Outcome of combined anatomic reconstruction of the anterior cruciate ligament with anterolateral ligament reconstruction versus with iliotibial band tenodesis

Alaa Zenhom Mahmoud Hassan, Assem M. Noureldin Zein

Department of Orthopedic Surgery, Mina University, Kornish El-Nile, Minia, Egypt

Correspondence to Alaa Z.M. Hassan, MD, Department of Orthopedic Surgery, Mina University Hospital, Kornish El-Nile, 6th District New Minia City, Minia 61519, Egypt
Tel: +201006476082; e-mail: alaazenhom915@yahoo.com, alaa.zenhom@mu.edu.eg

Received: 04-Nov-2023
Revised: 28-Nov-2023
Accepted: 14-Dec-2023
Published: 03-Apr-2024

The Egyptian Orthopaedic Journal 2024, 59:64–74

Background

Isolated anterior cruciate ligament (ACL) tears without anterolateral structures injuries are treated successfully by isolated reconstruction of ACL. However, most ACL injuries are associated with the injuries of anterolateral stabilizers of the knee; mainly the iliotibial tract (ITB) and the anterolateral ligament (ALL). If ACL is only reconstructed in such a case, the incidence of postoperative rotational instability reaches 18%. New directions guided towards combined ACL reconstruction with extraarticular anatomical and nonanatomical reconstructions to improve knee rotation and translation and prevent pivot shift phenomena.

Patients and methods

We retrospectively reviewed all patients operated on for combined injuries of ACL and anterolateral stabilizers from February 2019 to February 2021. Preoperatively and postoperatively, all patients were examined clinically by knee stability tests: anterior drawer, Lachman, and pivot shift tests, applying the International Knee Documentation Committee score and return time to the sport.

Results

Forty patients were included with a mean age of 28±8.33 years (range, 18–44 years). Patients were divided into two groups, group A 20 patients (18 males and two females) were treated by combined ACL with ALL reconstruction, and group B 20 patients (18 males and two females) were treated by combined ACL with ITB tenodesis. Sports injuries were the cause in 15 patients in group A and 14 in group B, while five injuries were due to nonsport activity in group A and six in group B. The mean follow-up period was 33.5±2.1 months. Median postoperative subjective International Knee Documentation Committee scores in groups A and B were 95.4 and 94.25, respectively, without any statistically significant difference. Group A shows better postoperative improvement in pivot shift and one-leg hop test than group B with a significant difference (P<0.05).

Conclusion

No significant difference between ALL reconstruction or ITB tenodesis with ACL reconstruction according to subjective knee functions but there was a significant difference according to objective functions, also lateral knee pain was reported in group B and not observed in group A.

Keywords:
anterior cruciate ligament, anterolateral ligament, iliotibial band, the pivot shift

Egypt Orthop J 2024, 59:64–74
© 2024 The Egyptian Orthopaedic Journal
1110-1148

Introduction

The incidence of anterior cruciate ligament (ACL) injuries has been increasing especially among adolescent athletes [1]. Most of such injuries are associated with the injuries of anterolateral stabilizers (ALS) of the knee especially the iliotibial tract (ITB) and the anterolateral ligament (ALL) [2]. So, associated anterolateral injuries increase rotational and transitional knee instability [3]. Segond fracture is an avulsion of the anterolateral capsule of the lateral tibial plateau is a landmark of combined ACL and ALS injuries and is accompanied by high-grade pivot shift [4]. Isolated ACL tears without ALS injuries were treated successfully by isolated reconstruction of ACL with satisfactory results [5,6] with reported incidence of rotational knee instability postoperatively up to 18% [7]. Persistent knee laxity instability was reported after isolated ACL reconstruction in patients with combined ACL and ALL injuries and reconstruction of ALS improved knee laxity stability [8]. Inferior outcomes were reported after ITB tenodesis in cases of isolated anterolateral injuries (despite improving pivot shift), so its use gradually diminished [9]. Extraarticular

 DOI: 10.4103/eoj.eoj_139_23

reconstructions with ACL reconstructions have biomechanical and clinical advantages over isolated ACL reconstructions. [10]. Two different procedures are currently used for the reconstruction of anterolateral structures: ITB tenodesis and ALL reconstruction [11]. The ALL have an important role in preventing the pivot shift and controlling translational and rotational knee stability [12,13]. This had been guided to prevent the persistence of the pivot shift, anatomic ACL reconstruction together with the anatomic ALL reconstruction [14]. Recent reports described a technique utilizing hamstring tendons to reconstruct both ACL and ALL at the same time by using a single femoral tunnel and a single femoral fixation [15]. The literature did not show clear clinical or biomechanical superiority of one technique of ALS reconstructions over the other. The purpose of the current case series was to compare the outcomes of ACL reconstruction together with ALL reconstruction versus with ITB tenodesis.

Patients and methods

We retrospectively reviewed all patients with combined ACL and ALS injuries operated between February 2019 and February 2021, at the sports unit, Orthopaedic Department, Minia University Hospital.

Inclusion criteria: age ranged between 18 and 44 years old, with acute and chronic ACL injuries associated with ALL injury as suggested by high-grade pivot shift test or a Segond fracture and proved by MRI. Exclusion criteria: multi-ligamentous knee injuries, previous knee surgeries, knee arthritis, low-grade acute ACL injuries, and knee malalignment. All patients were followed up at 2, 4, 6 weeks 3, 6, 12, and 24 months postoperatively. Preoperatively and postoperatively, all patients were examined clinically by knee stability tests: anterior drawer, Lachman, and pivot shift tests. The subjective and objective International Knee Documentation Committee (IKDC) score. Visual analog scale and time of return to sport were used for clinical evaluation. Knee effusion was evaluated postoperatively follow-up. Radiological evaluation preoperatively was achieved by plain radiographs and MRI. Rehabilitation was started immediately postoperatively with gradual weight bearing with crutches in a brace, and progressive knee exercises were allowed. A knee brace was used for the first 3 weeks. Riding a bicycle was allowed for 1 month. Running at 3 months. Return to nonpivoting sports was allowed after 5 months, return to pivoting contact sports was allowed after 10–12 months. Our institute's Research/Ethics Committee approval was obtained as well as preoperative written informed consent from all patients.

