Publisher
MEDRESEARCH
www.medresearch.in

Surgical Review: International Journal of Surgery, Trauma and Orthopedics

2020 Volume 6 Number 3 May-June

E-ISSN:2455-5436
P-ISSN:2456-9518
RNI:MPENG/2017/70870

Research Article

Arthroscopic

Comparative analysis of arthroscopic ACL reconstruction between bone-patellar tendon graft and hamstring tendon graft

Samaiya S.[1], Moda M.[2*]

DOI: https://doi.org/10.17511/ijoso.2020.i03.01

[1] Sachin Samaiya, Associate Professor, RKDF Medical College and Research Center, Bhopal, Madhya Pradesh, India.

[2*] Manav Moda, Associate Professor, World College of Medical Sciences and Research Center, Jhajjar, Haryana, India.

Aim: The purpose of this study was to present the outcome of the results of the anterior cruciate ligament reconstruction with bone-patellar tendon-bone graft and the hamstring tendon graft and their comparative analysis. **Material and Method**: The basic population for the study consisted of the 35 patients who were operated upon (ACL reconstruction) during the period from August 2014to July 2018 and followed for ten months in two tertiary care institutes. The groups were analyzed with respect to the age, gender, duration between injury and surgery, side of the limb involved, and post-operative complications. **Result**: 16 patients were present in each group and a total o 32 patients were studied. 26 patients were male and 6 were female. The mean duration of follow-up was 10.1 months for the hamstring group and it was 10.3 months for the patellar tendon group. The primary mechanism of injury of ACL was sports activity in 22 (68.5%) in total and it was 10 patients (62.4%) in patellar tendon group and 12 patients (75%) in hamstring tendon group Medial meniscus was injured in 7 (41.8%) patients in patellar tendon group and 5 (31.3%) patients in hamstring tendon group. Final results were evaluated using Lysholm's score and IKDC score. **Conclusion**: There was a significant improvement in the stability of the knee postoperatively in both the groups but there was no significant difference in the functional outcome between patellar tendon and hamstring tendon groups.

Keywords: Anterior cruciate ligament, Bone graft, Intra-articular autografts

Corresponding Author

Manav Moda, Associate Professor, World College of Medical Sciences and Research Center, Jhajjar, Haryana, India.
Email: drmanavmoda@gmail.com

How to Cite this Article

Samaiya S, Moda M. Comparative analysis of arthroscopic ACL reconstruction between bone-patellar tendon graft and hamstring tendon graft. Surgical Review Int J Surg Trauma Orthoped. 2020;6(3):139-146.
Available From
https://surgical.medresearch.in/index.php/ijoso/article/view/185

To Browse

Introduction

The logical aims of the treatment of a torn anterior cruciate ligament are to obtain a painless knee joint with a full range of motion and strength. Conservative treatment of torn ACL often fails to lead to chronic instability, muscle weakness, and post-traumatic osteoarthritis [1,2]. The primary suture of a torn anterior cruciate ligament usually leads to late instability too [3]. The knee joint becomes very unstable when ACL is torn

Manuscript Received	Review Round 1	Review Round 2	Review Round 3	Accepted
18-05-2020	29-05-2020	04-06-2020		08-06-2020

Conflict of Interest	Funding	Ethical Approval	Plagiarism X-checker	Note
No	Nil	Yes	15%	

Because ACL is the crucial ligament in stabilizing the knee joint [4]. Therefore reconstruction of the torn anterior cruciate ligament with intra-articular autograft has become the most common method in ACL reconstruction [5]. The purpose of this study is to assess the outcome of arthroscopic assisted anterior cruciate ligament reconstruction and to compare the results of bone-patellar tendon-bone graft and STG graft.

Materials and Method

This is the prospective study which consisted of the 35 patient who was operated upon (ACL reconstruction) during the period from August 2014 to July 2018 and followed for ten months in two tertiary care institutes. All patient selected for the study were sampled by systemic random sampling method

Inclusion criteria- All patients with clinical and radiological evidence of anterior cruciate ligament injury.

