Timed up and go and brain atrophy: a preliminary MRI study to assess functional mobility performance in Multiple Sclerosis

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Background. Mobility impairment is one of the most disabling problems and cause of comorbidity (eg. falls and bone injuries) in MS. Timed up and go (TUG) is a widely used measure of functional mobility and an instrumented TUG which make use of inertial sensors has been recently tested in MS (Pau et al., 2017). This approach allows obtaining time, acceleration and velocities of each TUG sub-phase (i.e. sit-to-stand, intermediate and final turning, stand-to-sit). In addition, as it is based on open-task, TUG evaluate also programming, planning, navigation and other executive functions. Since clinical disabilities, especially motor and cognitive impairment, are highly related to brain atrophy (Charil, A., et al., 2006), and TUG is able to combine these abilities in a single task, the purpose of this study was to evaluate relationship between brain volumes and instrumented TUG (iTUG) performances.

Methods. Inclusion criteria for enrollment were a diagnosis of MS according to McDonald criteria and been able to walk at least 20m. iTUG was performed using a wearable inertial sensor as previously reported by Pau et al. Times and velocities of TUG sub-phases were calculated by processing the trunk accleeration data. .All patients underwent to a brain MRI and volumes of whole brain (B), white matter (WM), grey matter (GM) and cortical GM (C) were estimated with SIENAX (Smith et al., 2002). Relationship between brain volumes and TUG parameters were assessed by means of Spearman correlation.

Results. Sixty patients were enrolled (19 male); mean age was 41.5±11.6 years and mean EDSS was 2.3±1.2.

The following significant correlations were found:
•total TUG duration with B (Rho=0.270 p=0.038), WM (Rho=0.358 p=0.005), GM (Rho=0.309 p=0.017), C (Rho=0.317 p=0.014);
• for intermediate turning: mean velocity with B (Rho=0.365 p=0.004), WM (Rho=0.331 p=0.10), GM (Rho= 0.427 p=0.001), C (Rho=0.380 p=0.003), and maximal velocity with B (Rho= 0.274 p=0.035), GM (Rho=0.377 p=0.003), C (Rho=0.351 p=0.006).
•For the final turning: mean velocity with WM (Rho=0.256 p=0.042), G (Rho=0.350 p=0.007), C (Rho=0.304 p=0.019) and maximal velocity with B (Rho=0.265 p=0.043), G (Rho=0.390 p=0.002), C (Rho=0.400 p=0.002).

Table 1. Demographic and clinical features of MS patients included in the study.

	60 MS patients
Male Gender	19 (31.7%)
Age (mean ± sd) years	41.5 ± 11.6
Progressive course	4 (6.7%)
Disease Duration (mean ± sd) years	11.6 ± 7.5
EDSS score	2.3 ± 1.2

Table 2. Spatio-temporal parameters of gait measured with the iTUG

iTUG parameters	Mean
TUG TIME	14.02 ±7.08
Stand up time	1.67 ±0.51
First turning time	2.21 ±0.80
Second turning time	2.03 ±0.95
Maximal Velocity First turning	174.67 ±50.84
Maximal Velocity Last turning	191.51 ±54.50
Mean Velocity First turning	76.72 ±27.12
Mean Velocity Last turning	82.24 ±34.86

Conclusions. iTUG is a very useful tool in clinical setting as it can not only evaluate patients' disability in terms of impaired functional mobility, but also estimate pathological features such as cortical atrophy.