Journal of Sports Medicine & Doping Studies

Golez et al., J Sports Med Doping Stu 2018, 8:4
DOI: 10.4172/2161-0673.1000208

Research Article Open Access

Functional Outcome of Patients with Anterior Cruciate Ligament Reconstructed Knees with Hamstring Tendon Autograft: A Six-Month Follow-up

Ana Golež[1*], **Matja Sajovic**[2], **and Natasa Sipka**[3]

[1]*Department of Medical Rehabilitation, Celje General and Teaching Hospital, Oblakova 5, 3000 Celje, Slovenia*

[2]*Department of Orthopaedics and Sports Trauma Surgery, General Teaching Hospital Celje, Oblakova 5, 3000 Celje, Slovenia*

[3]*Rehabilitation Center Spa Zrece, Cesta na Roglo 15, 3214 Zrece, Slovenia*

[*]**Corresponding author:** Ana Golež, Department of Medical Rehabilitation, Celje General and Teaching Hospital, Oblakova 5, 3000 Celje, Slovenia, Tel: +38634233632, E-mail: golez.ana@gmail.com

Received date: July 04, 2018; **Accepted date:** September 28, 2018; **Published date:** October 05, 2018

Abstract

Background: Anterior cruciate ligament rupture is a common knee injury, especially in sportsmen. Rupture of the anterior cruciate knee ligament necessitates rehabilitation. If good operative results and intensive pre- and post-operative rehabilitation lead to an optimal outcome, patients can return to the pre-injury level of sports activity in the short term.

Objective: Muscle strength and stability of anterior cruciate ligament in reconstructed knees have been bilaterally compared with hamstring tendon autograft at 6 months following surgery.

Methods: Sixty-five patients, 44 men, and 21 women, participated in the study. The outcome measures consisted of isokinetic strength findings, balance, hop index and KT-1000 for knee laxity.

Results: A small difference between the operated and non-operated knees in isokinetic, balance (Mean of average difference between operated and non-operated leg was 1.036), hop index (Mean of average difference between operated and non-operated leg was 0.8540), and KT-1000 values (Mean of average difference between operated and non-operated leg was 2.238) was noted at 6 months after the surgery. The average deficit of the peak torque in the operated knee at angular velocity 240° was 13.4% for extensor muscles and 7.8% for flexor muscles.

Conclusion: Reconstructed knees with flexor tendons exhibit similar results as opposite, non-operated knees. Full weight bearing and no use of brace after surgery is advised. Good surgery technique and intensive pre- and post-surgery rehabilitation are very important. Six months after surgery patients are allowed to go back to sports activity.

Keywords: Anterior Cruciate Ligament; Biodex; Functional tests; Hamstring muscle tendon; KT-1000; Lysholm questionnaire; Reconstruction; Tegner Knee Scores

Introduction

Rehabilitation after the reconstruction of the anterior cruciate ligament (ACL) with a hamstring tendon autograft (STG) is primarily intended to restore function, prevent potential surgery-related complications, and allow for the level of sports activity to achieve the pre-injury level [1-3]. According to most surgeons, full activities should commence at 6 months after reconstruction; some of them allow them at 4 months [1]. Functional outcome can be evaluated subjectively and objectively by using clinical results of KT-1000, isokinetic testing and functional performance tests (e.g. balance test) [4,5].This prospective six-month follow-up study of ACL reconstructed with STG autograft was designed to evaluate the clinical outcome of operated and opposite, nonoperated knee and to introduce a programme of pre- and post-surgery rehabilitation. The hypothesis of this study was that ACL reconstruction and a programme of rehabilitation before and after surgery can lead to a good functional outcome.

Methods

After the study was approved by the National Ethics Committee, all the participants granted their informed consent. The study mostly included participants who underwent arthroscopically assisted ACL reconstruction due to their wish to return to a pre-injury level after diagnosis of ACL rupture. The study did not include patients who refused to participate in a research programme, patients with previous surgery, multi-ligament injury, arthroscopically diagnosed Outbridge chondral lesions stages III or IV, radiographically seen abnormality, or an abnormal contralateral leg. The patients, who fulfilled the study inclusion criteria from July 2014 to July 2016, were automatically included in the hospital database for ACL reconstruction.