Exclusion criteria- Pre-existing knee joint osteoarthritis.

The patients were divided into two groups -the patellar tendon group and the hamstring tendon group. The patients were alternated between the groups. Lysholm and Gilquist scoring system and IKDC scores were used to assess the outcome. Institutional Ethical permission was taken before the study. Statistical analysis was done by chi-square test, t-test, Mann Whitney test, and Wilcoxson Signed rank test

Surgical technique

Patient positioning and surgical preparation: The procedure is accomplished under suitable anesthesia most of the time under spinal anaesthesia. The normal knee and the injured knee are examined objectively to determine the amount of anterior tibial displacement and to check other injuries A well-padded tourniquet is applied on the proximal part of the thigh as high as possible. The patient is placed in a supine position with an abduction post at the thigh level. Scrubbing with savlon and betadine is done. Sterile draping is done taking all aseptic precautions. An intravenous antibiotic is given pre-operatively. Exsanguination is done with autoclaved eshmarch bandage. A tourniquet is inflated.

Diagnostic arthroscopy: Diagnostic arthroscopy is done to evaluate the knee joint for associated lesions, confirmation of the ACL tear, and to diagnose other lesions and to prepare for graft.

Standard anterolateral and anteromedial portal is used. The longitudinal anterolateral portal is created lcm above the joint line immediately adjacent to the patellar tendon and the anteromedial portal is created at the same level above the joint line, 5-8 mm medial to the patellar tendon. The knee is examined with scope and injury to ACL and other structures like menisci are confirmed and recorded. If necessary, the ligamentous mucosum and fat pad are excised to facilitate viewing the intercondylar notch. The ACL stump is debrided partially, leaving a substantial portion to guide tibial placement. The intercondylar notch is evaluated, notchplasty is performed, if needed, with its extent determined by the individual anatomy. Notchplasty allows improved identification of the femoral attachment of the native ACL and helps prevent graft impingement after reconstruction. The distal outlet of the notch is best visualized from 450-600 of knee flexion, and the proximal outlet at 900 of knee flexion.

Patellar Tendon Graft Harvest: Knee is held in 900 of flexion. A midline incision made on the patellar tendon extending from the inferior pole of the patella to just below the joint line. The paratendon is incised. With soft tissue retracted, the width of the patellar tendon is measured, and up to 10mm of the tendon is selected for harvest. Two longitudinal parallel incisions are made in mid substance of the patellar tendon, extending from the inferior pole of the patella to the surface of the anterior tibial tuberosity. The patellar bone block is marked with a scalpel. The bone block length is approximately 25mm which provides adequate potential for healing in the bony tunnel and yet produces minimal morbidity at the donor site. Care is taken not to over-penetrate the patella to prevent the creation of stress riser that may cause a patellar fracture later. The bone blocks are harvested with the help of osteotome. Two drill holes are placed in each graft bone fragment with a 2mm drill bit. Medial and lateral cuts are made both in patellar and tibial bone blocks. Cross-cutting the bone blocks proximally in the patella and distally in the tibia completes the cuts.

Graft preparation: The diameter of the bone plugs is trimmed to the approximate width of 9-10mm and diameters are checked by passing the graft through a tunnel template of the correct size. Two drill holes are made in the bone plugs followed by the passage of no 5 non-absorbable sutures through these holes. The sutures help in graft passage and graft tensioning. Finally, total length of the graft is measured.

Semitendinosus and gracilis graft harvest:

