OUTCOME OF SIMULTANEOUS ARTHROSCOPIC ANTERIOR AND POSTERIOR CRUCIATE LIGAMENT RECONSTRUCTION USING AUTOGENOUS GRAFTS WITH ALL-INSIDE TECHNIQUE

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Summary

Introduction: Bicruciate knee ligament injury is a lesion affecting both the posterior cruciate ligament (PCL) and the anterior cruciate ligament (ACL) simultaneously, which is one of the most severe knee joint injuries. Operative simultaneous reconstruction is the standard of treatment. ***Objectives:*** To evaluate clinical results of one-stage ACL and PCL reconstruction using autogenous tendon grafts with an all-inside technique. ***Material and methods:*** The medical records of patients operated on by a group of surgeons at the Orthopedic Center, Military Hospital 103 from March 2015 to March 2020 were retrospectively analyzed. Thirty-four patients (24 males, 10 females) with combined rupture of both ACL and PCL underwent one-stage ACL and PCL reconstruction using autogenous hamstring and peroneus longus tendon grafts with all-inside technique. **Results:** The mean time of follow-up was 32.09 ± 25.15 months (9 - 68 months). The mean age was 37.7 ± 9.0 years (range 23 - 56 years). At the final follow-ups, all patients were without limit extension, 5/34 patients (14.71%) with limit flexion. The Lachman test was negative in 32 patients (94.12%), the pivot shift testing in 32 patients (94.12%) was negative, 26 patients (76.47%) had a positive posterior drawer test. The Lysholm knee score preoperative and final follow-up were 46.76 ± 17.08 (range 12 - 82) and 89.29 ± 8.57 (range 50 - 99) ($p < 0.01$), respectively. ***Conclusion:*** This study demonstrates the effectiveness and safety of simultaneous arthroscopically assisted reconstruction of both ACL and PCL using autogenous hamstring and peroneus longus tendon for restoring knee stability with an all-inside technique.

* *Keywords: All-inside technique; Autogenous grafts; Simultaneous reconstruction; Anterior cruciate ligament; Posterior cruciate ligament.*

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INTRODUCTION

Bicruciate knee ligament injury is a lesion affecting both PCL and ACL simultaneously. It is one of the most severe knee joint injuries. Combined rupture of both ACL and PCL often results in significant functional disability and requires surgical treatment [1]. Studies approaches the outcomes of bicruciate knee ligament reconstruction on quality of life, symptom improvement, return to work and sports practice, the choice of grafts, the graft tensioning, as well as subjective and objective assessments of outcomes are still scarce in the literature, thus presenting a topic of substantial interest.

Today, early simultaneous reconstruction of the ACL and PCL is recommended. Also, staged procedures are much more time-consuming for the patient, and it requires two operative procedures as well as two rehabilitation programs.

Allogenous tendon grafts have been recommended specifically for combined ligament injuries as a reproducible procedure [2] because of some advantages; the lack of donor site morbidity, reduction of operating time, and the strength of the large grafts. The purpose of the present study is: *To evaluate the clinical results of one-stage ACL and PCL reconstruction using autogenous tendon grafts with all-inside technique*.

MATERIAL AND METHODS

Thirty-four patients with combined rupture of both ACL and PCL underwent one-stage ACL and PCL reconstruction using autogenous tendon grafts. All of these patients were operated on by a group of surgeons at the Orthopedic Center, Military Hospital 103 from March 2015 to March 2020.

** Inclusion criteria:*

Age 18 - 60 years, knee instability has both cruciate ligaments injury. Patients underwent one-stage ACL and PCL reconstruction using autogenous tendon grafts.

** Exclusion criteria:*

Patients with contraindications to arthroscopy (local skin in infection or disease), history of previous ligament reconstruction or arthroscopic knee procedures, joint inflammatory disease, patients with lesions or associated disease affecting the functional and motion assessment of the knee joint (such as certain hip, ankle, or lumbar spinal disease or having a patella or injury other bones that affect knee joint mobility), patients with collateral ligament injury/posterolateral rotatory instability were excluded from the study.

