

## **MUSCLE STRENGTH IMBALANCE IN ELITE SKIERS**

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### **ISOKINETICS**

In isokinetics, as opposed to isotonic and isometric exercising, constant speed of motion is chosen (1-300°/sec – dynamic speed), while the resistance is accommodating and varies to exactly match the force applied at every point in the range of motion.

Isokinetics is used for diagnostics and for rehabilitation

Isokinetic diagnostics, in which constant speed of motion is chosen and resistance is accommodating automatically, has proved to be a very reliable method of quantifying muscle strength.

Isokinetic testing is used to objectively measure biomechanical parameters necessary for evaluation of the locomotor system. Different velocities are used to measure maximal muscle strength, endurance range of motion, fatigue etc.

The testing shows us the exact muscle strength, work, range of motion, peak torque curve and other relevant parameters. Such data undergo a computer analysis which evaluates relative status of the tested individual, taking into account his age, gender, height, weight and level of sports activity.

## SUBJECTS AND METHODS

Subjects : 16 elite skiers (members of Croatian national ski team  
5 females, 11 males  
aged 12-20, mean 16 (SD=3)

annually undergoing muscle strength testing on isokinetic diagnostic machines. In this study, different muscle groups were examined in 16 elite skiers (5 females, 11 males), aged 12-20 (mean 16, SD=3).

Muscle testing is annually performed on Cybex 6000 for the trunk extension and flexion, and on Cybex Orthotron KT2, for extensors and flexors of the knees and hips, as well as for plantar and dorsal flexors (ankle). Detailed dynamic status, taken at low (60 °/sec) and high speed (180 °/sec), included: peak torque, work per repetition, range of motion, total work done, and fatigue index.

## RESULTS

The results have shown that the antagonistic muscles of the knees and ankles were reasonably well balanced. Mean values were: knee extensors 98% (SD=15), knee flexors 93% (SD=10), dorsal flexors 91% (SD=16), plantar flexors 87% (SD=9). However, great imbalance was found on the antagonistic muscles of the hip, where the mean values of muscle strength have been 116% (SD=19) for hip extensors, and 86% (SD=8) for hip flexors. These values represent percentage of the standard expected value for each subject, taking into account age, gender, height, weight and level of sport activity.

The huge imbalance in the antagonistic muscle groups makes these skiers vulnerable to different injuries, considering that there are many reports correlating antagonist muscle imbalance with the incidence of injury. The imbalance between hip extensors and flexors may be very dangerous, since it causes extra strain on the spine, which could lead to the lower back pain syndrome. Indeed, in our separate study of patients that we have treated for lower back pain problems (32 subjects), we have found that their main problem was not the weakness or imbalance of the extensors and flexors

of the trunk (72%, 81% respectively), but the strong imbalance in hip extensors and flexors (72% towards 49%). More importantly, the correction of hip muscle imbalance alone, was most often sufficient to alleviate back pain. Coincidentally, one of the skiers that has suffered from a heavy attack of lower back pain was the one that has shown the biggest hip imbalance of all tested skiers, having the strength of hip extensors 145% and hip flexors 92%. Hence, it appears necessary to specifically train these particular muscles, to establish balance in the whole kinetic chain and consequently avoid injuries.

## CONCLUSION

In conclusion, during isokinetic testing of elite skiers the great muscle strength imbalance was found between hip extensors and hip flexors, the extensors being on the average 35% stronger. These findings should be taken into account when planning strength training for competitive skiers, since this particular imbalance, if untreated, can lead to the lower back pain syndrome.

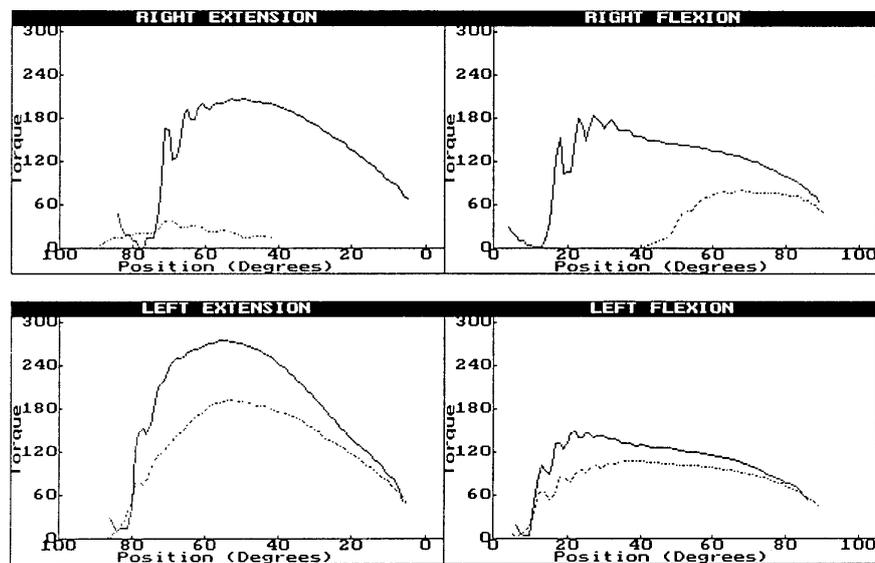


Figure 1. Knee extension/flexion isokinetic test results. Torque (Newton-Meters) is given as a function of the range of motion (Degrees).

