Muscle spasticity is not a prerequisite for associated reactions in people with acquired brain injury

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Introduction

Associated reactions (ARs) commonly occur in the hemiplegic upper limb following acquired brain injury (ABI). They hinder function and activities of daily living, increase falls risk and negatively effect self-esteem by adding to the stigma of disability. Spasticity is often considered to be a causative factor, but studies investigating this relationship have had small sample sizes and conflicting results. This may be partly due to inadequate assessment methods. A new, criterion-reference, ecologically-valid AR outcome measure during walking has been developed and can be used to further investigate these relationships.

ABI participant with a left upper limb AR

Aim

To determine whether impairments of contracture, hypertonicity and/or spasticity contribute to the expression of upper limb associated reactions during walking in a cohort of individuals with ABI.

Methodology

Forty-two adults with ABI underwent 3DMA walking assessment at their self-selected speed. An AR outcome measure was generated quantifying the upper limb kinematic deviation compared to healthy controls yielding a Kinematic Deviation Score (KDS) for each upper limb joint axis and the Kinematic Deviation Score worst axis (KDSw) for the whole upper limb AR. An experienced neurological physiotherapist conducted a clinical assessment to evaluate contracture and upper limb muscle (shoulder internal rotators, elbow flexors, wrist and finger flexor) hypertonicity and spasticity. These are both abnormal muscle tone but have different presentations. They have not previously been differentiated in AR research.

Table 1. Impairment and test

IMPAIRMENT	TEST
Contracture	Passive joint range of motion
Hypertonicity	Modified Ashworth Scale (Patrick & Ada, 2006; Pandyan et al, 1999)
Spasticity	Modified Tardieu Scale (Patrick & Ada, 2006; Sheean et al, 2010)

Scan me for associated reaction examples

Results

Contracture was a rare feature whilst upper limb muscle hypertonicity and spasticity were prevalent. Hypertonicity had moderate-to-strong correlations to ARs (Table 2) with a significant impact on AR severity ($p < 0.01$, ES = 0.81 – 1.49). A strong and moderate correlation existed for finger flexor and elbow flexor spasticity, respectively, with a significant severity impact ($p < 0.01$, ES = 0.80 – 1.19).

Table 2. Correlation between impairment and AR

IMPAIRMENT	CORRELATION TO AR (r)	PARTICIPANTS WITH IMPAIRMENT (%)
Contracture		
Shoulder external rotation	-0.37*	0
Elbow extension	**-0.53***	2.4
Wrist extension	**-0.53***	2.4
Upper limb Hypertonicity		
Shoulder internal rotators	**0.45***	62
Elbow flexor	**0.53***	71
Wrist flexor	**0.44***	64
Long finger flexor	**0.74***	57
Upper limb spasticity		
Shoulder internal rotators	0.31*	57
Elbow flexor	**0.40***	60
Wrist flexor	0.34*	52
Long finger flexor	**0.65***	48

Chi-squared analyses demonstrated that ARs could occur in the absence of tone impairment in the corresponding upper limb muscle group (Table 3).

Table 3. Proportion of participants with an AR at each joint axis with and without tone impairment

Joint axis AR present	Muscle group	Impairment present (%)	Impairment absent (%)
Upper limb hypertonicity			
Shoulder rotation	Shoulder internal rotators	19%	10%
Elbow flexion	Elbow flexors	69%	21%
Wrist flexion	Wrist flexors	20%	5%
Wrist flexion	Long finger flexors	21%	2%
Upper limb spasticity			
Shoulder rotation	Shoulder internal rotators	12%	17%
Elbow flexion	Elbow flexors	57%	33%
Wrist flexion	Wrist flexors	17%	7%
Wrist flexion	Long finger flexors	19%	5%

Conclusions

Associated reactions are complex and likely multifactorial. Contracture rarely contributes. Upper limb hypertonicity and spasticity are prevalent. Hypertonicity may play a greater role than spasticity. Both should be prioritised for assessment, but they are not prerequisites for ARs. This has important implications for management as not all people with ARs will benefit from pharmacological management (i.e. Botulinum Neurotoxin-A injections).

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