IJPMR 14, April 2003; 15-18

Study of Quantitative Assessment of Spasticity by Isokinetic Dynamometry

Dr M Supraja, MBBS, MD (PMR), Senior Resident
Dr U Singh, MBBS, DPMR, DNB (PMR), Professor and Head
Department of PMR, AIIMS, New Delhi 110029

Abstract

Spasticity is defined as velocity dependent increase in tonic stretch reflexes with exaggerated tendon jerks resulting from hyperactivity of stretch reflex. It is important to quantify spasticity to know the improvement following treatment. The present study was aimed at quantitative assessement of spasticity by using isokinetic dynamometer.

A group consisting of 12 cases with measurable spasticity due to various causes were compared to 12 able bodied controls. These measurements were made using isokinetic dynamometer. Ashworth scale was used for grading the spasticity before testing on the machine. Maximum peak torque was measured while the limb was passively moved in flexion and extension at knee joint at speeds of 30, 60 & 120 degree / second. On analysis, there was no significant difference between right and left sides. The maximum peak torque was higher in cases than controls at all angular speeds tested ($p<0.05$).These values increased with increase in speed of movement of the limb. Flexion torque (FT) at 30 degree per second was significantly higher than the extension torque (ET) ($p<0.05$). In the control group there was no significant difference between FT and ET.

Spasticity could be quantified using isokinetic dynamometer which correlated well with the Ashworth scale.The effect of any medication or intervention may be known using this method.

Key words: Isokinetic dynamometer; Maximum peak torque; Flexion torque; Extension torque.

Spasticity is difficult to characterize than to recognize and still more difficult to quantify[1]. Spasticity is very easily detectable by clinical examination but there is no effective method of quantifying muscular tonus inspite of the continuous efforts. Quantification is important to know the response to medication and evaluate the progression of the disease. Various neurophysiological and biomechanical methods have been used in various centers. Ashworth scale is the simplest one to grade spasticity by passively moving the limb. But this method is highly subjective. Here, in the present study we have made an attempt to quantify spasticity using isokinetic dynamometer (Biodex system II) in patients with clinically detectable spasticity and compared with the control group.

Address for correspondence: Dr M Supraja, Department of PMR, AIIMS, New Delhi 110029

Materials and Methods

A total number of 12 cases of any age and of either sex with clinically detectable spasticity were included in the study. The patients were selected from the out patient department of Physical Medicine and Rehabilitation, AIIMS, New Delhi. Out of these 12 cases, 10 cases had complete traumatic spinal cord injury and 2 cases presented with hemiplegia following cerebrovascular accident. All the cases selected had clinically detectable spasticity without any history suggestive of knee trauma or disease. Control group consisted of 12 subjects with age and gender matched to the cases and without any neurological

disease or knee injury. Isokinetic dynamometer (Biodex system II) was used for the measurement of resistance to passive movement of the knee joint.

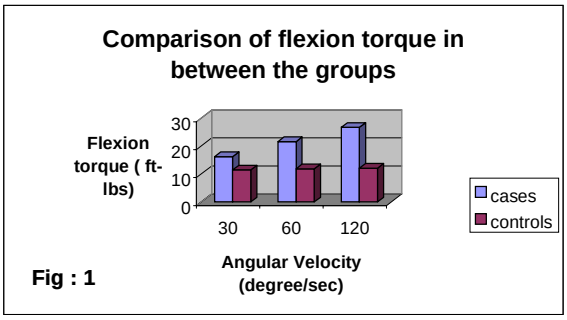

Fig : 1

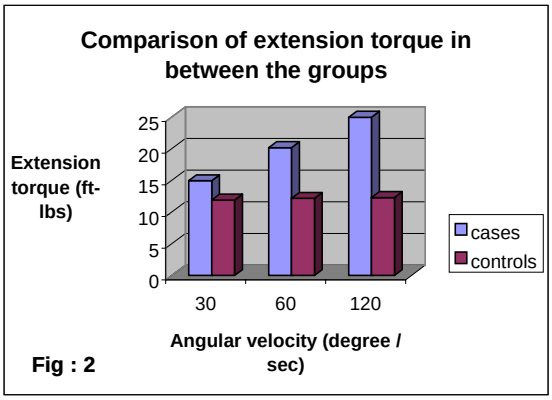

Fig : 2

All the patients were informed about the experiment's procedure and positioned properly by adjusting the height of the dynamometer persuing congruence between the dynamometer's axis and the axis of the knee joint. Patients were stabilized by restraining straps at the level of the chest, around the abdomen and thigh. The force acceptance unit was attached 5cm above the lateral malleolus. Test program is selected after feeding in the general information about the patient, joint tested, movements (flexion and extension) tested and side tested. After setting the range of motion, the evaluation mode is turned into passive mode. Resistace to passive movement of the knee joint during flexion and extension, measured as eccentric torque is recorded at speeds of 30°, 60° and 120° per second with resting period of 10seconds and 5repetitions each. Maximum peak torque value measured in foot-pounds was considered for comparison between the cases and the control group. As spasticity is highly variable, Ashworth scale was used for grading spasticity just before being tested on the machine. This grading was done by a single subject to avoid subjective variability. Both the limbs were tested in all the patients. On an average it took around 20minutes for each test and were performed by a single operator. The able bodied subjects in the control group were asked to keep their knees relaxed as much as possible and not to interfere with the passive movement of the knee joint.

Results

On analysis of the available data, the mean age of cases and controls at presentation was comparable ranging from 17-56years.Mean age of cases was 34.5 ± 11.36 (17-56) and that of controls was 35.0 ± 11.72(20-56).Male patients were more than the female patients with a ratio of M:F=10:2 indicating higher incidence of spinal cord injury in males.

