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# Multiple Sclerosis patients perform tandem gait with additional upper-limbs movements: proposal of an inefficiency index

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## Introduction

While early detection of balance and gait impairments in multiple sclerosis (MS) is crucial to propose early rehabilitation and to improve patient's follow-up, it is also challenging. By reducing the area of support and the step width, tandem gait highly challenges dynamic balance and requires limbs additional movements to maintain balance.

**The objective** of the present study was to propose an index to quantify limbs and trunk movements during tandem gait in early-stage MS patients compared to matched healthy participants.

## Methods

Fifteen patients with relapsing-remitting MS, with a median Expanded Disability Status Scale of 2.5 [0-4] and a disease duration of  $10.9 \pm 7.9$  years, were compared to 15 matched healthy participants. Three-dimensional motion analysis (Fig 1 & 2) was performed during tandem gait to calculate spatiotemporal parameters and an inefficiency index, based on the linear momentum of body segments. This index characterized the right and left upper, lower limbs and the head-trunk-pelvis additional movements to achieve tandem gait. The higher the inefficiency index is for a given body segment, the less efficient this segment is for the forward body progression.

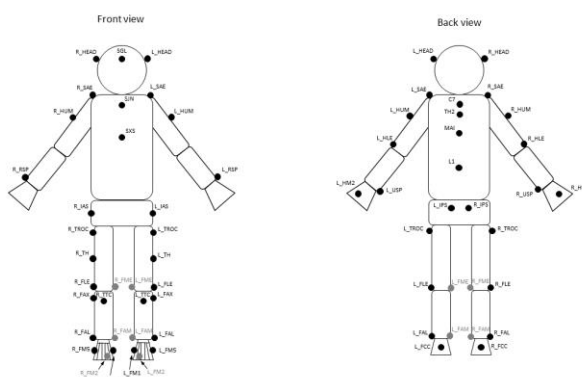


Fig 1: Whole body setup



Fig 2: Qualysis motion acquisition

## Results

Compared to the healthy participants, MS patients executed tandem gait with higher speed ( $p=0.03$ ), longer step length ( $p=0.03$ ) and an increased distance between the feet ( $p=0.02$ ). The right and left upper limbs inefficiency index were increased in MS patients ( $p=0.02$  and  $p=0.03$ , respectively) (Fig 3).

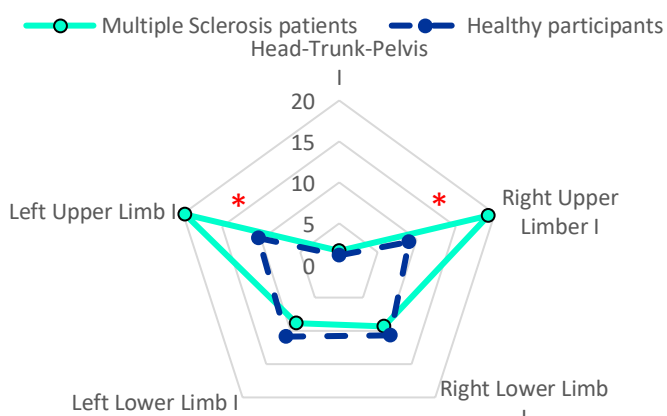


Fig. 3: Inefficiency index ( $I$ ) based on the linear momentum calculated for the body segments between MS patients and healthy participants during tandem gait. \*  $p < 0.05$

## Discussion

Even at the early stage of the disease, MS patients presented a less accurate tandem gait execution. The inefficiency index revealed that MS patients largely increased their upper limb movements. These additional movements could contribute to balance recoveries and indirectly illustrate the poorer balance performance of MS patients. This index could be used as a physical marker to follow balance deterioration and to assess the efficiency of the rehabilitation, even at the early stage of the disease.