Modified Pendulum Test for Elbow Muscle Tone

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Resting muscle tone is the passive tonus or tension of skeletal muscle that derives from its intrinsic molecular viscoelastic properties[1]. It is a static and isometric contraction between agonists and antagonists to maintain postural stability. Along with movement, the tone in all muscle groups involved will change and is always in a balanced condition in normal subjects. It usually declines during REM sleep.

Muscle tone is an expression of tissue stiffness and may change when influenced by disease. It is called hypotonia when the tone level decreases and hypertonia when it increases. Hypotonia is usually observed in patients with floppy baby syndrome, cerebellar dysfunction, and acute paralysis due to corticospinal dysfunction, and hypertonia in patients with rigidity or spasticity.

Elbow spasticity can be assessed by modified Ashworth scales[2]. The modified Ashworth scales are a six-point scoring system (grade 0: no increase in muscle tone; grade 1: slight increase in tone with a catch and release at the end of the range of motion; grade 1+: slight increase in tone with catch followed by minimal resistance in remainder of range; grade 2: more marked increase in muscle tone through most of range; grade 3: considerable increase in tone, passive movement difficult; grade 4: affected parts rigid in flexion or extension.). In the assessment of elbow spasticity of hemiplegia, the modified Ashworth scale was found to have adequate inter-rater reliability[3]. However, another studies showed that validity of the Ashworth scale is insufficient to be used to measure spasticity[4], especially at lower grades[5]. In a study of elbow spasticity, the reflexive electromyography threshold of the biceps brachii was more sensitive than the modified Ashworth scale to detect small changes of muscle tone after the botulinum toxin injection[6]. Furthermore, stretching cannot help measure resting posture and passive range of motion. Therefore, with appropriate biomechanical measures and electromyographic muscle activities, we can obtain a significant amount of more useful information in the research of spasticity.

The pendulum test is a biomechanical measure of muscle tone[7]. In the assessment of knee joints, the patient is seated or lying with the legs hanging off the couch. The patient is first instructed to remain relaxed. Then, the examiner raises one of the subject's legs to a horizontal position and then lets the leg fall and swing freely under the action of gravity. The number of swings is taken as an index of muscle tone. In subjects with spasticity or rigidity, the number of swings is usually reduced. Another parameter is to calculate the ratio between the initial flexion and the final position of the knee joint measured by goniometers, when the leg has come to a rest. This ratio shows a clear correlation to the severity of spasticity as evaluated by the Ashworth scale.

The conventional pendulum test is rarely applied for the elbow joint. Recently, biomechanical tests have been developed for elbow muscle tone[8-13]. One recent paper in Acta Neurologica Taiwanica described a modified

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Pendulum test and prompted a further examination of elbow muscle tone[12]. The modified model consists of linear stiffness, damping and gravity contribution. Using these parameters, it has been proven that the muscle tone of elbow muscles increased in patients with spastic limbs due to stroke[11,13] and decreased in diabetic polyneuropathy[12]. It seems that this newly modified pendulum test of the elbow joint is relevant to clinical practice. It may help measure the clinical outcome of neurological shock and the clinical course from acute flaccid paralysis to chronic spasticity. It will also help assess the treatment effect on elbow spasticity, such as the change of muscle tone before and after botulinum toxin injection.

REFERENCES

1. Masi AT, Hannon JC. Human resting muscle tone (HRMT): narrative introduction and modern concepts. J Bodyw Mov Ther 2008;12:320-32.
2. Bohannon RW, Smith MB. Interrater reliability of a modified Ashworth scale of muscle spasticity. Phys Ther 1987; 67:206-7.
3. Ansari NN, Naghdi S, Hasson S, et al. Inter-rater reliability of the Modified Ashworth Scale as a clinical tool in measurements of post-stroke elbow spasticity. Neuro-Rehabilitation 2009;24:225-9.
4. Fleuren JF, Voerman GE, Erren-Wolters CV, et al. Stop using the Ashworth Scale for the assessment of spasticity. J Neurol Neurosurg Psychiatry 2009. [Epub ahead of print]
5. Pandyan AD, Price CI, Barnes MP, et al. A biomechanical investigation into the validity of the modified Ashworth Scale as a measure of elbow spasticity. Clin Rehabil 2003; 17:290-3.
6. Lee HM, Chen JJ, Wu YN, et al. Time course analysis of the effects of botulinum toxin type A on elbow spasticity based on biomechanic and electromyographic parameters. Arch Phys Med Rehabil 2008;89:692-9.
7. Wartenberg R. Pendulousness of the legs as a diagnostic test. Neurology 1951;1:18-24.
8. Pandyan AD, Price CI, Rodgers H, et al. Biomechanical examination of a commonly used measure of spasticity. Clin R Biomech (Bristol, Avon) 2001;16:859-65.
9. Lee HM, Chen JJ, Ju MS, et al. Validation of portable muscle tone measurement device for quantifying velocity-dependent properties in elbow spasticity. J Electromyogr Kinesiol 2004;14:577-89.
10. Ocarino JM, Fonseca ST, Silva PL, et al. Alterations of stiffness and resting position of the elbow joint following flexors resistance training. Man Ther 2008;13:411-8.
11. Lin CC, Ju MS, Lin CW. The pendulum test for evaluating spasticity of the elbow joint. Arch Phys Med Rehabil 2003; 84:69-74.
12. Lin CC, Ju MS, Huang HW. Muscle tone in diabetic polyneuropathy evaluated by the quantitative pendulum test. Arch Phys Med Rehabil 2007;88:368-77.
13. Huang HW, Ju MS, Wang WC, et al. Muscle tone of upper limbs in patients with acute cerebellar stroke evaluated by quantitative pendulum test. Acta Neurol Taiwan 2009; 18:250-4.