** Definition of variables:*

Data on age, sex, time between initial injury and surgery, type of trauma, size of grafts, knee function Lysholm scale before and after surgery and complications were recorded for each patient.

** Surgical procedure and rehabilitation:*

The patient is placed in the supine position with a standard leg holder allowing the full range of motion under spinal anesthesia. A tourniquet is placed on the proximal thigh of the injured leg. The leg is prepared and draped in the standard sterile fashion. Standard arthroscopy is used to confirm ACL and PCL deficiency.

Tendon harvesting:

Hamstring tendon harvesting. An oblique incision of approximately 2 cm was made 2 cm medial to the tibial tubercle. Dissection was carried down through the subcutaneous tissue. Next, both semitendinosus and gracilis tendons should be individually identified and isolated. The tendons were then harvested using the stripper open (Arthrex) with knee flexion.

The peroneus longus tendon (PLT) harvesting was done in the ipsilateral leg. The incision location was marked at 2 - 3 cm above and 1 cm behind the lateral malleolus. The location of tendon division was marked at 2 - 3 cm above the level of the lateral malleolus. Distal part of the peroneus longus tendon was sutured with peroneus brevis tendon.

Graft preparation:

We used the hamstring tendon as the ACL graft. The tendons were quadrupled bands and looped with TightRope and Button (Arthrex). The graft ligament with 7 - 10 mm in diameter and 55 - 70 mm in length. Each end of graft was stitched with No.1 nonabsorbable sutures approximately 2 cm in length. Each stitch must pass through each strand of graft.

The peroneus longus tendon was used for the PCL graft. The tendon was tripled bands and looped with the two TightRopes (Arthrex) together to have a graft ligament of 7 - 9 mm in diameter and 70 - 90 mm in length. Each stitch must pass through each strand of graft.

PCL femoral tunnel preparation:

Under arthroscopy, the disrupted stump of the PCL was first debrided. The femoral remnant of the PCL was removed to assist in visualization. All patients have used the single tibial-single femoral tunnel technique. The femoral socket was created using the PCL femoral guide (Arthrex) under the arthroscopy with 20 mm of depth and the same diameter as the end of the graft.

ACL femoral and tibial tunnels preparation:

The ACL femoral tunnel was performed by the all-inside technique, the center of the femoral footprint was identified during the removal of the ACL remnants. The femoral socket was created with the help of a femoral offset guide (Arthrex). For the ACL tibial tunnel, the tibial drill guide (Arthrex) was set at 55°, and it was placed 2 cm medial to the tibial tuberosity on the distal tibial cortex. The tibial tunnel was drilled by a FlipCutter (Arthrex) with the same diameter as the graft. The length of tibial tunnel is about 20 - 30 mm, depending on the length of the graft.

PCL tibial tunnel preparation:

The accessory posteromedial and posterolateral portal were used to create a tibial tunnel. A posteromedial portal is established under arthroscopic visualization with the scope in the anterolateral using the out-in technique. The scope was through the posteromedial, the shaver, and radiofrequency were through the posterolateral to exposure of the anatomic tibial socket site as well as visualization. The PCL tibial guide (Arthrex) is positioned at the base of the PCL facet through the anteromedial portal while viewing from the posterolateral portal with 30° scope. The position entrance of the PCL tibial tunnel on the medial face proximal tibial is 1 cm distal to the entrance of ACL tibial tunnel. A FlipCutter (Arthrex) with the same diameter as the end of the graft was then drilled from anterior to posterior through the tibia until the drill tip penetrated the posterior cortex. The PCL guide is used to protect the tip of FlipCutter from plunging into the posterior neurovascular structures. The FlipCutter was reamed retrograde to a depth of 35 - 40 mm.