Among 65 patients there were 44 men (67.7%) and 21 women (32.3%). Average female age was 26 years, average height 169 cm and average weight 64 kg. Average male age was 28 years, average height

180 cm and average weight 90 kg. A hamstring tendon autograft was used for ACL reconstruction.

Operative method

The same orthopaedic surgeon made all reconstructions, usually under general or some cases in spinal anaesthesia, in a bloodless field and antibiotic prophylaxis (2 g cephalothin) by a single-incision technique. First a systematic arthroscopic examination was made and then additional surgery. The orthopaedic surgeon removed ACL remnants and made a lateral notchplasty if necessary.

He harvested the graft in a longitudinal incision, where the pes anserinus is inserted. Then he split the sartorius fascia, harvested the gracilis and semitendinosus tendons using a tendon stripper, cleaned the tendons and looped using a No. 2 Vicryl absorbable suture to make a quadruple graft, of length from 7 to 10 mm. He pretensioned the graft to 20 pounds. Later, the surgeon drilled the femoral tunnel in the most medial anatomic footprint of the posterolateral bundle, and the tibial tunnel in the central part of the anatomic footprint. Appropriate position of the tunnels was tried using drill guides. The graft was positioned through the tibial to a blind femoral tunnel and fixated it with cannulated interference screws. Tibial anatomical joint line fixation was achieved by absorbable interference screw (Arthrex) in an outside-in direction at a knee flexion angle of approximately 10° and manual pretension of the graft.

Postoperative rehabilitation

After surgery all patients were included in the same rehabilitation programme with full-weight bearing, full range of motion and with no brace. With mean 3-day hospitalisation the main goals were range of motion, muscle training, control of pain and swelling. 14 days after surgery patients started with stationary bicycling, closed kinetic chain exercises and knee flexion exercise with resistance. 6 weeks after surgery they underwent a supervised 2-week rehabilitation programme in a Rehabilitation Centre. 8 weeks after surgery they continued with light jogging and agility training. They were allowed to participate in sport-specific activities – maximum strength training, and increased agility training workouts at 10 weeks after surgery. If full range of motion, no effusion, good strength and stability of the operated knee were achieved patients could participate in full sport 6 months after surgery.

Clinical evaluation

Patients were tested by the same senior physical therapist, who did not participate in their rehabilitation, before, and then 3 and 6 months after surgery. They started with the isokinetic evaluation later with dynamic postural stability, finally knee laxity was tested. At 6 months follow up clinical evaluation isokinetics, balance and Tegner [6,7] were evaluated. On the isokinetic dynamometer Biodex (Biodex Medical Systems, Inc., USA) [8], the strength of the isokinetic flexors and extensors of the knees was tested. Patients were instructed to refrain from strenuous activities the day before the evaluation. They were also asked to manage their daily tasks as usual. Reproducibility and validity were ensured by a standardised testing protocol.

After a 10-minute warm-up on a stationary bicycle, patients performed some specific fitness exercises with leg flexion and leg extension. Patients were familiarised with the proper use of the isokinetic machine and became fully accustomed to it before testing. Before measuring, the subjects also had the opportunity to practice (pre-test). If leg pain occurred at rest in a test, this test was left out and the measurement was repeated. First the uninvolved limb was evaluated and then the involved limb. Quadriceps and hamstring muscle power during knee flexion and knee extension, respectively (open kinetic chain exercises), was evaluated with a battery of strength tests (Endurance and Power test, three times, 60 and 240°/sec knee flexion).

The measurement of the peak torque values of the isokinetic strength followed; the values obtained were then expressed as the difference between the involved and uninvolved limb and as the hamstring to quadriceps (H: Q, hamstring divided by quadriceps) ratio. Balance was evaluated 3- and 6-months after surgery. We assessed dynamic postural stability of the subject with the Biodex Stability System (BSS). All subjects had their single leg stability assessed first on the uninvolved and then on the involved limb. The participants were positioned and balanced centrally on a single limb in the centre of the unstable, dynamic platform, with the test extremity in light flexion, the contralateral extremity flexed, and arms crossed on the chest.

