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ISOKINETICS AND RECREATION

Introduction

In today's world where most of the people are leading a sedentary life, a lot of attention is focused on our movement system. Interest in physical fitness training for the general public has grown rapidly in the past decade. Unfortunately, attempts of such activities are often done hastily, without an adequate plan, program, or supervision, and without a proper physical preparation (of muscles, tendons, cardio-respiratory system, etc.). That often results oppositely of our intention, causing more damage than the benefits to the body. Sometimes such consequences are extremely serious such as myocardial infarction or stroke, but mostly the problems are connected to the musculo-skeletal system. Often we find torn muscles and tendons, damaged joints and ligaments, and in the worst cases even stress-fractures of the bones. Because of that it would be very beneficial to strengthen the muscles, prepare the joints, tendons and bones, before beginning the exercise program. One of the very effective methods for that is isokinetic exercising, during which the muscles are strengthened actively, without straining the joints. That is very important in the prevention, because it brings the antagonistic muscles in balance, as well as optimally prepares the musculo-skeletal system for the planned recreation. Before the beginning of isokinetic rehabilitation, isokinetic diagnostic testing is performed, which is very important not only because it's the base for rehabilitation, but also because it gives us the exact insight into the muscle strengths of the tested individuals. Isokinetic exercising is particularly useful for people which already have some pathological changes, especially of their joints (trauma, degenerative diseases, etc.). After the end of isokinetic rehabilitation it is very important to continue with some kind of planned physical activity, to sustain the accomplished muscle strength, and to develop the cardio-pulmonary system.

Basic principles of isokinetics and specific methods of exercising

In isokinetic exercises, as opposed to isotonic and isometric exercising, constant speed of motion is chosen (1-300°/sec – dynamic speed), while the resistance is accommodating (Davies, 1992). Therefore the velocity is constant at a preselected dynamic rate, where the resistance varies to exactly match the force applied at every point in the range of motion. Before the beginning of isokinetic rehabilitation it is necessary to undertake isokinetic diagnostic testing, for all muscle groups pertaining to the kinetic chain which we want to treat. Such testing shows us the exact muscle strength, work, range of motion, peak torque curve and other parameters relevant for obtaining the status of each leg. Such data goes through a computer analysis and gives each tested individuals his relative values, taking into account his age, gender, height, weight and level of sports activity. Based on such final values, a specific protocol is developed for each patient. According to this plan, extension, flexion, abduction, adduction and rotation exercises (depending on the treated joint) are performed daily, in duration of 30 minutes. During the exercising the protocols are constantly being modified, depending on the progress from one phase to the other, development of muscle strength, efficiency on different velocities, pain, fatigue, specific goals of rehabilitation, etc. During isokinetic rehabilitation the greatest progress was achieved during the first five days of isokinetic treatments, followed by a steady growth of muscle strength. This rapid increase in muscle strength, especially in the early stages of isokinetic rehabilitation, is probably due to a more efficient motor unit (motor nerve plus its attached muscle fibers) utilization (Cotton 1996), as well as increased muscle contractility (Akima et al. 1999), rather than the muscle hypertrophy. Isokinetic rehabilitation usually lasts about 3 weeks, and is considered finished

when: the muscle strength of the injured extremity comes within 10 % of the healthy one, the balance between antagonistic muscles is achieved, and when the subjective symptoms are gone, or reduced to the satisfactory level. After the end of isokinetic rehabilitation it is very important to sustain the developed muscle strength by doing the isotonic exercises (for example in the gym), as well as through aerobic exercising of the cyclical type, at least 3 times a week.

Advantages of isokinetics

Isokinetic exercising is very efficient, since it is the only way to load a dynamically contracting muscle to its maximum capacity throughout the range of motion. Also, it is very saf*e*, because an individual will never meet more resistance than he/she can handle, because the resistance is equal to the force applied.

Such exercising has accommodating resistance, predicated on changes in musculo-tendinous length-tension ratio, fatigue, pain, changes in skeletal biomechanics, etc. Because of this, even heavily injured individuals, and early postoperative patients could be treated. Furthermore, it enables a person to establish the balance between the antagonistic muscles (Kellis and Baltzopoulos 1999), which is very important since there are many reports showing strong correlation between strength imbalance and the incidence of injury (Yoon and Hwang 2000; Ernst et al. 2000; Lowell and Lauder 2001). Isokinetic resistance enables exercising at the functional speed to develop strength and endurance of the muscles, and to train the neuromuscular system to the speeds required for the dynamic functions of the extremities (Osteras et al. 1998). By using different velocities during exercising, specific goals can be trained: low speeds for strength and high speeds for the development of endurance. After isokinetic treatments there is minimal muscle soreness since only concentric muscle contractions are used in both directions, and they do not cause micro-tears of the muscle bundles. Isokinetic equipment gives us reliable and precise information during testing and also during exercising, which enables the supervisor to make an accurate plan of rehabilitation, and to control it. It also grants the patients the opportunity to monitor the movements, and gives them a positive feedback. Isokinetic rehabilitation has proven to be a particularly suitable method for treatment of wide range of different knee injuries (Keays et al. 2000; Kvist et al. 2001). Isokinetic rehabilitation is especially indicated in some specific cases: for people with extreme muscle atrophy, which consequently led to the "vicious cycle" (weak muscles cannot strengthen because every exercising loads the joints, damaged joints hurt and disable further exercising and muscle strengthening); in preparation for surgery, to enable the person to afterwards quickly get the muscle strength back; in early postoperative rehabilitation, especially of the joints themselves, when it is necessary to load the joints very slowly and carefully (other exercises could be dangerous); for the athletes or others who because of the nature of their profession need a speedy recovery.

