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PROSPECTIVE STUDY: MUSCLE PHYSIOLOGY IN STROKE PATIENTS

The relationship between isokinetic muscle strength and spasticity in the lower limbs of stroke patients

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Summary *Objective:* In this study the relationship between degree of spasticity and strength of knee extensor and ankle plantar flexor muscles of post stroke hemiparetic patients has been investigated.
Materials & methods: The participants of this study were 40 stroke patients whose elapsed time of stroke onset was at least 3 months. Their age averaged 59 years. Spasticity was measured with the Modified Ashworth Scale. Isokinetic muscle strength was measured with an isokinetic dynamometer. Two methods of torque normalization — subtractive and weight based normalization — were used for comparing torques among participants.
Results: Kendall's tau-b coefficient was calculated for investigating this relationship. This coefficient was not significant for the relationship between weight based normalized data and modified Ashworth scale (MAS) in any of each muscle groups ($\alpha = 0.05$). This coefficient was significant for the relationship between the subtractive normalization method and MAS in knee extensors ($P = 0.005$, $\alpha = 0.01$) and ankle plantar flexors ($P = 0.002$, $\alpha = 0.01$).
Conclusion: This study suggests a negative relationship between spasticity and muscle strength and provided evidence that spastic muscles are weaker.

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Introduction

Cardiovascular accidents (CVA) such as stroke are considered the third most common cause of death and long-term disability in western countries (Ada et al., 2006). In Iran the prevalence of ischemic stroke among Iranian young adults (15—45 years) has been recorded as 8 per 100,000 head of population (Ghandehari and Izadi Moud, 2006). According to a study carried out in Babol (2001—2003), a northern city of Iran, stroke incidence was reported to be 50 per 100,000 (Ahangar et al., 2005). In addition to long-term disability, stroke causes significant psychological problems for patients and their families. On a worldwide scale it is predicted that by 2020, stroke and heart coronary disease would have become the primary causes of death and long-term disabilities in both western (WHO, 2000; Foulkes et al., 1988) and other countries such as IRAN.

One aspect of stroke and coronary heart disease is lesions in the pyramidal and extrapyramidal pathways. These may be followed by positive and negative symptoms. Spasticity, clonus, associated reactions and abnormal postures are considered as positive symptoms. Negative symptoms include muscle weakness, muscle fatigue and lack of muscle precision (Bente and Bassoe, 2008). The most important negative sign in stroke patients is paralysis or weakness of muscles of the contralateral limbs, the trunk, and sometimes half of the face (Fredericks and Saladin, 1996). In contrast to this, one of the most important positive signs after stroke is spasticity. The pathophysiology of spasticity is still unclear. It has long been thought that the increased gain of stretch reflexes in spasticity resulted from hyperactivity of the gamma motor neurons. Recent studies indicate that while gamma motor activity may be present in some cases, changes in the background activity of alpha motor neurons and interneurons is probably a more important factor in spasticity (Fredericks and Saladin, 1996). Muscle weakness, paralysis and spasticity on the affected side are common symptoms in stroke patients (Andrews et al., 1982; Fugl-Meyer et al., 1975).

Literature on the subject indicates that stroke patients with spasticity experience more functional problems than patients without spasticity (Watkins et al., 2002), and research has shown a significant correlation between the affected limb muscle strength and functional outcomes (Hsu et al., 2002). Various therapeutic methods have been developed to reduce the impact of spasticity on physical performance. Bobath, who considered muscle spasticity as a major disorder, emphasized the use of inhibitory methods such as handling and reflex inhibitory patterns (RIP) (Bobath, 1990). In contrast, Carr and Shepherd considered muscle weakness as the most important issue. Their method of responding to spasticity is to use motor relearning programs (MRPs) as the pivotal method for strengthening weak muscles in patients suffering stroke (Carr and Shepherd, 1989).

Both these methods have their followers, but the superiority of one over the other has not yet been established. Langhammer, 2000, conducted a double-blind study and compared the effects of the two approaches to stroke rehabilitation mentioned above — the Bobath method and Carr and Shepherd's MRPs — on two groups of 33 and 28 stroke patients. Data were collected before, and at three days, two weeks and three months post intervention. In spite of modest differences between these two approaches at two weeks, the result of this study indicated no difference in the outcomes of these approaches at three days and three months post intervention, thus failing to indicate the superiority of one method over the other. The same investigator performed a follow-up study in 2003 and this time examined the effects of both treatment methods on participants after one and four years. These follow-up measurements also failed to show any significant differences between the two therapeutic approaches (Langhammer, 2003), leaving the question of the superiority of one approach over the other remaining unanswered.

Since the behavior of spastic muscles in stroke survivors has not been fully understood, any research in this area may shed light on the relationship between spasticity and muscle strength. Any positive relationship between spasticity and muscle strength would indicate that spastic muscles are strong, and therefore muscle weakness is not be the main problem would indicate the preferred treatment would tend to be the Bobath inhibitory methods. On the other hand, if the relationship between spasticity and muscle strength proves to be negative, indicating that spastic muscles are weak, then treatment methods would focus on facilitatory movement such as in motor relearning programs.

Recognition of the behavior of spastic muscles could be very important in determining the superiority of treatment methods. Moreover, to understand the behavior of spastic muscles it could be possible to make a decision about the potential impact of spasticity on the muscle strength. Studies have evaluated the effects of the strengthening and progressive resistance of isokinetic exercise on spastic muscle tone and strength in lower extremities. Some of these studies have shown that strength increased without changing muscle tone (Flansbjer et al., 2008; Badics et al., 2002; Shelly and Brenda, 1997). In 1987, Bohannon et al., (1987) also studied the effects of the strengthening and progressive resistance of isokinetic exercise on spastic muscle tone and strength, but in relation to upper limbs. They found a significant correlation between the spasticity and strength of the involved muscles.

The main aim of the current study is to investigate the correlation between degree of spasticity and isokinetic muscle strength in the lower extremities in unilateral stroke patients. To our knowledge, this is the first study investigating this relationship. We have hypothesized that, in lower extremity muscles in unilateral stroke patients, there is an inverse relationship between degree of spasticity and isokinetic muscle strength.

Materials and methods

In this non-experimental prospective study that performed in Rofaydeh Rehabilitation Hospital, 40 stroke patients (22 male and 18 female) were selected from hospitals and rehabilitation centers in Tehran in a simple non-probability sampling method. 21 participants had right side