Again knee is placed in 900 of flexion. A 4-5cm longitudinal skin incision is made over pes tendons, beginning 2-3cm distal to the joint line and 1-2cm medial to the tibial tuberosity. The sartorius aponeurosis is identified and is in line with its fibers distal to the underlying ST tendon. The ST is inserted into the upper part of the medial surface the tibia behind the sartorius and the gracilis. Using digital palpation, the ST is isolated where it naturally separates from the gracilis tendon, approximately 5-8cm proximal to their tibial insertions. Both the tendons are identified. A curved artery forceps or clamp is placed around the ST tendon for positive identification. While carefully avoiding injury to the underlying superficial medial collateral ligament, sharp division of ST [with periosteum at the tibial insertion site] with a scalpel, providing 1-2cm of tendon length. Running whipstitch is placed at the distal end of the tendon to control the free end. While traction is applied to the free end of the tendon using the whipstitch, the deep fascial bands to the medial gastrocnemius fascia can be identified and released with scissors. Premature amputation of the semitendinosus may occur without the release of these fascial attachments. With the knee flexed to 70-800, gentle traction is maintained on the distal tendon while a closed-end tendon stripper is advanced proximally in line with the tendon. Commonly, the graft will have a length of 24-40cm. While graft is transferred to the back table for preparations; inspection of the distal insertion of the superficial medial collateral ligament is done. If there is no injury to the MCL that requires surgical attention, the sartorius aponeurosis is then reapproximated with 2-0 vicryl suture. Similarly, the gracilis tendon is harvested.

Semitendinosus and gracilis graft preparation: The graft is prepared on the back table by the surgeon or an assistant. After harvest, the graft is kept moist at all times with a wet sponge to prevent tissue desiccation. Any muscle tissue remaining on the graft is removed with a cob periosteal elevator or metal ruler edge. The proximal end of the graft is thin and may be tabularized with a running baseball stitch using ethibond® No-5. Overall tendon length is measured, and a final quadrupled graft is calculated one-quarter of the overall length. The required minimum graft length is about 22cm because a minimum of 15mm of quadrupled graft is needed within bone the tibial and femoral tunnel. The semitendinosus tendon is sharply divided in half on the preparation board to create two equal length grafts. The free ends are applied sutures. The graft is doubled over and secured with vicryl to produce A quadrupled construct. Then the graft is sized. The graft is kept moist in a wet sponge.

Tunnel preparation

Femoral tunnel hole placement: The femoral tunnel is to be made at the isometric point. For making the femoral tunnel an additional entry portal is made around 1 cm away from the medial margin of the patellar tendon. A proper offset is chosen and passed inside the joint in the hyperflexed position of the knee. The guide pin is placed in the 1 0'clock position for left knee and 110'clock position for right knee and is placed 6-7mm anterior to the "over-the-top" position. The pin exits the femur and the skin through a small stab wound on the lateral aspect of the distal thigh, where it is grasped with a kocker's clamp to prevent migration. First, the femoral tunnel is drilled with a 4mm drill bit and lateral cortex perforated. Subsequently, the femoral tunnel is reamed with a suitable reamer size. The length of the femoral tunnel is defined by the size of the bone plug of the graft.

Tibial tunnel hole placement: The tibial tunnel is prepared. The pretibial periosteum is incised longitudinally, beginning at the superior margin of the sartorius insertion and the medial margin of the patellar tendon. This incision is taken 2-3 cm proximal toward the joint line. The limited subperiosteal elevation is performed with a cobb/periosteum elevator. In the case of the hamstring tendon graft, the donor site incision is used for tibial tunnel placement. The tibial drill guide is set at 550. The starting point for the guide pin on the proximal tibia approximately one finger breadths medial to the tibial tubercle and two fingerbreadths distal to the medial joint line. The desired point of pin placement on the tibia is continuous with a line marking the posterior edge of the lateral meniscus as its inner curve is projected centrally to intersect with the center of the medial intercondylar eminence. The pin should pass very close to the PCL (7mm) and should be inclined so that, when it is advanced it contacts the lateral condyle very close to the isometric point on the femur. Tibial drill guide at 550 -600 to the tibial plateau obtains sufficient tunnel length and an angle that allows the graft angle to approximately that of the original. The knee is moved through a range of motion to make sure that the guide pin does not impinge the PCL. Once the tibial pin is placed, the tibial tunnel is made with a suitable cannulated reamer.

