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Original Research Article

Functional outcome of anterior cruciate ligament reconstruction with quadruple hamstring tendon graft using EndoButton and bioabsorbable interference screw: minimum 2-year follow-up

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ABSTRACT

Background: Anterior cruciate ligament (ACL) is the most common ligament to be torn in the knee joint and ACL reconstruction (ACLR) is one of the most commonly performed surgery in orthopaedics nowadays. This study evaluated short term results of anterior cruciate ligament reconstruction with quadruple hamstring tendon (QHT) graft using EndoButton for femoral fixation and Bio absorbable interference screw for tibial fixation.
Methods: Out of the 68 patients who underwent single-bundle ACLR with QHT graft using EndoButton for femoral fixation and Bio absorbable interference screw for tibial fixation, 60 patients were followed up for a minimum period of 2 years. Patients were followed up at regular intervals and evaluation was done using the anterior drawer test, Lachman test, pivot-shift test, modified Cincinnati rating system and Tegner-Lysholm knee scoring scale.
Results: There was improvement in the Lachman test and pivot-shift test at 2 year follow-up, from grade 2 (n=47) or grade 3 (n=6) to grade 1 (n=17) or grade 0 (n=42) and from grade 1 (n=38) or grade 2 (n=12) to grade 1 (n=14) or 0 (n=45), respectively. The mean Modified Cincinnati score and Tegner-Lysholm knee score improved from 59.57 to 99.03 and 64.45 to 98.87 respectively at 2 year follow-up. Complications occurred in 3 patients, a re-rupture due to trauma at 1 year after surgery, development of a cyclops lesion with restricted range of motion and a superficial infection at the graft harvest site.
Conclusions: The two year follow-up results of ACLR with QHT graft using EndoButton for femoral fixation and bioabsorbable interference screw for tibial fixation are satisfactory and comparable with other modalities of graft fixation.

Keywords: Anterior cruciate ligament, EndoButton, Quadruple hamstring tendon graft, ACL reconstruction

INTRODUCTION

Anterior cruciate ligament (ACL) is the most common ligament to be replaced in the knee joint and ACL reconstruction (ACLR) is one of the most commonly performed surgery in orthopaedics nowadays.[1] Adequate fixation has been considered essential for good outcomes of ACLR.

With the increased interest in hamstring tendons, largely due to the development of new fixation methods, there have been a number of randomised controlled trials (RCTs) comparing patellar tendon and hamstring tendon grafts.[2-4] Both grafts have shown similar functional outcomes. Hamstring tendon grafts have been associated with less graft morbidity compared to bone-patella-bone-tendon (BPTB) grafts, particularly in terms of anterior knee pain, specifically on kneeling. Studies suggest BPTB grafts integrate early than hamstring grafts and have a slightly lesser anterior knee laxity as measured by arthrometer; but long term functional outcomes do not show much of a variation.[5-9]

In this study, we analyzed the mid-term functional results of ACLR with quadruple hamstring tendon (QHT) graft using EndoButton (Smith and Nephew) for femoral fixation and bio-absorbable interference screw (BIORCI,Smith and Nephew) for tibial fixation using modified Cincinnati rating system and Tegner-Lysholm knee scoring scale.[10,11]

METHODS

From November 2010 and July 2013, 68 patients with complaints of knee instability due to an ACL deficiency confirmed clinically by performing Lachman test, pivot shift test and an MRI, underwent ACLR using QHT graft fixed with EndoButton on the femoral side and bioabsorbable interference screw. Informed consent was obtained from all participants.

Inclusion criteria included skeletally mature patient with unilateral ACL tear, no previous surgery on the affected knee, no degenerative changes on radiographs or arthroscopy, less than 1 year since injury, no other associated ligament injury, and no morbid obesity. Exclusion criteria included patients with associated injuries to the knee such as medial collateral ligament tear, lateral collateral ligament tear, posterior cruciate ligament tear and injuries to any other joints in the lower limb that may hamper the post-operative rehabilitation program.

All the cases were operated by the same surgical team to reduce the variations that may arise due to the surgical procedure and further alter the functional outcome of the study. All patients were operated under spinal anaesthesia in supine position. Tourniquet was used routinely. On arthroscopic confirmation of ACL tear, the graft was than harvested. Any meniscal tears requiring balancing, partial meniscectomy was done during diagnostic arthroscopy. Both the gracilis and semitendinousus tendons were harvested using a 2 cm incision made antero-medially on the proximal tibia starting approximately 4 cm distal to the joint line and 3 cm medial to the tibial tuberosity midway between the anterior and posterior cortex. We use two different coloured suture materials to suture the tendons, so as to identify each tendon separately during graft tensioning. We routinely use ethibond (dyed green) and vicryl (blue) for two tendons. After suturing the two tendons are folded into four to make it a quadruple graft as shown in Figure 1.

