Reviewer ID: Carlos L. Cano Herrera

Last updated: February 9th, 2024

Research Summary – Pendulum Test (Wartenberg) - Spasticity

Author Year Research Design Setting (country)	Demographics and Injury Characteristics of Sample	Validity	Reliability	Responsiveness Interpretability

De Santis & Perez 2024
 	
Study to develop an objective and portable system to assess knee extensor spasticity during the pendulum test using inertial measurement units (IMU).
 	
USA
	N=23 Individuals with chronic (≥1y; at or above T12) SCI (8F), mean age 49.7 ± 13.4 years
	Medication(s) withheld on test days.
	Cause of injury: Traumatic (n = 17), non-traumatic (n = 6)
	Level of injury: C1 (n = 1), C2 (n = 2), C4 (n = 3), C5 (n = 2), C6 (n = 1), C7 (n = 1), C8 (n = 2), T3 (n = 1), T4 (n = 3), T5 (n = 2), T10 (n = 3), T12 (n = 1), L3 (n = 1)
	AIS score: A (n = 5), B (n = 2), C (n = 6), D (n = 10)
	
	N = 20 individuals with SCI participated in two study sessions (1 week apart) whereas N=3
			Test-retest reliability:
			Control Group:
			• Optical tracking system with pendulum test (OTS)
			  • ICC= 0.876 (95% CI=0.775-0.933); p<0.001
			• Inertial measurement units with pendulum test (IMU):
			  • ICC= 0.864 (95% CI 0.763-0.924); p<0.001
			SCI group:
			• OTS
			  • ICC=0.932 (95% CI= 0.874-0.964); p<0.001
			• IMU	

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	participated in only 1 session
	
	N = 22 age matched controls (12F), mean age 43.9 ± 16 years
			• ICC= 0.925 (95% CI= 0.861-0.960); p<0.001
			Overall:
			• OTS
			  • ICC= 0.952 (95% CI= 0.927-0.969); p<0.001)
			• IMU
			  • ICC= 0.951 (95% CI= 0.925-0.968); p<0.001	

Smith et al. 2000 Cross-sectional University Rehab centre (tertiary care)	N=22 (convenience samples; 21M, 2F) Mean age 33.4±12.5yrs (range 16-63yrs) 14 tetraplegic, 8 paraplegic 1 incomplete Mean DOI 29.8±43.2mo (range 4-172mo)	Average manually applied velocities during the Manual Muscle Test (MMT) were compared to muscle tone score from pendulum testing. Higher levels of muscle tone corresponded to lower applied velocities and vice versa, suggesting	**Test-retest, inter-rater, intra-rater:** *Inter-trial reliability (test-retest) = Seven pendulum tests were performed at the end of manual muscle testing.* **ANOVA.** There were no significant	

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	≤grade 3 muscle strength in knee extensors.	an inverse relationship between these two variables. **Pearson correlation coefficient.** Correlations between pendulum test score and average velocity were significant for two of the three therapists (A: r=0.223, p=.32; B: r=0.657, p<.001; C: r=0.67, p<.001). Including all three data sets gave an average correlation of 0.638 and significance level of 0.001.	differences between the 7 trials (p=.64). **ICC and 95% confidence interval.** ICC=0.92 r >0.87	