Graft Passage: A beath needle with a double looped passing sutureis passed through the femoral tunnel while maintaining the knee in a 70-80 0

Flexed position. The tip of the needle is pushed through the soft tissue and exits the skin on the anterolateral aspect of the distal thigh. The paaser suture is pulled out through the tibial tunnel with the help of a probe. The graft suture is then looped across the passer suture and graft is pulled from the tibial tunnel into the joint and in the femoral tunnel. The graft is inserted so that the cancellous bone of the femoral plug is facing supero-laterally in the femoral tunnel. The graft is passed under the arthroscopic vision and it is verified that the tibial bone plug does not enter into the joint. Same procedure is followed for the STG graft. Assessment of graft clearance is performed both at 30o of flexion and in full knee extension.

Graft fixation: A screw guide wire is passed through the anteromedial portal and an interference screw is passed over it. Once the femoral plug is stabilized, the range of motion of the knee with arthroscopic visualization confirms that no impingement occurs. The knee is moved cyclically 20-25 times from full flexion to full extension; then the second interference screw is placed over a screw guide pin in the tibia to fix the tibial bone plug. In the patellar tendon group, metallic interference screws were used and in hamstring tendon group bioabsorbable interference screws used. The additional fixation with a non-absorbable suture of graft over a screw with washer put I tibia was done for hamstring tendon group. The wound is closed in layers, sterile dressing applied, compression bandage gave and the operated leg is kept in a long knee brace. The patient is shifted to the recoveryroom for observation for some time and shifted towards. Post-operatively patient is given analgesics as per pain tolerance, and intravenous cephalosporin (monocef) and an aminoglycoside (gentamycin) are given. The leg is kept on a pillow, the patient is encouraged to do toe and ankle movements, as soon as the effect of anesthesia is over. The patient is encouraged to move in bed after 4-6 hours. The dressing is changed at 72 hours and the patient is discharged and followed in OPD and advised to attend the physiotherapy sessions for post-operative rehabilitation. A definite protocol was used for the rehabilitation of patients.

Results

(Table 1) 16 patients were in each group and a total of 32 patients. 26 patients were male and 6 were female. The mean duration of follow-up was 10.1 months for the hamstring group and it was 10.3 months for the patellar tendon group.

Table-1: Age distribution in both groups.

S. No	Description	Patellar tendon group	Hamstring tendon group
1	Age at the time of reconstruction	Mean 25 years (19-38 years)	Mean 26.1 (19-46 years)
2	The delay between injury and reconstruction	Mean 16.9 2-48 months	Mean 16.7 2-96 months
3	Follow up after surgery	Mean l0.3 months	Mean 10.1 months

Table-2: Gender distribution in both groups.

Gender	Patellar tendon group	Hamstring tendon group
Male	13	13
Female	3	3

Table-3: Distribution according to the duration between injury and reconstruction of ACL.

Duration	Number of patients in the hamstring group	Number of patients in the patellar tendon group
< 3 weeks	0	0
4-8 weeks	1	1
9-12 weeks	1	1
13-52 weeks	8	9
1 year-4year	5	5
>4years	1	1

Table 4: Side involved in an ACL tear.

Side	Patellar tendon group	Hamstring tendon group
Right	11	7
Left	5	9

All patients had a single knee injury. 18 patients had a right knee injury and 14 had left knee injury

Table-5: Mechanism of injury.

No	Mechanism of injury	Patellar tendon Group	Hamstring tendon group
1	Sports		
	a) soccer	6	5
	b) cricket	1	1
	c) kabbadi	2	1
	d) Lawn tennis	---	2
	e) hand ball	1	---
	f) Weight Lifting	1	1
	g) Basket ball	1	---
2	Road traffic accident	3	3
3	Domestic incident	1	3

The primary mechanism of injury of ACL was sports activity in 22 (68.5%) in total and it was 10 patients

(62.4%) in the patellar tendon group and 12 patients (75%) in hamstring tendon group. Soccer was the most common sport in both the group and road traffic accident was next in frequency. There was a highly significant difference in the mechanism of injury (P= 0.05) sports taking the lead.

Table-6: Associated injury with an ACL tear.