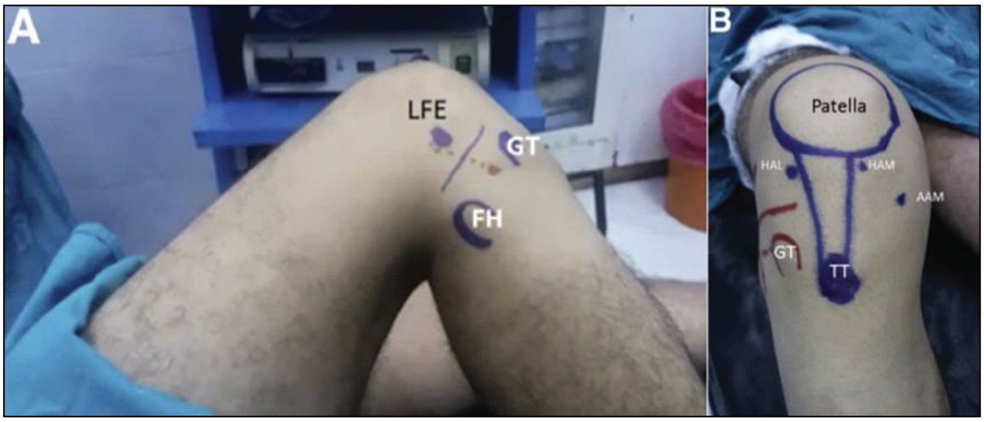
Surgical technique

In group A patients were treated by combined ACL and ALL reconstruction. We used our published technique for a combined anatomic reconstruction of the ACL and ALL reconstruction. Using hamstring grafts through a single femoral tunnel and with a single femoral fixation [15].

Patient position and surgical landmarks

After general or spinal anesthesia, the patient was placed in the supine position. Knee stability tests were performed, and arthroscopic landmarks and ALL reconstruction were drawn (Fig. 1). The patient was prepared and draped in the usual manner after a high thigh nonsterile padded tourniquet was applied.

Figure 1



Arthroscopic landmarks. (a) Lateral photo of the right knee. (b) Front photo of the right knee. AAM, accessory anteromedial portal; FH, fibular head; GT, Gerdy's tubercle; HAL, high anterolateral portal; HAM, high anteromedial portal; LFE, lateral femoral epicondyle; TT, tibial tuberosity.

Graft preparation and harvesting

A small incision (2–3 cm) was made at the anteromedial aspect of the proximal leg. The pes anserinus fascia was incised, and a striper was used to strip the maximum length of the semitendinosus and gracilis tendons. The tendons were released with a sleeve of the periosteum as distal as possible. Muscle fibers were cleaned from the tendons. The graft was stitched by Vicryl to make it a quadrable tendon graft with a length of 14–16 mm and a diameter of 8–9 mm.

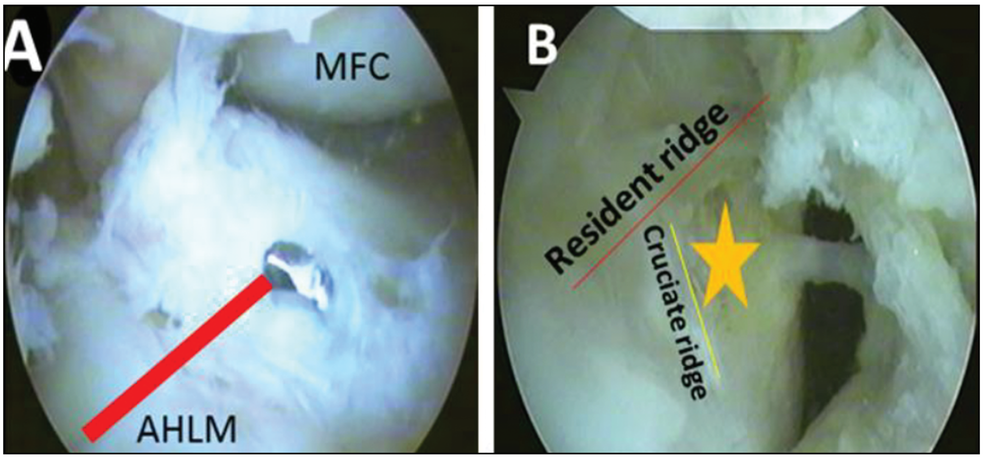
Arthroscopic intraarticular anterior cruciate ligament reconstruction

A routine knee scope was performed. Any meniscal pathology was managed. The anatomic tibial footprint of the ACL was detected and cleaned then a guide wire was inserted at its center parallel to the posterior border of the anterior horn of the lateral meniscus (Fig. 2a). Through a high anteromedial portal viewing the medial aspect of the lateral femoral condyle, a guide wire was inserted just proximal to the bifurcate ridge and posterior to the resident ridge to drill the anatomic femoral point of ACL (Fig. 2b). Skin and ITB were incised down to the bone. A mark was made by electric cautery just proximal and posterior to the lateral femoral epicondyle to landmark anatomical femoral attachment of ALL on the lateral aspect of the lateral femoral condyle (Fig. 3). From outside-in femoral tunnel was prepared and started from the anatomic attachment of the ALL extraarticularly to the anatomic attachment of the ACL intraarticularly (Fig. 4). Then the tibial tunnel was drilled. The tendon graft was passed from the tibial tunnel to the femoral tunnel till the attached U loop rested on the tibial outer cortex. The graft was fixed at the femoral tunnel in the proximal or anterior part by a biodegradable screw with the same size of graft diameter from the outside and the knee was 30° flexion (Fig. 5).

Extraarticular anterolateral ligament reconstruction

The tendon graft was fixed at the femoral tunnel and the extra length was left outside the femoral tunnel. A small skin incision was done 5–10 mm below the knee joint line midway between the head of the fibula and Gerdy's tubercle (GT). C guide was used to insert

Figure 2



(a) The tibial footprint points. (b) The femoral anatomic point.

