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Arthroscopic anterior cruciate ligament reconstruction: Comparison of functional outcome between femoral fixations by suspensory fixation versus aperture fixation

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Abstract

Background and objectives: Anterior cruciate ligament reconstruction is one of the most common knee operations. The graft fixation ways differ from suspensory fixation methods (Endobutton) to aperture fixation (Interference screws). The use of a hamstring tendon autograft has become a common choice among orthopedic surgeons because of less donor site problem. The aim of this study is to compare the functional outcome between suspensory fixation and aperture fixation of arthroscopic anterior cruciate ligament reconstruction. **Methods:** Arthroscopic autogenous hamstring anterior cruciate ligament reconstruction was performed for forty-one patients who were divided into two groups, with a minimum of six months follow up evaluation. The suspensory fixation group underwent endobutton fixation on the femoral side and interference screw on tibial side. The aperture fixation group underwent interference screw fixation at both femoral and tibial tunnels. Both groups were assessed and their functional outcomes were compared before surgery, at three months and six months by using Lysholm knee score. **Results:** There was significant improvement in functional outcome in both groups, at six months of follow up, the Lysholm score in endobutton group improved from 77.2 to 93.2 and in interference screw group from 71.5 to 89. The endobutton group had better functional outcome when compared to interference screw group. **Conclusions:** The endobutton fixation provided better functional outcome at the end of six months when comparing the result. We recommend larger population and longer periods of follow up.

Key words: Arthroscopic anterior cruciate ligament reconstruction, Comparison, Endobutton fixation, Interference screw fixation.

Introduction

Anterior cruciate ligament (ACL) reconstruction is one of the most common knee operations[1]. The favorability of this procedure is related to its ability to permit an individual to return to his/her pre-injury level of activity that would otherwise not be easy[2]. Several elements like choice of graft, tunnel orientation, method of graft fixation, and integration of the ACL graft into the tunnels are expected to affect the success of the procedure[1]. An essential component during reconstruction of a ligamentous unstable knee is an early rehabilitation protocol which stresses immediate full range of motion, making stronger, neuromuscular coordination, and early weight bearing. This protocol needs rigid fixation of the graft component in order to tolerate the stresses of early rehabilitation[2].

Anterior cruciate ligament (ACL) reconstruction using a hamstring tendon autograft has become a common choice among orthopedic surgeons. Significant advantages of hamstring grafts include less donor site morbidity, less quadriceps weakness, less kneeling pain, and fewer sensory deficits associated with graft harvest[3]. Quadrupled hamstring tendon has adequate strength and stiffness. The incorporation of the graft substitute to the bone, the fixation method, is the weak element in the immediate postoperative period, rather than the graft substitute itself. Therefore, graft and fixation incorporation must provide rigid mechanical fixation from zero hour to biologic incorporation of the hamstring autograft into the bone tunnels which needs 12 weeks [2,4]. The fixation of soft collagenic tissue from the graft tendon within the bone tunnel is started by Sharpey fibers and depends on

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the tendon-bone area of contact[5]. In terms of mechanical factors, graft motion in tunnels shows up to be an important issue. Two kinds of motion occur: sagittal or coronal graft motion, the "windshield wiper" effect, (side to side motion) and longitudinal graft motion, the "bungee cord" effect, (up and down motion)[6]. The graft fixation ways differ from aperture fixation [Interference screws] to suspensory fixation methods [Endobutton][7]. There are two types of endobutton; fixed-length loop device and adjustable-length loop device[8]. The fixed-length loop device composes of a button with a continuous suture loop over it[9].The adjustable-length loop device can be tightened intraoperatively, thus eliminate the necessity for over drilling and enhancing bone preservation by not making excess space in the bone tunnel[8]. Lysholm knee score will be used for assessing functional outcome. The Lysholm scale or questionnaire measures the symptoms, function and complains in patients with different knee injuries and surgeries, measuring function in daily activities, no measuring function in sports and recreational activities. It is consisted of an 8-item questionnaire scored on a 0–100 weighted scale, measuring pain (25 points), instability (25 points), locking (15 points), swelling (10 points), limp (5 points), stair-climbing (10 points), squatting (5 points) and use of support (5 points). The final score is expressed nominally and ordinally, with a score ranging from 95 to 100 points regarded as "excellent"; 84 to 94 points, "good", from 65 to 83 points, "fair", and "poor" when values were equal or below 64 points[10-12]. The purpose of this study is to compare the functional outcome between suspensory fixation and aperture fixation of arthroscopic anterior cruciate ligament reconstruction.

