Clinical outcomes of percutaneous reconstruction of anterolateral ligament in anterior cruciate ligament-deficient knee in skeletally mature patients

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Background
Rupture of the anterior cruciate ligament (ACL) is one of the most common sports injuries of the knee joint. The results of combined ACL and anterolateral ligament (ALL) reconstruction have shown a significant improvement in clinical outcome.
Objectives
To evaluate clinical outcomes of combined ACL and ALL reconstruction in ACL-deficient knee.
Patients and methods
This study included 20 patients aged from 21 to 45 years, who presented with ACL-deficient knee. Combined ACL and ALL reconstruction were performed to all cases. Patients were followed up for 24 months postoperatively. Patient assessment included preinjury, preoperative and postoperative subjective and objective International Knee Documentation Committee, Tegner activity scale, and Lysholm scores.
Results
Our study showed that the postoperative mean Lysholm knee score (94.20 ± 4.55) was significantly improved than preoperative (65.62 ± 3.42) (P<0.001) and there were 17 (85%) patients postoperatively with an excellent score. Also, postoperative mean Tegner activity score and International Knee Documentation Committee (8.22 ± 1.64 and 87.25 ± 8.71, respectively) were significantly improved than the preoperative (6.73 ± 1.21 and 52.71 ± 11.35, respectively) values (P=0.031 and P<0.001, respectively). The instrumented knee laxity test was performed using a KT-1000 arthrometer where the mean of postoperative translation (3.28 ± 0.74 mm) was significantly lower than the preoperative (11.15 ± 0.82 mm) (P<0.001) value.
Conclusion
Our technique of combined ACL and ALL reconstruction was found to be effective in improving subjective and objective outcomes. Also, no serious complications were noted with this operative procedure.

Keywords:
anterior cruciate ligament-deficient knee, anterior cruciate ligament reconstruction, anterolateral ligament reconstruction

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Introduction

Anterior cruciate ligament (ACL) injuries account for more than 60% of all knee injuries in pivoting sports. Several surgical techniques for ACL reconstruction were developed to improve functional stability of the injured knee and minimize meniscal and articular cartilage damage as well as to provide athletes a chance to return to their preinjury sporting activities. Although the long-term outcomes of ACL reconstruction are favorable, normal rotational stability of the knee is not fully restored. Such abnormal biomechanics of the joint can be a reason for the development of further articular injuries [1,2].

The anterolateral ligament (ALL) contributes to the rotational stability of the knee joint, which has been proven in many anatomical and biomechanical studies [3,4]. Tear to the ACL is known to often come with injury of the ALL [5]. Today, we have various techniques of the ALL reconstruction [6].

Percutaneous ALL reconstruction differs from other lateral extra-articular tenodesis-type procedures because the procedure is anatomically based and can be percutaneously performed [7]. Nonanatomic procedures (typically with a strand of ITB passed under the lateral collateral ligament) have been reported to be associated with overconstraint, early arthritis, and an increased risk of infection [8,9]. In

contrast, ALL reconstruction restores normal knee kinematics and avoid overconstraint when correctly fixed in full extension and neutral rotation [10]. However, a recent study has demonstrated that combined ACL and ALL reconstruction is associated with a reoperation rate that is not comparable with the rate seen after isolated ACL reconstruction, and it has a very low rate of complications [11]. This makes an anatomic ALL and ACL reconstruction being the procedure of choice when considering an extra-articular procedure. This is further supported by the fact that combined ACL and ALL reconstruction is currently the only type of lateral extra-articular procedure that has been demonstrated to significantly reduce the risk of ACL graft rupture and improve the rate of return to sports [12].

We aimed to evaluate clinical outcomes of combined ACL and ALL reconstruction in ACL-deficient knee.

