Decreased Isometric Knee Flexion Torque with Hip Extension in Hemiparetic Patients

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I measured the 90-degree isometric knee flexion torque of 12 hemiparetic patients while they performed unilateral knee flexion in sitting and supine positions. The measurements were taken to clarify why hemiparetic patients have difficulty flexing their involved knees when their involved hip is extended. The patients generated more torque in the sitting position than in the supine position and more torque on their nonparetic side than on their paretic side. The ratio of supine-to-sitting knee flexion torque did not differ significantly between sides. This finding suggests that hemiparetic patients do not have relatively greater difficulty generating knee flexion torque on their involved side with the hip extended than with the hip flexed. Recommendations for assessment and treatment are made with this finding in mind.

Key Words: Hemiplegia, Knee, Physical therapy.

Muscles can generate more force in a lengthened position than in a shortened position. This increased force production has been demonstrated in healthy muscles, in general, and in healthy hamstring muscles, in particular. Although integrated electromyographic activity is related directly to muscle force production at a given muscle length, Lunnen and associates have shown that IEMG decreases in healthy hamstring muscles when the muscles are required to perform maximal isometric contractions at progressively greater lengths. According to Lunnen and associates, therefore, greater electrical activation is required for each unit of force as the hamstring muscles contract in a shortened position.

The extent to which muscle length affects force production in paretic muscles has not been established. Nonetheless, clinicians who treat hemiparetic patients are well aware of the difficulty that these patients have in performing knee flexion with the hip extended in comparison with knee flexion with the hip flexed (when the muscle is at a greater length). According to Brunnstrom, hip and knee flexion are, along with ankle and toe dorsiflexion and hip abduction and external rotation, components of the flexion synergy of the lower limb.

One might conclude from Brunnstrom’s association of hip and knee flexion that the relative ease with which hemiparetic patients generate knee flexion torque when the hip is flexed is a manifestation of lower limb flexion synergy. Greater electrical activation is required for each unit of force, however, as the hamstring muscles contract in a shortened position, and voluntary electrical activation of the paretic muscles is the main problem experienced by hemiparetic patients. Thus, the increased capacity of hemiparetic patients to generate knee flexion torque when the hip is flexed may be a simple function of muscle length.

As do some other clinicians, we routinely perform isokinetic and isometric tests using the Cybex® II isokinetic dynamometer to evaluate hemiparetic patients. Such evaluations previously included isometric tests of knee flexion torque in the sitting position (hamstring muscles lengthened) and the supine position (hamstring muscles shortened). These tests were included because we believed that they would help document the patient’s progression “out of synergy.” The purpose of this article is to present the results of these tests. I expected that knee flexion torque would be greater in the sitting position than in the supine position on both the paretic and nonparetic sides, but that the supine-to-sitting ratio of knee flexion torque would be greater on the nonparetic side than on the paretic side. Finding a greater supine-to-sitting ratio of knee flexion torque on the nonparetic side would confirm my hypothesis that hemiparetic patients have relatively greater difficulty generating knee flexion torque with the hip extended on their involved side than with the hip flexed.

METHOD

Subjects

The supine-to-sitting ratio of knee flexion torque was obtained retrospectively from the records of 12 consecutive patients who met three criteria: 1) They generated measurable isometric knee flexion torque, with the hip both flexed and extended; 2) they demonstrated observable difficulty in flexing the involved knee when the hip was extended, but not when it was flexed; and 3) they had no chart-documented history of neurologic or orthopedic problems affecting either lower extremity. The patients, who were hemiparetic secondary to cerebrovascular accidents, had a mean age of 54 ± 20 years and were a mean period of 19 ± 22 weeks postonset of hemiparesis. The patients were divided evenly by sex and between those who were paretic on the left side and those
who were paretic on the right side. The patients were informed of the purpose of the procedure prior to testing.

