Spasticity – Perceptions, Definitions and Measurement

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Abstract

Spasticity is a widely recognised clinical problem and the advent of new medications such as Botulinum Toxin together with the need to evaluate critically all treatments has created a need for reliable methods of measurement. However, the selection of appropriate methods is severely hampered by a lack of standardisation of techniques and, perhaps, more important, a lack of consensus as to the most clinically applicable definition of the spasticity.

This paper reports the major conclusions of an in-depth review of the literature on spasticity measurement and makes particular recommendations relating to its definition and classification.

1 Introduction

Spasticity has long been recognised as an impairment associated with cerebral palsy, stroke, spinal cord injury and many other neurological conditions. Many definitions have been proposed and the most commonly used is probably that of Lance (1980) [1] “a motor disorder, characterised by a velocity-dependent increase in tonic stretch reflexes (muscle tone) with exaggerated tendon jerks, resulting from hyper-excitability of the stretch reflex as one component of the upper motor neurone (UMN) syndrome”.

However, while the Lance definition is commonly accepted, spasticity is frequently associated with other impairments, for instance, the problems of co-contraction seen in the gait of patients with cerebral palsy or stroke. In the same way that the definition is unclear, there is little consensus on the measurement of spasticity. It was this lack of clarity which led to the establishment of the EU-SPASM network to establish standards for the definitions and measurement of this impairment. As a major part of this task, members of the Consortium have performed an in-depth review of the published techniques of measurement under three broad categories – clinical scales, neurophysiological techniques and biomechanical techniques. Working definition... “Assuming that all involuntary activity involves reflexes, then spasticity is intermittent or sustained involuntary hyperactivity of the skeletal muscle associated with an UMN lesion.”

1.1 Scales

Clinical scales are almost certainly the commonest method for clinical measurement of spasticity. Of these scales, the Ashworth [2] and Modified Ashworth [3] are by far the most popular. It is important to note, however, that these scales are not validated for all the joints at which they are used. Furthermore, while the MAS has been validated at the elbow, its reliability at the knee has been shown to be considerably less strong.

A study of the psychometric properties of clinical scales for the evaluation of spasticity, and associated clinical phenomena (i.e. resistance to passive movement, passive range of motion, limb position at rest including postural alignment, tendon reflexes, clonus, spasms, or associated reactions) has been performed. The review identified studies of 24 scales for measurement of spasticity and associated clinical phenomena, 10 scales for ‘active’ function, and 3 scales for ‘passive’ function with a documented association with spasticity. However, many of these scales have not been critically evaluated or validated and, in particular, the test retest reliability is unknown.

In the relatively few cases where reliability data are available, as for inter-rater reliability of the Ashworth and modified Ashworth scales, the evidence signals that a high inter-rater
reliability can be achieved at particular joints. However, such reliability has not been demonstrated for many of the available scales. If these methods are to be used in objective studies in the future it is recommended that more validation studies are performed.

1.2 Neurophysiological

Neurophysiological methods for the assessment of spasticity aim predominantly at studying electrical muscle activity (EMG) and can be broadly classified according to the stimuli as follows:

1. Electrical stimuli (H-reflex, F-wave)
2. Mechanical stimuli (Tendon reflex, Polysynaptic responses)
3. Passive movements (Stretch reflex, Pendulum test)
4. Active movements
5. Evoked potentials (Transcranial magnetic stimulation, Lumbosacral Potentials)

The neurophysiological approach of quantifying spasticity closely corresponds to the definition of spasticity given by Lance, as well as the working definition of spasticity defined by the SPASM consortium. The literature about the methods is abundant, especially with regard to the H-reflex. However, several methods have not fully been investigated and the involved mechanisms and pathways are not yet fully understood, resulting in lack of knowledge about correct application and performance of these methods as well as the interpretation of the results.

In general, the methods are characterized by large inter and intra subject variability as well as inter and intra session variability. Furthermore, neurophysiological assessment methods correlate only moderately to poorly with biomechanical and clinical methods of spasticity assessment.

The assessment of abnormal muscle activation patterns during movement is relatively new and is attracting increasing attention. It appears to be more relevant than reflex measurements since it reflects functional movement. However, protocols need to be further developed and standardized and also surface EMG processing needs to be defined further.

In general it can be concluded that although the neurophysiological methods could serve as indicators of spasticity, considerable methodological implications as well as their narrow scope in studying spasticity severely limit the application of these methods in the clinical as well as the experimental environment. The combination of neurophysiological, biomechanical, as well as clinical methods would clearly be preferred to obtain a complete view of spasticity.

2 Biomechanical Methods

Perhaps surprisingly, there is only a relatively small body of literature concerning the measurement of spasticity using biomechanical methods. One of the outcomes of the review has been a highlighting of the problem of terminology often leading to a misunderstanding of some terms and the conflicting use of others. Not surprisingly, as there are different definitions of spasticity, different groups have measured different characteristics; the most obvious is the confusion that still remaining between the contributions to resistance to passive movement from neural and non-neural components. Interpretation of results is therefore often difficult.

A clinically relevant test should distinguish and measure both biomechanical and neurogenic components of the UMN syndrome. Furthermore, it is important to impose specific conditions on any new test procedure. The controlled displacement method using passive movement is perhaps the most comprehensive test to examine these. For example, in this method, different frequencies, amplitudes and speeds of movement may be applied to distinguish between phasic and tonic stretch responses and the purely biomechanical properties of the muscle tissue. To measure the responses objectively and to assist in distinguishing particular components of the test or syndrome, it is suggested that resistive force, angular movement and EMGs are recorded simultaneously.

For a more complete understanding of the phenomenon of spasticity, it is recommended that measurements should be based on the study of more than a single parameter. It is particularly recommended that all biomechanical testing should include the use of EMG recordings. Similarly, response during functional movement or voluntary activation
should be considered. To establish a means to assess for accuracy and robustness of the measurement, a series of clinical trials should operate to compile a sufficient set of normative data. These would also prove essential to enable results from future trials to be interpreted unequivocally.

3 Conclusions
This detailed study has highlighted the fact that there are considerable variations of opinion as to what actually constitutes spasticity. This weakness of definition leads inevitably to a variety of measurement approaches and makes the comparison of research studies difficult if not impossible. While the definition of Lance (1990) has become widely accepted by the rehabilitation community, the various measurement approaches frequently do not adhere to it. It is suggested that, if spasticity is to be regarded as an impairment, then the SPASM Group working definition may be more appropriate in that it embraces a wider range of reflex associated disorders and more closely matches clinical practice. However, it may be that it is inappropriate to regard spasticity as an impairment at all and it should be thought of as an “umbrella” term embracing a range of more specific terms such as contracture, hypotonicity, clasp knife phenomenon etc. Further, it may be considered under the ICF definitions so that each of the three categories can be studied and measured with less ambiguity.

References

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