Patients and methods

This was prospective case series study that included 20 patients aged from 21 to 45 years, who presented with ACL-deficient knee and carried out at the Orthopedic Department, Helwan University Hospital from February 2017 to January 2019. Informed consent was obtained from all participants before enrollment into the study. The Ethics Committee of Helwan University approved this study and permitted us to review patients' medical data.

The diagnosis of an ACL tear was confirmed by physical examination and MRI. The patients were considered eligible for enrollment if they had a unilateral primary ACL tear. The main indications for combined ALL and ACL reconstruction are young age (around 20 years) high-demand athlete, high-grade pivot shift on examination (≥grade III), Segond fracture on radiograph, revision ACL reconstruction, and chronic ACL injury of more than 12 months.

Patients who had multiligament knee injuries, triple or quadruple semitendinosus diameter of 7 mm, and lateral compartment arthritis were excluded.

Surgical procedure

Combined ACL and ALL reconstruction was performed as described elsewhere [13,14]. Concomitant intra-articular meniscal and chondral pathology were addressed in the standard manner. The procedure is briefly summarized here. Landmarks of tibial and femoral attachment of ALL are demonstrated in Fig. 1.

Figure 1

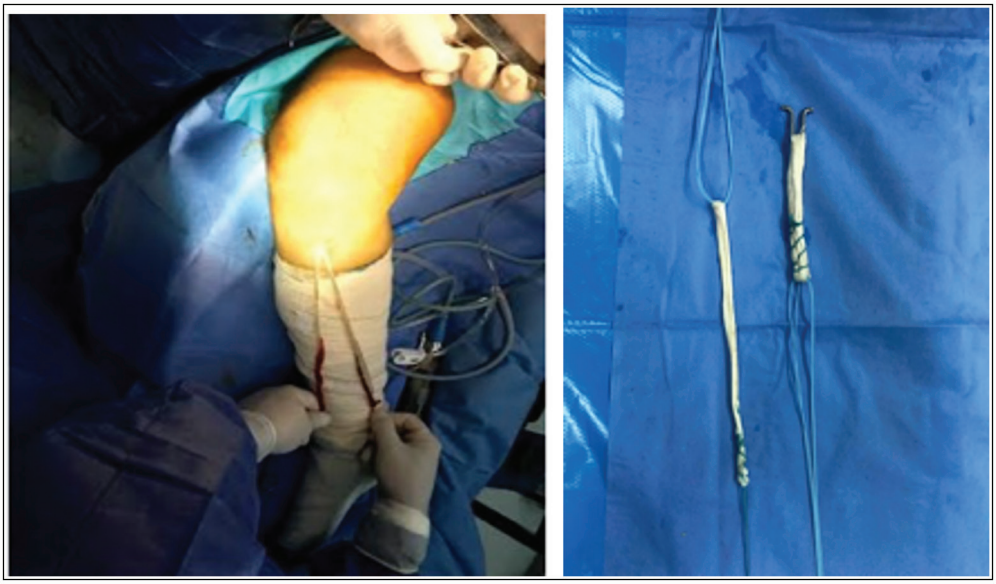
Landmarks of ALL attachment. ALL, anterolateral ligament.

Hamstring tendon autografts were harvested. The gracilis tendon was detached and sutured in double loop, and semitendinosus is detached from its tibial attachment and harvested in a quadruple loop (Fig. 2).

The ACL graft was then created using a quadruple semitendinosus tendon, and the gracilis tendon is used forming the ALL graft. An outside-in femoral guide was placed proximal and posterior to the lateral epicondyle and at the femoral origin of the ACL and used to drill a tunnel of the same size as the graft diameter. For ALL reconstruction, a 7 mm drill was used to create a tibial and femoral tunnel (Fig. 3).

