EVALUATION OF KNEE FLEXORS AND EXTENSORS MUSCLE STRENGTH AFTER LIGAMENTOPLASTY FOR ANTERIOR CRUCIATE LIGAMENT AFTER 6 MONTHS OF SURGERY

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Abstract

The alteration of the strength of the quadriceps and hamstrings after six months of reconstruction of the anterior cruciate ligament (ACL) induces a decrease in performance and can cause injury. Hypothesis: The muscular strength of the operated side of anterior cruciate ligament after 6 months of surgery shows some muscular weakness in the quadriceps and hamstrings in comparison with the healthy side. Motor performance will be dependent on the total recovery of muscle strength of these young athletes.

Purpose: This study evaluated the isokinetic muscle strength parameters after 6 months of anterior cruciate ligament rehabilitation in young athletes. Methods: We measured muscle strength of 50 patients, 6 months after surgery after ACL reconstruction. The parameters used to evaluate the strength of the quadriceps and hamstrings were the: peak torque, average power, total work, max repetition total work and the ratio agonist / antagonist (AGO/ANTAG). They were studied at various speeds: 120, 180.300 degrees / sec.

Results: muscle strength in the operated side after 6 months of conservative treatment shows a deficit only at the level of the quadriceps muscle in comparison with the healthy side.
Conclusion: hamstrings are recovered more quickly than the quadriceps.

Keywords: Biodex, isokinetic, anterior cruciate ligament (ACL), Ratio

Introduction

The anterior cruciate ligament (ACL) injury has become one of the most prevalent knee injuries, primarily in adolescents and young adults playing sports with pivot / contact like football, skiing, basketball (Park et al., 2010). ACL is an essential stabilizer of the knee, in preventing the anterior translation of the tibia on the femur, and stabilizing the knee against the constraints of rotation and valgus (Levy et al., 1982). In addition, knee instability is the most critical functional problem in ACL injuries, mainly in the activities requiring pivoting and side stepping, and that can be the major reason of disability in practicing sports activities and restriction of daily living activities (Wong et al., 2012).

However, it is noteworthy that patients still suffer from persistent weakness of the thigh muscles, postoperative pain (Rosenberg et al., 1992), patellofemoral osteoarthritis, anterior knee pain (AKP), functional deficits and a decline in sports activities, after ACL reconstruction despite the completion of ligamentous stability (Shino et al., 1993). Then, the goal of ACL reconstruction cannot be reached without the recovery of muscle strength, even if the knee recovered its stability and the adequate range of motion (Niga et al., 1996). Therefore, rehabilitation after ACL reconstruction typically begins during the short duration of hospitalization, with a period of 6 months approximately (Beynnon et al., 2002). The aim of our study was to examine the changes in the knee muscles strength after systematic and progressive rehabilitation exercises for 6 months of male athletes after ACL reconstruction.

Material and methods

Fifty subjects were treated surgically by ACL reconstruction using a standard Kenneth Jonnes (KJ) technique after complete rupture of ACL, participated in the study, with mean age about 27.02 (18–45) years.

Rehabilitation program was initiated with a partial weight bearing during the second postoperative week with a gradual advancement to full weight bearing during the fourth postoperative week; running was started between the third to fourth postoperative months and cutting motion exercises at the sixth postoperative month. Return to full sports activities was allowed after the achievement of at least 70% of quadriceps strength

compared to the opposite limb, and a complete full range of motion without hydarthrosis.

Muscle strength during an isokinetic exercise was measured using the Biodex dynamometer (Biodex, Shirley, NY, USA). Patients were fixed to the testing device with straps around their chest, pelvis, and thigh. We adjusted the height of the seat in a way to align the posterior one third of the tibiofemoral joint with the axis of the rotation of the dynamometer during flexion-extension motion of the knee. A resistance pad was placed over the distal one third of the lower leg, without restricting ankle dorsiflexion or plantar flexion (Lee et al., 2013). The isokinetic strength of the quadriceps and hamstring muscles were measured at a velocity of 120,180 and 300°/s. We explained to the subjects about the device as they can understand the measurement methods. Each subject was given a 10 minute of warm-up period by aerobic ergometer cycling.
Each test included a series of movements of flexion and extension of the knee, resulting in five movements roundtrip knee over the average speed 120°/s, 10 movement in average speed 180°/s and 10 fast moves 300°/ s. A rest period of 25 seconds was provided between tests. These muscles actions must reach a maximum, the changes in the direction of movement between flexion-extension and extension-flexion should take place without interruption .The regime was concentric.

