ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION BY HAMSTRING GRAFT KNOT TECHNIQUE

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Abstract

Background: Anterior cruciate ligament (ACL) is among the most prevalent injuries associated with sports. So, while performing this procedure in developing countries it is more cost-effective to use less hardware so that to reduce procedure overall cost on patient.

Objective: This research aimed to examine the clinical results of ACL repair using femoral press-fit approach versus fixation with endobutton in cases with ACL tear.

Methods: This prospective research was carried out on 20 individuals who were scheduled for arthroscopic ACL repair employing semitendinosus and gracilis autograft fixed with Hamstrings graft knot technique for 10 patients. The patients had been followed up for 6 months.

Results: The MRI showed that 5 patients showed isolated anterior cruciate ligament tear, 3 patients showed medial meniscus tear, 1 patient lateral meniscus tear. Symptoms evaluation with Modified Cincinnati score: In the symptom evaluation of the knee 6 patients normal, 1 patients near normal and 3 patients abnormal.

Conclusions: Hamstring graft knot technique in ACL surgery is a dependable and cost effective option in repair of ACL.

Keywords: Femoral press-fit, Reconstruction technique, Anterior Cruciate ligament

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Introduction

Hamstring are the most commonly used grafts with equally successful long-term results [2]. Quadriceps tendon is emerging as an attractive alternative because of its predictable thickness and less donor site morbidity [3]. Stable graft fixation is paramount for a successful outcome as the graft relies on its initial stability for the first 6–8 weeks. Various absorbable and nonabsorbable implants in the form of screws, stables, pins, and buttons have been used. Although, these implants provide good initial stability for accelerated rehabilitation, they can be associated with implant migration, osteolysis, and soft tissue irritation. They can also increase the complexity of revision surgery. Cost is another important issue and implants can produce signal interference during subsequent MRI imaging.

To avoid all these issues with nonbiological implants, Peter Hertel [4] introduced a novel concept of press-fit PBTB graft fixation in 1987.

Hardware-free press-fit stabilization is a possible remedy for these disadvantages. After BPTB press-fit procedure, good mechanical and functional result studies following 5 and 10 years have been reported. ACL repair via the hamstring tendon is a technique that is becoming more and more prevalent [5].

For stabilization of hamstring graft in bone tunnels, a multitude of fastening methods were employed. Endobutton stabilization has been linked to graft movement in bone tunnels. The fixing strength of both titanium and bioabsorbable interference screws was found to be satisfactory. The development of Sharpey-like fibers proximal to the joint fixation is essential for full graft recovery. Despite appropriate stabilization, bone tunnel enlargement has been seen during ACL restoration, particularly when tendon grafts are used [6].

We suggest that press fit method usage at femoral side is more cost effective than the other methods of fixation such as endobutton and interference screws. Also Press fit method suspected to be more stable fixation of the graft instead of the surface fixation techniques, which causes the working length of the graft to increase so leads to weakness of the graft. A procedure using a bottle-shaped femoral tunnel and a knot in the hamstring grafts to accomplish implant-free press-fit stabilization of tendons was disclosed [3]. According to reports, pullout strength of this technically complex method is comparable to interference screw implantation. The approach has not been directly compared to press-fit PT stabilization as of yet [7].

This research was designed to evaluate clinical outcomes of hamstring graft knot technique of ACL reconstruction versus fixation with endobutton in cases with ACL tear.

Patients and methods

This prospective research was carried out on individuals scheduled to undergo arthroscopic ACL rebuilding employing hamstring tendons autograft. All patients have femoral part of the graft fixed with a different fixation technique. ALL of these patients were undergo hamstring graft knot fixation at femoral side. During that time twenty patients with ACL deficient knee, suffering from instability were operated upon, all surgeries were done at Helwan University Hospital during the period from February 2020 to February 2022.

Inclusion criteria: Radiologically mature patients with age from 18 to 45, symptomatic ACL injury, which occurred more than 3 weeks previously, no history of cruciate ligament damage or surgery in the afflicted knee, no associated other ligaments injury and no degenerative changes in joint or aberrant bone structure shown on a typical knee x-ray.