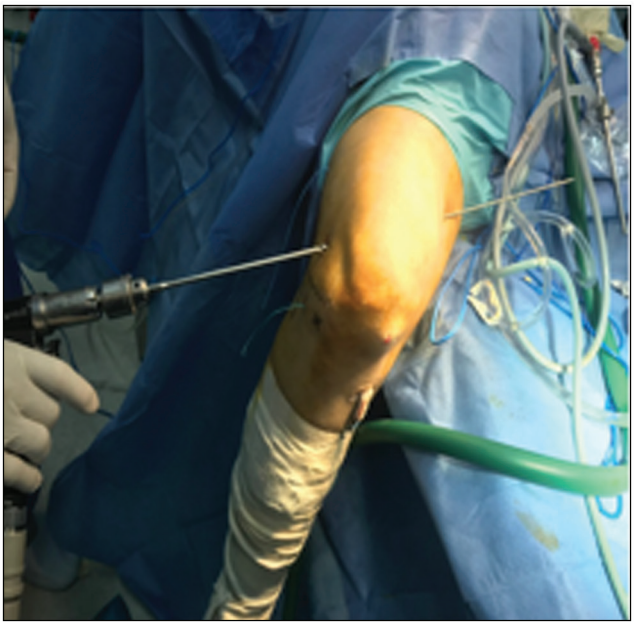
The ACL and ALL grafts were then routed proximally through the knee. The ACL portion of the graft was fixed with interference screws on the femoral sides and with loops in the tibial side while the knee in 30° of flexion (Fig. 4). The ALL graft was then routed deep into the iliotibial band from the femur, through the tibial tunnel, and back under the iliotibial band to the anatomic origin of the ALL (Figs 5,6). The knee was placed in full extension and neutral rotation, and the graft was secured to itself at this location with a previously placed and fixed by an interference screw on the tibial and femoral side.

Figure 2



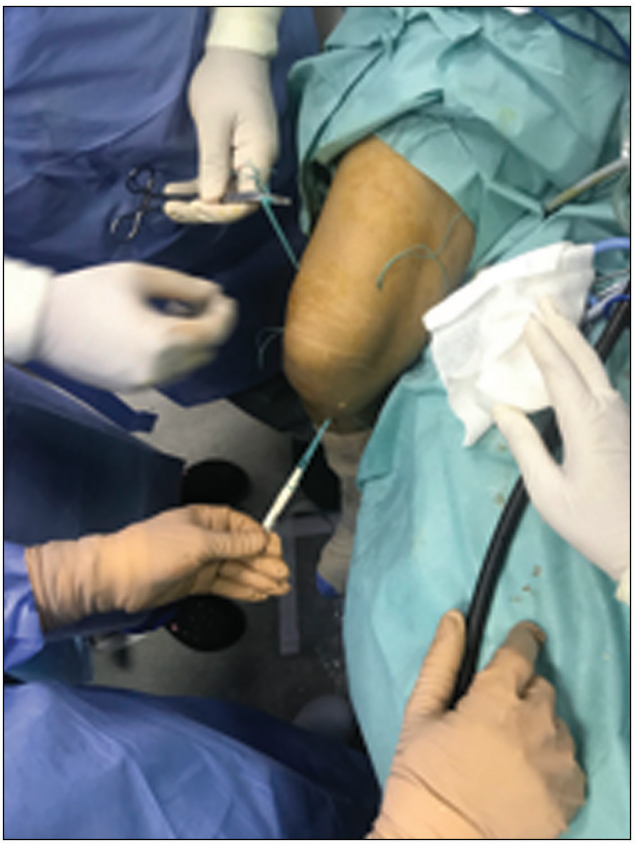
Harvesting of gracilis and semitendinosus tendons.

Figure 3



Femoral guide was placed proximal and posterior.

Figure 4



ACL graft routed proximally through the flexed knee at 30°. ACL, anterior cruciate ligament.