Figure 3

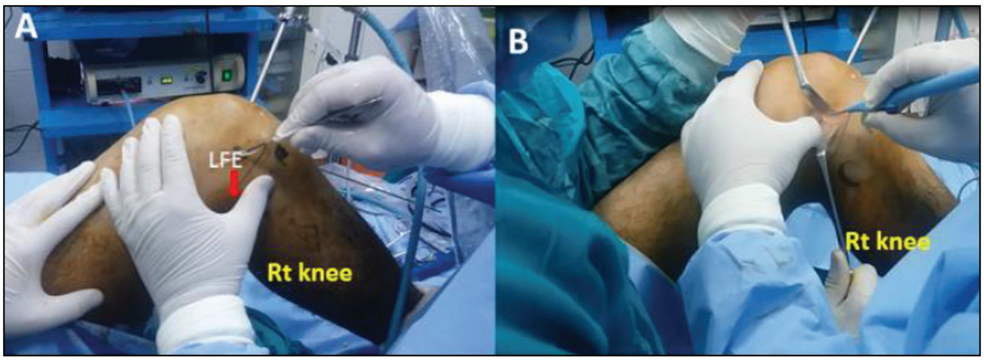
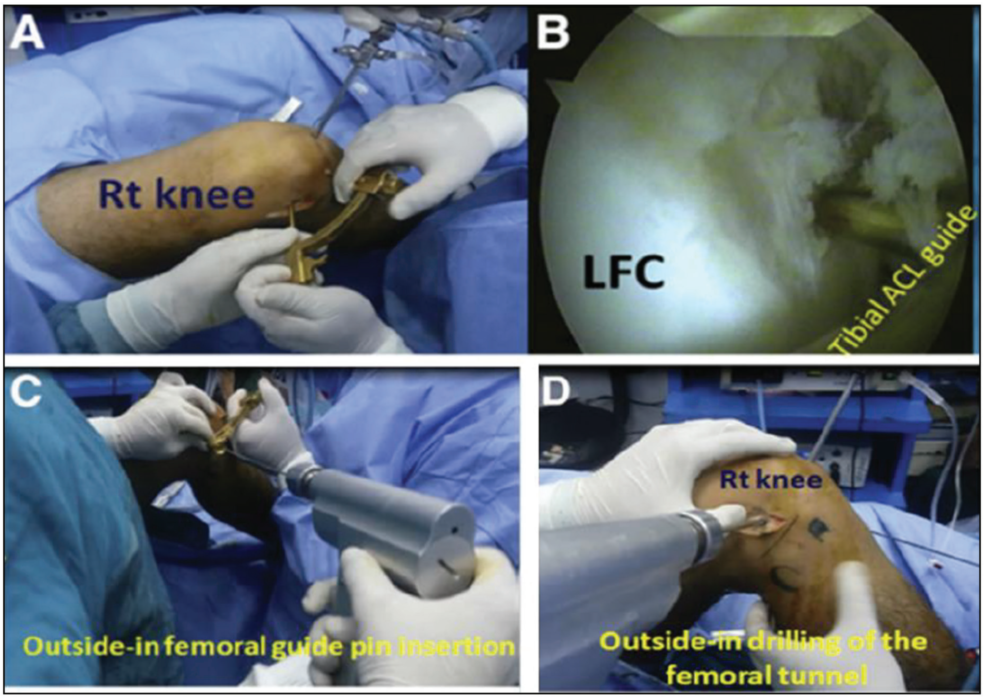


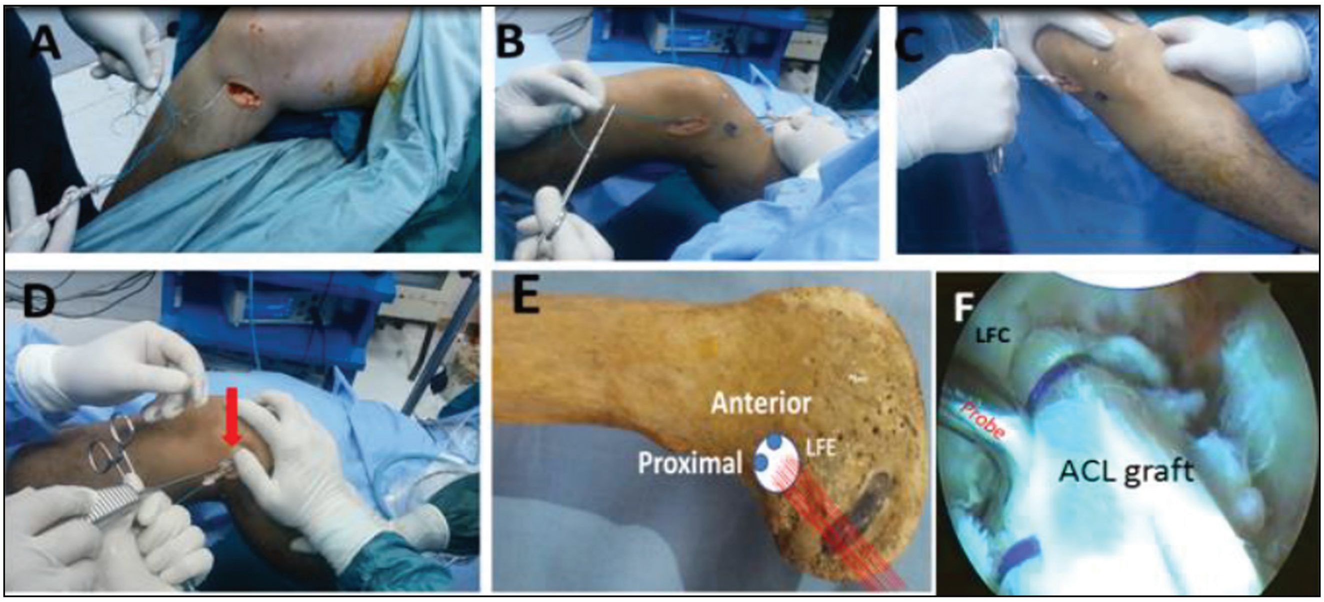
Photo showing the preparation of femoral attachment of ALL. ALL, anterolateral ligament.

Figure 4



Femoral tunnel preparation (right knee) (a) outside-in C guide insertion. (b) Arthroscopic view showing wire on the anatomic femoral ACL attachment. (c) Outside in drilling. (d) The tunnel from outside. ACL, anterior cruciate ligament.