We do not suture the tendons together as we feel that keeping the tendons separately may mimic double bundles of the original ACL. The torn ACL remnants at the tibial footprint were retained as much as possible so as to help in graft integration (biological fixation). Some studies also suggest retaining the stump remnants which contain proprioceptors that may help in better proprioception of the knee.[12] After the procedure, periosteal flap and the Sartorius fascia were sutured back over the tunnel to cover the cannulated screw. No patient was treated with selective reconstruction of only one of the ACL bundles. The tibial tunnel was created with the knee in 90° flexion using a 55° tibial guide (Stryker). The tunnel diameter was determined by the size of the QHT graft that was prepared.

Figure 1: Showing the prepared QHT graft with EndoButton after harvesting semitendinosus and gracilis tendons.

The femoral tunnel was prepared using a femoral aimer of the appropriate size, the size of which was determined by the graft size. A beath needle was inserted through the femoral aimer with the knee being flexed to 120° - 130°, and finally, the guide wire was advanced until it passed through the lateral cortex of the femur. 2 mm of posterior cortex was preserved in all cases. The femoral tunnel was then drilled. After measuring the length of the femoral tunnel, the appropriate depth was drilled. The prepared graft with the EndoButton was then passed from the tibial tunnel to the femoral tunnel using no.5 polyester suture material. The graft was marked so that the surgeon knew when to flip the EndoButton. Femoral fixation was performed with 15 mm continuous loop EndoButton (Smith and Nephew) in all cases. Tibial fixation was achieved with a bioabsorbable interference screw (BIORCI, Smith and Nephew) with a diameter 2 mm more than the tunnel diameter. In two cases, we could not feel the EndoButton toggle after the flip. The position of the EndoButton on the lateral cortex of the lateral femoral condyle was confirmed using C-arm fluoroscopy.

All patients subsequently underwent the same accelerated postoperative rehabilitation program called SERP (simple and effective rehabilitation program) formulated by us at our department of arthroscopy and sports medicine.[13]

Statistical analysis was performed with the SPSS version 13.0 software for Windows and $p < 0.05$ was chosen to indicate statistical significance.

RESULTS

Of the 68 patients, 8 patients were lost to follow-up. Rest 60 patients were followed up for a minimum period of 2

years. Out of these 60 patients, 51 were male and 9 were female, with surgery performed on 38 right knees and 22 left knees. The mean age of the patients was 31.73 years with a range from 18-55 years. Majority of patients (n=33) were between 20-29 years age group. Most common mechanism of injury was road traffic accident in 44 patients (73.33%), followed by sports related injuries in 11 patients (18.33%) and fall from height in 5 patients (8.33%). The average time between injury and surgery was 4.3 months. The mean duration of hospital stay in our series was 4 days with a range of 3-5 days. The mean follow-up period was 37 months (range, 24 to 56 months). 14 patients (23.33%) had associated meniscal injuries. The patients were preoperatively evaluated by Lachman test, anterior drawer test, pivot-shift test, modified Cincinnati rating system and Tegner-Lysholm knee scoring scale.

Out of the 14 patients with meniscal tears, 10 had posterior horn medial meniscal tear, 3 had posterior horn lateral meniscus tear and one had bucket handle tear of medial meniscus. Seven patients underwent partial meniscectomy and 7 patients underwent balancing of the meniscus. Patients who underwent meniscal repair were not included in the study as the post-operative protocol varied in these patients.

The results of the anterior drawer, Lachman test, pivot-shift test, modified Cincinnati rating system and Tegner-Lysholm knee scoring scale at 2 years postoperative are shown in Table 1. Table 2 shows the functional results of QHT graft ACLR at the end of 2 years as assessed by Modified Cincinnati rating system and Tegner-Lysholm knee scoring scale.

Table 1: Clinical results of physical examination of patients at 2 years post-surgery.

