P608

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Relative Contribution of Walking Speed, Ataxia and Gait asymmetry to the Composition of Gait in Multiple Sclerosis

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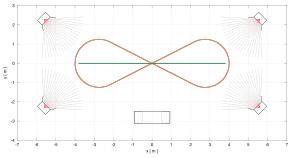
Introduction - Objective: Walking speed measured according to the T25FW is the most widely used descriptor of gait in MS clinical research and practice but other dimensions influencing gait variance exist according to alternative gait analysis methods. The relative importance of these different dimensions of gait relatively to its variance is unknown.
Methods: We measured the performances of persons with MS and healthy subjects on the T25FW and the Timed 20-Meter Walk (T20MW) performed in tandem with a new gait analysis system (GAIMS). We performed a factorial analysis of variance to underline the main dimensions influencing gait variance and observed their composition.
Findings - Conclusion: The main factor influencing gait variance in conventional walk tests is mostly composed of features related to walking speed. Balance, gait asymmetry and variability also participate to this variance but to a lesser extent. The inverse is observed in tests performed in tandem gait.

Introduction and Objective

- Walking speed (WS) measured according to the Timed 25-Foot Walk (T25FW) performed as fast as possible (AFAP) is the most widely used gait descriptor (GD) when characterizing the walking impairment of persons with multiple sclerosis (pwMS) in clinical practice and trials[1, 2].
- It has however been demonstrated through the use of other GDs that alternative dimensions of gait such ataxia or gait asymmetry[3] also participate to its variance and have the potential to distinguish between pwMS and healthy volunteers (HV), as well as between pwMS with different levels of disability.
- The tandem gait (TG) is a classic semiological approach in neurology to detect subtle ataxia[4]
- Our objective was to determine and characterize the main dimensions explaining gait variance in such a population

Fig 1 ***The two trajectories of GAIMS included the T25FW as straight line (green) and the T20MW as an 8-shaped line (orange), here viewed from above***



Methods

- This study was approved by the local ethics comittee
- Sixty-nine pwMS and 37 HV were recruited
- Subjects performed several walk tests including the T25FW according to the MSFC guidelines (AFAP) and a distance of 20 meters (T20MW) performed in tandem gait. Both walk were recorded with a gait measure system allowing the measurement of 26 GDs relative to their feet trajectories (Fig 1, GAIMS, see P800 on Friday, Clinical assessment tools session).
- The GDs were either *conceptually* related to the Walking Speed or to Ataxia, Asymmetry and Variability of Gait (Table 1). Certain GDs were considered « non specific » because although their measurement was necessary for the calculation of the whole GD set, their direct relevance toward gait characterization was unclear.
- Data were standardized to z-score
- A factorial analysis of variance (FA) was performed on the data set
- For the first 3 factors, the factorial weights of all GDs were examined. A factorial weight threshold of 0.6 was operationnaly set to consider the contribution of a GD to a factor as significant. According to the observed pattern of GD participation, the dimensions underlying gait variance were drawed
- Statistical analysis were performed using Statistica, version 10 for Windows (Statsoft Inc., France)

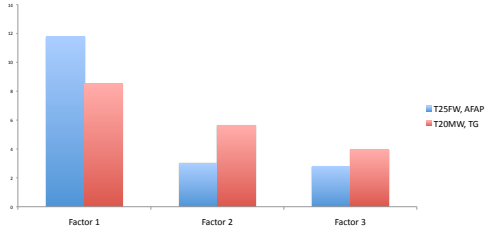
Table 1 ***Gait Descriptors created to characterize the gait of pwMS and healthy subjects using GAIMS***

Gait Descriptors related to Walking Speed	*Gait Descriptors related to Ataxia, Asymmetry and Variability of Gait*	*Gait Descriptors "Non specific"*
4. v_p: mean velocity of the person	10. $d_\perp$: mean value of the lateral inter-feet distance.	1. l_p: length of the person's unregistered trajectory.
5. v_l: mean velocity of the left foot	11. Maximal deviation of the person.	2. l_l: length of the left foot unregistered trajectory.
6. v_r: mean velocity of the right foot	12. Mean deviation of the person: mean value of the deviation signal.	3. l_r: length of the right foot unregistered trajectory.
8. v: useful velocity	13. RMS deviation	7. l: length of the segment that is analysed.
14. V_l: maximum velocity of the left foot.	19. ϕ: left foot spatial lateness (or right foot advance).	9. d: mean value of the inter-feet distance signal.
15. V_r: maximum velocity of the right foot.	23. σ_l: variability of the left foot strides.	17. Δ_l: stride length of left foot.
16. Δ: median gait cycle duration.	24. σ_r: variability of the right foot strides.	18. Δ_r: stride length of right foot.
20. Proportion of the gait cycle time in double limb support.	25. e_l: mean distance between the support points of the left foot and the path.	
21. Proportion of left foot moving time over the gait cycle. 22. Proportion of right foot moving time over the gait cycle.	26. e_r: mean distance between the support points of the right foot and the path	