Patient and methods

This prospective randomized comparative study was performed on a continuous series of forty-one patients operated on by the same surgical team, from June 2018 to October 2018 at Shar teaching hospital for ACL rupture, using hamstring tendon autograft fixed to the femur by two different techniques i.e. suspensory (Endobutton 'fixed-length loop device') and aperture (interference screw) fixation. Two groups were defined randomly; Continuous Loop endobutton fixation (EB) group and interference screw fixation (IS) group used on the femoral footprint.

Endobutton group contained twenty-one patients (all were men; mean age, 25.04 years) and IS group included twenty patients (all were men; mean age were 31.45 years). In EB group, fourteen patients had right-knee involvement and eight had left-knee involvement; in IS group thirteen had right and seven had left knee involvement. The mean follow-up duration was six months for both groups. Inclusion criteria were; age group between 19 to 47 years and they had complete ACL tear on clinical assessment and MRI findings. Exclusion criteria were; chondral lesions that could modify the post-operative rehabilitation protocol, collateral and /or PCL injuries, chronic ACL insufficiency with osteoarthritis, bilateral knee injuries, associated tibial plateau fractures, previously operated knee, non-compliant patients for rehabilitation and graft diameter less than 8 mm. All the patients were assessed clinically, history of instability in the forms of sense of knee giving away often secondary to a deceleration and rotation motion, positive Lachman test and anterior drawer test and radiologically, confirmation of ACL deficient by using of; 1). Plane radiography, to assess the presence of preoperative associated injuries and degenerative changes, 2). MRI scanning, this can clarify the pictures of existing ACL rupture.

So the above evaluations, were criteria based on which the patients were considered for surgery. Operation performed after getting informed consent from the patients, where clinical re-examination on the operating table had demonstrated a positive Lachman test and pivot shift test in all patients. Arthroscopic ACL reconstruction was done. Systematic examination of the knee carried out with addressing patellae, trochlea, menisci, compartments, posterior cruciate ligament and residual ACL. Ceftriaxone (1 g, via the intravenous route) was administered prophylactically 1 hour prior to induction of anesthesia. Patients were positioned supine on the operating table. All surgical procedures were performed under general or spinal anesthesia; a pneumatic tourniquet was used. Leg and foot prepared with Povidone-Iodine solution, draped in standard fashion. In all patients, two standard portal techniques were used; anterolateral portal and anteromedial portal.

With the knee flexed at 90 degrees, the autogenous hamstring (semitendinosus and gracilis) tendons were harvested through an anteromedial longitudinal incision. Gracilis and

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semitendinosus tendons identified and soft tissue accessory attachments were released. Tendons stripped at the musculotendinous junction and detached from the tibia. Tendons prepared as a four-strand graft with "whip stitching" by using ethibond. The diameter of the grafts that used was between 8.0 mm to 9.5 mm. Graft stored in moist saline gauze. Through the standard anterolateral and anteromedial portals, arthroscopic shaver and curette used to debride residual ACL tissue from lateral femoral condyle. The femoral tunnel was made through trans-portal approach (AM portal). Entry point made using a microfracture awl. Then the knee flexed to more than 110 degrees. Long guidewire passed, exiting through the lateral skin of thigh. The femoral tunnel over drilled with a 4.5 mm drill and graft size to a depth of 30 mm. Using the drill guide, set at 50 degrees, guide wire placed in tibial foot print by using tip aimer, under arthroscopic vision. Then it over drilled with a 4.5 mm drill and graft size tibial drill. Shaver used to remove residual ACL tissue from the margins of the tunnel. Posterior lip of tunnel smoothed with a rasp. In EB group, the graft was pulled through the tibial tunnel and into the femoral tunnel using the "lead" suture on the EndoButton-Continuous Loop. After the graft was fully seated in the femoral tunnel, the "follow" suture was pulled to flip the EB. In IS group, the polyester passing suture was passed through the loop of the graft, and then the graft was pulled by passing the suture from the extra-articular anteromedial cortical surface of the tibia through the tibial and femoral tunnels to the anterolateral cortex of the femur. Femoral fixation was performed using an IS (sized as 7 * 25 mm). In both groups, ten cycles of knee flexion–extension was performed to ensure graft pre-tensioning. Next the tibia-side graft was fixed with an interference screw 35 mm in length, at 10 degrees of knee flexion under maximal manual tension. The diameter of the screw was 1 mm greater than that of the tibial tunnel.