Rehabilitation

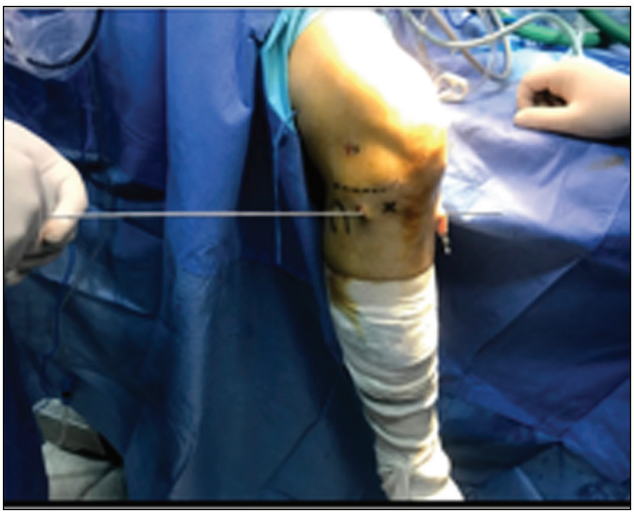
Patients were asked to mobilize brace free, weight bearing with crutches immediately after surgery, unless they underwent a meniscal repair, in which case they were instructed to remain in partial weight bearing and limit their flexion to 90° for 6 weeks. Cycling was recommended at 1 month, jogging at 3 months, and return to competition at 6–9 months.

Outcome measures

Patients were reviewed at 3 and 6 weeks and at 3, 6, 12, and 24 months postoperatively. Patient assessment included preinjury, preoperative and postoperative subjective and objective International Knee Documentation Committee (IKDC), Tegner activity scale, and Lysholm scores. A sports medicine physician, a surgeon, or an author other than the primary surgeon performed the physical examinations. This examination included complete ligament examination following the

instruction for the 2000 IKDC knee examination form. Instrumented knee testing was performed before surgery and at final follow-up with the Rolimeter Arthrometer (Aircast Europa, Neubeuern, Germany). A record of whether the patient underwent any subsequent knee injury or surgery was made, including revision ACL reconstruction or a contralateral ACL rupture.

Figure 5



Placement of the tibial guide wire for ALL tibial tunnel. ALL, anterolateral ligament.

Figure 6

The ALL graft is routed deep into the iliotibial band from the femur, through the tibial tunnel. ALL, anterolateral ligament.

Statistical analysis

The data collected were tabulated and analyzed by SPSS (Statistical Package for the Social Sciences), version 25 (IBM, Armonk, New York, USA) on an IBM-compatible computer. According to the type of data qualitative represent as number and percentage, quantitative continues group represent by mean±SD. The following tests were used: paired *t* test and χ^2 test. *P* value was considered significant if less than 0.05 and statistically highly significant as *P* value less than 0.001.

Results

A total of 20 patients with ACL-deficient knee were enrolled in the current study. Their mean age was 32.81 ± 7.33 and ranged from 21 to 45 years and the majority were males (16 patients, 80%). The mean duration from injury to surgery was 1.8 ± 0.6 month. Meniscal tears and surgery distributed in Table 1.

Regarding functional outcome, postoperative mean Lysholm knee score (94.20 ± 4.55) was significantly improved than preoperative (65.62 ± 3.42) (*P*<0.001) and there were 17 (85%) patients postoperatively with an excellent score. Also, postoperative mean Tegner activity score and IKDC (8.22 ± 1.64 and 87.25 ± 8.71, respectively) were significantly improved than preoperative (6.73 ± 1.21 and 52.71 ± 11.35, respectively) (*P*=0.031 and *P*<0.001, respectively). The instrumented knee laxity test was performed using a KT-1000 arthrometer, where the mean of postoperative translation (3.28 ± 0.74 mm) was significantly lower than preoperative (11.15 ± 0.82 mm) (*P*<0.001) (Table 2).