In order to analyze the quadriceps and hamstring isokinetic strength, we assessed the mean peak torque, max repetition total work, an AVG power, ratio AGO/ANTAG, and the results of the operated leg were expressed as a percentage of the non-operated leg. These measurements procedures were performed at 6 months after surgery.
Comparisons of data were performed using unpaired Student's t tests. The level of significance was set at P value <0.05.

Fig1. BIODEX

Statistical analysis methods

All data were analyzed statistically, using a current SPSS statistical package Version 21 and the data presented as Mean ± Standard Deviation of Means (S.E.M). Comparison between affected side and healthy side was performed using t-test and p value was considered statistically significant if $P \leq 0.05$, P value >0.05 insignificant.

Results

Paired Samples Test				
		Mean	**Std. Deviation**	**p**
Pair 1	300°/extension/healthy side 300°/extension/affected side	16.4560	15.3088	.000
Pair 2	300°/flexion/ healthy side 300°/flexion/ affected side	-.4080	14.6049	.844
Pair 3	180 /extension/ healthy side 180 °/extension/ affected side	29.2520	27.3057	.000
Pair 4	180 °/flexion/ healthy side 180 °/flexion/ affected side	.6240	14.7687	.766
Pair 5	120 °/extension/ healthy side 120°/extension/ affected side	33.0740	26.8345	.000
Pair 6	120° /flexion/ healthy side 120° /flexion/ affected side	.5940	15.6137	.789

Table 1: Results obtained with Biodex on healthy side and side operated at a PEAK TORQUE

Paired Samples Test				
		Mean	**Std. Deviation**	**P**
Pair 1	300°/extension/healthy side 300°/extension/affected side	32.5500	39.8898	.000
Pair 2	300°/flexion/ healthy side 300°/flexion/ affected side	-11.8080	49.4542	.098
Pair 3	180 /extension/ healthy side 180 °/extension/ affected side	40.2660	51.0567	.000
Pair 4	180 °/flexion/ healthy side 180 °/flexion/ affected side	-4.7580	40.3242	.408
Pair 5	120 °/extension/ healthy side 120°/extension/ affected side	32.2740	34.6817	.000
Pair 6	120° /flexion/ healthy side 120° /flexion/ affected side	-4.5720	23.6370	.178

Table 2: Results obtained with Biodex on healthy side and side operated at an AVERAGE POWER

Paired Samples Test				
		Mean	**Std. Deviation**	**p**
Pair 1	300°/extension/healthy side 300°/extension/affected side	18.4520	19.9063	.000
Pair 2	300°/flexion/ healthy side 300°/flexion/ affected side	-1.9260	17.9895	.453
Pair 3	180 /extension/ healthy side 180 °/extension/ affected side	28.0780	30.1943	.000
Pair 4	180 °/flexion/ healthy side 180 °/flexion/ affected side	-.0780	21.1330	.979
Pair 5	120 °/extension/ healthy side 120°/extension/ affected side	28.9980	27.0262	.000
Pair 6	120° /flexion/ healthy side 120° /flexion/ affected side	-1.7300	22.3706	.587

Table 3: Results obtained with Biodex on healthy side and side operated at a MAX REP TOTAL WORK

Paired Samples Test				
		Mean	**Std. Deviation**	**p**
Pair 1	300°/extension/healthy side 300°/extension/affected side	118.5240	161.8520	.000
Pair 2	300°/flexion/ healthy side 300°/flexion/ affected side	-35.4260	187.1259	.187
Pair 3	180 /extension/ healthy side 180 °/extension/ affected side	233.6740	295.1588	.000
Pair 4	180 °/flexion/ healthy side 180 °/flexion/ affected side	-10.2240	221.7589	.746
Pair 5	120 °/extension/ healthy side 120°/extension/ affected side	118.0860	142.4496	.000
Pair 6	120° /flexion/ healthy side 120° /flexion/ affected side	-8.0760	97.5883	.561

Table 4: Results obtained with Biodex on healthy side and side operated at TOTAL WORK

According to the Biodex test, patients in our sample showed only deficits of the quadriceps muscle. There is a significant difference between the results obtained from the healthy and the operated side ($p = 0$) at the confidence level of 95% for the extension movement. So, we can consider that there is a significant difference between the healthy and affected side at the confidence level 95% for the extension movement. Therefore, there is no significant difference for the flexion movement.

These results confirmed the presence of a deficit in operated patients during the extension for the peak torque, average power, max work and the total work.

