Suggestion from the Field

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Recent studies involving patients with CNS lesions have clearly demonstrated that agonist paresis rather than antagonist spasticity is the primary factor limiting torque production.1,2 The presence of spasticity can, nonetheless, be important because of its effect on the quality of movement and because of the propensity of spastic muscles toward contracture.3 Therefore, methods for more precisely documenting spasticity remain of value to those clinicians who include among their therapeutic goals the reduction of spasticity. Among the methods proposed for measuring spasticity (resistance to passive movement) are the Ashworth test4 and the goniometric pendulum test.5-7 Alfieri reported that the Ashworth test can provide an indication of therapeutic efficacy but is of limited objectivity because it uses an ordinal scale.8 The pendulum test, on the other hand, provides a more objective measurement on a continuous ratio scale. The instruments required for the pendulum test are an electrogoniometer and recording system. The Cybex® II isokinetic dynamometer,9 which is available to some clinicians, can be used to perform a pendulum test because it incorporates an electrogoniometer and recorder.

The purpose of this article is to describe how the Cybex® II isokinetic dynamometer can be used to document objectively spasticity in patients with CNS lesions and to discuss some limitations of the procedure.

To perform a pendulum test with the Cybex® II isokinetic dynamometer, we take the following steps:

1. The patient is positioned in either a sitting or supine position on the Cybex® exertest table.
2. The patient is stabilized to the table with thigh, pelvis, and trunk straps.
3. The dynamometer input shaft is positioned laterally over the knee’s axis of rotation, and the skin pad of the dynamometer lever arm is strapped just proximal to the malleoli.
4. The speed of the isokinetic dynamometer is adjusted to 300°/sec.
5. The patient is instructed to relax completely.
6. The stylus of the position angle (electrogoniometer) channel is adjusted to assure that angular recordings of knee position will fall within the range of the scale.
7. The knee is flexed by the examiner and the lower leg pushed back until the heel contacts the padded table-leg clamp.
8. A short strip of chart paper is run at 5 mm/sec to mark this position.
9. The lower leg is then raised by the examiner until the knee is fully extended.
10. Paper speed is set at 5 mm/sec.
11. The patient is reminded to relax his leg, which is then dropped by the examiner.
12. Steps 4 through 11 are performed two more times.

Recordings like those in the Figure, excluding Step 7, are obtained by following these steps. Recordings obtained during three sequential drops are quite similar (Figure). Individuals without known neurologic or orthopedic problems usually demonstrate from five to six peaks in their goniogram; the knee flexion range exceeds 115 degrees on the first backward swing (peak). More specifically, on the first swing, the knee of healthy subjects flexes sufficiently to allow the heel to contact the padded table-leg clamp as in Step 7. A healthy subject demonstrates similar goniograms when tested in the sitting and supine positions (Figure A,B), but a patient with spasticity of the knee extensor muscle frequently demonstrates more knee flexion on the first peak of the goniogram when tested in the sitting position rather than in the supine position (Figure C,D). This suggests spasticity of the two joint rectus femoris muscle and emphasizes the need to test patients in the supine position. Patients with spasticity often fail to reach even 90 degrees of knee flexion on the first peak of their goniogram in the supine position. By comparing the knee flexion obtained on the first peak of the swing with the flexion demonstrated when the heel is in contact with the padded table-leg clamp or with full knee extension, an objective measurement of a movement limitation secondary to spasticity can be obtained. For example, in frame D of the figure, the knee flexion shown in the first peak of the goniogram is approximately 80 degrees. This flexion is nearly 40 degrees less than that shown in the first peak of the goniogram obtained from the same patient in a sitting position (Figure C).

Two important differences exist in the instrumentation used by others5-7 and that of the Cybex® II isokinetic dynamometer. First, with the Cybex® II isokinetic dynamometer, the maximum angular velocity of the knee is limited to 300°/sec, whereas during a typical pendulum test, undamped acceleration of the leg allows speeds in excess of 300°/sec. We know this because a small torque curve of short duration occurs.

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when a pendulum test is performed using the isokinetic dynamometer. The curve is representative of a damping of the lower leg’s fall when angular velocity first reaches 300°/sec. Because spasticity is velocity-dependent, the limitation of angular velocity to 300°/sec may make the test less sensitive. Angular velocity is, however, of limited importance as the speed of knee flexion during gait does not generally exceed 300°/sec.

A second difference is that the thickness of the Cybex® exertest table and the padded table-leg clamp may limit the amplitude of leg swing and, therefore, the magnitude of the goniogram. By positioning patients far enough forward on the table, the first obstruction is usually avoided. The second obstruction is not likely to be of any consequence when testing spastic quadriceps femoris muscles because they usually respond to passive stretch long before movement is limited by contact of the heel with the table-leg clamp.

In spite of its possible limitations, the pendulum test performed on a Cybex® II isokinetic dynamometer may prove for others, as it has for us on over 100 patients, a useful part of the objective evaluation of patients with CNS lesions.

Figure: Repeated pendulum test goniograms of a healthy subject in sitting (A) and supine (B) positions and a patient with transverse myelitis in sitting (C) and supine (D) positions.

REFERENCES