No	Structure involved	Patellar tendon group	Hamstring tendon group
1	Medial meniscus	7	5
2	Lateral Meniscus	2	2
3	Both Menisci	0	2
4	Medial Collateral Ligament	1	0
5	Lateral Collateral Ligament	0	0

The medial meniscus was injured in 7 (41.8%) patients in the patellar tendon group and 5 (31.3%) patients in the hamstring tendon group. The lateral meniscus was injured in 2 (12.5%) patients in the patellar tendon group and 2 (12.5%) patients in the hamstring tendon group. 2 patients (12.5%) in the hamstring tendon group had both menisci injury. The medial collateral ligament was injured (grade 1) in 1 patient (63%) in the patellar tendon group. Meniscal injury showa significant difference in distribution with medial meniscus being more commonly involved ($p < 0.05$).

Table-7: Final evaluation of the functional result of ACL reconstruction in both groups (Lysholm and Gillquist score).

Result	Patellar tendon group	Hamstring tendon group
Excellent	4	2
Good	10	13
Fair	1	1
Poor	1	0

Table-8: Final evaluation of the functional result of ACL reconstruction in both groups(IKDC SCORE).

Result	Patellar tendon group	Hamstring tendon group
Normal	9	10
Near normal	6	6
Abnormal	1	0
Severely abnormal	0	0

Final results were evaluated using IKDC and Lysholm's score.

Discussion

Having to make the decision as to which graft to use Routinely, the literature showed that ultimate tensile strength of the central third of patellar tendon and of the hamstring tendon graft tendon was comparable with each other and with normal ACL, although the patellar tendon stiffness was higher than both hamstring tendon and ACL [6]. Fixation of the soft tissue to bone was known to be a weak feature of the hamstring tendon graft while bone to bone fixation of patellar tendon failed at higher tensile force Kurosaka et al [7]. Literature also shows satisfactory results after ACL reconstruction with patellar tendon or with hamstring tendon graft Lipscomb et al [8]. This study though had a limited number of patients in each group was free from surgeons' bias. Soccer was the most often responsible for the rupture of ACL amongst the sports group, which constituted the single largest etiological group. This is in accordance with many authors like Noyes et-al, who have found that ACL tear was most frequent in young athletes. Regarding the indication of ACL reconstruction, age has been one of the controversies. This study shows that age does not affect the post-operative results in terms of the functional index and objective scaling. Patients in their 30s and 40s can undergo ACL reconstruction without developing any restriction of mobility. The evaluation was performed with Lysholm and Gilliquist [9] score which is designed especially for evaluation for injuries involving knee ligament. This score gives an accurate indication of function, which is a number of points assigned to the category of instability or giving way. The mean score for our patients increased from 54.6 to 90.1 and from 55.3 to 89.2 in patellar and hamstring tendon group respectively. This finding indicates the nearly normal function of the knee and compares favorably with mean scores of 92 points for patients treated for ACL tear by Anderson C. and Gilliquist J et al [10]. The Lachman test has proved to be the most accurate test for the assessment of the laxity of the anterior cruciate ligament. At the time of follow up, 12 patients (75%) were Lachman negative, and 3 (18%) patients were grade I and 1 patient was grade 2 in the patellar group, 13 patients (82%) were Lachman negative, and 3(18%) patients were grade 1 in hamstring group. These results compare favorably with the findings in younger patients in which 88% of sixty-eight knees had a postoperative value of 1+ or less on the Lachman test (Buss DD et al) [11]. So it is inferred that this stability contributed to the overall success of the reconstruction. The present study demonstrates that ACL reconstruction with aggressive rehabilitation can yield reliable stability

