Trunk-lower limb coordination pattern during gait in patients with ataxia

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Introduction

Although deficit of coordination between the upper and lower body segments might play an important role in impairing gait and stability in ataxic patients, this deficit has not been investigated in subjects with ataxia so far. The aim of the present study is to evaluate the coordination between trunk and thigh in a sample of patients with ataxia compared with healthy controls and to correlate the coordination measures with the clinical severity.

Methods

Recordings were performed using the SMART-D 500 motion analysis system (BTS,Milan, Italy) equipped with eight infrared cameras and adopting Davis protocol [1]. Sixteen patients with degenerative cerebellar ataxia and sixteen age- and sex-matched controls were studied. Patients were asked to walk barefoot at a comfortable speed along a 10-meter walkway. We assessed the coordination on the sagittal plane between trunk and thigh, considered as rigid segments, by the continuous relative phase (CRP) method [2], (figure 1,2). We used the coefficient of multiple correlation (CMC) [3] to measure the within-subject (CMC_{WS}) variability, and the SARA scale to assess clinical severity.

Results

Trunk-thigh coordination has a higher within-subject variability in ataxic patients (median CMC_{WS}: 0.53 for patients, 0.89 for controls, $p<0.001$), (figure 3). We also found that the CMC_{WS} of the CRP curves negatively correlates with the gait (ρ: -0.565, p: 0.023) and stance (ρ: -0.567, p: 0.022) sub-scores and the total score of the SARA scale (ρ: -0.711, p: 0.002).

Conclusion

Our study shows a deficit of spatio-temporal coordination between upper and lower body segments in ataxia. Such a deficit is correlated with the disease severity indicating an important role of inter-segmental coordination impairment in determining the ataxic gait. CRP curves are dissimilar between ataxic patients and controls, the former showing a chaotic behavior compared to the well-shaped CRP curves observed in the latter. Our findings provide a rational to develop rehabilitation programs focused on the coordination between trunk and thigh.

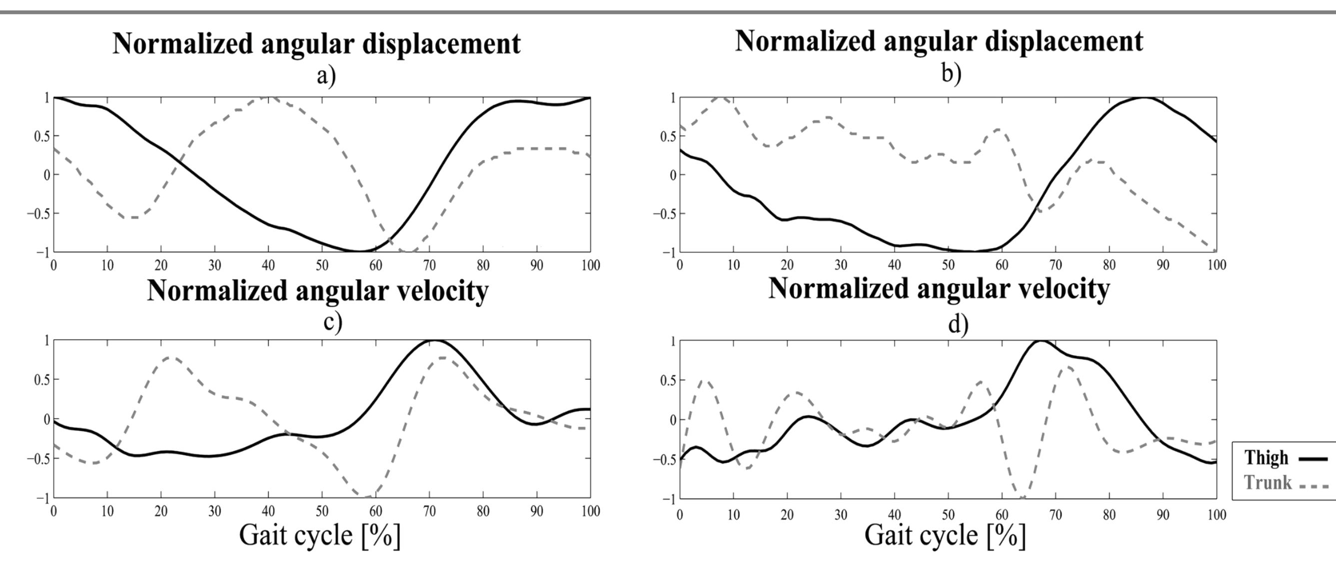

Figure 1 Normalized angular displacement and normalized angular velocity of trunk and thigh in a representative healthy subject (a and c) and ataxic patient (b and d).