Graft passage and fixation:

We fixed the PCL graft first and followed by the ACL graft fixation. Pull the PCL graft into the femoral socket through the anterolateral portal. The TightRope sutures should be tensioned to seat the graft to a depth of approximately 20 mm in the femoral socket. Then pass the graft into a tibial socket, the arthroscope is then placed into the posteromedial portal, and the tibial portion of the graft was visualized to ensure that at least 20 mm of the graft in the tibial socket. Retensioning the femoral-sided and tibial-sided TightRope secured the PCL graft in both the femoral and tibial sockets with the knee flexed to 90° and an assistant applied anterior drawer.

Next, ACL graft passage and fixation. We shuttled femoral Button sutures through the anteromedial portal, passed the graft through the anteromedial portal, and fixed the graft on the femoral side and then shuttled the tibial sutures and fixed the graft on the tibial side. The knee is moved through its range of motion, and additional tension may be applied by pulling the tibial sutures by hand, with a reverse Lachman maneuver performed as tension is applied. Under the endoscopy, check and re-evaluate the strength of the grafts, and clean the joint.

Rehabilitation:

A fully extended knee with a posterior tibial support brace is applied to the operative extremity. Full weight bearing is permitted as tolerated, with the brace locked in full extension. Quadriceps isometric exercise and passive range of motion should be initiated during the early post-operative period, shortly following surgery. For 1 month, a protected range of motion from 0° to 60° is allowed. Full weight-bearing is permitted with a normal gait at 6 weeks. At 8 weeks, the range of motion progressed to 90°. Finally, the patient is allowed to resume normal daily activities after 12 weeks and sports after 9 months.

** Clinical assessment at follow-up:*

Patients were followed up at regular intervals for evaluation and supervision of the rehabilitation process. For the overall evaluation of the functional outcome of the procedure; the range of motion and Lysholm score were measured at the final follow-up. For the stability of the knee, Lachman test, Pivot shift test, anterior drawer test, and posterior drawer test were done.

** Statistical analysis:*

Data were analyzed using the SPSS software for windows, version 20.0 (SPSS Inc., Chicago, IL, USA). Quantitative variables: Data presented as mean ± variance, maximum, and minimum value. Qualitative variables: Presented by frequency and radio. For comparison of pre-operative and post-operative results in a single group, the paired T-test was used. The Mc Nemar test was used to compare the pre-operative and post-operative Lachman test, anterior drawer test, Pivot shift test, and posterior drawer test. A p-value of less than 0.05 was considered statistically significant.

** Research ethics:*

All patients' data were secure throughout the study to protect the anonymity of the patients. All patients gave their written and informed consent to enter the study.

RESULTS

Simultaneous ACL and PCL reconstruction was done in 34 patients (24 males, 10 females) with hamstring tendon and peroneus longus tendon autograft; the mean duration of follow-up was 32.09 ± 25.15 months (9 - 68 months). The mean age at the time of surgery was 37.7 ± 9.0 years (range 23 - 56 years). Nine patients with acute ACL and PCL injuries were operated on after four weeks, and in the remaining chronic cases. The mechanism of injury was sports activities in 10 patients, road traffic accidents in 22 patients, and working accidents in two patients. Four patients had history of a knee dislocation. Demographic data are represented in *Table 1*. The mean operating time (also the total tourniquet time) was 92.94 ± 21.15 minutes (range 60 - 140 minutes). 11 patients required partial meniscectomies for associated meniscus tears.

Table 1: Data for the patients (n = 34).

Variables	Number of patients
Gender (male/female)	24/10
Mean age at surgery (mean, range), year	37.7 ± 9.0 (23 - 56)
Mean duration of surgery (mean, range), min	92.94 ± 21.15 (60 - 140)
Mechanism of injury (sports, traffic accident, others)	10/22/2

In the complications, we found one case of knee joint synovitis who underwent surgery to clean the joints and placed negative pressure drainage for 72 hours. The patient's condition was then stabilized, and the rehabilitation program was continued.

At the final follow-ups, all patients were without limit extension. There were 5/34 patients (14.71%) with limited flexion (one patient was limited to 15 degrees and the four patients were limited to 5 - 10 degrees). Clinical examination demonstrated that the Lachman test was negative (grade 0) in 32 patients (94.12%), two patients (5.88%) had Lachman test positive. On pivot shift testing, 32 patients (94.12%) had a grade 0 test result, and two patients (5.88%) had a positive test result. 8 patients (23.53%) demonstrated a positive posterior drawer test.

