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Elderly fallers enhance dynamic stability through anticipatory postural adjustments during a choice stepping reaction time

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Number of characters (3000 max): 2929

BACKGROUND AND AIM:
In the case of disequilibrium, stepping is a natural, effective and privileged strategy to recover balance. The capacity to step quickly is thus critical to avoid falling, in particular for elderly. It can be simply assessed through the choice stepping reaction time test (CSRT), where elderly fallers (F) need more time than elderly non-fallers (NF). However, reasons for this result remain unclear. To answer this, we investigated the characteristics of anticipated postural adjustments (APA) developed by elderly F in a CSRT context and their consequences on the dynamic stability.
METHODS:
44 community-dwelling elderly subjects (20 F and 24 NF, mean age 75, height 1.63 m, and weight 66.8 kg) performed a CSRT with four targets (Lateral Left, Central Left, Central Right, and Lateral Right, Fig A). Duration of the step phases, presence of APA error, trajectories of both the center of pressure (CoP) and extrapolated center of mass (XCoM) and size of the margin of stability (MoS) at the foot-off (FO) were analyzed using two-way repeated measures ANOVAs.
RESULTS:
Total stepping time was longer in F compared to NF, independently of the target direction. This elongation is due to a significant increase of the APA phase duration. Both APA subphases ("loading" and "unloading" mechanisms) were significantly elongated. Elderly F did not make more APA errors than NF but used two distinct balance strategies during APA, depending on the axis (Fig B). In the AP direction, F had a smaller backward movement and slower peak velocity of the CoP. In the ML direction, the CoP movement was similar in amplitude and peak velocity between groups but lasted longer. The biomechanical consequence was an increased MoS at FO in both directions.
