International Journal of Research in Medical Sciences
Sharma S et al. Int J Res Med Sci. 2017 Oct;5(10):4506-4511
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: http://dx.doi.org/10.18203/2320-6012.ijrms20174586

Original Research Article

Arthroscopic anterior cruciate ligament reconstruction with central quadriceps tendon bone (CQTB) graft: an outcome study in fifty Indian patients

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Received: 02 August 2017
Accepted: 28 August 2017

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ABSTRACT

Background: Arthroscopic ACL reconstruction using biologic autografts is the current gold standard in the management of symptomatic ACL tears. The commonly used BPTB (Bone-Patellar Tendon-Bone) and quadrupled hamstring tendon grafts have their own disadvantages. This study was conducted to evaluate the efficacy of CQTB (Central Quadriceps Tendon Bearing) graft as an autograft for ACL reconstruction in relieving instability in ACL deficient knees.

Methods: 50 patients (45males; 5 females) with symptomatic ACL laxity, who underwent arthroscopic ACL reconstruction using the CQTB graft were followed up for 1 year. The functional improvement was analyzed by comparing the pre-operative Lysholm scores with those at 03 months, 06 months and 12 months post operatively. The objective improvement was analyzed comparing the Anterior Drawer and Lachman test grades pre-operatively and after 1 year follow up. The mean length of the graft and the post-operative morbidity were also noted.

Results: The average Lysholm scores improved from a pre-operative value of 44.34 to 78.98,87.86 and 91.58 at 03months,06 months and 1 year respectively. ($p<0.05$; ANOVA). The number of patients with Grade I, II and III laxities on Anterior Drawer test improved from 01, 36 and 12 respectively to 43, 06 and 01 respectively 1 year after surgery ($p<0.05$; paired t test). The number of patients with Grade I, II and III laxities on Lachman test reduced from 1, 34 and 15 y to 39, 10 and 01 respectively. The average thickness of graft harvested was 9.21mm.

Conclusions: CQTB autograft is a viable option along with other available autografts in its ability to reconstruct native ACL, without any hazards and additional complications.

Keywords: ACL tear, ACL reconstruction, Anterior Drawer, CQTB, Lysholm Score, Lachman

INTRODUCTION

Anterior Cruciate ligament (ACL) is one the most important intra-articular ligament responsible for the stability of the knee joint in terms of antero-posterior and rotatory movements at knee joint during normal gait and activities of daily living.[1] The treatment options for ACL deficient knee include non-operative management, repair of the anterior cruciate ligament (either isolated or with augmentation) and reconstruction with either autograft or allograft tissues or synthetics grafts. Non-operative treatment is a viable option for a patient who is willing to make lifestyle changes and avoid the activities that cause recurrent instability.[2,3] Current research supports the

concept that under observance of several key factors, arthroscopically assisted ACL reconstruction done with a biologic autograft significantly improves the stability and function of the knee in most ACL deficient patients.[4]

The most recurring graft choices are the bone-patellar tendon-bone (BPTB) and the Semitendinosus/Gracilis (hamstring) tendon.[5] Unfortunately, BPTB autograft has been extensively associated with persistent donor-site morbidity such as tenderness, anterior knee pain, pain on kneeling, infrapatellar contracture syndrome, patellar tendon rupture and fat pad herniation.[6-8] Another very popular and routinely used autograft world over is quadrupled hamstring tendon. Hamstring acts as ACL agonist by resisting anterior translation of tibia. So, the use of Hamstring autograft leads to added biomechanical disadvantage due to iatrogenic agonist weakness and disruption of the protective ACL proprioceptive arc, along with the graft harvest site morbidity and delay in graft incorporation which require added period of restricted activities.[9]

A rather uncommonly used autograft is the central Quadriceps Tendon Bearing Graft (CQTB). The quadriceps tendon graft has several potential advantages over BPTB and has recently gained attention as a promising option for primary and revision ACL reconstruction. The quadriceps tendon graft offers excellent biomechanical strength (ultimate tensile load of 2352±495 N), large cross-section area, appropriate length, and the advantage of having a bone plug on one end harvested from the upper pole of the patella which provides for bone to bone fixation within the femoral tunnel allowing early osteointegration of the autograft. There are few studies evaluating the clinical outcome of the CQTB graft for ACL reconstruction. Studies that have evaluated this graft show no difference in one-year outcome when compared to the BTB graft.[10] So, this study was conducted to evaluate the efficacy of quadriceps tendon as an alternative autograft for reconstruction of anterior cruciate ligament in ACL deficient knees in relieving the primary symptoms of instability.

