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Last updated: May 13th, 2024

Research Summary – Surface Electromyography (sEMG) – Other Physiological Systems

Author Year Country Research Design Setting	Demographics and Injury Characteristics of Sample	Validity	Reliability	Responsiveness Interpretability
Silverman et al. 2021 Study to assess the correlation of time-domain EMG features with the exerted joint torque (validity) and their test-retest repeatability (reliability), which may contribute to characterizing muscle activation following SCI	N = 9 healthy uninjured participants 7M, 2F Mean (SD) age 32.3 (8) years N = 4 participants with cervical incomplete SCI 3M, 1F Mean age 46.75 years AIS C or D	**Spearman coefficients:** All EMG features correlated well with torque in uninjured participants (TA: ρ = 0.92-0.97; SOL: ρ = 0.94-0.97). The strong correlation between time-domain SEMG features and torque measurement remained true in four participants with SCI for both muscles tested (TA: ρ = 0.86-0.95; SOL: ρ = 0.86-0.95).	In healthy participants, the ICC of the slopes demonstrated high reliability for all SEMG features. - For TA, slopes of linear regression had high repeatability (ICC > 0.94). - In SOL, point estimates were high as well (ICC > 0.86), however the lower confidence bound estimates were variable. In TA, y-intercepts of linear regression similarly showed good performance	

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			as per point estimates (ICC > 0.7), albeit with wider confidence bounds, and generally better than those for SOL. Grouped statistical analysis of reliability was not possible in the SCI series due to the small number of participants and clinical heterogeneity in injury severity and muscle performance.	
Lim et al. 2005 Cross-sectional retrospective study of a neurophysiological method of voluntary motor control	67 participants with incomplete spinal cord injury (iSCI) 63 males, 4 females mean age: 49.5±15.2 AIS C=32 AIS D: 35 15 AB participants Level of injury:	The AIS unilateral motor scores were correlated to the different similarity indexes (SIs) representing individual motor tasks or combinations of tasks, for example, proximal movements		

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characterization . VA Medical Centers in Houston and Dallas Texas, USA.	40 cervical 18 between T1-T9 9 below T10	together or flexion movements together. Correlation coefficients ranged from 0.22 to a high of 0.80 (P<.01) which was observed for the four unilateral motor tasks taken together. Hip–knee flexion, dorsiflexion and plantar flexion showed the strongest correlation coefficients, 0.80 (r<0.01) with unilateral motor scores. All correlation coefficients between motor score and combined SI values that included the dorsiflexion task were over 0.75 (P<.01) An SI value of 0.85 was found to separate AIS-C and AIS-D groups		

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		with a sensitivity of 0.89 and a specificity of 0.81.		
Lim & Sherwood 2005 Retrospective analysis 2 Texas Department of Veterans Affairs (VA) medical centers	69 incomplete SCI participants (65 males, 4 females) mean age: 48.1±4.6 yrs 54.8 ± 3.6 months postinjury 15 AB participants (11 males, 4 females) mean age: 36±10 yrs Injury classification: AIS C: 34 AIS D: 35	No group difference existed for AIS-C (r=0.80±0.08) and AIS-D (r=0.87±0.12) in the correlation analysis of SI.	**Interpretability:** Correlation analysis results showed a moderate to strong correlation for 3 repeated measures: r= 0.83 to 0.98 for magnitude (P<.05) r= 0.77 to 0.88 for similarity index (SI) (P<.05) The magnitude (r=0.93±0.04) showed stronger correlation than SI (r=0.83±0.04) overall. Flexion movements (r=0.95±0.03 for magnitude and r=0.86±0.03 SI) showed significantly higher correlation	

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			than extension movements (P<.05). **Test-retest, Inter-rater, Intra-rater:** 3 repetitions for each of the 10 motor tasks were analyzed for repeatability with the use of ICCs. **Short term reliability:** The reliability of the 2 components of the VRI (voluntary response index), magnitude and SI (similarity index) were good (ICC= 0.93±0.05 for magnitude and ICC=0.83±0.04 for SI) for the 69 SCI participants. ICCs of magnitude were slightly larger than those of SI (P<.01)	

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			The magnitude of 15 AB participants showed good reliability (ICC=0.90±0.04). **Intermediate term reliability**: Data recorded 1 week apart from 6 participants for 10 motor tasks showed fairly strong correlation for magnitude (r=0.91, P<.01) and SI (r=0.87, P<.01).	
Lim et al. 2004 Retrospective analysis Not specified	9 SCI participants with injury levels ranging from C6 – T8 (time post injury: 11±5 months) 10 neurologically healthy participants (9 males, 1 female) mean age: 37.9 13.9 years	The VRI changes over the time in which STAT was administered were variable across SCI participants. In general, SIs (similarity index) moved toward 1.0 following completion of training.		

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	10 AB participants served as control to establish “prototype” responses 9 SCI participants were enrolled in independent studies to evaluate the effect of supported treadmill ambulation training (STAT). This participant group was expected to improve their gait as a result of STAT and, in fact, all showed increases in over-ground gait speed. For the purpose of this report, the STAT group served to test the sensitivity of VRI calculations to motor control changes brought by intervention.	Participant 1 had starting SI values bilaterally near 1.0 and participants 3 and 4 were nearly 1.0 on their right. Five participants (2r, 4r, 6r, 7r, 8l) showed a unilateral increase toward the prototype, range 0.08 to 0.16, and mean change of 0.11±0.04. Two participants (3 and 7) showed unilaterally and one participant (9) bilaterally decreased SIs, or movement away from the prototype.		

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Calancie et al. 2001 Longitudinal study Jackson Memorial Hospital at the University of Miami School of Medicine	N=45 No indication of age. Acute Traumatic SCI Level of injury: 34 cervical 11 T2-L3.	EMG was used to record isolated, maximal contractions of 12 muscles groups and voluntary recruitment efforts were scored from 0 to 5. Eight of the 12 muscle groups were assessed for strength with Manual Muscle Testing (MMT). EMG was performed in the acute phase (~ 1 week post injury) and MMT was performed in the sub-acute phase (2mo±1wk). Muscles examined with both methods were: biceps, triceps, extensor carpi radialis (ECR), abductor digiti minimi (ADM), psoas major, quadriceps,		

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		tibialis anterior (TA) and soleus. **Nonparametric Spearman Rank correlations were used to compare muscle strength scores from EMG and MMT.** When muscle scores of zero were found for both EMG and MMT but were included in the analysis, all correlations were significant (P<.01) at both time points. If those with double zero scores were excluded from the data analysis, all were significant except for the soleus muscle at the acute time point (r=0.28, P=.19).		

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		Correlation coefficients are as follows when zero scores were not included (acute, sub-acute): biceps (0.56, 0.40), triceps (0.77, 0.70), ECR (0.64, 0.64), ADM (0.49, 0.67), psoas (0.47, 0.77), quadriceps (0.54, 0.61), TA (0.57, 0.78) and soleus (0.28, 0.59).		