All knees were arthroscopically examined to ensure appropriate fixation, changes in position during motion and graft inspection to reveal no lateral wall or roof impingement. After Anterior drawer, Lachman, and pivot shift tests were done and all were negative and the full range of motion had been retained, the joint space was washed out, the arthroscopic portals and the graft harvesting incision were sutured.

No patient received prophylactic anticoagulant therapy. In terms of pain relief, opioid analgesics (for the first 2 days) and non-steroidal anti-inflammatory drugs (for 2 weeks; orally or parenterally as required) were prescribed. All patients received Ceftriaxone 1g intravenously every 12 h for 24 h) postoperatively. An ice bag was applied to the operative knee for 20 min., three times a day, during the first postoperative week. The same rehabilitation protocol was applied in both groups following reconstruction, including; quadriceps, foot and knee low-impact aerobic exercise started on the second day and full weight bearing with assisted crutch as tolerated. At six weeks, half squats, stair climbing, cycling and jogging were allowed progressively. Patients generally were allowed to start running after regaining quadriceps control at around five months and return to sporting activities by six months.

They were regularly followed up at three and six months. Clinically (anterior drawer and Lachman tests) assessment, radiological (plane X-ray to assess postoperative relation of graft and hardware to the bone tunnels) evaluation and functional outcomes were assessed by Lysholm knee score, all were done during follow up.

Results

In this prospective, randomized comparative study, two groups of forty patients have been participated, twenty-one patients in EB group and twenty patients in IS group. All were men [100%], from the age of 18 to 38 years. Mean age in EB group was 25.04 years and in IS group was 31.45 years. In EB group, 66.67% the right knee was involved and 33.33% was the left knee. While, in IS group, 65% were right knee and 35%were left knee. Associated injuries in EB group; Six of them (28.6%) had medial compartment type I injury, six other (28.6%) had medial meniscus tear and two (9.5%) had lateral meniscus tear. While in IS group; eight of them (40%) had medial compartment injury type I, thirteen (65%) had medial meniscus tear and nine (45%) had lateral meniscustear, Table (1).

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Table (1): Patient's demographic data

Variables	Endobutton group	Interference screw group
Age	25.04±5.58	31.45±3.30
Sex (N %) Female Male	 0(0) 21(100)	 0(0) 20(100)
Right/Left (N %) Right Left	 14(66.67) 7(33.33)	 13(65) 7(35)
Medial Compartment (N %) No injury Injury	 15(71.4) 6(28.6)	 12(60) 8(40)
Medial meniscus (N %) No injury Injury	 15(71.4) 6(28.6)	 7(35) 13(65)
Lateral Compartment (N %) No injury Injury	 21(100) 0(0)	 20(100) 0(0)
Lateral meniscus (N %) No injury Injury	 19(90.5) 2(9.5)	 11(55) 9(45)

All associated meniscus injuries were treated concomitantly by partial meniscectomy. The average follow-up time for the patients of both groups was six months. The mean Lysholm score difference was statistically not significant between the two groups at three-month (p-value = 0.241), which the mean Lysholm score difference at six-month was statistically significant (p-value=0.020), Table (2) & Table (3).

Table (2): Pre and three-month post intervention functional outcome of the two procedures according to Lysholm functional assessment.

Femoral tunnel fixation method	Pre-Lysholm Mean ±SD	3m Lysholm Mean ±SD	p-value
Endobutton	77.19 ±13.16	83.80 ±9.64	0.241
Interference screw	71.75 ±9.85	86.05 ±2.68	

Table (3): Pre and six-month post intervention functional outcome of the two procedures according to Lysholm functional assessment.

