TRAINING DELAYED ISOKINETICS IN THE SURGICAL RECONSTRUCTION OF THE ANTERIOR CRUCIATE LIGAMENT: A CASE STUDY

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INTRODUCTION: Isokinetic testing is a commonly utilized tool for the assessment of muscular performance in the physiotherapy and sports medicine setting. Isokinetics are frequently chosen because of their inherent patient-safety, objectivity, and reproducibility in testing measures (Dvir, 1995). Numerous authors have documented clinical outcome studies utilizing peak torque (PT) parameters, especially the bilateral comparison ratio of the quadriceps and hamstrings muscles peak torque measurements (Wilk et al., 1994). Human movements, especially sports movements, utilize a series of accelerating and decelerating limb movements that are accomplished through concentric, eccentric, and static muscular contractions. While running the limb is constantly accelerating and decelerating to accomplish body propulsion (Stanton et al., 1989). Therefore, the neuromuscular system monitors and controls these continued changes in limb angular velocity. This complex function is accomplished through the interaction of afferent neurological input and the ability to cause change through efferent output, which produces a muscular response. Thus, the neurophysiologic integrity of the muscles is critical in the assessment of the contractile tissue, and traditional isokinetic test data interpretation (i.e., PT) may not adequately assess normal muscular function (Davies, 1992). Thigh muscle atrophy secondary to immobilization or surgery is one of the well-known sequelae after treatment of all kinds of knee ligament injuries. Grade III sprains of the anterior cruciate ligament (ACL), medial collateral ligament (MCL), and lateral collateral ligament (LCL), treated either conservatively or operatively, result in a 10% to 35% strength deficit of the quadriceps and hamstrings muscles (Kannus et al., 1992). There are, however, no detailed quantitative studies concerning the long-term effects of grade II knee ligament sprains or surgical reconstruction on muscle function, despite the fact that the development of commercial isokinetic testing dynamometers has made it possible to adequately measure thigh muscle function at orthopaedic and sport injury clinics (Kannus, 1990 and Dvir et al., 1989). The purpose of this work is to study the effect of training isokinetics on the PT of the femoral quadriceps and hamstrings muscles three years after surgical reconstruction of ACL.

METHODS AND PROCEDURES: The subject, a 23-year-old, male, non-sedentary, was given 2 bilateral concentric isokinetic reciprocate evaluations, one before and the other after training at speeds of 60, 180 and 300º/s. Before participating in this study, the subject signed an informed consent form in accordance with guidelines established by the University's Human Subjects Research Committee (Resolution 196/96). Only the right lower limb was trained (surgical reconstruction of ACL), 3 times a week during 4 weeks. Each training session consisted of warming up (a period of five minutes on a stationary bike without load and general stretching), followed by isokinetic training in the Isokinetic Dynamometer BIODEX Multi Joint System 2–Medical Systems. The subject was properly positioned in the dynamometer, stabilized in the chair of the *Biodex* by x-straps placed across the chest, pelvis, and mid-thigh. He was instructed to cross his arms over his chest during testing. The subject was instructed to perform 3 concentric submaximal isokinetic contractions followed by 12 sets of 5 extensions and flexions of the knee at the angular speed of 60º/s (0 to 90º range of motion), with an interval of 10 seconds between sets. The isokinetic values (PT) were collected utilizing *Biodex 4.5 Software*. The analysis of the data was done using a Student's *t*-Test. In all tests an alpha level less than 0.05 ($p < 0.05$) was considered significant. The results of PT are given as a mean ± standard deviation throughout the study.

RESULTS AND DISCUSSION: The results obtained through the pre- and post-training evaluations are shown in Tables 1 and 2. Results of the paired t-test revealed non-significant differences of the mean values of the PT between limbs at the different tested speeds (Table 3). A statistically significant increase was verified in the values of the PT of the limb involved in the extension movement at the trained speed of 60º/s ($p < 0.02$) and at the non-trained speed of 180º/s ($p < 0.04$) (Table 4). At 300º/s, non-significant differences for the extension movement were detected. There were no significant differences concerning flexion movements at any of the tested speeds (Table 4).

Table 1. PT values obtained in the pre-training evaluation with different tested speeds and movements for the involved and non-involved limbs

	Peak Torque (Nm)					
	Constant Velocity Setting (º/s)					
	60		180		300	
Extension						
Noninvolved	208.63	±38.30	185.37	±5.51	158.3	±18.11
Involved	189.46	±17.37	184.87	±2.90	157.47	±10.7
Flexion						
Noninvolved	143.57	±12.91	113.97	±10.63	118.7	±11.05
Involved	142.23	±12.5	123.13	±9.29	118.27	±6.35

Table 2. PT values obtained in the post-training evaluation with different tested speeds and movements for the involved and non-involved limbs

	Peak Torque (Nm)					
	Constant Velocity Setting (º/s)					
	60		180		300	
Extension						
Noninvolved	279.07	±15.56	215.47	±10.21	170.43	±3.44
Involved	260.77	±6.12	193.16	±5.99	150.1	±3.1
Flexion						
Noninvolved	150.6	±9.41	119.87	±6.96	116.33	±11.05
Involved	153.2	±9.4	112.57	±2.25	106.4	±7.67

Table 3. Student's t-test for PT between limbs before training with different tested speeds and movements.