Results. This study confirms the study of O'Brien et-al [12] and Bach et-al [13]. 2 patients had a loss of extension of 50 in the patellar tendon group. None had a loss of extension of more than 80 in this group. Only 1 patient in the hamstring group had a loss of extension of 50. Similar results were reported by Buss et al. after the reconstruction of the ACL in young patients. The potential for arthrofibrosis defined by many as 100 loss of motion in the involved knee post-operatively [14] is a real concern for a patient of ACL reconstruction. This finding was not noted in any of our patients of either group at the time of follow up evaluation. Giving way has been reported previously in the association of lower knee rating scores [14]. Our patient, but for one in the patellar tendon group, reported no giving way post-operatively. Other authors have reported rates of one of the sixty-eight young athletic patients who had reconstruction of ACL [14]. Postoperatively most of the patients in both the group were able to resume their preoperative activity. None of the patients in either group sustained reinjury. Analysis of the knees for which both preoperative and postoperative radiographs showed no postoperative increase in findings that are associated with the insufficiency of the ACL. However, these findings may differ after a longer follow up. On subjective assessment 14 (88%) patients considered their knee normal, and 1 (7%) patients considered their knee near normal and 1 (7%) patient considered his knee abnormal in patellar tendon group and14 (88%) patients considered their knee normal, and 2 (12%) patients considered their knee near normal in hamstring tendon group. None had abnormal knee. On assessing the patients on IKDC score postoperatively 9 (56.25%) patients had grade A 6 (38%) had grade B and 1(6.25%) had grade C in the patellar tendon group. In hamstring tendon group 10 (62%) patients had grade A and 6 patients (32%) had grade B. On objective evaluation by Lysholm's score 4 (25%) patients and 10 (62%) patients in patellar tendon group had excellent and good results respectively whereas in hamstring tendon group the figure was 2 (13%) patients had excellent results and 13 (81%) patients had good results. The majority of patients in both the groups had returned to their unaided work over a periodof 6-12 months which is in accordance with many studies [15]. The optimal time for the early phase ACL reconstruction has been a somewhat controversial issue. Some studies have suggested that the procedure should not be done during the first week after the injury because of an increased Arthrofibrosis [14] while other studies have found no difference in obtaining a full range of the knee after early ACL reconstruction [16,17]. This study demonstrated that central third patellar tendon autograft as well as quadrupled hamstring tendon graft is effective for reconstruction of an acutely ruptured as well as chronically insufficient ACL. However, the patients with early reconstruction were more satisfied with their knees than patients with late reconstruction. Also, the former patients have less pain and functional limitation and could return to more strenuous athletic activities than those with late reconstruction.The above-noted findings thus support the concept that the ACL reconstruction needs to be done before degenerative changes of the knee develop and this may be the best concern athletically active persons. In fact, the concept of reconstruction in the acute phase has become popular in some centers in central Europe, with good results. One of the major problems with the patellar tendon autograft procedure is the post-operative anterior knee pain [14,18]. In this study, only 2 patients had anterior knee pain in the patellar tendongroupand none had in the hamstring tendon group at the follow-up. Shelburne and Trumper [19] suggested that the extension deficit of the knee is the main reason for the anterior knee pain and thus recommended that immediately after surgery full extension should be allowed. Many previous studies have shown that an ACL reconstructed knee with patellar tendon autograft often has an extension torque deficit Muneta et al [20], and therefore, great emphasis has been paid to find out the most efficient methods of strengthening the muscle without damaging the reconstructed graft. With hamstring graft strength deficit seems to be less. However the muscle strength during flexion is composite of the coordinated movement of various muscles, including biceps muscle of the thigh, the semimembranosus muscle, the semitendinosus, and the gracilis, and accordingly, it is difficult to analyze the properties of the individual flexor muscles. Kartus et a1 [21] reported recently in their study of 604 patients with 2-5 years of follow up with another study of cadaveric knee dissection and MRI study that main reason of anterior la-lee pain is damage to an infrapatellar nerve in the graft harvesting. They concluded that the subcutaneous graft harvesting technique produced significantly less disturbance in anterior knee sensitivity and a significantly smaller residual donor site gap, as compared with the traditional technique. In the literature, several authors have reported patellofemoral problems,