Table 2 ***Demographic data***

	Healthy Volunteers	people with MS			
		All	EDSS ≤ 2.5	EDSS 3.0 – 3.5	EDSS 4.0 - 5.5
Number	37	61	19	12	30
Age (years, mean ± SD)	31.2 ± 1.3	42.5 ± 11.7	37.2 ± 11	47.4 ± 9.6	47.3 ± 11.9
Gender (female, %)	46.4	63.6	78.9	66.6	50
EDSS (mean ± SD)	n.a.	3.3 ± 1.3	1.8 ± 0.8	3.2 ± 0.2	4.2 ± 1
MS type (CIS/RR/P, %)	n.a.	14.9/59.6/23.4	37.8/62.2/0	25/66.6/0.8	3.3/46.7/50
Disease duration (year, mean ± SD)	n.a.	11.7 ± 10.6	6.74 ± 6.7	14.67 ± 11.9	13.2 ± 9.8

Figure 2 ***Eigenvalues of the first 3 factors obtained from the factorial analysis of the T25FW and the T20MW***



Findings

Demographic charateristics (**Table 2**):

- pwMS were around 11.3 yo older than HV (p<0.001), with a higher female representation
- no other significant differences were observed between groups pwMS and HV

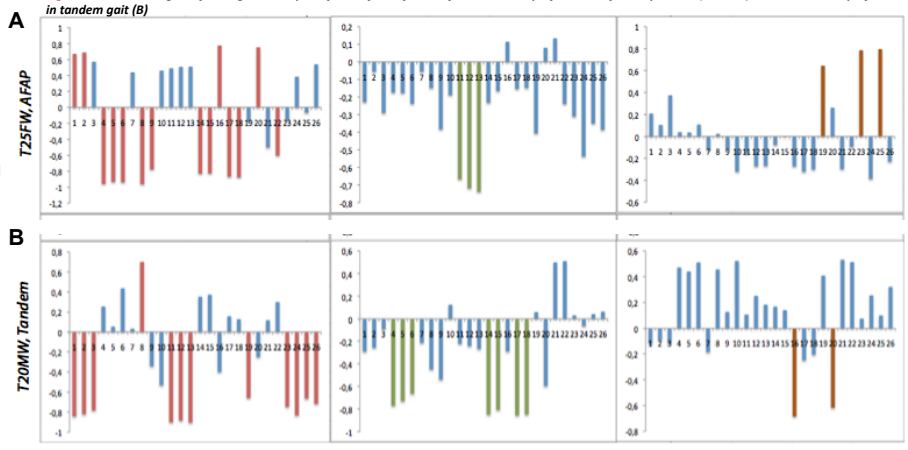
Factorial Analysis of variance (FA, **Fig 2**)

We performed a FA of our data set (considering both pwMS and H) and kept for analysis the first 3 factors. For the T25FW performed as fast as possible and the T20MW performed in tandem gait, we observed a clear predominance of the first factor (11.79% and 8.53%, respectively) over the second (3.02% and 5.65%, respectively) and third (2.81% and 3.95%, respectively) ones (Fig 2).

Observation of individual GDs participation (**Fig 3**), showed that:

- when examining the 1st factor:
  - most GDs obtained from the T25FW performed AFAP were conceptually related to Walking Speed (fig 3A).
  - while in the T20MW performed in tandem gait these were mostly related to ataxia, asymmetry and variablity of gait (fig 3B)
- when examining the 2nd and 3rd factors together, we observed that
  - most GDs obtained from the T25FW were related to ataxia, asymmetry and variablity of gait (fig 3A)
  - while those obtained from the T20MW were mostly related to Walking speed (fig 3B)

Figure 3 ***Factorial weights of each gait descriptors for the first 3 factors, for the T25FW performed as fast as possible (AFAP, A) and the T20MW performed in tandem gait (B)***



Conclusion – Discussion – Perspectives

1. In a population of persons with multiple sclerosis and healthy controls, the main features influencing the variance of gait evaluated with « conventional » walk tests are related to walking speed
2. Features related to balance and other qualitative alterations of gait also participate to the variance of gait, but clearly to a lesser extent
3. Evaluation of gait according to the « heel-to-toe » paradigm allows to better delineate features related to ataxia

Further work will implie the development of new gait features and evaluation of how these may help to distinguish pwMS from HV and pwMS with different levels of disability

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Disclosures

R. Phan-Ba serves on scientific advisory boards for Genzyme-Sanofi Aventis and has received funding for travel from Genzyme-Sanofi Aventis, Bayer Schering Pharma and Biogen Idec.
S. Pierard and M. Van Droogenbroeck have nothing to disclose.