



## Short Communication

# Vestibular asymmetry increases double support time variability in a counter-balanced study on elderly fallers



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## ABSTRACT

Vestibular asymmetry is a common cause of dizziness in the elderly, for whom it precipitates the risk of falling. Previous studies have shown that those with vestibular asymmetry displayed an altered variability in double support time (DST) compared to controls. However, swing time (SwT) variability findings are conflicting. In this study, we investigated if vestibular asymmetry might be causally connected to increased DST variability. We studied a group of eight elderly fallers with wrist fractures across three months, during which time four of them regained vestibular symmetry while four others developed an asymmetry. We evaluated the variability of DST and SwT, both when the participants suffered from vestibular asymmetry and when they did not. On average, variability in DST was significantly greater by 2.38 %CV (coefficient of variation) when participants scored positive for vestibular asymmetry compared to when not,  $t(5) = 4.39$ ,  $p = 0.01$ ,  $\xi = 1.67$ . In contrast, SwT variability differed non-significantly by 0.44 %CV when participants had tested positive versus negative for vestibular asymmetry,  $t(5) = -0.87$ ,  $p = 0.39$ ,  $\xi = -0.29$ . As a possible rationale for our results, we propose that increased DST variability may be the result of a re-stabilization strategy. Further research on DST variability and its correlation to the duration of vestibular asymmetry is recommended.

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## 1. Background

The prevalence of dizziness increases with age; indeed, for those past 65, it is more common than not [1]. One major cause is vestibular asymmetry: an asynchronous firing of the vestibulo-ocular organs, which in turn is the consequence of a variety of diseases, such as vestibular neuronitis and Ménière's disease. The detrimental effects of vestibular asymmetry is many times severe—for the elderly, it precipitates the risk of falling [2].

Since falls occur predominantly during locomotion, many studies have aimed to establish how the gait of those with vestibular asymmetry compares to that of people with healthy vestibular function. That research, however, has frequently been marred on account of the confounders often present in people with vestibular diseases. In a previous study, we approached that

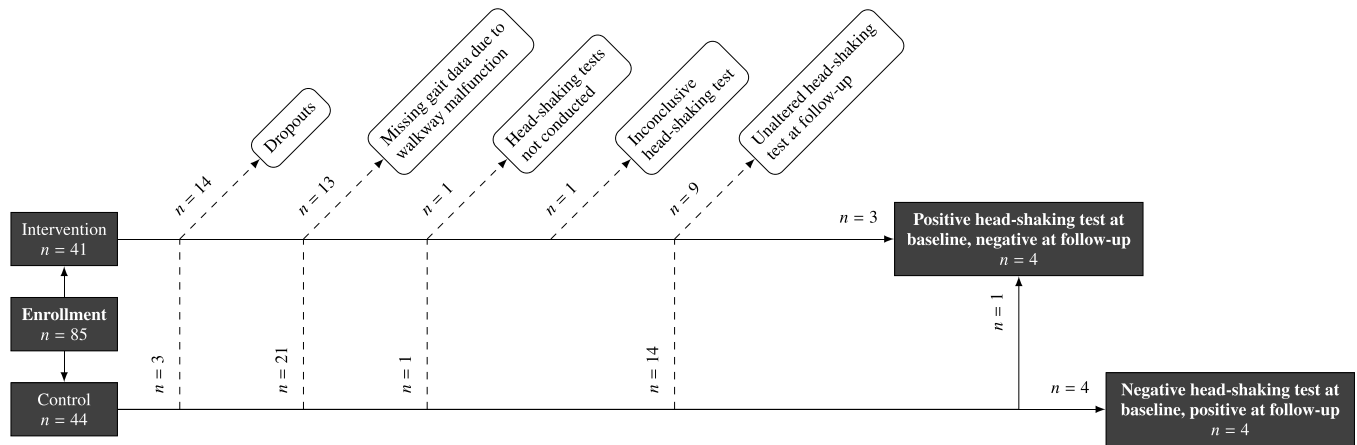
limitation by investigating the gait of a relatively homogeneous sample of elderly female fallers with wrist fractures, finding increased double support time (DST), but not swing time (SwT), variability in those with vestibular asymmetry [3]. Increases in DST variability has been reported before, but has as such then coincided with greater variability also in SwT [4,5], or been found selectively in SwT [6].