Figure 5

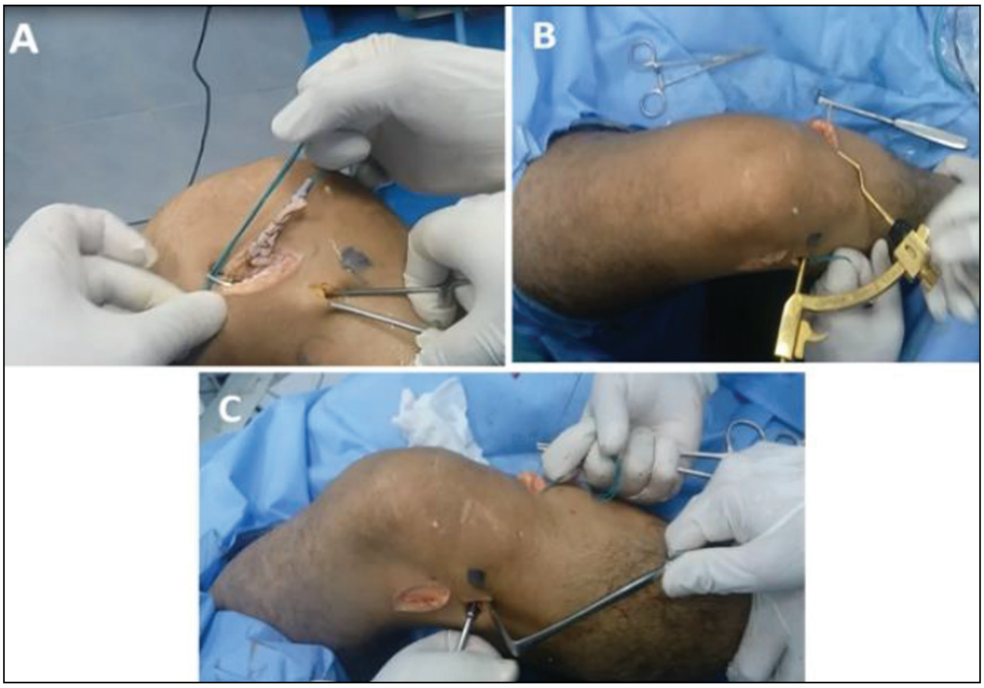


Graft fixation steps (right knee).

guide wire from this point to exit at a point at the super medial tibial outer cortex below the ACL tibial tunnel. The tunnel was drilled to a depth of 30 mm with a drill of the same size as the graft diameter. The remaining part of extraarticular part of the graft was passed under the iliotibial band and fixed by a metal or biodegradable screw the same size as the graft diameter with the knee in 30° flexion and neutral rotation (Fig. 6). Postoperative radiograph is shown in Fig. 7.

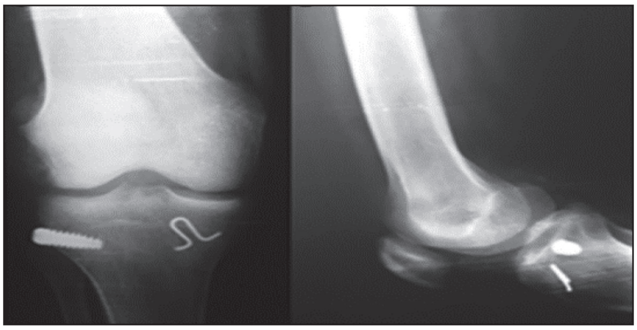
In group B patients were treated by ACL reconstruction and ITB tenodesis. The same steps previously mentioned were used for ACL reconstructions except for less

Figure 6



Anterolateral ligament reconstruction steps in the right knee.

Figure 7



Postoperative radiograph showing tibial fixation of ACL graft by U loop and tibial fixation of ALL by metal screw. ACL, anterior cruciate ligament; ALL, anterolateral ligament.

Figure 8

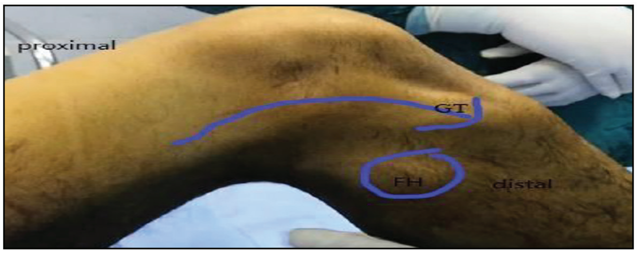


Photo showing skin landmarks for ITB harvesting. ITB, iliotibial tract.

length ACL autograft was prepared than graft length used in group A and extraarticular graft length was replaced by iliotibial band tenodesis using the modified Lemaire technique [16].

Harvesting and preparing the iliotibial tract band

A curved skin incision 10 cm in length was performed starting 2 cm proximal to GT and extended proximally and slightly posterior to the femoral axis (Fig. 8). ITB was exposed after blunt dissection of subcutaneous tissue. A 10-cm long and 1-cm width of ITB was stripped and dissected bluntly from posterior to anterior. The stripped part of ITB was separated proximally whereas the distal insertion on GT was lifted intact. The final 30 mm of the proximal portion of the strip was knout-stitched by no. 2.0 absorbable Vicryl (Figs 9,10). The band of ITB is placed at the proximal and posterior of the lateral femoral epicondyle and this site is marked by electrocautery after identification of the lateral collateral ligament (LCL) (Fig. 10). The ITB graft was passed deep to the LCL and the band of ITB was kept in the subcutaneous tissue layer to avoid the risk of graft dehydration and infection. Damage to the joint capsule was avoided as it may that resulted in synovial fluid leakage (Fig. 10).

Passage of band of ITB and ACL autograft: Two sutures were inserted from outside in the femoral tunnel into the knee joint. One of these sutures was retrieved from the anteromedial portal and used to pull up the ITB graft from outside inside through the femoral tunnel into the joint. The second suture was retrieved through the tibial tunnel with a grasper, and this was used to pull up the ACL graft from distal to proximal till the other end of the graft with attached U loop rest on the medial tibial outer cortex (Fig. 11).