METHODS

This observational study was carried out in 50 patients presenting with ACL injury and symptomatic instability reporting to the Orthopedic OPD of a tertiary care hospital from June 2014 to February 2015. The aim of the study was to evaluate the efficacy of quadriceps tendon as an alternative autograft for reconstruction of anterior cruciate ligament in ACL deficient knees in relieving the primary symptoms of instability. The objectives were to assess the quality of graft in terms of thickness and length during the harvest, assess the graft's capability in neutralizing the Anterior Drawer and Lachman tests in the follow up period, to assess the improvement in the 'sense of instability' as reported on Lysholm score card and to assess any donor site morbidity. The subjects of this study comprised of skeletally mature physically active individuals of both sexes who suffered a primary ACL injury with symptomatic instability.

Patients with co-existing PCL injury, multi-ligamentous knee injuries and preexisting osteoarthritis were excluded. All patients presenting with acute injuries were initially managed conservatively with rest, icepacks, analgesics and protected weight bearing for 04 weeks followed by gradual attempt at return of full pre-injury knee ROM and muscle strength. Patient underwent strengthening exercises for hamstring and quadriceps (static and close chain) for 06 weeks. Patients were re-evaluated at the end of 3 months. All patients who were able to regain their pre-injury ROM were evaluated for their symptoms. Most symptomatic patients also had objective evidence of ACL laxity and all those who were symptomatic and willing to take part in this study were included in the study after obtaining a written informed consent. All the patient reporting with symptoms of ACL deficiency were evaluated clinically with Anterior Drawer and Lachman tests. The Lysholm score was used to note the functional status of the knee. An MRI scan of the injured knee was performed to confirm the presence of ACL deficiency and associated meniscal, PCL, collateral ligament and osteochondral injuries. All the patients were explained the cause of their problems and also the various treatment modalities available for their management. The surgery was performed in a standard fashion under tourniquet control under spinal anaesthesia/CSEA/GA.

Diagnostic arthroscopy was done as a part of initial surgical procedure, which reconfirmed the presence of ACL injury and also presence of other injuries like meniscal tears and chondral defects in the articular cartilage. All unstable meniscal tears were managed by partial/ subtotal meniscectomy. The original attachment site of ACL at the tibial and femoral site were cleared of the remnants of native ACL to improve the arthroscopic visualization of prospective sites of tunnel placement. After diagnostic arthroscopy, the CQTB autograft was harvested and prepared. A 3- to 5-cm vertical incision was made on the midline of the Quadriceps tendon extending upwards from superior pole of patella. The quadriceps tendon and upper half of the patella were exposed. Prospective CQTB auto graft along with the bone plug was marked using a marker and a scale. A longitudinal incision was made on the quadriceps tendon approximately 2 to 3 mm lateral from the musculo-tendinous margin. It was oriented parallel with the main body of the tendon and centered over the base of the patella. A parallel incision was made 9 to 10 mm laterally depending on the available thickness of quadriceps tendon.

Most of the time it was possible to isolate a tendon strip approximately 9-mm wide and 5-6 mm thick. A 20-25 x10-mm bone block was demarcated on the upper patella in line with the tendinous portion of the graft with the

knee flexed to 60°. The knee was flexed to avoid patellar movement while performing the bone cuts. The bone block was harvested with a small oscillating saw. After taking the bone block, quadriceps tendon was harvested along with the attached bone plug from distal to proximal till the premarked position over the tendon, which was approximately 6 to 8 cm from the base of patella. Special care was taken to lift the tendon from suprapatellar bursa to prevent inadvertent opening up of the suprapatellar pouch while harvesting the tendon. After harvesting the graft, it was measured and dimensions noted. Single drill hole was made in the bone block for insertion of No. 2 Polyester suture for graft placement in femoral tunnel. The tendinous end was weaved with Bunnell stitch of No. 5 non-absorbable material. Both the margins of the graft are sutured together with a running 2/0 Vicryl and pre-tensioned for 15 minutes to a tension of 50 N. The technique of CQTB graft harvest is summarized in Figure 1.

After the graft harvest, the tibial tunnel was prepared using the special arthroscopic tibial jig adjusted to 40-50º angle aiming as close to the native ACL tibial footprint. The tibial tunnel was reamed with a cannulated reamer depending on the size of graft (9mm or 10mm) to permit its easy passage. The femoral tunnel was prepared using the Antero-medial arthroscopy portal technique.[11] As the average graft diameter was 9mm, a 7 or 6 mm femoral tunnel offset guide was used to locate the femoral tunnel through anteromedial portal. Femoral tunnel was drilled at 2 or 10 o' clock position through this anteromedial portal over a guide wire.

