.1 (0.22)	.22	1.3 (0.13)	1.26 (0.15)	**.01**

Table 2: Kinematics of LBP patients and healthy participants during normal and supported treadmill walking [mean (SD)].

Angle (deg)	LBP patients			Controls		
	Supported	**Normal**	***p***	**Supported**	**Normal**	***p***
Knee flexion (°)	55.8 (7)	59.7 (7.5)	**.01**	58.7(5.8)	61.8 (6.4)	**.02**
Hip excursion (°)	40 (5.4)	36.2 (5.4)	**.01**	40.4 (3.7)	38.9 (4.9)	.34
Trunk sagittal plane (°)	4.1 (1.3)	3.8 (1.9)	.65	3.96 (1.5)	3.8 (1.3)	.9
Trunk coronal plane (°)	6.2 (2.2)	8.7 (3.7)	**.01**	5.5 (2.2)	10.9 (3.3)	**.00**
Trunk transverse plane (°)	6 (2.6)	9 (5.3)	**.02**	7.6 (5.4)	10.5 (4.3)	**.02**