The evaluation of the Lysholm knee score pre-operative and final follow-up were 46.76 ± 17.08 (range 12 - 82) and 89.29 ± 8.57 (range 50 - 99) ($p < 0.01$), respectively.

Table 2: Functional outcomes before and after surgery (n = 34).

Clinical test	Before surgery	After surgery	p
Lysholm (mean, range)	46.76 ± 17.08 (12 - 82)	89.29 ± 8.57 (50 - 99)	< 0.001
Anterior drawer test (+)	33 (97.06%)	4 (11.76%)	
Lachman test (+)	34 (100%)	2 (5.88%)	
Posterior drawer test (+)	34 (100%)	8 (23.53%)	
Pivot ship test (+)	32 (94.12%)	2 (5.88%)	

The average diameter of PCL graft at tibial ends and femoral ends was 8.03 ± 0.72 mm (10.00 - 7.0 mm) and 8.16 ± 0.70 mm (10.00 - 7.0 mm), respectively. The average length of PCL grafts was 88.68 ± 21.44 mm (140 - 7.0 mm), with the shortest length of 70 mm. After excluding the 30 mm intra-articular length, the remaining length in each tunnel averaged 25 mm, with a minimum of 20 mm.

The average diameter of ACL graft at tibial ends and femoral ends was 7.90 ± 0.72 mm (9.0 - 7.0 mm) and 8.03 ± 0.73 mm (9.50 - 7.0 mm), respectively. The average length of ACL grafts was 65.38 ± 17.70 mm (130 - 55 mm).

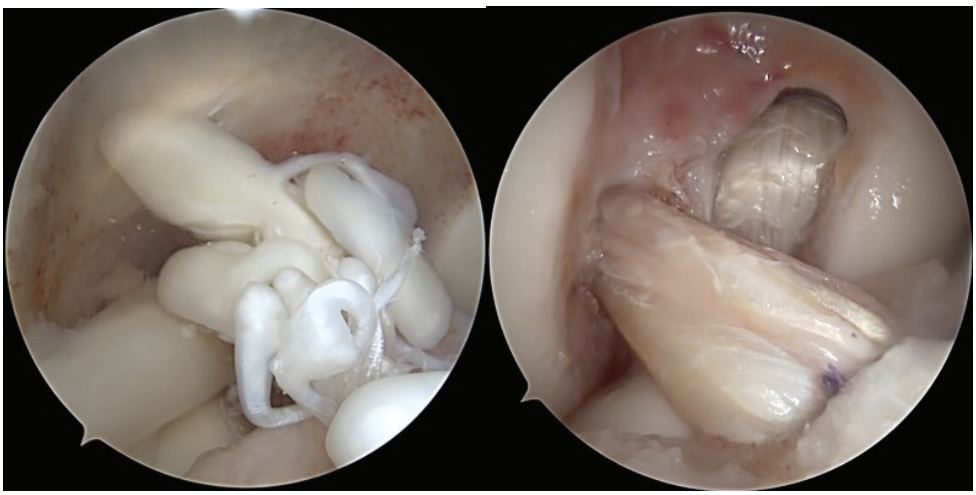

Figure 1: Before and after ACL reconstruction.

DISCUSSION

A road traffic accident was one of the most common causes of multi-ligament injuries, followed by sports injuries. Roman, et al [3] reported that 60% out of 30 patients had an injury due to road traffic accidents which are consistent with our study, where 22/34 patients presented with road traffic accidents and 12 patients with sports injuries. Saravanan, et al [4] showed that 8/12 patients combined PCL and ACL injury due to traffic accidents, 4 patients with sports injuries.

Surgical intervention for multi-ligament injuries was either two-stage ACL & PCL reconstruction or single-stage arthroscopic ACL & PCL reconstruction. Mariani, et al reported that 15 patients with multi-ligament instability treated with simultaneous arthroscopic reconstruction of ACL & PCL would have a high level of efficacy and safety, and avoid major exposure with open reconstruction.