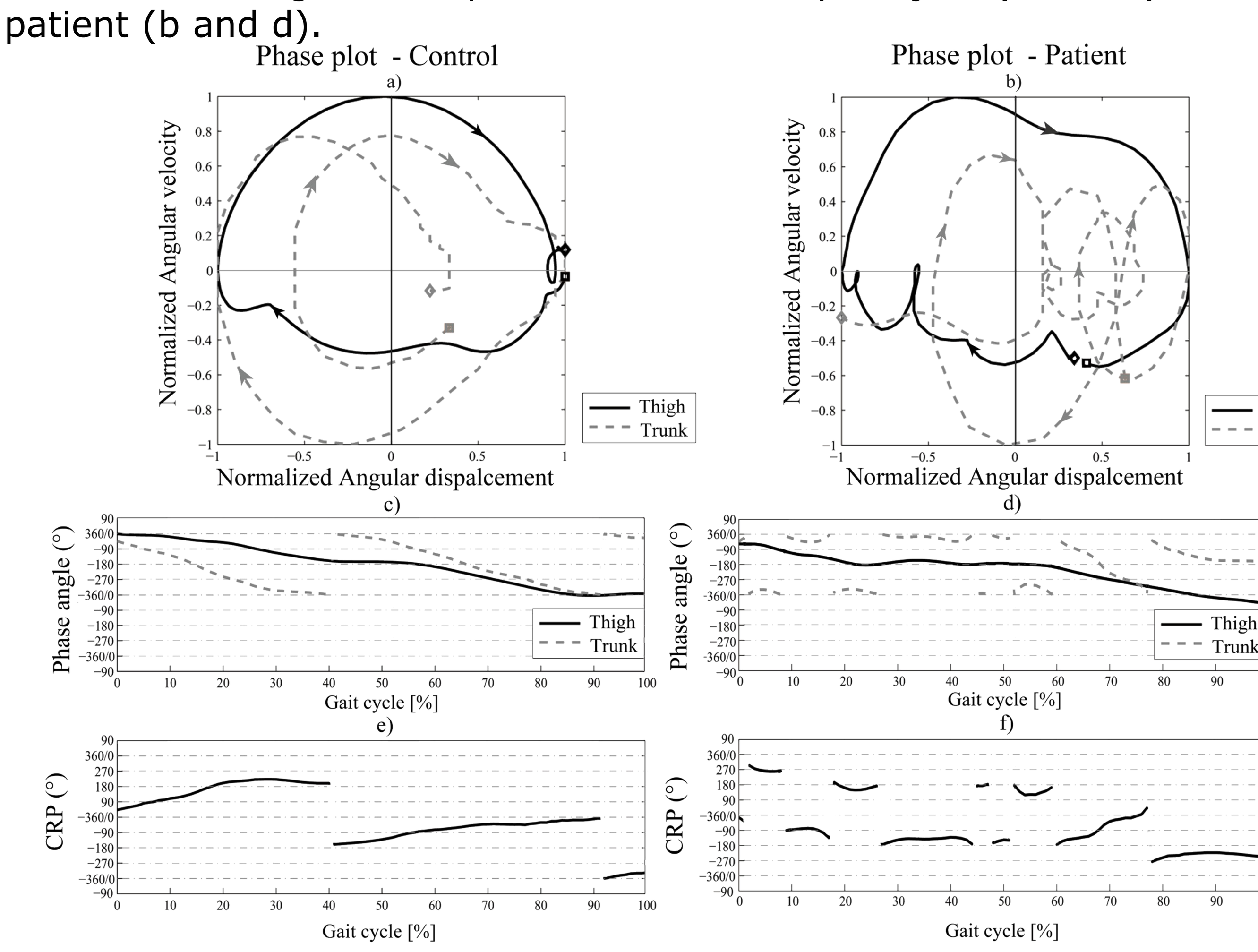

Figure 2 Phase plots of trunk and thigh respectively in a representative control a) and ataxic patient b). Thigh and trunk phase angles in a representative control c) and ataxic patient d). CRP curves with discontinuities respectively in a healthy subject e) and a patient f).

