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EDITORIAL

Assessment of muscle tone

Newly available anti-spastic treatments have brought about a flurry of interest in the management of spasticity. Discussing their benefits and side-effects has stimulated a more objective look at not only the management of spasticity, but our whole understanding of the subject. The debate on assessing muscle tone is important, and scientists and clinicians have struggled to develop useful measurement tools.

First, we must define what is meant by spasticity. Lance's definition is a velocity-dependent increase in tonic stretch reflexes (muscle tone) in response to a passive stretch, with exaggerated tendon jerks, in association with other features of the upper motor neurone syndrome [1]. The emphasis is therefore on velocity-dependence and passive stretch. Lesions in any part of the corticofugal pathway (hemisphere, internal capsule or brain stem) can give rise to the problem, and spastic hypertonia from loss of descending inhibitory control results from exaggerated spinal proprioceptive reflexes [2].

The Ashworth scale and modified Ashworth scales are in general use, and their reliability is good in some areas, but their validity in their general application to spasticity assessment is not. The original Ashworth scale has only been validated for measuring spasticity around the elbow after stroke [3]. It is a pity that more work has not gone into carrying out more validation studies in other indications [4]. This scale does not distinguish between increased neurogenic muscle tone and mechanical limb stiffness. Despite this, it has become the measure against which all other measures are compared. Based on the fact that resistance to passive movement (as performed during the Ashworth scale) is influenced by various factors, Lance's definition [1] is not addressed, despite the validity of the scale as a measure of that resistance. Measures of resting posture and passive range of motion do not depend on stretch reflex activity [5], which is the element that requires to be measured.

Two recent papers in *Age and Ageing* have prompted a further examination of this area of clinical practice [6, 7]. In a comparison of reliability with the Medical Research Council (MRC) scale for muscle power, Gregson *et al*. showed good inter-rater and intra-rater reliability for wrist, elbow and knee flexor function, but less good association for the ankle [6]. The authors rightly warn of making assumptions about the scale when measuring foot dorsi- and plantar flexion. A straight comparison between the modified Ashworth and MRC scales is difficult, as the former behaves as a nominal measure, whereas the latter is ordinal. A better comparison may have been with the original scale, which does not have the difficulties in the context of differences between grades 1 and 1+.

The measurement of the velocity-dependent catch (the clasp-knife effect) is demonstrated by other means. Tardieu described one in 1954 in a report that went unnoticed at the time (possibly because it was written in French), but interest in the method has recently been resurrected [8]. Its modification by Held *et al*. [9] was validated by Boyd and Graham [10] and measures the angle at the point of resistance to a rapid velocity stretch when the overactive stretch reflex produces a 'catch'. Both the dynamic and static muscle length and joint range of movement are assessed, and the technique is described in Table 1. Inter- and intra-rater reliability studies are underway in order to define the best conditions under which to carry out the examination (J. M. Gracies, personal communication).

Why measure tone?

So why are we measuring tone and why is it important? In clinical practice, a useful easy-to-measure tool is needed, whereas in research a standardized testing protocol is required to follow the definition of the condition as closely as possible. The Ashworth scale fails in this, but remains a useful bedside clinical measure. Pandyan *et al*. thus support the use of this scale as an ordinal measure of resistance to passive movement [11].

For research purposes, the Wartenberg pendulum test follows the definition and gets round the complex variables that occur in the α-motor neurones of agonist and antagonist muscles during passive movements. In this, the leg moves under gravity and the observer measures the pendular activity of a spastic limb as it relaxes. It is best carried out on the lower limb, for it is not so reliable for other limb segments. Rymer and Katz conclude, however, that biomechanical measures correlate most closely with the clinical state, as extending a limb against passive resistance may be related more to the visco-elastic properties of the soft tissues than to spasticity [12]. Electromyographic activity and the motor unit magnitude correlate well with the torque and ramp and hold displacement around the elbow [13].

Functional aspects

But how does all this relate to function and to response to treatment? Many scales bear little resemblance to what is happening to the patient, which is of course

Table 1. The Tardieu scale

Velocity of stretch	Dynamic range of motion	Quality of muscle reaction
V1: as slow as possible	R2: slow passive range of movement or muscle length	0: no resistance through course of passive movement
		1: slight resistance through course of passive movement
V2: speed of limb falling under gravity		2: clear catch at precise angle, followed by release
V3: as fast as possible	R1: fast velocity movement through full range of movement	3: fatiguable clonus at precise angle
		4: unfatiguable clonus at precise angle
		5: rigid limb and joint

most relevant to clinical practice. In a pilot study of young people with hip and thigh spasticity due to cerebral palsy, there was a decrease in the fixed flexion deformity at the hip, an improvement in walking speed and stride length and increased patient satisfaction for at least 4 months after an injection of botulinum toxin—despite the fact that the Ashworth scale returned to near-pre-treatment levels during the same period [14]. Functional aspects are therefore important to measure, but one of the problems is that spasticity is but one feature of the upper motor neurone syndrome and functional change with treatment may be dependent on these other features. Few studies have shown a global correlation with the Ashworth score. In measurement of function, using the Rivermead or Fugl–Meyer motor assessment scores, or in goal attainment, most correlation is with other impairment measures (such as the spasm frequency score, adductor tone, pain score etc). Therein lies the dilemma. We will thus need to keep on measuring spasticity in the clinical setting with the Ashworth scale, but realise its limitations and always combine management of the patient with a functional outcome measure in relation to the rehabilitation goal.

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