Fixation of ITB and the ACL graft: the surgical assistant pulls up sutures of the ACL graft and ITP to keep them tensioned while the knee joint is at a neutral extended position. A guide wire was inserted at the femoral tunnel from outside in and a screw of suitable diameter was used to fix both ACL graft and ITB at one tunnel. The graft was tensioned. Knee range of motions was checked (Fig. 12). In both groups the tourniquet was released, and good hemostasis was ensured. The joint and wound were irrigated with normal saline. The intraarticular surgical drain was used to avoid hemarthrosis. For good hemostasis ropivacaine 7.5 mg/ml (20 ml) and epinephrine (2 ml) were injected in the subcutaneous layer. A surgical drain was used in graft harvesting wounds in the case of a hamstring graft. The proximal portion of the ITB was sutured then the wound was sutured in layers. No anticoagulant therapy was used due to the immediately postoperatively gradual weight bearing was allowed in a hinged knee brace, and progressive knee rehabilitation exercises were allowed. Surgical drains were removed after 24 h. The brace was taken off after 3 weeks. Return to nonpivoting sports was allowed after 5 months, return to pivoting contact sports was allowed at 10–12 months.

Figure 9

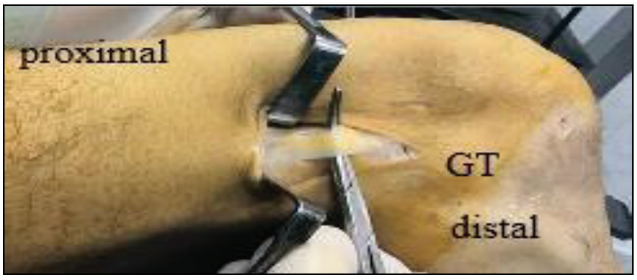


Photo showing ITB band dissection. ITB, iliotibial tract.

Statistical analysis

The analysis of the data was carried out using the IBM SPSS (Statistical Package for the Social Sciences), version 25 (IBM, Chicago, Illinois, USA) statistical package software. Data were expressed as mean±SD and both number and percentage for qualitative data. Analyses were done between the two sides and between each two times for parametric quantitative data using the paired samples *t* test, while the χ^2 test was used to compare categorical variables. A *P* value less than 0.05 was considered statistically significant and less than 0.001 was considered highly significant.

Results

Forty patients fulfilled the inclusion criteria with a mean age of 28 ± 8.33 years (range, 18–44 years). Twenty patients were included in group A and 20 patients were included in group B. Each group included 18 males and two females. Sports injuries were the cause of injuries

Figure 10

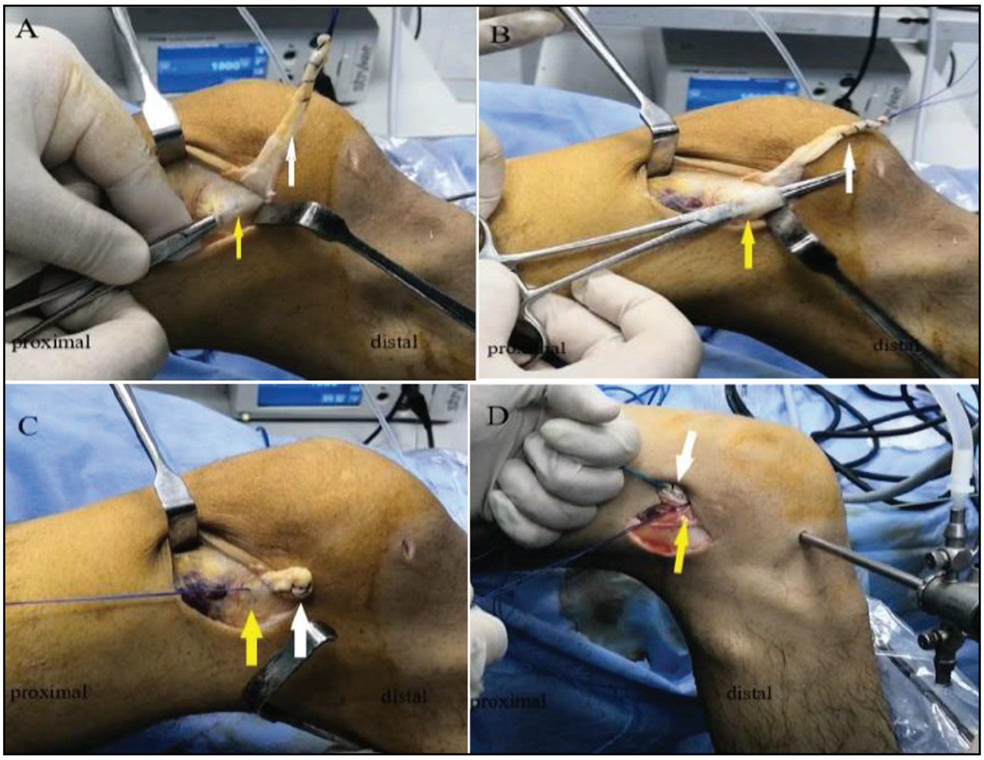
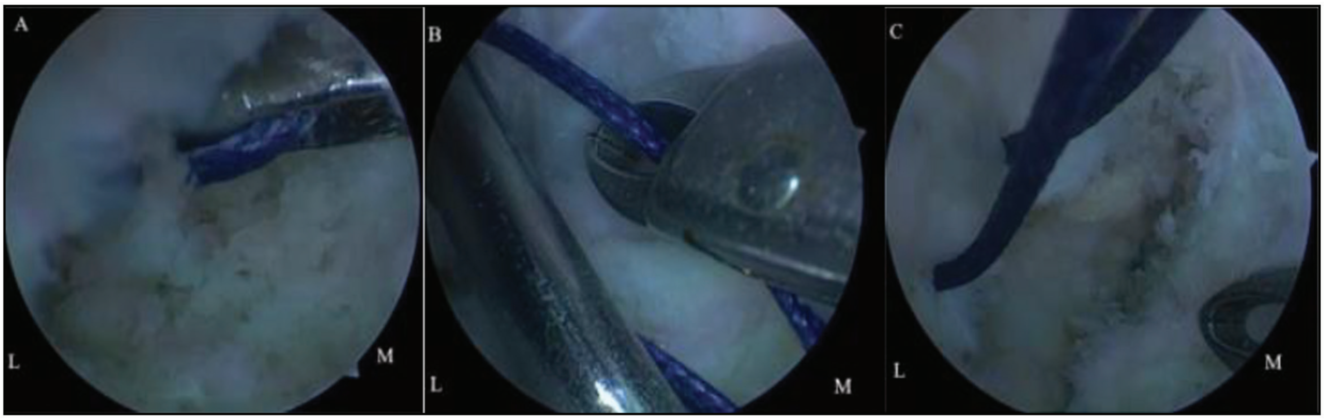