Femoral tunnel was initially drilled over a guide wire with 4.5mm drill and the depth of femoral tunnel was noted. Later the femoral tunnel was enlarged with the appropriate size drill depending on the thickness of bone block and to the depth depending on the length of bone block. Knee was flexed to around 120º to get the desired location of femoral tunnel. The prepared CQTB graft was advanced through the tibial tunnel, and into the femoral tunnel, while ensuring that the graft was orientated so that the cortical side of the bone block was posterior [closer to over the top position] and the cancellous portion was anterior. After seating the full bone plug in the femoral tunnel, the graft was secured in femoral tunnel using 25mm titanium interference screw, the diameter of the screw being only 1 mm less than the diameter of the bone plug. The tibial end of the graft was then secured using either interference screw or over a suture disc after keeping the knee in extension and in tension.

Joint lavage was done and port site closed with suture and graft harvest site was also closed in layers, taking care to give a watertight closure in cases where suprapatellar pouch had opened while harvesting the graft. Post operatively, gradual passive knee ROM was started after 24 hours, with the aim to achieve full passive ROM by the end of 4 weeks. Static Hamstring and quadriceps exercises were started as soon as the patient came out of anaesthesia, to prevent disuse atrophy. Patients were made touch-down weight bearing ambulant 48 hours after the surgery, partial wt bearing after 2 weeks and full weight bearing after 6 weeks. Patients were also instructed to use elbow crutch/axillary crutch/ walker depending upon individual comfort. In the initial 6 weeks following surgery patients were started on active hamstring and static quadriceps exercise and were started with active hamstring and close chain quadriceps exercise after 6 weeks. Patients were not allowed to active straight leg raise for the first 4 weeks after surgery. Serial data collection at the end of 3, 6, 12 months using the Lysholm score was done for noting the functional improvement and the Anterior drawer and Lachman tests at the end of 12 months to note the objective clinical improvement.

RESULTS

A total of 50 patients presenting with symptomatic instability in the knee joint following traumatic injury were included in the study. Most of the patients were physically active young individuals and sports persons. All patients were followed up for minimum of 1 year and their data compiled and inferences were drawn as follows. The demographic distribution of the patients and pre-operative variables were as depicted in Table 1.

15 patients had an associated medial meniscus tears and 16 had lateral meniscus tears. 07 patients had both medial and lateral meniscus tears. Total of 26 out of 50 patients had a co-existing meniscal injury requiring operative intervention in the form of partial or subtotal meniscectomy. Post operatively the patients were re-evaluated at 6 weeks, 3 months, 6 months and 1 year using Lysholm score for noting the functional improvement in terms of "subjective instability". The post-operative average Lysholm score showed a gradual improvement over the three follow up durations as shown as shown in Figure 2.

The average Lysholm scores improved from a pre-operative value of 44.34 to 78.98,87.86 and 91.58 at 03 months, 06 months and 1 year respectively. The difference was found to be statistically significant ($p<0.05$) using the ANOVA test on all follow up visits. The improvement in Anterior drawer and Lachman test grades were used to quantify the objective improvement in neutralizing the "anterior instability". The number of patients with Grade I, II and III laxities on Anterior Drawer test before the surgery were 02, 36 and 12 respectively. On follow up at 1 year, the patients with grade I, II and III laxities were 43,06 and 01 respectively as shown in Figure 3.

The difference was found to be statistically significant using the paired test($p<0.05$). Similarly, the number of patients with Grade I, II and III laxity using the Lachman test reduced from 01, 34 and 15 to 39, 10 and 01

respectively one year after the surgery as shown in Figure 4.

The difference was found to be statistically significant using the paired t-test ($p<0.05$). The average length of graft harvested in this study including the bone plug was 90mm (range 80-100mm). The average thickness of graft harvested was 9.21mm (range 8-10mm). There were two complications in present study; both were superficial infection at graft harvest site, which was presumed to be due to suprapatellar collection after the graft harvest due to inadvertent opening up of the suprapatellar pouch. Both patients responded to local dressing and course of antibiotics after draining the superficial collection and had excellent recovery with no functional deficits and were able to go back to his pre-injury activity level at the end of 1 year.

DISCUSSION

The ACL does not heal when torn because of lack of sufficient vascularity. Surgical reconstruction is the standard treatment in sports medicine for ACL rupture[4]. Patients with ACL injuries are typically younger and more active than other orthopaedic patients, and reconstructions should exhibit good longevity with the ability to withstand high stresses over millions of cycles. Reconstruction of the anterior cruciate ligament (ACL) has been shown to provide good results predictably. Historically ACL tear is most common in physically active individuas.[12,13] In present study average age of presentation was 30 years, with male preponderance (M:F 45:5). As most of our clientele involved highly active males, more number of males were included in the study.[14-16]

Most patient sustained injuries as a result of twisting injury to knee in road traffic accidents or sports related activities. In present study 28 patients had injury following sports related incidents and 22 patients sustained injury following road traffic accidents. 15 patients had an associated medial meniscus tears and 16 had lateral meniscus tears. 07 patients had both medial and lateral meniscus tears. A Total of 26 out of 50 patients had a co-existing meniscal injury requiring operative intervention in the form of partial or subtotal meniscectomy. The key factors significantly influencing the functional outcome have been described as individual choice of graft material, anatomic bone tunnel placement, anatomical graft fixation and sufficient initial graft fixation strength.