Examples of isokinetic diagnostics and treatment

In the first example we'll show how isokinetic diagnostic and rehabilitation has been successfully used for treating a knee injury and how it has enabled a person to regularly participate in the recreational activities. A 12 year old patient was diagnosed with right knee instability, and was suffering from it, accompanied with great pain, for 3 years. During that time he was treated with immobilization on several occasions, and has received classical physical therapy (mostly kinesitherapy), without much success. His right knee was so painful, and his muscles so week that he could only walk with the crutches for the last few months. At the age of 15, on the first diagnostic test performed on the isokinetic device, his muscle strength was extremely low. He underwent 17 treatments of isokinetic rehabilitation, which has enabled him to actively improve the strength of his muscles, without straining his knees. Subsequent isokinetic testing has showed dramatic improvement in muscle strength. Consequently, his knees were stable, and he was completely pain-free. Afterwards he has continued muscle strengthening using standard weightlifting program in the fitness center, and was able to continue rowing recreatively. A year after the rehabilitation, another isokinetic diagnostic testing was performed, which has shown excellent results, with further muscle strength improvement.

Today he does not have any problems with his knees, and is still in the rowing program, as well as exercising in the gym.

An example of isokinetic diagnostic testing is shown in Figure 1 and Table 1. Detailed dynamic isokinetic status was taken on the Cybex Orthotron diagnostic device prior and after rehabilitation. In Table 1, Test1 refers to testing prior to the isokinetic rehabilitation and Test2 was taken after the rehabilitation was completed. The upper row of Figure 1 shows the difference in peak torque in Tests1 (dotted line) and Test2 (full line), for the right, injured leg (extension and flexion, respectively). In the lower row the same parameters were measured for healthy (left) leg. Uninvolved leg was also measured at the beginning of rehabilitation. It was demonstrated that the healthy leg could be used as a reference guide for the outcome of rehabilitation (Petschnig et al. 1998), regardless of whether this leg is dominant or not.

During 17 treatments of iskinetic rehabilitation, different things were exercised: strength development, endurance improvement, proprioception, specific movements for range of motion improvement (angle selection), interval training, excitation of neuromuscular system, etc. All the time during each treatment, strength improvement was monitored (through peak torque) on the Orthotron rehabilitation device itself. That maximal peak torque obtained every day, has proven to be quite a reliable estimate of the final peak torque which is achieved on the final isokinetic testing (on the diagnostic device), and is therefore very useful in the check up of the daily progress.

At the end of rehabilitation, the final diagnostic testing was performed, which included the same parameters as the initial one. When we look at the low speed (60 deg/sec) test results (Table 1), the improvement in peak torque for injured leg was 477% in extension and 144% for flexion. Healthy leg was exercised only during the rest periods for impaired leg, and still improved 35 % in extension and 48% in flexion. In the high speed (180deg/sec) testing (Table 1), during Test1 injured (right) leg was not able to perform a given task since it couldn't have achieved a speed of 180 deg/sec. It is often the case that in the early stages of rehabilitation athletes are not able to exert tension at fast speeds (Charteris 1999). After rehabilitation (Test2), the peak torque of the injured leg surpassed the starting value of the healthy leg (137 Nm compared to the 125 Nm). Furthermore, the work per repetition and fatigue index have greatly improved in Test 2, so that in low speed testing work per repetition has improved form 18 to 194 Joules. All of these improvements were achieved in just 17 treatments, in 23 days.

In the second example we have tested a 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).

Isokinetic muscle testing has been done for extensors and flexors of the knees and hips on the speeds of 60 and 180°/sec, on Cybex Orthotron KT2 machine, and for extensors and flexors of the trunk on 30 and 60°/sec speeds On Cybex 6000 isokinetic machine. 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. Mean percentage for trunk extensors was 71% and for trunk flexors 82%. All these numbers represent percentages of the standard expected value for each subject, taking into account age, gender, height, weight and level of sport activity. 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. This great imbalance found between flexors and extensors of the hip suggests that in such patients, muscle strength evaluation should be performed in these muscle groups and therefore include muscles of the whole kinetic chain important for lower part of back (knees, hips and trunk extensors and flexors). Consequently, it is very important to do the muscle strengthening in the same way, starting with muscle extensors and flexors of the knees and hips, and when this strength and balance is satisfactory add muscle strengthening 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 helpful in planning recreational programs.