The choice of grafts is one of the most important issues in reconstructing multiple ligaments. Previous studies used various grafts, including allograft and/or autograft [5]. The techniques used by Fanelli and Edson included allograft Achilles tendon graft, allograft bone-patellar tendon-bone, autograft bone-patellar tendon-bone, and autograft hamstring tendon. Statistically, significant improvement was noted in knee stability and function. Bone-patellar tendon-bone autograft is regarded as the treatment of choice because of its superior strength and minimal healing period [6]. There are some disadvantages when using quadriceps tendon as grafts, including: morbidity or weakness after removing a section of the quadriceps, post-operative pain during kneeling, pain during squatting, post-operatively detectable pivot shift tests, and weakness in knee extension [6]. Hamstring tendon autografts have the added advantage of easier passage through the bone tunnel in comparison with bone-patellar tendon-bone grafts [5].

Because of tissue availability and surgical simplicity, hamstring, and PLT autografts were used in these series for the simultaneous arthroscopic reconstruction of the ACL and PCL. PLT autograft is thicker and wider than the hamstring tendon, thus providing an ample source of tendons for PCL reconstruction purposes. Both ends of the PCL graft were fixed with Tightrope. For ACL reconstruction, the femoral end of the ACL graft was fixed with a Button, the tibial end was used Tightrope. This technique provides stable fixation for ACL and PCL reconstruction with some advantages,

including creating the femoral socket, accurate measurement of the whole thickness of the femoral condyle before drilling, the possibility of minor changes according to the desired femoral canal length, the ability to achieve no space in the femoral canal between the graft and bony canal, and lower pain levels after surgery [7].

In the present study, we have shown that combined ACL and PCL injuries can be successfully treated with one-stage arthroscopic bi-cruciate ligament reconstruction using autogenous hamstring tendon and PLT. Statistically significant improvement in knee function was noted with the Lysholm score. The Lysholm score pre-operatively was 46.76 ± 17.08 (range 12 - 82), and the post-operative was 89.29 ± 8.57 (range 50 - 99), $p < 0.01$. Riku Hayashi evaluated the clinical results of one-stage ACL and PCL reconstruction using autogenous tendon grafts for chronic instabilities of the knee. The Lysholm score averaged 95.1 ± 4.4 points (range 85 - 100) at the final follow-up [8].

At final follow-up, 2/34 knees (5.88%) had abnormal Lachman, and pivot ship 8/34 (23.53%) had abnormal posterior drawer test results, 4/34 knees (88.24%) had abnormal anterior drawer test results. In Yang-Pin Lo'study, after reconstruction, 10/11 knees (91%) had normal Lachman and pivot shift test results. However, 6/11 knees (55%) had a normal tibial step-off and normal posterior drawer test, and 5/11 knees (45%) revealed a decrease of 5 mm in tibial step-off, corresponding to a grade I posterior drawer [7].

In this study, 5 patients (14.71%) developed ROM problems after surgery. All patients were without limit extension, knee ROM was abnormal in one patient (lost 15° of flexion), and four patients were limited to 5 - 10°. Knee ROM was abnormal in one patient (lost 11 - 15° of flexion) and severely abnormal in the other patients (lost 25° of flexion). After reconstruction, combined anterior and posterior cruciate ligaments on 19 patients, Riku Hayashi found no patients with loss of knee extension of more than 5°, while three patients revealed loss of knee flexion of more than 16°. The mean flexion loss was 8.9 ± 7.8 (range 0.0 - 25.0) at the last follow-up [9].

Though the functional outcome of simultaneous bicruciate ligament reconstruction was good, one limitation of our study was the small study population size due to the rarity of the injury. A large-scale randomized trial is needed to verify the efficacy of the procedure.

CONCLUSION

This study demonstrates the effectiveness and safety of simultaneous arthroscopically assisted reconstruction of both ACL and PCL using autogenous hamstring and peroneus longus tendon for restoring knee stability with an all-inside technique.

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