Such as crepitation, pain, and limitation in the range of motion of the knee, after an ACL reconstruction Agliette et al [22] Rosenberg reported that half of their patients had abnormal patellar signs in the radiographic evaluation and that the effect of the procedure on the extensor mechanism of the knee was also significant. However, their study had only ten patients. In the present study, one patient in the patellar tendon group had mild degenerative changes in the patellofemoral joint, and the correlation to the patellofemoral crepitation was not significant. 1 patient in the hamstring group had pre-existing mild degenerative change but their changes didn't progress. Lysholm score was lower in patients with patellofemoral OA than patients without such changes. Patients without the patellofemoral OA were subjectively satisfied than patients with patellofemoral OA. Most of the patients in our series were satisfied with their knee. It was somewhat surprising that patients who had undergone partial meniscectomy had no major difference at the follow-up. Schimmer et al found in their 12 years follow-up study of partial meniscectomy, comparing the result with their earlier 4-year follow-up study, the factor with the highest impact on long term results was damage to the articular cartilage. This damage did not influence knee function for several years, but became increasingly symptomatic over time, after 5 years or more. The arthroscopic ACL reconstruction is a well-established procedure. The study confirms the validity of the procedure and also states that irrespective of the type of autograft STG or BPTB the outcome of a properly done procedure remains satisfactory. In the present study all patients were satisfied however The major limitation of the study was a small sample size and a short follow up. An instrument measurement like KT arthrometer to document tibial translation can also be used in these patients. A longer follow up is desirable to assess the behavior of the graft in the long term and its effect on the final outcome of the ACL reconstruction.

Conclusion

This studied showed that an arthroscopic ACL reconstruction by patellar tendon graft or hamstring tendon graft significantly increases the stability of the knee. It gives good ligamentous knee stability and function.

What does the study add to the existing knowledge?

There was a significant improvement in the stability of the knee postoperatively in both the groups but there was no significant difference in the functional outcome between patellar tendon and hamstring tendon groups

Author's Contribution

Dr. Sachin Samaiya: Operating the cases, manuscript preparation **Dr. Manav Moda:** Operating the cases, review of the literature and statistical analysis of the study

Reference

01. Kannus P, Järvinen MA. Conservatively treated tears of the anterior cruciate ligament, Long-term results. J Bone Joint Surg. 1987;69(7)1007-1012.
[Crossref]

02. Odensten MA, Hamberg P, Nordin MA, Lysholm JA, Gillquist J. Surgical or conservative treatment of the acutely torn anterior cruciate ligament- a randomized study with a short-term follow-upobservations. Clin Orthop Relat Res. 1985;198;87-93.
[Crossref]

03. Hughston JC. The importance of the posterior oblique ligament in repairs of acute tears of the medial ligaments in knees with and without an associated rupture of the anterior cruciate ligament; Results of long-term follow-up. J Bone Joint Surg. 1994;76(9)1328-1344.
doi:[Article:https://doi.org/10.2106/00004623-199409000-00008][Crossref]

04. Kurosaka M, Yoshiya S, Andrish JT. A biomechanical comparison of different surgical techniques of graft fixation in anterior cruciate ligament reconstruction. Am J Sports Med. 1987;15(3)225-229.
doi:[Article:https://doi.org/10.1177/03635465870151500306][Crossref]

05. Kartus J, Magnusson L, Stener S, Brandsson S, Eriksson BI, Karlsson J. Complications following arthroscopic anterior cruciate ligament reconstruction A 2–5-year follow-up of 604 patients with special emphasis on anterior knee pain. Knee Surg Sports Traumatol Arthrosc. 1999;7(1)2-8.
doi:[Article:https://doi.org/10.1007/s001670050112][Crossref]

06. Dickison and Bennet. Therapeutic exercises. Clin Sports Med. 1985;4(3)417-429.
[Crossref]

07. Noyes FR, Butler DL, Grood ES, Zernicke RF, Hefzy MS. Biomechanical analysis of human ligament grafts used in knee-ligament. J Bone Joint Surg. 1984;66(3)344-352.
[Crossref]

08. Brant Lipscomb A, Johnston RK, Snyder RB. The technique of cruciate ligament reconstruction. Am J Sports Med. 1981;9(2)77-81.
doi:[Article:https://doi.org/10.1177/03635465810 0900201][Crossref]