According to instructions, the subject maintained a stable position on the platform for 20 seconds, while the stability of the system was set at level 4 at 3 months after ACL reconstruction and at level 1 at 6 months after surgery. They repeated this 20-second trial three times with each limb. BSS recorded movement of the platform away from a level position in degrees of deflection. Data were obtained to estimate the overall stability. Lower values represented increased ability to maintain a stable platform. The KT-1000 arthrometer (MEDmetric, San Diego, CA) was used to measure objective anterior-posterior knee laxity.

The laxity data were expressed as the side to side difference in anterior tibial translation. We measured and quantified the amount of movement in millimetres (mm) by pulling the tibia anteriorly by strapping the KT-1000 on the leg. We applied 15, 20 and 30 pounds of anterior displacement force to the knee joint. Anterior tibial translation measurements were performed as advised by the manufacturer. Clinical variables were collected and included demographics, knee impairment measures, and self-reported questionnaire responses using the Lysholm and Tegner questionnaire. Participants were group as "*yes, return to pre-injury level of sports activity*" or "*no return to pre-injury level of sports activity*"

Statistical analysis

Statistical analysis was carried out by an independent expert statistician, who did not partake in the study protocol. A p value less than 0.05 was considered statistically significant. We showed the results as a mean and standard deviation (SD) of the mean. Differences between values were tested with an Analysis of Variance test (ANOVA).

Results

From July 2014 to July 2016, sixty-five patients underwent primary arthroscopically assisted ACL reconstruction with a hamstring tendon autograft. Radiographic evidence of knee joint osteoarthritis was not evident in any of the patients. Menisci were resected in 39 of 65 hamstring tendon group (60%) patients.

Among 65 patients there were 44 men (67.7%) and 21 women (32.3%). All 65 patients in the study were available for a follow-up

evaluation at 3 and 6 months. No deep venous thrombosis, infections, nerve injuries or other surgery complications occurred in this series. Length of hospital stay was two or three days (Table 1).

Subjects No.	
Total number of patients	65
Age, years (mean;median)	28.5 (SD ± 8.05); 28 (14 - 46)
Gender	
Male	44 (67.7%)
Female	21 (32.3%)
Time from injury to surgery, months, mean (SD)	16.4 (± 17.39)
Meniscal lesion (n)	39 (60%)
Medial meniscal lesion (n)	31 (48%)
Lateral meniscal lesion (n)	12 (18%)
Medial and lateral meniscal lesion (n)	4 (6%)
Bucket handle meniscal lesion (n)	9 (14%)
Cornu posterior meniscal lesion (n)	11 (17%)

Table 1: Data on subjects.

All the participants found the postoperative rehabilitation protocol comfortable. They managed to fully extend the leg in the early postoperative period. Signs of arthrofibrosis or impingement syndrome did not occur in the tested subjects, so further surgery was not required. The mean time from injury to surgical repair was 16.4 months (SD 17.39) and mean age of patients at surgery was 28.5 years (SD 8.05), median 28 years (from 14 to 46 years). The main causes of the ACL rupture were injuries from football (36.9%), basketball (13.8 %), skiing (10.8%) and other activities (10.8%). All causes are shown in Table 2.

	Frequency	Percent	Valid Percent	Cumulative Percent
Football	24	36.9	36.9	36.9
Skiing	7	10.8	10.8	47.7
Basketball	9	13.8	13.8	61.5
Volleyball	5	7.7	7.7	69.2
Handball	4	6.2	6.2	75.4
other sports	6	9.2	9.2	84.6
Work	3	4.6	4.6	89.2
Other activities	7	10.8	10.8	100
Total	65	100	100	

Table 2: Causes of the anterior cruciate ligament rupture.