Cause of spasticity was spinal cord injury in 10 patients and cerebrovascular accident in 2 patients. On grading of spasticity according to ashworth scale, four patients presented with grade1 spasticity, six patients with grade 2 and two patients with grade 3.No significant differences were found between right and left sides tested.

The torque value measured during extension movement of the knee joint is the eccentric torque value of the hamstring muscles (ET) and the one measured during flexion movement of the knee joint is the eccentric torque value of the quadriceps muscle (FT). Maximum peak torque recorded was 34foot-pounds (FT120) which was the flexion torque at angular speed of 120 degree per second. The maximum peak torque value was higher in the cases than controls at all the angular speeds tested ($p<0.05$) on student t test analysis. Torque values increased with increase in the speed of

movement of the limb. Flexion torque was more than the extension torque at 30degree (FT30>ET30) with high significance ($p<0.05$). Flexion torque at 60 and 120 degree per second was also higher compared to the extension torque. However the values were not significantly higher.

Comaparison of flexion torque in between the cases and control group is shown in Fig : 1and that of extension torque is shown in Fig: 2. In the control group there was no significant increase in the torque values with increasing speeds and no difference was found between flexion torque and extension torque.

Discussion

Stretch reflex is velocity dependent frequently presenting a linear interrelation which seems to increase with the degree of spasticity[2]. Stretch reflex reduction due to fatiguability on repeated testing has been shown previously[3]. So the test is carried out with 5 repetitions at each speed and at 30 degree initially followed by 60degree and finally at 120 degree per second.

There are various techniques of study of assessment of spasticity. The neurophysiologic techniques include H reflex and the tendon jerks[4,5]. The ratio of H(max) and M(max) is more sensitive than the amplitude of H reflex alone[6]. Tendon jerks are elicited by tapping with a patellar hammer when the patient is relaxed. Biomechanic methods for assessing spasticity include gravitational method,[7,8,9] manual method which is passively moving the limb, controlled displacement method and controlled torque method[10].

The controlled displacement method was used in the present study. In this method, velocity remains constant and so the displacement. But the torque value varies each time depending upon the resistance felt while passively moving the limb. Advantage of controlled displacement method is that the velocity and range of motion can be standardized and controlled. The ability to vary velocities allows for the evaluation of rate dependent characteristics of muscle tone[11].

In the present study, there was no significant difference between FT and ET at 60 and 120 degree per second but FT30 was more than ET30 in cases. Study by Franzoi et al 1999[12] showed higher FT values compared to ET in the control group. In our study there was no significant difference between FT and ET in the control group.In a study by firoozbakshi et al[5] in 1993 FT>ET at all the speeds in the spastic group..

Torque values were more compared to the control group especially at higher speeds. This finding is consistent with the other 2 studies. We have considered maximum peak torque values for comparison in between the groups.

Usually quadriceps muscle is strongly affected by spasticity as shown by Vodovnik et al[13] in 1984.This explains higher FT than ET. Higher the grade on ashworth scale higher was the torque value. This means when the spasticity is more the eccentric torque value increases. The torque values correlated well with ashworth scale.

Spasticity can be quantified effectively by using isokinetic dynamometer. This can be repeated very easily and the values can be compared over time. The efficacy of medications or any other interventions can be tested by estimating the torque values before and after the procedures. Higher speeds are more useful than the lower speeds.

References

1. Katz RT. Management of spasticity. In: Braddom RL, Buschbacher RM, dumitru D, Johnson EW, Matthews D, Sinaki M(eds). Physical Medicine and Rehabilitation. WB Saunders: Philadelphia 1996:580-592.
2. Burke D,Gilles JD,Lance JW.Hamstring stretch reflex in human spasticity. J Neurol Neurosurg Psychiatry 1971:34:231-235.
3. Burke D,Gilles JD,Lance JW.The quadriceps stretch reflex in human spasticity J Neurol Neurosurg Psychiatry 1970:33:216-223.

4. Benecke R.Conrad B, Meinck HM, Holme J.Electromyographic analysis of bicycling on an ergometer for evaluation of spasticity of the lower limbs in man.Adv Neurol 1983;39:1035-1046.
5. Firoozbakhsh KK,Kunkel CF, Scremin AME, Moneim MS.Isokinetic dynamometric technique for assessment of spasticity.Am J Phys Med & Rehab 1993;72:379-385
6. Richard T.Katz, W.Zev Rymer, Spastic hypertonia:Mechanisms and Measurement.Arch Phys Med Rehabil 1989; 70: 144-155.
7. Badj T, Vodovnik L.Pendulum testing of spasticity.JBiomed Eng 1984; 6:9-16.
8. Brown RA, Lawson DA,Leslie GC, Part JN.Observations on the applicability Wartenberg pendulum test to healthy elderly subjects.J Neurol Neurosurg Psychiatry 1988; 51: 1171-1177.
9. Price R.Mechanical spasticity evaluation techniques.Critical Reviews in Physical and Rehabilitation Medicine 1990; 2: 65-73.
10. Douglas AJ,Walsh, EG, Wright EW, Edmond P.Muscle tone around the human knee in paraplegia.Quaterly Journal of Experimental Physiology.1989: 74: 897-905
11. Perell K.Scremin A, Scremin O, Kunkel C.Quantifying muscle tone in spinal cord injury patients using isokinetic dynamometric techniques. Paraplegia 1996; 34: 46-53.
12. AC Franzoi, C Castro and C Cardone. Isokinetic assessment of spasticity in subjects with traumatic spinal cord injury(ASIA A).Spinal Cord.1999; 37: 416-420.
13. Vodovnik L, Bowman BR, Bajid T. Dynamics of spastic knee joint. Med Biol Eng Comput 1984:22:63-69.