In the present study, we sought to investigate if vestibular asymmetry might be causally connected to increased DST variability. This required the experimental induction (or deduction) of vestibular asymmetry in our participants, which we achieved by studying a cohort across three months, during which time some regained vestibular symmetry while others developed an asymmetry. As far as we can tell, this is the first attempt to evaluate the effects of vestibular asymmetry within participants; moreover, we aimed to establish if our previous results could be significantly reflected in an altered study design. We hypothesized that variability in DST, but not SwT, would increase when participants suffered from vestibular asymmetry compared to when they did not.

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**Fig. 1.** The selection process from initial enrollment until final inclusion of study participants ( $n = 8$ ), for whom the result of the head-shaking test varied between baseline and follow-up measurements from either positive to negative or vice versa.

## 2. Method

### 2.1. Participants

The study was conducted as part of a larger study on vestibular rehabilitation [7]. The sampling process is described in Fig. 1. Eighty-five individuals, aged 50 or older, were recruited from a hospital ward in southern Sweden after having suffered radiologically confirmed fall-related wrist fractures. After being forwarded to a primary care clinic, they were randomly allocated to a control ( $n = 44$ ) or intervention ( $n = 41$ ) group, and respectively undertook either conventional care or a vestibular rehabilitation regimen (as detailed here [7]). Head-shaking tests (HST) and gait analysis were conducted at baseline and three months later at follow-up.

Fourteen persons opted to drop out from the intervention, as did three controls. Additionally, 34 participants were excluded because the walkway unit malfunctioned. Moreover, two who declined the HST and one for whom the test was inconclusive were omitted. For the remaining participants, the results of the HSTs were compared between baseline and follow-up. Those with identical results were excluded ( $n = 23$ ). Eight persons remained, four with a positive to negative change, and four with a negative to positive change on the HST. In the former group, three came from the intervention group and one from the control group, while in the latter group all of the participants came from the control group.

**Table 1**

Characteristics of the participants, including which group they were assigned to as well as their results on the head-shaking test.

Sex	Age	Height (cm)	Weight (kg)	Group <sup>a</sup>	Head-shaking test <sup>b</sup>	
					Baseline	Follow-up
Female	54	179.00	75.00	C	N	Right
Female	62	173.50	80.00	C	N	Down
Female	67	160.00	67.00	C	N	Right
Female	67	162.00	70.00	C	N <sup>c</sup>	Right
Female	58	166.00	77.00	C	Right	N
Female	71	164.00	76.00	I	Right	N
Female	80	165.00	74.00	I	Left	N
Male	89	170.00	70.00	I	Right <sup>c</sup>	N <sup>2</sup>
Mean	68.5	167.4375	73.625			
SD	11.50155	6.343937	4.307386			

<sup>a</sup> C = control group, I = intervention group.

<sup>b</sup> N = negative test; else the direction of positive nystagmus.

<sup>c</sup> At the time of the test the respective participant lacked sensation for vibration from the lateral malleolus/tibial tuberosity and caudally.

### 2.2. Vestibular asymmetry

Vestibular asymmetry was diagnosed with the HST, which in pooled analyses has shown good specificity (82%) but lackluster sensitivity (45%) [8]. Nevertheless, the test has previously proved predictive of falls in people with multi-factorial dizziness [2].

The test was conducted in the supine position by rotating the head in the transverse plane at 2 Hz for approximately 15 s, using frenzel goggles to tape the results. An experienced physician—blinded to the patients' diagnoses—conducted and assessed the tests, which were considered positive if nystagmus could be detected and its direction determined.

### 2.3. Gait analysis

A GAITRite® walkway (CIR systems Inc., NJ, USA) with an active area of 4.88 m was used to collect gait data. Patients were instructed to start walking at their preferred speed 2 m before, and continue 2 m past the walkway, doing so in two or three passes. The variability of DST and SwT was expressed as the coefficient of variation in percent (%CV) in line with similar studies [4–6]. Following preliminary analysis we opted to use the means of the both legs.

### 2.4. Subject characteristics

Participant characteristics are presented in Table 1. Vibration tests revealed sensation deficits for two individuals (see Table 1).

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