Table 1 Distribution of patients regarding basic characteristics

	Case (*N*=20) [*n* (%)]
Age (year)	
Mean±SD	32.81 ± 7.33
Range	21–45
Sex [*n* (%)]	
Male	16 (80)
Female	4 (20)
Duration from injury to surgery (month)	
Mean±SD	1.8 ± 0.6
Range	2–8
Meniscal tears [*n* (%)]	
Medial	5 (25)
Lateral	7 (35)
Both	1 (5)
Medial meniscal surgery [*n* (%)]	
Repair	4 (20)
Meniscectomy	1 (5)
Lateral meniscal surgery [*n* (%)]	
Repair	5 (25)
Meniscectomy	2 (10)

Table 2 Functional outcomes of patients treated by combined reconstruction of anterior cruciate ligament and anterolateral ligament

	Cases (*N*=20) [*n* (%)]		*P* value
	Preoperative	Postoperative	
Lysholm knee scoring scale			
Excellent (95–100)	0	17 (85)	<0.001*
Good (84–94)	0	2 (10)	
Fair (65–83)	13 (65)	1 (5)	
Poor (≤64)	7 (35)	0	
Mean±SD	65.62±3.42	94.20±4.55	<0.001*
Range	60–70	83–98	
Tegner activity score			
Mean±SD	6.73±1.21	8.22±1.64	0.031*
Range	5.0–8.0	6.0–9.0	
IKDC			
Grade I	0	16 (80)	<0.001*
Grade II	0	2 (10)	
Grade III	9 (45)	1 (5)	
Grade IV	11 (55)	1 (5)	
Mean±SD (range)	52.71±11.35	87.25±8.71	<0.001*
KT-1000 arthrometer			
Mean±SD	11.15±0.82	3.28±0.74	<0.001*
Range	4.6–12.0	1.4–5.0	

IKDC, International Knee Documentation Committee; *no significance.

Regarding postoperative tests, 18 (90%) patients showed negative anterior drawer test and one patient recorded for both grades I and II. Also, 19 (95%) patients showed negative Lachman's test and one patient recorded for grade I. Nineteen (95%) patients showed negative pivot shift and one patient recorded for grade II (Table 3).

Considering postoperative complications, three (15%) patients had hemarthrosis managed by repeated aspirations, two (10%) patients showed flexion contracture (5–10°) that resolved 2 months later by physiotherapy, and no one showed ACL graft rupture. Overall, 95% of patients returned to sport at the latest follow-up. The rate of return to self-described preinjury levels of sport was 70% (14/20) (Table 4).

Discussion

During the past few decades, ACL reconstruction has significantly advanced. Surgeons and scientists are working hard on improving the functional outcomes and quality of life of patients with ACL injuries. Excellent results were obtained with such development; however, rotational instability remains an issue in a large minority of patients. Nevertheless, rotational instability has still not been fully resolved with double-bundle ACL reconstruction. Surgeons have therefore combined ACL reconstruction with lateral extra-articular tenodesis to overcome this problem [15].

Table 3 Clinical outcomes of patients treated by combined reconstruction of anterior cruciate ligament and anterolateral ligament

Postoperative tests	Case (*N*=20) [*n* (%)]
Anterior drawer test	
Negative	18 (90)
Grade I	1 (5)
Grade II	1 (5)
Grade III	0
Lachman's test	
Negative	19 (95)
Grade I	1 (5)
Grade II	0
Grade III	0
Pivot shift	
Negative	19 (95)
Grade I	0
Grade II	1 (5)
Grade III	0

Table 4 Distribution of patients regarding postoperative complications

Complication	Cases (*N*=20) [*n* (%)]
Hemarthrosis	3 (15)
Flexion contracture	2 (10)
ACL graft rupture	0
Total	5 (25)

ACL, anterior cruciate ligament.

The potential advantage of a combined ACL+ALL graft has been attributed to load sharing of the ALL with the reconstructed ACL. Furthermore, it has also been reported that at lateral exploration of apparently isolated acute ACL injured knees, injury to the anterolateral structure is identified in ~90% of cases [8,16]. Furthermore, a biomechanical study has demonstrated that when a combined ACL and anterolateral injury exists, an isolated ACL reconstruction fails to restore normal knee stability [11].