All subjects completed the Lysholm questionnaire before the surgery, and at 3 months and 6 months after surgery. The study showed a considerable improvement in Lysholm questionnaire6 knee scores, achieving almost 94% at 6 months after surgery (statistics are shown in Table 3). Results were moderate before surgery, good at 3 months after surgery, and excellent at 6 months after surgery. Tegner activity level scale [7] scores showed that most subjects participated in sports competitively (running, tennis, handball, and motor racing) or recreationally (soccer, rugby, football, bandy, basketball, ice hockey, squash, racquetball, and running) before injury and maintained their sports activity at Level 7. Six months after surgery they were mostly active in recreational sports (handball, tennis and badminton, racquetball, jogging at least 5 times per week, down-hill skiing), corresponding to Level 6. Statistics are shown in Table 4.

	Lysholm questionnaire knee score before surgery	Lysholm questionnaire knee score 3 months after surgery	Lysholm questionnaire knee score 6 months after surgery
No. of Valid	65	65	65
No. of Missing	0	0	0
Mean	71.54	89.2	93.8
Median	72	91	94
Mode	49	93	95
Std. Deviation	15.887	6.558	4.848
Minimum	39	60	78
Maximum	100	100	100

Table 3: Lysholm questionnaire knee score before, 3 and 6 months after surgery.

	Tegner activity level scale scores before surgery	Tegner activity level scale scores 6 months after surgery
No. of Valid	65	65
No. of Missing	0	0
Mean	6.91	5.95
Median	7	6
Mode	7	5
Std. Deviation	1.366	1.328
Minimum	4	3
Maximum	10	10

Table 4: Tegner activity level scale scores before and 6 months after surgery.

Comparison of the knee extensor and flexor isokinetic results between operated and non-operated knees are shown in Tables 5 and 6, respectively. On average, the peak toque in the operated knee at angular velocity 180° was reduced by 19.8% for extensor muscles (Table 5) and by 14.5% for flexor muscles at 3 months after ACL reconstruction (Table 6).

	Peak torque (3 months, 180°) deficit, extensors	Peak torque BW (3 months, 180°) deficit, extensors	Peak torque (6 months, 60°) deficit, extensors	Peak torque BW (6 months, 60°) deficit, extensors	Peak torque (6 months, 240°) deficit, extensors	Peak torque BW (6 months, 240°) deficit, extensors
No. of Valid	63	63	65	65	65	65
No. of Missing	2	2	0	0	0	0
Mean	19.779	19.7857	15.885	15.8969	13.415	13.4231
Median	18.9	18.9	12.8	12.8	13.9	13.9
Mode	3.7a	3.80a	3.9a	3.90a	8.5a	8.50a
Std. Deviation	13.2549	13.2542	14.7727	14.77382	11.3911	11.38918
Minimum	0.3	0.3	-6.9	-6.9	-8.5	-8.5
Maximum	63.9	63.9	64.6	64.6	41.4	41.4

Table 5: The knee extensors peak-torque deficit of the operated knees according to non-operated knees.

	Peak torque (3 months, 180°) deficit, flexors	Peak torque BW (3 months, 180°) deficit, flexors	Peak torque (6 months, 60°) deficit, flexors	Peak torque BW (6 months, 60°) deficit, flexors	Peak torque (6 months, 240°) deficit, flexors	Peak torque BW (6 months, 240°) deficit, flexors
No. of Valid	63	63	65	65	65	65
No. of Missing	2	2	1	0	1	0
Mean	14.546	14.5302	12.285	12.2708	7.837	7.8246
Median	16	16	14	14	8	8
Mode	5.2a	16.00a	8.1	15.5	7.5	7.5
Std. Deviation	11.335	11.33437	12.6448	12.64816	12.7243	12.73769
Minimum	-18.4	-18.4	-15.6	-15.6	-34.4	-34.5
Maximum	38.3	38.3	40.5	40.5	47.7	47.8

Table 6: The knee flexors peak-torque deficit of the of the operated knees according to non-operated knees

At angular velocity 60°, the mean deficit of peak torque in the operated knee 6 months after ACL reconstruction was 16.9% for extensor muscles (Table 5) and 12.3% for flexor muscles (Table 6).

At 6 months after surgery, the average deficit of the peak torque in the operated knee at angular velocity 240° was 13.4% for extensor muscles (Table 5) and 7.8% for flexors muscles (Table 6).