	EXTENSION			Test1	FLEXION	
	Test1	Test2	Change		Test2	Change
<b>LOW SPEED TEST RESULTS</b>						
Peak Torque (Newton-Meters)						
Right:	35	202	477 %	75	183	144 %
Left:	198	268	35 %	100	148	48 %
Work Per Repetition (Joules)						
Right:	18	194	978 %	46	152	230 %
Left:	188	251	34 %	113	141	25 %
Range of Motion (degrees)						
Right:	42	8	-34 °	91	88	-3 °
Left:	5	11	6 °	89	86	-3 °

<b>HIGH SPEED TEST RESULTS</b>						
Initial Peak Torque (Newton-Meters)						
Right:	0	137	0 %	0	137	0 %
Left:	125	172	38 %	87	103	18 %
Fatigue Index						
Right:	0	31	0 #	0	20	0 #
Left:	9	31	22 #	11	11	0 #
Total Work Done (Joules)						
Right:	0	1058	0 %	0	1056	0 %
Left:	1463	1793	23 %	948	1094	15 %

Table 1. Numerical values of the isokinetic diagnostic testing. Knee extension/flexion measured at low and high speed for the involved (right) and uninvolved (left) leg

Second aspect of isokinetics relevant in the area of recreation is its use as a diagnostic tool since it gives us a reliable current status of the movement system for each tested individual. Furthermore, it helps us in acquiring a better global view of the problems in the locomotor system of the general population. This can be seen in the study of the group of individuals that have been suffering from lower back pain symptoms.

Isokinetic diagnostics testing has shown us the exact location of problems (weak muscle groups), and has given us guidelines for further recreational activities. This group consisted of 32 patients (11 males, 21 females), in the ages between 20 and 60 years (working population). The results obtained have shown that the knee extensors and flexors were reasonably well balanced. However, the great imbalance was found on the antagonistic muscles of the hip, where the mean values of muscle strength have been 72 % for hip extensors and 50 % for hip flexors (Figure 2). Mean percentage for trunk extensors was 71% and for trunk flexors 82%.

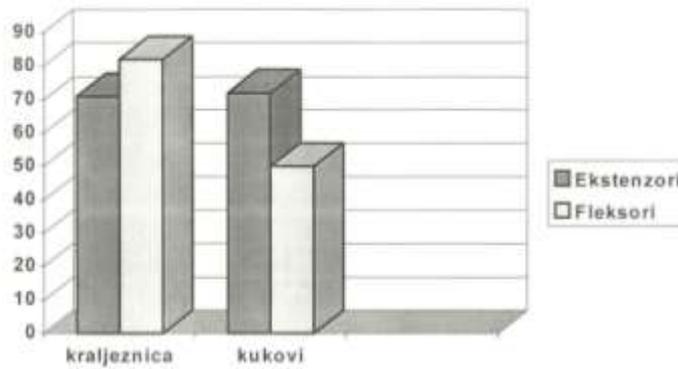


Figure 2. Mean percentages of muscle strength of extensors and flexors of trunk and hips for the group of individuals with lower back pain symptoms

These results suggest that the main problem in patients with lower back pain syndrome is not mainly in the weakness of trunk extensors and flexors, as commonly believed, but in the great imbalance found between flexors and extensors of the hip. Consequently, it is very important to start muscle strengthening of the hips, and when this strength and balance is satisfactory, add exercises for the trunk extensors and flexors. This is also very important in prevention, suggesting that to avoid lower back problems exactly these antagonistic muscles should be tested and rehabilitated if necessary. Therefore, these findings could be extremely important in planning recreational programs.

In addition, *isokinetic diagnostics* has been used to evaluate present status of the musculoskeletal system, which would then enable the person to either enter the isokinetic rehabilitation, or to participate in some other forms of physical activities with the full knowledge of the current muscle strengths. Also these tests have shown us that certain muscle disbalances could lead into serious problems (such as weak hip flexors causing low back pain syndrome) if not treated properly. This gives recreational trainers the guidelines for optimal recreational programs.