The most important finding of our study was that combined ACL and ALL reconstruction can result in favorable clinical and functional outcomes, with no specific complications. This was demonstrated by better postoperative laxity restoration, higher IKDC scores, and no graft rupture.

In the same line, a prospective randomized trial showed that reconstructing the ALL during ACL reconstruction improved the objective and subjective outcomes at a mean follow-up of 27 months [16].

In a case series of patients with combined ACL and ALL reconstruction, significant improvements were observed in objective and subjective outcomes at a mean follow-up of 32.4 months. Our general findings are very similar to what was found in that study.

Nevertheless, none of their patients had a pivot shift of grade II or III and an IKDC score of C or D at final follow-up. On the other hand, one of our patients had a grade II pivot shift at final follow-up, and one had an IKDC score of C and another one for D. These minor differences could be the result of the different techniques used in the two studies, different study designs (i.e., retrospective vs. prospective), or basically patients' personal characteristics and compliance to postoperative rehabilitation and precautions [17].

In a case series of 83 patients who underwent combined ACL and ALL reconstruction, significant improvement in clinical and functional outcomes was achieved at a mean follow-up of 32.4 months. The pivot shift test result was normal in 91.6% of these patients, and the final IKDC scores were 91.6%. In addition, the mean instrumented anterior knee laxity decreased from 8 to 0.7 mm at a mean follow-up of 60 months [18].

Our results did not report any graft rupture. Similar results were observed in a retrospective study comparing isolated ACL reconstruction with combined ACL and ALL reconstruction in patients with chronic ACL tears. Graft rupture rate was reported in 7.3% among the patients treated with isolated ACL reconstruction, while there were no cases in the other group [19].

Also, in a prospective cohort study that included 502 patients, graft failure rate in the group of patients who underwent combined ALL and ACL reconstruction was 2.5–3.1 times less than the rate in the other two ACL reconstruction groups (B-PT-B grafts and 4HT grafts) [20].

In the current study, postoperative mean Lysholm knee score, Tegner activity score, and IKDC scores were significantly improved than preoperative. Also, 18 (90%) patients showed negative anterior drawer test and one patient recorded for both grades I and II. Nineteen (95%) patients showed negative Lachman's test and one patient recorded for grade I.

Same findings recorded by Mogos *et al*. [21] who performed surgical treatment of 32 patients underwent single-step reconstruction of ACL together with the reconstruction of ALL. The postoperative period (12 weeks) showed improvement of IKDC, Tegner, and Lysholm scores, and pivot-shift test, Lachman test, and results of the anterior drawer test decreased from 7.19 ± 1.96 mm (preoperatively) to 0.13 ± 0.34 mm (12 weeks after the surgery).

A biomechanical study had demonstrated that the load-bearing ability of the ALL in an ACL-intact knee was minimal in response to the simulated anterior drawer, Lachman, and pivot-shift tests. Nevertheless, in the ACL-deficient knee, the load-bearing ability of the ALL increased to nearly sixfold in response to the anterior drawer and Lachman tests and to threefold in response to the pivot-shift test. They also found that in the ACL-deficient knee, anterior translation increased by 2–3 mm on all the three simulated tests after sectioning the ALL. These biomechanical findings, in addition to our clinical findings, highlight the importance of the ALL in anterior and rotational stability of the knee joint [22].

The main limitation of this study was the small population and no comparative group. This limited the ability to provide a reliable estimate of graft rupture in many of the categories and also prevented comparison with other published data.

Conclusion

Our technique of combined ACL and ALL reconstruction was found to be effective in improving subjective and objective outcomes as demonstrated by decreased instrumented knee laxity, better postoperative IKDC scores, and no graft rupture. Also, no serious complications were noted with this operative procedure.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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