At 6 months after surgery the results of objective stability, according to balance index (mean of average difference between operated and non-operated leg was 1.036, hop index (mean of average difference between operated and non-operated leg was 0.8540) and KT-1000 values (mean of average difference between operated and non-operated leg was 2.238), show non-significant differences between the operated and non-operated knees (Table 7).

	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean Lower Bound/Upper Bound	Mini-mum
KT-100 difference, Total	65	2.238	2.01	0.2493	1.740/2.737	-3
Hop index, Total	65	0.854	0.13021	0.01615	0.8217/0.8863	0.41
Balance index, Total	65	1.036	0.3763	0.0467	0.942/1.129	0.2

Table 7: Results of KT-1000, hop index and balance index at 6 months after surgery of operated and non-operated leg.

At six months after surgery 69.2% side to side difference in anterior translation of the tibia on the femur was less than 3 mm in most patients, 24.6% had it between 3 to 5 mm and 6.2% between 5 and 10 mm (Table 8).

	Frequency	Percent
Valid <3 mm	45	69.2
3-5 mm	16	24.6
6-10 mm	4	6.2
Total	65	100

Table 8: Results of KT-1000 at 6 months after surgery of operated and non-operated leg.

Discussion

In our study, we compared the functional outcomes of the ACL reconstructed knees with the hamstring muscle autograft, and of the non-operated knees in 65 patients. All patients were operated by the same surgeon and all participants followed the same rehabilitation protocol. Functional results of arthroscopic ACL reconstructed knees

with hamstring tendon autografts have been published in many studies [1,4,5,8-18]. They tested stability of the operated knees and performance of the patients with different tests. We selected, in our opinion, the most appropriate tests to check functional results of our patients and then compared them to the results of other studies. Results of the functional results in our study show good or excellent functional results in most of the ACL reconstructed knees with the hamstring tendon autografts. The tested rehabilitation protocol provides immediate postoperative passive and active extension of the operated knee, as well as muscle activation of the operatedon lower limb. The surgeon has overall supervision of the rehabilitation programme and the senior physiotherapist is the same for all patients. Full weight bearing prevents lower limb muscles atrophy and all patients are motivated to perform it. Patients do not use a brace during postoperative rehabilitation. With 14-day rehabilitation in the Rehabilitation Centre, a careful gradual increase of activities is possible. Patients are constantly motivated to achieve the best possible results, which are objectively tested at 6 months after surgery. When 85% of muscle strength of the opposite knee is achieved for flexor- and extensor muscles, it is believed that functional stability of the operated knee is good enough that patients can return to the pre-injury level of sports activity [1,8,12,13].

Some authors advise it at 4 and other at 6 months postoperatively [1,8,12,13]. In our study, there was non-significant difference at 6 months after surgery in the balance index, single-leg hop index and KT-1000 results of the operated and non-operated leg. At six months after surgery more than two thirds of patients had good results of the KT-1000 test. Our results show that at 6 months after surgery functional results of the operated knees are good enough to allow the patients to return to full sports activity. Tegner activity level scale7 scores showed that most participants participated in competitive or recreational sports before injury, and at six months after surgery they mostly participated in recreational sports. Probably more patients returned to pre-injury level of sports activity in the long term, so it would be advisable to repeat the Tegner activity level questionnaire later [7].

Conclusion

The study was designed to assess the functional results in case of hamstring reconstructed knees due to ACL injury at the 6 months follow up. Clinical results at 6 months after surgery showed non-significant difference between operated and non-operated knees regarding isokinetics, balance, hop index and KT-1000 values. The main reasons for the excellent functional results are probably due to qualitative operative technique and aggressive post-operative and delayed rehabilitation with no use of post-operative braces. Further studies should be done to follow the clinical results of the operated knees in the longer period too, especially with the aspect of post-surgery ability to return to recreational or professional sport activity.

Acknowledgement

I would like to thank Professor Janez Stare, PhD, Assistant Professor Matjaž Sajovic, MD, PhD, Nataša Šipka, PT, and all volunteers for all their help.

Conflict of Interest

None declared.