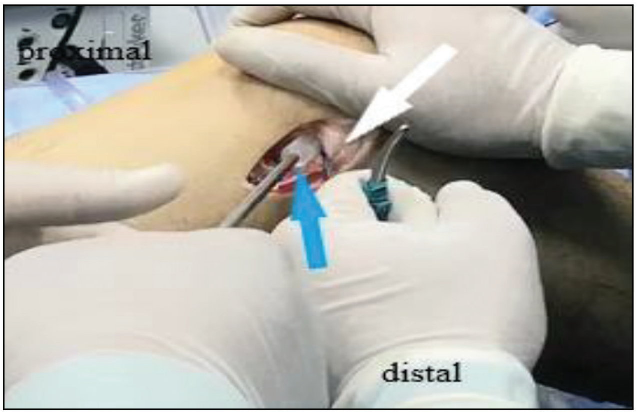
Photo showing ITB passed deep to LCL. ITB, iliotibial tract; LCL, lateral collateral ligament.

Figure 11



Sutures passing for ITB and ACL graft. ACL, anterior cruciate ligament; ITB, iliotibial tract.

Figure 12



Fixation of both ITB and ACL graft from outside into femoral tunnel. ACL, anterior cruciate ligament; ITB, iliotibial tract.

in 15 patients in group A and 14 in group B, while fivr injuries were due to nonsport activity in group A and six in group B. The dominant side was affected in 15 patients in both groups, while the nondominant side was affected in five patients in both groups. Indications for operative interventions were the presence of a Segond fracture (*n*=35), chronic ACL injury (*n*=30), grade 3 pivot shift (*n*=40), and participation in sports activities (*n*=30). Time from injury to operation was 2.16 months in group A while it was 2.14 months in group B. Operative time was 49 min (SD 7) in group A and 47 min (SD 8) in group B. There was no statistically significant difference between the two groups. The mean postoperative follow-up period was 33.5 ± 2.1 months.

Subjective assessment

Knee pain

Table 1

Knee effusion

Table 2

Table 1 Preoperatively and 6-week postoperatively knee pain by visual analog scale

Pain	Group A		Group B	
	Pre	Post	Pre	Post
Normal (0)	16	18	15	16
Mild (1–3)	4	2	5	3
Moderate (4–6)	0	0	0	1
Sever (7–10)	0	0	0	0

Table 2 Postoperative knee effusion

Knee effusion	Group A	Group B
Effusion after 6 weeks normal	14	12
Nearly normal	6	7
Abnormal	0	1
Severely abnormal	0	0
Effusion after 24 months		
Normal	20	20
Nearly normal	0	0
Abnormal	0	0
Severely abnormal	0	0

Giving way (partial or complete)

All patients of both groups had a history of giving way preoperatively and at the end of follow-up, no patients complained of giving way (partial or complete) in both groups.

Objective assessment: 1-postoperative range of motion

Tables 3 and 4

Ligamentous examination: Lachman test

Preoperatively, regarding IKDC score all patients of both groups were evaluated as severely abnormal with anterior tibial translation more than 10 mm with soft endpoint (Table 5).

Anterior drawer test: preoperatively, regarding IKDC score all patients of both groups were evaluated as severely abnormal with anterior tibial translation of more than 10 mm with the soft end point (Table 6).

Table 3 Lack of knee extension after 6 weeks postoperatively

Groups	Normal: <3 degrees	Postoperative lack of extension			*P* value
		Nearly normal: 3–5 degrees	Abnormal: 10 degrees	Severely abnormal: >10 degrees	
Group A	17 (85)	3 (15)	0	0	>0.05
Group B	15 (75)	4 (20)	1 (5)	0	

Table 4 Lack of knee flexion after 6 weeks postoperatively

Groups	Postoperative lack of flexion			Severely abnormal: >25
	Normal: 0–5	Nearly normal: 6–15	Abnormal: 16–25	
Group A	20	0	0	0
Group B	20	0	0	0

Table 5 Lachman test after 6 weeks postoperatively

Lachman test (postoperative)	Group A	Group B	*P* value
Normal	17	15	>0.05
Nearly normal	3	5	
Abnormal	0	0	
Severely abnormal	0	0	

Table 6 Anterior drawer test after 6 weeks postoperatively

Anterior drawer test (postoperative)	Group A	Group B	*P* value
Normal	18	13	> 0.05
Nearly normal	2	7	
Abnormal	0	0	
Severe abnormal	0	0	

Pivot shift: preoperatively, in group A 18 (90%) patients were grade III (gross), one (5%) patient was grade II (clunk), and one (5%) patient was grade I (smooth gliding). In group B, 16 (80%) patients were grade III (gross), three (15%) patients were grade II (clunk) and one (5%) patient was grade I (smooth gliding). *P* value more than 0.05. Postoperatively, in group A all patients were normal (grade 0), while in group B 15 (75%) patients were grade I (smooth gliding) and five (25%) patients were grade II (clunk) and the difference between the two groups was statistically significant ($P<0.05$) (Table 7).

Postoperative pivot shift shows better improvement in group A than group B with significant difference ($P<0.05$).

Functional test, postoperative one-leg hop test
Table 8

Postoperative one-leg hop test shows better improvement in group A than group B with significant difference ($P<0.05$).