09. Shelboume KD, Wilckens JH, Decarlo M. Arthrofibrosis in acute anterior cruciate ligament reconstruction- The effect of timing of reconstruction. Am J Sports Med. 1991;19(4)332-336.
doi:[Article:https://doi.org/10.1177/03635465910 1900402][Crossref]

10. Anderson C, Ondenstein M, Good L Gillquist. Surgical or non-surgical treatment of acute rupture of the anterior cruciate ligament- A randomized study with long-term follow-up. J Bone Joint Surg Am. 1989;71(7)965-974.
[Crossref]

11. Buss DD, Min R, Skyhar M, Galinat B, Warren RF, Wickiewicz TL. Nonoperative treatment of acute anterior cruciate ligament injuries in a selected group of patients. Am J Sports Med. 1995;23(2)160-165.
doi:[Article:https://doi.org/10.1177/036354659502 300206][Crossref]

12. O'brien SJ, Warren RF, Pavlov H, Panariello R, Wickiewicz TL. Reconstruction of the chronically insufficient anterior cruciate ligament with the central third of the patellar ligament. J Bone Joint Surg. 1991;73(2)278-286.
[Crossref]

13. Bach BR, Tradonsky S, Bojchuk J, Levy ME, Bush-Joseph CA, Khan NH. Arthroscopically assisted anterior cruciate ligament reconstruction using patellar tendon autograft. Am J Sports Med. 1998;26(1)20-29.
doi:[Article:https://doi.org/10.1177/0363546598026 0012101][Crossref]

14. Shelbourne KD, Trumper RV. Preventing Anterior knee pain after anterior cruciate reconstruction. Am J Sports Med. 1997;25(1)41-47.
doi:[Article:https://doi.org/10.1177/03635465970 2500108][Crossref]

15. Lysholm J, Gillquist J. Evaluation of knee ligament surgery results with special emphasis on use of a scoring scale. Am J Sports Med. 1982;10(3)150-154.
doi:[Article:https://doi.org/10.1177/03635465820 1000306][Crossref]

16. Fu FH, Bennett CH, Ma CB, Menetrey J, Lattermann C. Current trends in anterior cruciate ligament reconstruction- Part II, Operative procedures and clinical correlations. Am J Sports Med. 2000;28(1)124-130.
doi:[Article:https://doi.org/10.1177/0363546500028 0010801][Crossref]

17. Major RA, Woodfin B. achieving full range of motion after ACL reconstruction. Am J Sports Med. 1996;24(3)350-355.
doi:[Article:https://doi.org/10.1177/03635465960 2400317][Crossref]

18. Noyes FR, Barber-Westin SD. Anterior cruciate ligament reconstruction with autogenous patellar tendon graft in patients with articular cartilage damage. Am J Sports Med. 1997;25(5)626-634.
doi:[Article:https://doi.org/10.1177/03635465970 2500507][Crossref]

19. Rosenberg TD, Franklin JL, Baldwin GN, Nelson KA. Extensor mechanism function after patellar tendon graft harvest for anterior cruciate reconstruction. Am J Sports Med. 1992;20(5)519-525.
doi:[Article:https://doi.org/10.1177/036354659202 000506][Crossref]

20. Muneta T, Seklya I, Ogiuchi T, Yagishita K, Yamamoto H, Shinomiya K. Objective factors affecting overall subjective evaluation of recovery after anterior cruciate ligament reconstruction. Scand J Med Sci Sports. 1998;8(5)283-289.
[Crossref]

21. Aglietti P, Buzzi R, Zaccherotti G, De Biase P. Patellar tendon versus doubled semitendinosus and gracilis tendons for anterior cruciate ligament reconstruction. Am J Sports Med. 1994;22(2)211-218.
doi:[Article:https://doi.org/10.1177/036354659402 200210][Crossref]

22. Johnson RJ, Beynnon BD, Nichols CE, Renstrom PA. The treatment of injuries of the anterior cruciate ligament. J Bone Joint Surg. 1992;74(1)140-151.
[Crossref]