References

1. Sajovic M, Pavlic Zaloznik S (2014) Knee objective stability and isokinetic thigh muscle strength after anterior cruciate ligament reconstruction: A randomized six-month follow-up study. J Sports Med Doping Stud 4: 1-5.
2. Yosmaoglu HB, Baltaci G, Kaya D, Ozer H (2011) Tracking Ability. Motor, Coordination and Functional Determinants after Anterior Cruciate Ligament Reconstruction. J Sport Rehabil 20: 207-218.
3. Alonso AC, D'Andrea Greve JM, Camanho GL (2009) Evaluating the Center of Gravity of Dislocations in Soccer Players With and Without Reconstruction of the Anterior Cruciate Ligament using A Balance Platform. Clinics 64: 163-170.
4. Holsgaard-Larsen A, Jensen C, Aagaard P (2014) Subjective vs. Objective Predictors of Functional Knee Joint Performance in Anterior Cruciate Ligament-Reconstructed Patients-Do We Need Both? Knee 21: 1139-1144.
5. Almangoush A, Herrington L (2014) Functional Performance Testing and Patient Reported Outcomes following ACL Reconstruction: A Systematic Scoping Review. Int Sch Res Notices 2014: 1-14.
6. Lysholm J, Gillquist J (1982) Evaluation of Knee Ligament Surgery Results with Special Emphasis on Use of A Scoring Scale. Am J Sports Med 10: 150-154.
7. Tegner Y, Lysholm J (1985) Rating Systems in the Evaluation of Knee Ligament Injuries. Clin Orthop 198: 43-49.
8. Myer GD, Paterno MV, Ford KR, Quatman CE, Hewett TE (2006) Rehabilitation After Anterior Cruciate Ligament Reconstruction: Criteria-based Progression through the Return-to-Sport Phase. J Orthop Sports Phys Ther 36: 385-402.
9. Abrams GD, Geoffrey D, Harris JD, Gupta AK, Joshua D, et al. (2014) Functional Performance Testing After Anterior Cruciate Ligament Reconstruction: A Systematic Review. Orthop J Sports Med. 1:2325967113518305.
10. Adachi N, Ochi M, Uchio Y, Sakai Y, Kuriwaka M, et al. (2003) Harvesting Hamstring Tendons for ACL Reconstruction Influences Postoperative Hamstring Muscle Performance. Arch Orthop Trauma Surg 123: 460-465.
11. Ardern CL, Webster KE (2009) Knee Flexor Strength Recovery following Hamstring Tendon Harvest for Anterior Cruciate Ligament Reconstruction: A Systematic Review. Orthop Rev (Pavia) 1: e12.
12. Feller JA, Webster KE (2013) Return to Sport following Anterior Cruciate Ligament Reconstruction. Int Orthop 37: 285-290.
13. Hartigan EH, Zeni J, Di Stasi S, Axe MJ, Snyder-Mackler L (2012) Preoperative Predictors for Noncopers to Pass Return to Sports Criteria After ACL Reconstruction. J Appl Biomech 28: 366-373.
14. Keays SL, Bullock-Saxton JE, Keays AC, Newcombe PA, Bullock MI (2007) A 6-year Follow-up of The Effect of Graft Site on Strength, Stability, Range of motion, Function, and Joint Degeneration After Anterior Cruciate Ligament Reconstruction. Am J Sports Med 5: 729-739.
15. Kong DH, Yang SJ, Ha JK, Jang SH, Seo JG, et al. (2012) Validation of Functional Performance Tests After Anterior Cruciate Ligament Reconstruction. Knee Surg Relat Res 24: 40-45.
16. Mattacola CG, Perrin DH, Gansneder BM, Gieck JH, Saliba EN, et al. (2002) Strength, Functional Outcome, and Postural Stability After Anterior Cruciate Ligament Reconstruction. J Athl Train 37: 262-268.
17. Nakamura N, Horibe S, Sasaki S, Kitaguchi T, Tagami M, et al. (2002) Evaluation of Active Knee Flexion and Hamstring Strength After Anterior Cruciate Ligament Reconstruction using Hamstring Tendons. Arthroscopy 18: 598-602.
18. Shelbourne KD, Nitz P (1990) Accelerated rehabilitation after anterior cruciate ligament reconstruction. Am J Sports Med 18: 292-299.