All patients were subjected to pre-operative assessment (Personal history, complaints during usual daily activity or during particular movement in activity, pain site, swelling time), Clinical examination (anterior drawer test in neutral, external and internal rotation, posterior drawer test, Lachman test, Pivot shift test, McMurray test, valgus and varus stress tests at 0° and 30°, effusion tests and thigh circumference measurement, and evaluation of knee back and patellofemoral joint are performed). Radiographic evaluation (Both lateral and antero-posterior positions plain X-ray knee and MRI). Operative data including [date of surgery, number and names of surgeons. Operation duration (tourniquet time). Method of operation, instruments and screws utilized, kind of graft, manner of fixing (Femoral and Tibial), operative details, complication], and clinical evaluation.

The patients were graded as regards locking into three grades according to the severity: Mild + locking with sever exertion. Moderate ++ locking with moderate exertion. Severe +++ Locking with daily activities. Trauma mechanism and duration

Clinical evaluation: Modified International Knee Documentation Committee (IKDC) system was used for pre-operative and post-operative clinical evaluation at the first, third, sixth, twelfth months after that. The results were further grouped into A, B, C and D: A as normal, B near normal, C bad, and D very bad.

Patient admitted to the hospital at the day before the operation. MRI and X-Ray already done included in the file of the patient.

Intra-operative preparations: The affected knee was marked, and hair was shaved all around the knee. Prophylactic antibiotics were given to the patient. Individuals were positioned on operating table in supine position which is angled at knee level. A lateral post is used to provide a valgus force, while the opposing leg is abducted and straightened. Spinal anesthesia had been used for all patients. Pre-operative examination had been done under anesthesia for both knees. Above knee tourniquet was applied to the proximal thigh for homeostasis and visualization during arthroscopy. The limb was sterilized and wrapped according to hospital policy. Diagnostic arthroscopy was done.

Harvesting of the Graft: Skin incision. Gracilis and semitendinosus tendons may be collected by making an incision 4 cm medial and immediately distal to the tibial tubercle. Three fingernails below the medial joint line and placed on subcutaneous region of tibia is an alternate explanation of incision placement. The orientation of incision may be longitudinal, oblique, or transverse. Anatomical route of infrapatellar branch of saphenous nerve in incision region renders oblique and transverse incisions more favorable for preventing injury to this tissue. Sharp dissection is performed via subcutaneous tissue and fat. Deep to layer I, gracilis (superior) and semitendinosus (inferior) tendons may be palpated as independent components, as stated earlier.

Exposing tendons: Sartorius tendon (layer I) is cut along path of gracilis and semitendinosus, either above or between gracilis tendon and semitendinosus tendon. Tendons are exhibited. Utilizing a Kocher clamp to retract crural fascia, gracilis tendon is first gripped with a curved clamp.

Arthroscopic examination: The standard anterolateral and anteromedial portals were used, and thorough arthroscopic examination of the knee was done. All articular surfaces, both menisci, patella and PCL were visualized. Partial meniscectomy for all detected meniscal lesions was done.

Notch preparation: Notch preparation was done routinely on all patients to provide visibility of the femoral attachment site and to prevent ACL graft interference. The intercondylar notch was firstly exposed by resecting ligamentum mucosa. Next, a full radius motorized shaver blade was used. ACL remnant was examined, and the notch shape and size were analysed using a motorized shaver.

Tibial tunnel placement: Tibial tunnel should be positioned. Guide was set at 55° angle. This allowed proper trans-tibial femoral tunnel placement. Too steep angels would place the femoral tunnel far anterior while a flat tibial tunnel would place femoral tunnel far posterior violating posterior cortex. Guide aimer was passed through medial portal.

Now we have created a femoral tunnel bottle neck shaped with the upper major part corresponding to the diameter of the knot surrounded by compacted spongy bone and a distal part of 12 mm length

corresponding to graft loop diameter surrounded by cortical bone.

Graft passage: a guide wire was passed with eyelet from tibial tunnel into femoral tunnel then we passed graft suture into guide wire eyelet then graft sutures pulling into femoral tunnel, tibial tunnel through knee joint. In cases that we did the femoral tunnel through the anteromedial portal the passage of the graft was a more difficult step than cases of femoral tunnel done through tibial tunnel. We passed the guide wire through the anteromedial portal into the femoral tunnel and the sutures of the graft passed through the eyelet of the guide wire and then pulling on the sutures to bring them inside the knee then the sutures were grasped by a grasping forceps introduced from tibial tunnel into knee. Then we used a probe to direct graft into tibial tunnel. We pulled on the sutures on the graft and move the knee through a full range of motion 20 times with forceful traction on the loops to ensure that the knot press-fitted into bottle neck femoral tunnel. Abrupt jolt signals that knot has reached tunnel's step, and knot tightens.

