was predicted [1]. Since changes in hip angle have a larger effect on the hamstrings muscle length than changes in the knee, it is quite important to take hip angle into account [4]. Hence, it is advised to fixate the hip and pelvis as much as possible during the test in order to minimize their contribution to the test-outcome.

References


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O-03

Coordination between pelvis, thorax and leg movements in gait

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1. Summary/conclusions

We analyzed the relationship between pelvis and thorax transverse rotations and the movements of the legs during gait in healthy volunteers. Transverse rotations of the thorax in healthy gait were out of phase with the leg movements at all velocities, whereas pelvic transverse rotations were in phase with the thorax rotation at low gait velocities and in phase with the leg movements at higher velocities.

2. Introduction

In normal gait, with increasing velocity the relative phase of pelvis and thorax rotations in the transverse plane increases, such that the coordination between these segments shifts from relatively in phase, towards a more out-of-phase pattern [1]. This phase shift is suppressed in several pathologies that affect locomotion, such as pelvic-girdle pain, low-back pain and Parkinson’s disease [2–4]. Since many years, it has been assumed that in walking faster then 3 km/h pelvic step becomes important to launch the swinging leg, and that transverse counter rotation of the thorax is then needed to keep the angular momentum of the body around the vertical axis close to zero [5]. Therefore, the absence of a counter rotation of the thorax is thought to lead to inefficient gait. However, given the low inertia of the pelvis relative to the thorax, it seems unlikely that thorax rotation is aimed at compensating for pelvis rotation. We therefore, studied the coordination of thorax and pelvis rotations relative to leg movements.

3. Statement of clinical significance

Coordination between pelvis and thorax in gait is changed with disorders affecting locomotion. A better understanding of the nature and effects of these changes may refine diagnostics of gait disorders and give directions for interventions.

4. Methods

Nine healthy male volunteers walked on a treadmill at nine different velocities, ranging from 2.0 km/h to 5.2 km/h, while 3D kinematics were recorded (Optotrak 3020, Northern DigitalTM, ON, Canada). From these data, relative timing between the pelvis and thorax rotations, between pelvis rotation and the thigh motion (sagittal plane motion of the distal right femur), and between thorax rotation and thigh motion was calculated as the Relative Fourier Phase (RFP) with 0° being in phase and 180° out of phase.

5. Results

The rotation of the thorax to the right (right shoulder backward) reached its maximum close to the instant of the maximum forward swing of the right thigh and vice versa for the rotation to the left, indicating a counter movement of the thorax relative to the legs at all velocities tested (Fig. 1). The RFP between thorax rotation and thigh motion ranged from 157° (S.D. 18) at the lowest velocity to 178° (S.D. 17) at the highest velocity. The pelvis moved in synchrony with the thorax at low velocities and thus out of phase with the thigh (RFP: 112° (S.D. 18) at 2.0 km/h) and more or less in synchrony with the thigh, though still somewhat delayed (RFP: 52° (S.D. 33) at 5.2 km/h), at higher velocities (Fig. 1).

Consequently, the observed shift from in-phase towards out-of-phase pelvis–thorax coordination with increasing velocity (RFP: 44° (S.D. 18) at 2.0 km/h to 126° (S.D. 41) at 5.2 km/h) is mainly due to altered timing of pelvis rotations relative to the legs at higher velocities.

6. Discussion

The results presented suggest that thorax counter-rotation could be actively controlled to compensate the angular momentum around the vertical of the swing leg instead of the pelvis. Alternatively, it could be a consequence of the second-order dynamics of the system. At low velocity, thorax and pelvis may be strongly coupled. Counter-rotation with respect to the legs could then arise due to inertia of pelvis and thorax together. If, at higher velocities, the cou-
pling between pelvis and thorax decreases, the system could be regarded as a system with two degrees of freedom (at the hips and the lumbar spine). This would lead to a decrease in pelvis-femur RFP, and an increase in pelvis–thorax RFP. While the in-phase relationship between pelvis rotation and leg swing at high velocities contributes to step length, the pelvis rotation does not launch the leg since it follows the thigh movement at a slight delay.

Preliminary analysis of data from patients with pelvic-girdle pain, low-back pain, and knee osteoarthritis indicate that changed pelvis–thorax coordination can be caused by an alteration of the coordination of the pelvis relative to the leg movement, or by an alteration of thorax rotation relative to the pelvis. This suggests that different changes in gait coordination may lead to the same suppression of the phase shift of thorax relative to pelvis rotation with increasing gait velocity.

References

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Fig. 1. Typical example of the transverse rotations of thorax and pelvis and the forward/backward movement of the right distal femur in a healthy subject at three velocities.

O-04
Can gait analysis guide management in children with spastic diplegia?
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1. Summary

The short-term outcome in three groups of children with spastic diplegic cerebral palsy (SDCP), referred for three-dimensional gait analysis (3DGA) and treatment recommendations, was assessed retrospectively by looking at changes in the Normalcy Index (NI) [1] and minimum knee flexion in single support (MKFS) on a subsequent gait analysis. The groups consisted of 15 children who had multilevel surgery recommended and performed following 3DGA (operative group, OG), 15 children who had multilevel surgery recommended but not performed for family or administrative reasons (operation not done group, ONG), and 15 children in whom surgical intervention was not thought to be needed at that time (non-operative group, NG) (Table 1). The NI results show that 3DGA was able to separate children with SDCP into distinct groups on the basis of severity of involvement. The NI in the OG decreased significantly between gait analyses, while the NI in the ONG and NG did not change significantly although subgroups showing improvement and deterioration were noted in both groups. The MKFS