Final postoperative subjective International Knee Documentation Committee score

The median value of the IKDC score in groups A and B were 95.4 and 94.25, respectively, without any

Table 7 Pivot shift test preoperatively and 6 weeks postoperatively

Pivot shift	Group A		Group B		*P* value (post-operative)
	Pre	Post	Pre	Post	
Normal	0	20	0	0	<0.05
Nearly normal+	1	0	1	15	<0.05
Abnormal++	1	0	3	5	<0.05
Severely abnormal+++	18	0	16	0	<0.05

statistically significant difference between both groups ($P>0.05$).

Postoperative complications

Group A: one patient complained of the prominence of the screw at the tibial attachment of ALL reconstruction which was managed by screw removal after 1 year without any anterolateral instability reported.

Group B: one case suffered from hematoma at the ITB harvesting site but further this complication was avoided in the next cases by ensuring good hemostasis after tourniquet release. One patient complained of swelling at the screw site of the femoral attachment which affected the range of movement and was managed by screw removal as well as intraoperatively reactive calcification was detected around the screw at the femoral attachment and removed. One patient complained of lateral side knee pain up to 6 months postoperative without effect on range of movement or daily activity.

Return to sports activity level

The mean time from surgery to pre-injury sport level was 8 ± 0.7 months in group A and 8.7 ± 0.5 months in group B with no statistically significant difference between two the groups.

Discussion

This study found that combined ACL and ALS injuries could be managed by ACL reconstruction with either ALL reconstruction or with ITB tenodesis with good results. Both techniques restored knee stability without limitations of knee motion or stiffness. No significant difference between ALL reconstruction or ITB tenodesis with ACL reconstruction according to subjective knee functions

Table 8 Preoperatively and 6 weeks postoperatively one-leg hop test

One-leg hop test %of the opposite side	Group A		Group B		*P* value (postoperative)
	Pre	Post	Pre	Post	
Normal >90%	0	14	0	3	<0.05
Nearly normal 89–76%	0	6	0	17	<0.05
Abnormal 75–50%	20	0	20	0	
Severely abnormal <50%	0	0	0	0	

but there was a significant difference according to objective functions.

Kittl *et al*. [17] reported that no role for the ALL in internal rotational knee control. They also found that the ITB acts as a primary restrain against internal rotation during knee flexion from 30° to 90° while ACL has a significant contribution at 0° only and has no restraint to the pivot shift. Fetto and Marshall [18] pointed out that after the cut of the ITB in an ACL intact knee, a pivot shift appeared. In a meta-analysis, Hewison *et al*. [19] reported that the pivot shift was reduced if ACL reconstruction was performed together with extra-articular reconstruction of ALL compared with isolated ACL reconstruction. We would like to insist on a nonisometric reconstruction with graft length change that will be achieved if the ITB and hamstring autograft were anchored while the knee was almost in full extension led to tightness of graft in extension and laxity during flexion and this allows full range of motion and physiological internal rotation during increased knee flexion. Inderhaug *et al*. [8] demonstrated that knee kinematics is restored if lateral tenodesis is performed with ITB fixed at full knee extension which supports our study. Contrary to Inderhaug and colleagues findings, Geeslin *et al*. [20] reported no significant difference in graft fixed in full extension, or at 30 or 70° of flexion. They also found that decreased knee flexion after ACL reconstruction with either anterolateral reconstruction or ITB tenodesis and over-constraint was noted.

Many techniques have been described for lateral extraarticular tenodesis with ITB. Ireland *et al*. [21] described Macintosh procedure in which ITB was detached proximally and passed deep to the LCL. Other techniques were described by Losee *et al*. [22] and the Lemaire superficial procedure. All procedures that had a graft passed superficial to the LCL had less favorable kinematic effects, were unable to restore knee stability, and constrained knee motion. On the other hand, procedures that had graft passed deep to LCL like the modified Lemaire technique [16] and MacIntosh tenodesis, keep the graft posterior to the axis of rotation during the range of knee motion by the 'pulley effect' of the LCL and so, give more consistent graft behavior, even with differing femoral fixation sites [23]. In a long-term study with a minimum follow of 20 years, Zaffagnini *et al*. [24] demonstrated that ACL reconstruction augmented by extraarticular tenodesis had better results in controlling internal rotational instability. This is supported also, by Williams *et al*. [25], Song *et al*. [26], and Delaloye *et al*. [27].

Most of the studies comparing ALL reconstruction and ITB are biomechanical and thus did not consider loosening and changes that occur in vivo with soft tissue reconstructions. After extraarticular procedures, there was no clear evidence for an increase in lateral compartment osteoarthritis [28]. Nonanatomic techniques with prolonged knee immobilization led to an increased rate of failure after isolated reconstruction of anterolateral knee structures in ACL knee injuries with anterior tibial translation without ACL reconstruction [29]. ACL reconstructed knees with persistent rotational instability showed difficulty in performing pivoting sports, for example, soccer, and showed secondary meniscal and chondral injuries with subsequent knee osteoarthritis [30].

According to the postoperative leg hop test in our study, there was a significant difference between the two groups with the superiority of group A over group B which ranges between normal and nearly normal, and no cases were rated abnormal. A study by Getgood *et al*. [31] concluded that the knees that underwent ACL reconstruction combined with iliotibial tenodesis had better results according to the postoperative leg hop test over the knees that underwent ACL reconstruction only.

In the current study no significant difference between the two groups in anterior drawer and Lachman tests, a finding that was supported by Williams and colleagues and Zaffagnini and colleagues who demonstrated that three (6%) of 50 patients with positive Lachman and pivot-shift test results at 5-year follow-up had the same knee assessment at 10-year follow-up. At the final follow-up, four (14%) of 29 patients had positive pivot-shift and Lachman tests.

In our study, we reported a significant difference between the two groups as regards the pivot shift test postoperatively with the superiority of group A over group B. Hurley *et al.* [32] reported improved pivot shift and a low rate of failure in ACL reconstruction with ALL reconstruction or ITB tenodesis versus isolated ACL reconstruction. Ra *et al.* [33] found that improved anterior tibial translation and rotational knee instability in ALL reconstruction more than ITB tenodesis without any knee constrained. Rayes *et al.* [34] compared the study between ACL reconstruction by BTB with ITB tenodesis versus hamstring tendon ACL reconstruction with ALL reconstruction and reported equal results. Monaco and colleagues, found a kinematic study that combined anatomic ACL reconstruction with ALL reconstruction giving synergistic in controlling both anterior tibial translation and the pivot shift. It is unique for our technique in that we used a single femoral tunnel and fixation for both extra and intraarticular grafts with less morbidity and cost to the patient, and provided an anatomic reconstruction of both ligaments, as the femoral tunnel connects the two anatomic attachment sites of both ACL and ALL on the lateral femoral condyle.