Femoral tunnel fixation method	Pre-Lysholm Mean ±SD	6m Lysholm Mean ±SD	p-value
Endobutton	77.19 ±13.16	93.19 ±2.90	0.020
Interference screw	71.75 ±9.85	89.05 ±6.35	

ACL: Anterior Cruciate Ligament, EB: EndoButton, IS: Interference screw

Discussion

Arthroscopic treatment of ACL tear is commonly performed by using hamstring autograft[7]. Because hamstring autograft has less donor site morbidity, less quadriceps weakness, less kneeling pain, and fewer sensory deficits associated with graft harvest[3]. Also, it shows favorable strength and stiffness of these graft substitutes as compared to the native ACL[2]. Choosing of graft, tunnel orientation, method of graft fixation, and integration of the ACL graft into the tunnels, are essential to provide favorable outcome[1]. Mainly two types of fixation devices have been used in ACL reconstruction which are; suspensory fixation and aperture fixation.

Cortical fixation with suspensory fixation has several advantages like: the point of fixation is away from the joint space, increases the area of contact between the graft and the bone, decreases the risk of posterior wall blowout, and increases the effective graft length[13-15]. It has disadvantages like: bungee cord and wind-shield wiper motion by allowing excessive movement of the graft and causing tunnel enlargement[6,16].

Aperture fixation, using interference screw fixation, is documented to decreasing graft-tunnel motion, minimizing the bungee and windshield-wiper effects that can result in tunnel widening, poor graft-to-bone healing, and failure[17]. It has some problems such as divergent screw placement, laceration of sutures or grafts by screw threads, and increasing

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difficulty of revision surgery in the presence of screws[18]. Interference screws make a limited tendon-bone contact area because much of the tunnel circumference is engaged by the screw itself which leads poor integration[5,17].

The main purpose of these devices is to give a secure fixation so that the graft obtains proper healing into the tunnel. This allows starting early range of motion, exercise, weight-bearing hence and early return to sports without any loss of fixation[7].

In this study, we have used endobutton and interference screw femoral fixations. Both modes of fixation of ACL have shown improved function and satisfaction of patients as indicated by Lysholm score after surgery. When the results of both groups at three months were compared, there were no statistically different between them, this is comparable with the study of Kumar, et al.[7] who had performed ACL reconstruction for twenty patients. The difference was more significant for the EB group when compared with IS group at six months of follow up.

We think there are several reasons behind the results which are; endobutton provides cortical fixation whereas interference screw provides cancellous fixation and the point of fixation in endobutton group is away from joint line. Both these facts make the fixation to be more secure with endobutton and causing less intra-articular irritation, making effusion and pain less in endobutton group. So that these reasons made the patients feel their knees are more stable and made them more complaint with physiotherapy program.

The final result of this study is comparable to the end result of Browning III, et al.[3] in a meta-analysis of forty-one studies, in which twenty used suspensory fixation techniques and twenty one used aperture fixation techniques, have shown that suspensory fixation of hamstring graft is more stable and has fewer graft failure compared with aperture fixation and it's comparable to the final result of Kumar, et al.[7] who found that endobutton fixation yielded better functional outcome than aperture fixation at one year follow up.

Ma, et al.[13] in a prospective, non-randomized, clinical study found that using aperture fixation techniques with interference screw for hamstring ACL reconstruction can significantly improve the clinical outcome when it is compared to suspensory fixation techniques with endobutton, and Aydin, et al.[9] in a retrospective, comparative study concluded that femoral fixation devices have no effect on clinical outcome. These are not in agreement with our result and the explanation of that is there was the large number of patients and longer follow up.

Limitation

The main limitation of our study is that there was a short time of postoperative follow-up period in which we believe that we need much time for comparing results in both groups. We are currently waiting for longer term results to verify whether these early results will remain in the same value or not. Additionally, there are limited numbers of patients enrolled in the study.

Conclusions

The endobutton fixation provided better results in terms of functional outcome at the end of six months when compared to aperture fixation.

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