Test	Pre-operative	At 2 year follow-up	p-value
Anterior Drawer			
0	0	44	0.001
1	0	14	
2	56	2	
3	4	0	
Lachman test			
0	0	42	0.001
1	7	17	
2	47	1	
3	6	0	
Pivot-shift			
0	9	45	0.001
1	38	14	
2	12	1	
3	1	0	
Modified Cincinnati rating system (SD)	59.57 (5.166)	99.03 (2.584)	0.001
Tegner-Lysholm knee scoring scale (SD)	64.45 (5.987)	98.87 (2.677)	0.001

Values are presented as number or mean (standard deviation).

Table 2: Functional results of QHT graft ACLR at the end of 2 years as assessed by modified Cincinnati rating system and Tegner-Lysholm knee scoring scale (mean).

Scoring	6 months	9 months	12 months	18 months	24 months
Modified Cincinnati rating system	84.72	93.35	96.23	98.55	99.03
Tegner-Lysholm knee scoring scale	83.00	93.03	95.98	98.37	98.87

In one case, intraoperatively, the EndoButton was fixed in the soft tissue just off the cortex, which was verified by the immediate postoperative radiograph. But this did not affect the functional outcome of the ACLR. The average length of the femoral tunnels was 36.7 mm (Figure 2). There was no case of blow out of posterior cortex of femoral tunnel. This can be attributed to the use of femoral aimer in all our cases. Complications occurred in 3 patients. One patient sustained a re-rupture of the ACL due to trauma at 1 year after surgery.

MRI confirmed intra-substance tear of ACL which was further confirmed on arthroscopy at the time of revision ACLR as shown in Figure 3. Patient underwent arthroscopic ACLR using ipsilateral BPTB graft. Patient recovered without any further complications. One patient had extension deficit of 30 degrees at 3 months postoperative period. An MRI showed a cyclops lesion in the anterior aspect of intercondylar eminence of tibial plateau as seen in Figure 4.

Figure 2: A) Postoperative anterior-posterior and B) lateral radiograph of an ACLR, showing femoral and tibial tunnels and femoral fixation with EndoButton.

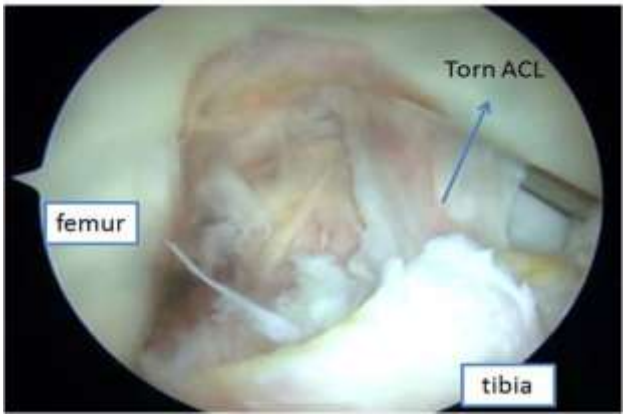

Figure 3: Arthroscopic image showing torn reconstructed ACL in a patient who sustained a re-rupture of the ACL due to trauma at 1 year after surgery.

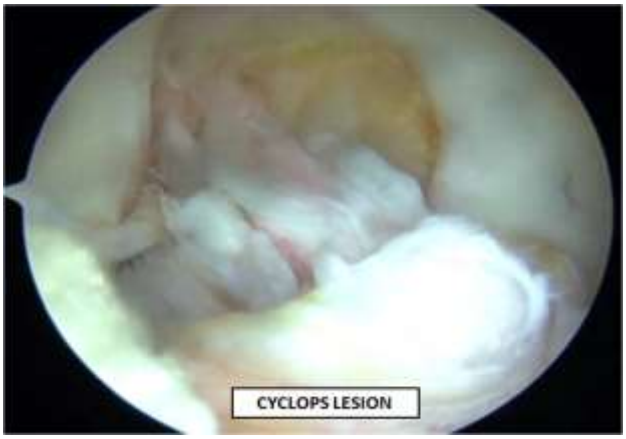

Figure 4: Arthroscopic image of a cyclops lesion in the anterior aspect of intercondylar eminence of tibial plateau in a patient with restricted terminal extension of the knee.

Patient underwent arthroscopic debridement of the cyclops lesion and intensive physical therapy for facilitating recovery of normal mobility. The cyclops lesion was most probably due to the remnants of the ACL at its tibial footprint. One patient had superficial infection at the graft harvest site. Culture grew *Staphylococcus aureus*. Infection subsided with a single debridement and intravenous antibiotics. The wound subsequently healed without affecting the rehabilitation program. There was no case of deep infection. One patient, had quadriceps muscle hypertrophy (2.2 cm) compared to the opposite side which persisted even till 2 years of follow up but did not affect the functional outcome.