Graft distal stabilization: Graft tibial stabilization by bioresorbable interference screws in all patients in the two groups. Using arthroscopy, inspect and probe graft to ensure that it is taut. Ensure that there is no impingement and that no bone or screw protrudes from tibial tube into joint. Examine knee stability using Lachman and pivot shift manoeuvres.

Ending of operation: The last step is to ensure the stability by doing Lachman test, anterior drawer test and testing the graft tension by probing. A suction tube inserted into the knee through the anterolateral portal. Skin closure by subcuticular suture. Dressing and an elastic bandage wrapped around knee, together with a creep bandage reaching from toes to mid-thigh area. Mean operative duration was 75 minutes with a range between 60 minutes and 90 minutes.

Postoperative rehabilitation protocol: Restoration after ACL repair has evolved significantly during previous decade. The present protocol emphasizes early extension, unrestricted weight bearing and a more expedient return to athletic activity [8].

Ethical consideration: This study was ethically approved by the Institutional Review Board of the Faculty of Medicine, Helwan University (approval code: REC-FMHU 8-2020). Written informed consent was obtained from each participant. This study was executed according to the code of ethics of the World Medical Association (Declaration of Helsinki) for studies on humans.

Statistical analysis

Statistical analysis was done by SPSS v26 (IBM Inc., Chicago, IL, USA). Quantitative variables were presented as mean and standard deviation (SD) and compared between the two groups utilizing unpaired Student's t- test. Qualitative variables were presented as frequency and percentage (%) and were analysed utilizing the Chi-square test or Fisher's exact test when appropriate. A two tailed P value < 0.05 was considered statistically significant.

Results:

Table (1) showed age groups and incidence in the studied groups.

Table (1): Age groups and incidence

Patients	**Group 1**	**Percentage**
21-25	3	35**%**
26-30	4	30**%**
31-35	0	15**%**
36-40	3	20**%**
Affected side		
Right side	6	60**%**
Left side	4	40**%**
Cause of injury		
Sports related	14	70**%**
Miss stairs	3	15**%**
Traffic	2	10**%**
Twisting while walking	1	5**%**

Locking: Two cases suffered from severe locking, three patients suffered from moderate locking, two patients suffered from mild locking, while thirteen patients did not suffer from locking. Average time among injury and surgery was five months, with minimum time was one month and the maximum time was 1 year (Table 2).

Table (2): Showing locking and injury operation time

Patients	**No.**	**Grade**	**Percentage %**
Mild	2	+	10**%**
Moderate	3	++	15**%**
Severe	2	+++	10**%**
No locking	13	0	65**%**
Total	20		100**%**
Time months	**No**		**Percentage**
1-4	10		50%
5-8	4		20%
9-12	6		30%
Total	20		100**%**

Our study included 20 patients all have jerk test positive with 10 individuals grade II (obvious), 5 individuals grade I (just detectable) and 5 patients grade III (gross). Lachman test was positive in all individuals. 3 individuals were grade I, 12 individuals were grade II and 5 individuals were grade III (Table 3).

Table (3): Pivot shift and Lachman test

Jerk test	**Grade**	**No.**	**Percentage**
Just detectable	+	5	25%
Obvious	++	5	25%
Gross	+++	10	50%
Lachman test			
(5mm) anterior tibial excursion	+	3	15%
(5-10mm) ant tibial excursion	++	12	60%
(>10mm) ant. tibial excursion	+++	5	25%

ADT is conducted with knee flexed 90 degrees and rotated neutrally. Test was done to detect associated meniscal injury. The test was negative in 12 patients, positive for torn medial meniscus in 5 patients, positive for torn lateral meniscus in 3 patients a positive for both menisci in 0 patients (Table 4).