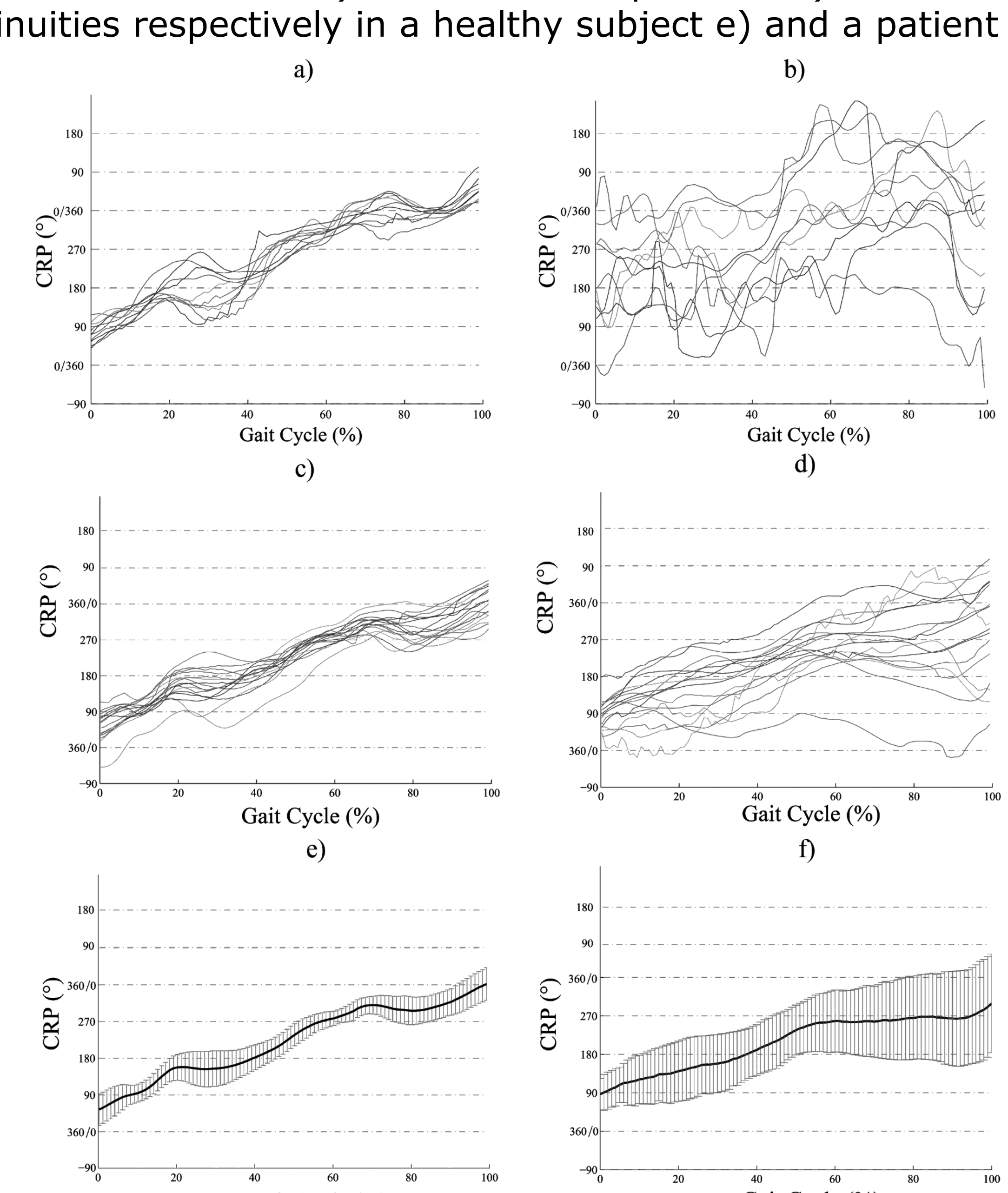

Figure 3. CRP curves relative to 10 trials in a healthy subject a) and an ataxic patient b). Mean CRP curves of each healthy subject c) and ataxic patient d). Time series of the mean CRP and its SD in the healthy e) and ataxic group f).

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