DISCUSSION

Various fixation methods have been described for ACLR. They can be classified into aperture fixation and suspensory methods. The aperture fixation methods like the interference screws allows for early firm fixation and heal with tight bone-tendon interface.[4,5] The suspensory methods can be sub-classified into cortical, cancellous and cortio-cancellous suspension methods.[14] The cortical suspensory method provides excellent fixation strength, but it has been associated with bungee cord effect and a windshield wiper effect due to the far fixation point from the articular surface.[15,16] The cortico-cancellous suspension method like the cross pin fixation is said to have strong stability and stiffness due to its rigid fixation.[14,17] Milano et al in a study comparing the biomechanical strength of different femoral fixation devices for ACLR with QHT graft concluded that the cortical-cancellous suspension fixation seemed to offer the best and most predictable results in terms of elongation, fixation strength, and stiffness.[14] For both compression and suspension, cancellous fixation devices attained the weakest fixation. According to their design, cortical suspension devices showed a greatly variable mechanical behaviour.

Pioneered by Dr. Thomas Rosenberg and introduced around 1990, it was the first device specifically designed to hold soft tissue grafts like the hamstring tendons. It is now the most widely used femoral fixation device for ACLR worldwide. Originally, a Dacron tape was used for connecting the button to the tendon. Since the last decade, this technique of using a dacron tape has been replaced with a continuous loop. This eliminates the need to tie knots and occasionally resulted in the failure of the knot. Due to its biomechanical properties and ease of fixation, EndoButton has now become the gold standard for fixation of soft tissue grafts on the femoral side.

Hamstring tendon grafts have become popular over the years due to less graft site morbidity compared to BPTB grafts, particularly in terms of reduced anterior knee pain and their easy accessibility wherein the graft harvesting and tibial tunnel fixation can be carried out with a single incision.[4-9] They can be doubled, tripled, or quadrupled easily. Chen et al, reported that ACLR using a quadrupled hamstring autograft had little graft site morbidity, low re-operation rate, and excellent clinical

results. Most orthopedicians appear to favour a QHT graft as it matches the native ACL in terms of strength, stiffness and other biomechanical parameters.[18] Biomechanical studies done by Hamner et al, demonstrated the superior load to failure of the quadruple bundle graft (2,422 N ± 538) when compared with that of the patellar tendon graft (1,784 N ± 580).[19]

In our study we found a significant improvement in the functional outcome of the patients who underwent ACLR with QHT graft. There was improvement in the Lachman test and pivot-shift test at 2 year follow-up, from grade 2 (n=47) or grade 3 (n=6) to grade 1 (n=17) or grade 0 (n=42) and from grade 1 (n=38) or grade 2 (n=12) to grade 1 (n=14) or 0 (n=45), respectively. The mean modified Cincinnati score and Tegner-Lysholm knee score improved from 59.57 to 99.03, and 64.45 to 98.87 respectively at 2 year follow-up. These results are comparable to the results achieved by various other authors world-wide.[4,9,20,21]

In this study, we had one case of graft re-rupture, but it was not related to the surgical technique. One patient was diagnosed to have cyclops lesion on MRI resulting in painful restriction of terminal extension. Localized anterior arthrofibrosis or cyclops lesion is the second most common cause of extension loss after ACLR.[22] The patients showed significant symptomatic improvement following arthroscopic resection and aggressive physical rehabilitation. We had one case of superficial infection (1.67%) at the graft harvest site, that subsided with debridement and intravenous antibiotics. No deep infection occurred. Maletis et al evaluated the incidence of post-operative ACL reconstruction infections in the total 10,626 cases and concluded that infection rate varied with graft choice.[23] They reported an overall incidence of surgical site infection (SSI) of 0.48% (n=51), with 17 (0.16%) superficial infections and 34 (0.32%) deep infections. Hamstring tendon autografts (0.61%) had the highest incidence of deep SSIs of the total graft types (BPTB autograft 0.07% vs. allograft 0.27%). The limitations of this study are no inclusion of a control group and non-inclusion of radiologic evaluation

CONCLUSION

Arthroscopic ACLR using QHT autograft and an accelerated post-operative rehabilitation program like the SERP has showed significant improvements in functional scores and helped the patient achieve an early pre-injury status. The two year follow-up results of ACLR with QHT graft using EndoButton for femoral fixation and bioabsorbable interference screw for tibial fixation are satisfactory and comparable with other modalities of graft fixation.

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