Table (4): Anterior drawer test in neutral tibial rotation (ADT-NR) and preoperative McMurray test

ADT-NR	**Grade**	**No.**	**Percentage**
5mm anterior tibial excursion	+	3	15%
5-10mm ant tibial excursion	++	11	55%
>10mm ant. tibial excursion	++	6	30 %
McMurray test	**No. of patient**		**%**
Negative	12		60%
Positive for Medial meniscus	5		25%
Positive for Lateral meniscus	3		15%
Positive for both menisci	0		0%

Thigh girth is measured in all cases 15 cm proximal to joint line and compared to the sound side. There were 8 patients equal to other side, 5 patients had thigh girth < 5 mm compared to other side, 3 patients have from 6-10 mm difference, and 4 patients has > 1 cm difference. The MRI showed that 11 patients showed isolated anterior cruciate ligament tear, 8 patients showed medial meniscus tear and 1 patient lateral meniscus tear (Table 5).

Table (5): pre-operative thigh girth and MRI findings

Item	**No.**	**Percentage**
Equal	8	40%
1-5 mm	5	25%
6-10 mm	3	15%
11-15 mm	4	20%
MRI findings		
Lateral Meniscus	1	5%
Medial Meniscus	8	40%
Isolated ACL tear	11	55%

All the patients at the end of 6 months follow up were functionally evaluated based on Modified Cincinnati score. Of the 20 patients, 14 patients had normal result, 4 patients had nearly normal outcome and 2 of our patients had poor results. Symptoms evaluation with Modified Cincinnati score: In the symptom evaluation of the knee 14 patients normal, 4 patients near normal and 2 patients abnormal (Table 6).

Table (6): Subjective outcome with IKDC scoring and modified Cincinnati score

IKDC scoring	Group A	Percentage
Normal	7	70%
Near Normal	2	20%
Abnormal	1	10%
Modified Cincinati score		
Normal	7	70%
Near Normal	2	20%
Abnormal	1	10%

Discussion

Implants used for traditional ACL graft stabilization have been linked to complications including graft damage, implant osteolysis, implant migration, and soft tissue irritation. Additional advantages of implant-free ACL reconstruction include reduced costs, enhanced graft integration, and simplicity of revision surgery [9].

Shanmugaraj *et al.* (10) evaluated original press fit stabilization to interference screw stabilization and discovered that ultimate load for press fit was 215N less than for interference screw 328N. **Musahl *et al.* (11)** utilized a cyclic loading regimen to replicate early post-surgical restoration and found that mean load to failure for titanium screws was 945N, 797N for bio absorbable screws, and 410–710N for press fit approach. Eighteen of thirty press-fit bone grafts failed due to bone plug pull out or breakage. They determined that press-fit stabilization was insufficiently stable for fast rehabilitation regimen.

Biazzo *et al.* (12) found that press fit stabilization in a 1 mm undersized tunnel had same pullout strength as interference screw stabilization. **Shanmugaraj *et al.* (10)** stated that failure load findings for press fit and interference screw stabilization groups in their biomechanical investigation were comparable. Two more studies later observed that femoral press-fit stabilization of (570–1,210N) provided a better failure load compared to interference screw stabilization. **Biazzo *et al.* (12)** investigated hamstring knot press fit femoral method and determined that it had a failure load of 540N and a stiffness of 37.8N/mm. Employing their robotic universal force moment sensor, anterior translation with endobutton fixed grafts and hamstring knot press-fit grafts worked comparably. **Schilaty *et al.* (13)** evaluated in a cadaver biomechanical model use of quadriceps tendon for press-fit ACL restoration and showed that failure loads were equal to those of bone tendon bone grafts (BTB).

Concerning IKDC, outcomes of our research group are similar to those of prior clinical trials assessing press-fit ACL restoration. We had 90% normal or almost normal findings regarding IKDC, Yu-jie L had 87 %, Felmet had 98 % and Kaseb et al. had 92 % normal or near normal subjective outecomes. These data assessment revealed that they are similar in most respects to outcomes of previous clinical investigations and suggested subjective and objective effectiveness of the procedure. Nevertheless, our research showed that this method had disadvantages and hazards. In beginning, our procedure was technically rigorous and has a less steep learning curve than other commonly used ACL rehabilitation methods.

Conclusions: Hamstring graft knot ACL surgery approach can be used as a dependable option in ACL rehabilitation. In addition, it is preferred because it is biological, economical, post-operative MRI friendly, improved graft incorporation and allows easier revisions. On the other hand, it doesn't carry the risk of implants usage for conventional ACL graft stabilization, which has been linked to complications including graft damage, implant migration implant osteolysis and soft tissue irritation.

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Conflict of Interest: Nil

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