	Student's t-test		
	Constant Velocity Setting (º/s)		
	60	180	300
Extension	0.45	0.86	0.87
Flexion	0.77	0.38	0.95

Table 4. Student's t-test for PT obtained in the pre- and post-training evaluation with different tested speeds and movements for the involved and non-involved limbs.

	Student's t-test		
	Constant Velocity Setting (º/s)		
	60	180	300
Extension			
Noninvolved	0.14	0.07	0.40
Involved	0.02	0.04	0.32
Flexion			
Noninvolved	0.46	0.61	0.84
Involved	0.34	0.23	0.18

The values of PT obtained in the pre-training isokinetic evaluation were in agreement with the normative values suggested by Freedson et al. (1993). However, for Kannus et al. (1991) a significant deficit in the force of the quadriceps muscle evidenced at low speed is representative of differences between the limbs. That was verified at extension movement at 60º/s.

We still verified a larger deficit of PT in the femoral quadriceps muscle than in the hamstrings. Other authors (Tegner et al., 1986 and Bonamo et al., 1990) also found a larger deficit of the quadriceps muscle than in the hamstrings in long-term tears of ACL. For Arvidsson et al. (1981) and Kannus et al. (1992), that occurs in the complete chronic deficiencies of ACL and after different types of knee surgery, because the hamstring muscles need to maintain an additional static tension during walking, standing, and especially during high speed activities.

The effectiveness of the training was observed by the significant increase ($p< 0.02$) at extension PT of 60º/s for the trained limb. Moreover, we verified a significant increase ($p< 0.04$) of the extension PT at the non-trained speed of 180º/s. These results were satisfactory, considering the reduced number of training sessions (in a total of 10). The protocols more frequently found in the literature use 8 weeks of training.

Although not statistically significant, the gains in the non-involved limb (non-trained) were observed at almost all speeds tested and in both extension and flexion movements. Additional studies to understand the gain in the non-trained contralateral limb are necessary.

CONCLUSION: The isokinetic training was effective for the increase in the strength (PT) of the right lower limb knee extensors. There was also an increase in strength (PT) at 180º/s of the right lower limb extensor that had not been trained.

REFERENCES:

Arvidsson, I., Eriksson, E., Häggmark, T., Johnson, R. J. (1981). Isokinetic Thigh Muscle Strength after Ligament Reconstruction in the Knee Joint: Results from a 5-10 Year Follow-Up after Reconstruction of the Anterior Cruciate Ligament in the Knee Joint. *Int. J. Sports Medicine* **2**, 7-11.

Bonamo, J., Collen, F., Firestone, T. (1990). The Conservative Treatment of the Anterior Cruciate Deficient Knee. *American J. Sports Med.* **18**, 618-623.

Davies, G. J. (1992). A Compendium of Isokinetics in Clinical Usage. S & S Publishers.

Delitto, A., Irrgang, J. J., Harner, C. D., Fu, F. H. (1993). Relationship of Isokinetic Quadriceps Peak Torque and Work to One Legged Hop and Vertical Jump in ACL Reconstructed Knees. *Phys. Ther.* **73**(6), S85.

Dvir, Z. (1995). ISOKINETIC: Muscle Testing. Interpretation and Clinical Applications. Singapore: Churchill Livingstone.

Dvir, Z. (1989). Thigh Muscle Activity and Anterior Cruciate Ligament Insufficiency. *Clinical Biomechanics* **4**, 87-91.

Kannus, P. (1990). Relationship between Peak Torque and Angle-Specific Torque in an Isokinetic Contraction of Normal and Laterally Unstable Knees. *JOSPT* **13**, 89-94.

Kannus, P. et al. (1992). Function of the Knees with Chronic Partial Deficiency of the Anterior Cruciate Ligament - Isometric and Isokinetic Evaluation. *American J. Sports Med*. **20**(2), 162-168.

Stanton, P., Purdam, C. (1989). Hamstring Injuries in Sprinting – The Role of Eccentric Exercise. *JOSPT* **10**(9), 343-349.

Wilk, K. E., Romaniello, W. T., Sodcia, S. M., Andrews, J. R. (1994). The Relationship between Subjective Knee Scores, Isokinetic Testing, and Functional Testing in the ACL-Reconstructed Knee. *JOSPT* **20**(2), 60-73.