CONCLUSIONS:
The results about the step timings are concurring with previous studies in the literature. The presence of APA error seems however not to be an evident reason for APA elongation in F. Analysis of APA tend to indicate that F voluntarily elongate their APA during a CSRT. This strategy allows increasing the condition for dynamic stability at the end of the APA, *i.e.* when the base of support is reduced to only one foot. By delaying the FO, elderly F chose to prioritize the stability to the detriment of the objective of the task (a quick step), probably because a higher fear of falling. It is concluded that elderly F used a "safer" balance strategy than NF during the CSRT. If delaying the FO is possible during a voluntary step initiation task, it may however become a severe balance issue in a more demanding context such as protective steps. An elongated APA duration during the CSRT could thus be understood as an indicator of the risk of fall in community-dwelling elderly.
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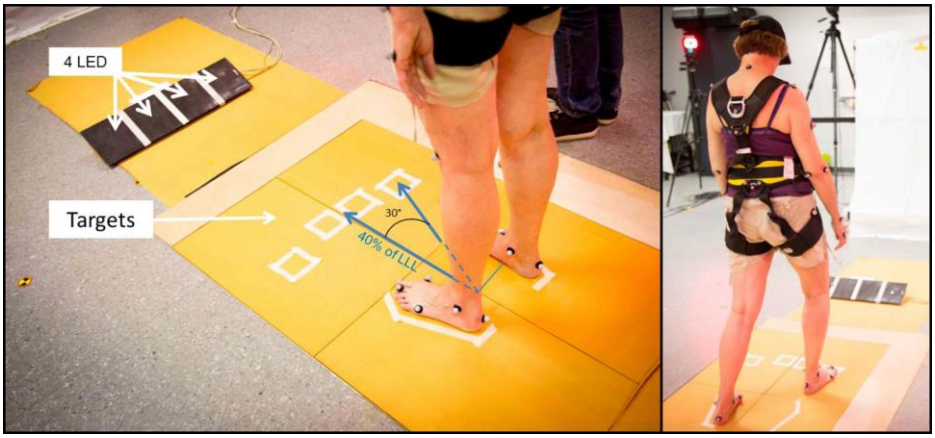
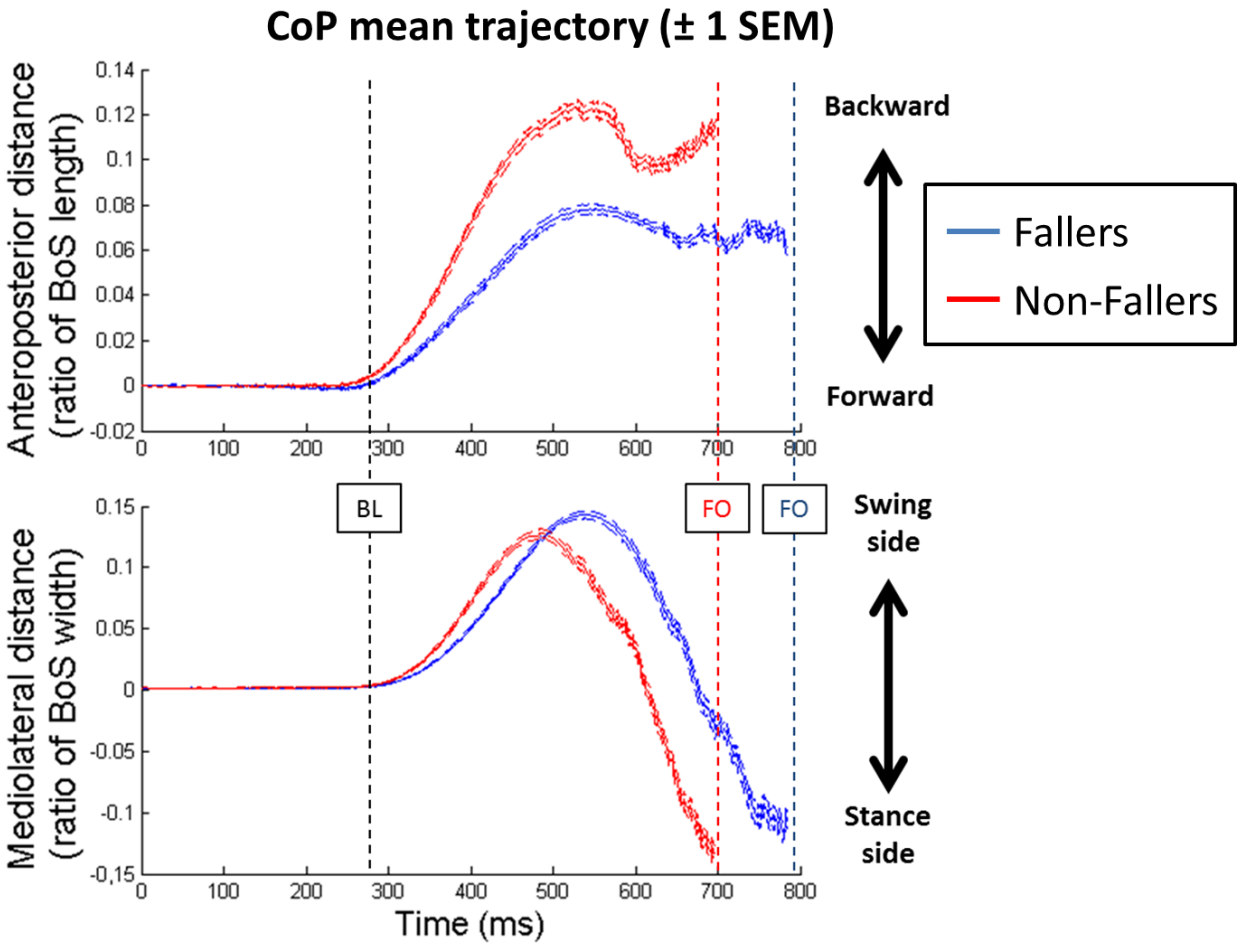
As APA are not invariant but adapted to external and internal constraints, we hypothesized that elongation of the APA in elderly F is the result of a strategy to increase their conditions for dynamic stability.

Trajectories of 39 reflective markers and ground reaction forces from 4 forceplates were collected.

A/ Experimental Setup



B/ APAs (CoP trajectories) for the two groups



BL : begining of the loading phase; FO : Foot-off.