Conclusion

Isokinetics has proved to be very helpful in the field of recreation. On the one hand 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 optional recreational programs

Isokinetic rehabilitation performed according to the individually designed protocols has proven to be very effective method in treating different injuries and malfunctions of the movement system. Objective parameters indicate great improvements of muscle strength, while the subjective parameters show great clinical improvement (pain and swelling greatly reduced, increased feeling of muscle strength, greater stability of the joints, better mobility and range of motion, etc.). Rehabilitation is very fast, on the average 15 treatments are sufficient, and the greatest increase in muscle strength is noticed in the first 5 days. Return to the working, sports, and daily activities is for most of the injuries within one month. That consequently enables a person to participate in various sports and recreational activities, and to lead a healthier and happier life.

Recreation

Benefits of physical activity

Regular physical activity is very important for every human being; it positively affects the whole organism, diminishes the risk of the most common diseases of our time (cardiovascular , different cancers, diabetes). It also reduces hypertension, and is very useful in the prevention of osteoporosis. In people with damaged locomotion system it complements well with classical physical therapy, increasing its benefits, as well as diminishes the recidivism of such damages. Continuous exercising done in the right way improves functional and motor abilities of the organism, as well as its morphological qualities and psychosocial characteristics. When we talk about developing functional capacities, we mean improving the cardiorespiratory and locomotor system, that is increasing endurance, improving heart and lungs function, better circulation, as well as increasing strength and endurance of the muscles, agility, speed, coordination, flexibility, which is all very important at any age. Also, regular physical activity greatly affects psychosocial characteristics of an individual, increasing good mood, emotional stability, reducing depression and anxiety, helping with sleep disorders, etc.

Basic principles of recreational exercising

With every planning of the physical activity it is every important to choose the right kind, intensity, duration, and frequency of activity.

There are various kinds of recreational exercises, but

Figure captions

Figure 1. Knee extension/flexion isokinetic test results. Torque (Newton-Meters) is given as a function of the range of motion (Degrees). Dotted lines refer to Test1, performed at the beginning of isokinetic rehabilitation and full lines refer to Test2, performed after the rehabilitation was completed. Both the involved (right) and uninvolved (left) legs are tested. Some important numerical values of these tests are given in Table 1

Table Captions

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

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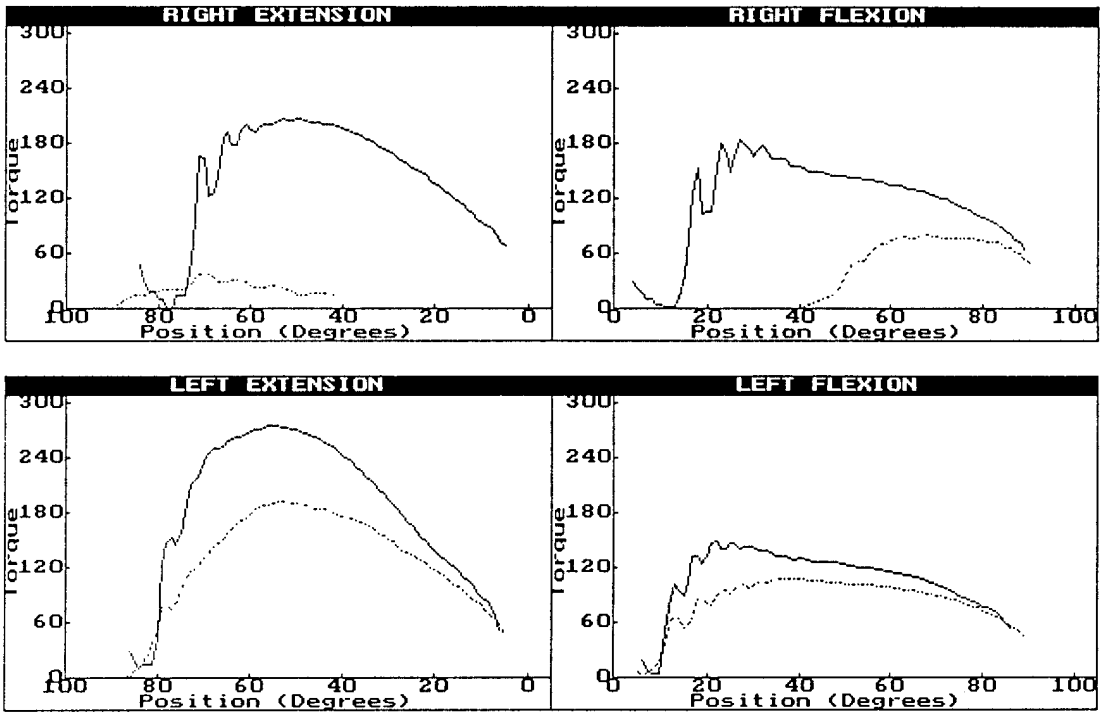

Comments:

Figure 3.

	EXTENSION			FLEXION		
	Test1	Test2	Change	Test1	Test2	Change
LOW SPEED TEST RESULTS						
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 °
HIGH SPEED TEST RESULTS						
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 %