Discussion

Isokinetic assessment can be used to measure torque values at several joints in the body; and the knee presented the most commonly tested joint.

This assessment is typically based on comparing the involved joint with the uninvolved joint (Holmes et al., 1984).

Our study was to affirm the presence of muscle weakness in the knee by using the biodex test after 6 months of rehabilitation after ACL reconstruction. According to the biodex test, the patients in our sample showed a weakness only in terms of quadriceps and not hamstrings. Our results confirmed the presence of a deficit in operated patients during the extension for the peak torque, average power, max work and the total work, and a muscular ratio (hamstring / quadriceps) less than 0.60.

Consequently, it was reported that is difficult to generalize that the normal H/Q (Hamstring/quadriceps) ratio is considered to be 50% to 80% as averaged through the full range of knee motion, with a higher ratio at faster speeds (Grace et al., 1984). For a 100% ratio, the hamstrings have an increased functional capacity for providing stability to the knee (Harter et al., 1990). This significant knee stability may reduce the possibility of an anterolateral subluxation of the tibia (Li et al., 1996).

However, a study conducted by Rosene et al. (2001) reported that an H / Q ratio of 0.52 in 12 female volleyball players aged twenty years old, with a measurements on isokinetic machine at a speed of 60 degrees / second which is higher than the ratio of our study. Another study conducted by Magalhaes et al. (2004) described a H / Q ratio of 0.51 for high level Volleyball men professional players, which is higher than the ratio of our patients.

Soderman et al. (2001) which presented a lower H / Q ratio among female footballers who had a secondary rupture of anterior cruciate ligament extern (ACLE) and Ahmad and al. that reported a generally lower ratio H / Q in women.

Our results presenting a muscular ratio (hamstring / quadriceps) less than 0.60 agreed with all these studies.

In addition our results confirm the result of kobayshi et al. (2004) study that measured muscle strength in 36 patients after ACL reconstruction with autologous "bone-patellar tendon-bone." The isokinetic quadriceps and hamstring strength was studied during the concentric contraction at 60 and 180 degrees / sec and was measured at 1, 6, 12 and 24 months after surgery. At 24 months, the quadriceps muscle strength had recovered approximately 90% of the force on the opposite side, 60 and 180 degrees / sec.

Therefore, these results are not consistent with those of Withrouw et al. (2006) which states that subjects who underwent ligament reconstruction by the kenneth jones method after 6 months of surgery have deficits in the hamstrings and quadriceps.

In contrast, the strength of the hamstring had regained 90% of its value in six months. Another study conducted by Keays et al. (2000) is

consistent with our study that have concluded that the quadriceps strength was recovered more slowly than the hamstrings strength after ACL reconstruction, the quadriceps muscle performance was recovered favorably after returning to sport. Hamstrings recovered well at six months after surgery and they played an important role in protecting the transplant because they limit the anterior drawer. Niga et al. (1996) measured the intensity of the extensor muscle periodically 3, 6, 9, 12, 15 and 18 months after surgery. They found that the quadriceps strength has recovered with time; it has specifically recovered over 80% with an ACL ligament 18 months after the operation.

Sachs et al. (1989) have found that the average of quadriceps strength was only 60.8% at 1 postoperative year.

Recently in 2013, a study by Lee et al. (2013) was carried out as a comparison between the affected side and the healthy side of 10 subjects, including 5 females and 5 males at 12 weeks after surgery of an ACL ligament reconstruction; the results showed that: at 60 ° / s, the isokinetic muscle function of women showed no significant change between before and after the operation in the total work, peak torque and average power for the healthy side and the affected side. Even at 60 ° / s, the isokinetic muscle function of men showed no significant change between before and after surgery in the max time, total work and average power, carried out on the healthy side. In extension, the peak torque showed no significant change on the affected limb. However, the difference in results may be due to a separate rehabilitation protocol, frequency and intensity of different physiotherapy treatment.

Conclusion

Our initial hypothesis that muscle strength of the operated side of anterior cruciate ligament had some muscle weakness after 6 months of surgery in the quadriceps and hamstrings in comparison with the healthy side, is partially verified because our results showed a deficit only in terms of quadriceps for the 5 parameters (peak torque, AVERAGE POWER, MAX WORK, RATIO AGON / ANTAG and TOTAL WORK). Quadriceps strength was recovered more slowly than the hamstrings strength after ACL reconstruction. Based on these results, our conclusion is that strengthening exercises for the quadriceps muscle need to be intensified after ACL reconstruction.

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