Procedure

All testing was performed by the same clinician using the Cybex® II dynamometer testing chair. The patients were stabilized during testing by strapping their tested thigh, pelvis, and trunk to the chair. During sitting tests, the chair back was in the upright position, resulting in a trunk-thigh angle of about 95 degrees. During supine tests, the chair back was in the down position, resulting in a trunk-thigh angle of about 180 degrees. Under both test conditions, the input shaft of the dynamometer was positioned at the knee and the lever arm strapped to the leg proximal to the malleoli of the tested leg.

Testing was performed on the sound leg before testing of the involved leg. The isometric knee flexion tests were performed on each lower limb several minutes after velocity spectrum testing was completed. Isometric tests were performed in the following order: two tests in the sitting position, four tests in the supine position, and two tests in the sitting position. Each maximum knee flexor muscle group contraction was of 4 to 6 seconds’ duration and was followed by a 30-second rest. Consistent verbal reinforcement was provided during muscle contractions. The Cybex® II recorder damping was set at two, and paper speed was set at 5.0 mm/sec.

The highest torque maintained for 1.5 seconds was measured from each torque curve. The mean was calculated for all four measurements obtained during testing in the sitting and the supine positions. These means were used to calculate the supine-to-sitting ratios for the paretic and nonparetic sides.

Data Analysis

The ratios obtained from the two sides were compared using Student’s t test for related samples. The t test was performed using the Stats Plus software package.9

RESULTS

The results are reported in the Table. Knee flexion torque was greater on the nonparetic side than on the paretic side. Knee flexion torque also was greater in the sitting position (when the hip was flexed and the hamstring muscles lengthened) than in the supine position (when the hip was extended and the hamstring muscles shortened), bilaterally. Although the mean supine-to-sitting ratio of knee flexion torque was greater on the nonparetic side (.70) than on the paretic side (.57), the t test did not reveal the difference to be significant, \( t = 1.314, df = 11, p = \text{NS} \).

DISCUSSION

I expected two findings to emerge during this study: 1) Knee flexion torque would be less on the paretic side and 2) knee flexion torque, as in subjects without hemiparesis,8 would be less on both sides when the subjects were in a supine position (hip extended) than when they were in a sitting position (hip flexed). I did not expect to find a higher supine-to-sitting ratio of knee flexion torque on the involved rather than on the uninvolved side. Only three patients demonstrated the anticipated higher supine-to-sitting ratio of knee flexion torque on the nonparetic side. The alternate hypothesis, therefore, was not upheld.

This finding suggests that no relative difference between the involved and uninvolved sides exists when hemiparetic patients flex their knees in the supine versus sitting position. Hemiparetic patients probably have difficulty in flexing their paretic knees when their hips are extended because they have decreased muscle activation7 and because, with the hip extended, they are unable to take advantage of the normal capacity for greater force production with increased muscle length.3 Further verification of this conjecture could be obtained by electromyography. Electromyography also could be used to investigate the degree of activation of other muscles with patients in various positions.

CLINICAL IMPLICATIONS

Because the supine-to-sitting ratio of knee flexion torque does not differ between sides in hemiplegic patients, the difficulty demonstrated by patients in flexing their involved knee with their involved hip extended cannot be considered abnormal. Rather, this difficulty may be attributable to normal length-tension factors. Although difficulty with knee flexion when the hip is extended is worthy of direct measurement and is of functional significance in hemiparetic patients, it may not be a necessary focus of clinical intervention. Clinicians may wish to direct their efforts toward helping patients flex their knees, regardless of hip position. As long as the supine-to-sitting ratio of knee flexion torque remains higher on the involved side than on the uninvolved side, increases in knee flexion torque with the hip flexed probably will be accompanied by increases in knee flexion torque with the hip extended.

CONCLUSION

During isometric knee flexion with the knee flexed at a 90-degree angle, 12 patients generated more torque in the sitting position than in the supine position and they generated more torque on their nonparetic side than on their paretic side. The supine-to-sitting ratio of knee flexion torque did not differ significantly between sides. This finding suggests that decreased isometric knee flexion torque on the involved side is the consequence of a general paresis and normal length-tension factors.

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REFERENCES