Anatomically, the quadriceps tendon is longer and thicker than the patellar tendon and attaches to the patella more widely. The mean cross-sectional area of the quadriceps tendon is larger than that of the patellar tendon regardless of preconditioning, and the mean ultimate tensile stress and strain of the patellar tendon are larger than those of the quadriceps tendon. Therefore, the mean ultimate tensile failure loads (ultimate tensile strengths) for the two tendon types are similar.[17,18] In present study the average graft length was 90mm and graft thickness was 9.2mm which is sufficient for ACL reconstruction.[17,18]

The success rates of ACL reconstruction surgery have been reported to vary between 73 and 95%, and the return to pre-injury activity level varies from 37 to 75%.[19,20] The post operative average Lysholm score showed a gradual improvement over the three follow up durations. The average Lysholm scores improved from a pre-operative value of 44.34 to 78.98, 87.86 and 91.58 at 03months,06 months and 01 year respectively.

The difference was found to be statistically significant ($p<0.05$) using the ANOVA test on all follow up visits. Based on Lysholm scores at the end of 1 year, 44 patients had excellent results, 5 had good results and only 1 patient had fair result. In current study, all patients but 1 had good or excellent result i.e. more than 95% at the end of 1 year which was comparable with other studies.[21,22] ACL reconstruction in our study was able to neutralize the Anterior drawer and Lachman test grades to Gd 1in 86% and 78 % respectively.

Anterior drawer grades improved to grade I in 43/50 patients. 6 patients had grade II laxity and only 1 patient had Grade II laxity from pre operative grade III in 12 patients, grade II in 36 and grade I in 2 patients. Post op Lachman test also showed good improvement from pre operative 15 patients having grade III laxity, 34 grade II laxity and 1 patient grade I laxity to 39 patients having Grade I or less laxity and 10 patients having grade II laxity and only 1 patientt having grade III laxity. The improvement in Anterior drawer and Lachman test gradings over 01 year was statistically significant using paired t-test ($p<0,05$). Stefano Zaffagnini et al in their analysis of graft behavior suggests that the most horizontal femoral tunnel performed better than the vertical tunnel, thus constraining optimally both antero-posterior and internal-external rotations.[23]

In the present study, we used Antero-medial portal to drill the femoral tunnel to achieve more anatomical tunnel placement in all the cases. After ACL reconstruction, major cause of early failure is failure of fixation during initial phase of graft incorporation in the femoral and tibial tunnel.[24] Graft fixation in femoral tunnel was more important to prevent early failure, so in we used bone plug in the femoral tunnel along with that an interference screw to provide added stability of fixation to graft while bone to bone healing takes place in the femoral tunnel and graft incorporates. This helped early mobilization of the patients.

Tibial end of the graft was fixed either securing the graft with and interference screw or fixing it over a titanium suture disc. Only two patients had complications in the form of a superficial collection, which was manged successfully with drainage of the collection and a course of oral antibiotics.

CONCLUSION

Primary ACL reconstruction was performed in 50 patients (5 female, 45 male) who presented with clinical and objective evidence of anterior knee instability using CQTB (central quadriceps tendon bone) autograft and were followed up for one year. All patients had statistically significant subjective improvement of their instability using the Lysholm Score and objective improvement in their Anterior drawer and Lachman test gradings when serially followed up for 1 year after the surgery. Benefits of Quadriceps tendon bone autograft are the ease of harvest, small learning curve to harvest the graft, consistent graft thickness and length available, presence of bone plug at one end which enhances the bone to bone healing of the graft and early graft incorporation and lesser graft harvest site morbidity compared to BPTB and lesser chances of iatrogenic hamstring weakness as in cases of hamstring autograft. The authors recommend quadriceps tendon autograft as a viable option along with other available autografts in its ability to reconstruct native ACL, without any hazards and additional complications. Further long-term clinical studies are required to understand the biomechanical advantages of CQTB autograft over the available options.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Sharma S, Joshi G, Philip VM, Kaushal N. Arthroscopic anterior cruciate ligament reconstruction with central quadriceps tendon bone (CQTB) graft: An outcome study in fifty Indian patients. Int J Res Med Sci 2017;5:4506-11.