In our study, no cases were detected in the two groups that suffered postoperatively loss of range of motion, except three cases of group A and four cases of group B who had a lack of extension between 3–5° (nearly normal) but they improved at the end of follow up and became normal. In both groups, all cases evaluated normal in lack of flexion. Williams and colleagues in a comparative study, as regards knee motion, reported no difference between the two groups treated by isolated ACL reconstruction, and by combined ACL plus lateral tenodesis but a loss of 3° flexion in both groups was reported. Zaffagnini and colleagues in a long-term study found that 48 (96%) of 50 patients restored full extension at 5 years' follow-up 50 (92%) of 54 patients at 10 years' follow-up and 26 (90%) of 29 patients at 20 years' follow-up. In addition, there were one (2%) of 50 patients at follow-up for 5 years, six (11%) of 54 patients at follow-up for 10 years and four (14%) of 29 patients at follow-up 20 years had a loss of flexion more than 5°.

Regarding return to preinjury activity, in our study, the mean time from surgery to preinjury sport level was 8 ± 0.7 months in group A while was 8.7 ± 0.5 months in group B with no significant difference between the two groups. In a study of 25 patients who underwent ACL reconstruction with ITB, Feller *et al*. [35], found that two patients lost in follow-up, two were playing at a lower level; four stopped practicing sports, and 17 (74%) were playing at the same level or higher than preinjury at 2 years follow-up. The current study has its own limitations: retrospective design and a small patient sample. Follow-up was relatively short that did not allow assessment for knee osteoarthritis. The tibial translation was not evaluated in the current study and should be included in further studies.

Conclusion

In cases of combined ACL and ALS injuries, no statistically significant difference could be found between ALL reconstruction or ITB tenodesis according to subjective knee functions. Combined ACL reconstruction with extraarticular reconstructions improved and secured anteroposterior and rotational laxity control without any specific limitations of knee motion or stiffness, especially in high-grade pivot ACL injuries with anterolateral instability. Clinical and objective significant differences were found between the two groups; lateral knee pain was reported in group B and not observed in group A, and the pivot shift test and the postoperative one-leg hop test showed a significant difference between the two groups with the superiority of group A over group B.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1 Beck NA, Lawrence JTR, Nordin JD, DeFor TA, Tompkins M. ACL tears in school-aged children and adolescents over 20 years. Pediatric 2017; 139:e20161877.

2 Getgood A, Brown C, Lording T. The anterolateral complex of the knee: results from the International ALC Consensus Group Meeting. Knee Surg Sports Traumatol Arthrosc 2019; 27:166–176.

3 Claes S, Vereecke E, Maes M, Victor J, Verdonk P, Bellemans J. Anatomy of the anterolateral ligament of the knee. J Anat 2013; 223:321–328.

4 Monaco E, Fabbri M, Mazza D. The effect of sequential tearing of the anterior cruciate and anterolateral ligament on anterior translation and the pivot-shift phenomenon: a cadaveric study using navigation. Arthroscopy 2018; 34:1009–1014.

5 Ardern CL, Sonesson S, Forssblad M, Kvist J. Comparison of patient-reported outcomes among those who chose ACL reconstruction or non-surgical treatment. Scand J Med Sci Sports 2017; 27:535–544.

6 Chambat P, Guier C, Sonnery-Cottet B, Fayard JM, Thaunat M. The evolution of ACL reconstruction over the last fifty years. Int Orthop 2013; 37:331–336.

7 Webster KE, Feller JA. Exploring the high reinjury rate in younger patients undergoing anterior cruciate ligament reconstruction. Am J Sports Med 2016; 44:2827–2832.

8 Inderhaug E, Stephen JM, Williams A, Amis AA. Biomechanical comparison of anterolateral procedures combined with anterior cruciate ligament reconstruction. Am J Sports Med 2017; 45:347–354.

9 Rackemann S, Robinson A, Dandy DJ. Reconstruction of the anterior cruciate ligament with an intra-articular patellar tendon graft and an extra-articular tenodesis: results after six years. J Bone Joint Surg Br 1991; 73:368–373.

10 Vadala' AP, Iorio R, De Carli A. An extra-articular procedure improves the clinical outcome in anterior cruciate ligament reconstruction with hamstrings in female athletes. Int Orthop 2012; 37:187–192.

11 Chahla J, Menge TJ, Mitchell JJ, Dean CS, LaPrade RF. Anterolateral ligament reconstruction technique: an anatomic-based approach. Arthrosc Tech 2016; 5:e453–e457.

12 Zein AMNE. Step-by-step arthroscopic assessment of the anterolateral ligament of the knee using anatomic landmarks. Arthroscopy 2015; 4:825–831.

13 Helito CP, Bonadio MB, Rozas JS, Wey JMP, Pereira CAM, Cardoso TP, *et al*. Biomechanical study of strength and stiffness of the knee anterolateral ligament. BMC Musculoskelet Disord 2016; 17:193.

14 Sonnery-Cottet B, Daggett M, Fayard J-M. Anterolateral ligament expert group consensus paper on the management of internal rotation and instability of the anterior cruciate ligament— deficient knee. J Orthop Traumatol 2017; 18:91–106.

15 Zein AMNE, Ali M, Ali H, *et al*. Combined anatomic reconstruction of the anterior cruciate and anterolateral ligaments using hamstring graft through a single femoral tunnel and with a single femoral fixation [published online]. Arthrosc Tech 2017; 6:567–577.

16 Lemaire M, Combelles F. The modified Lemaire technique. Rev Chir Orthop 1980; 66:523–525.

17 Kittl C, El-Daou H, Athwal KK. The role of the anterolateral structures and the ACL in controlling laxity of the intact and ACL-deficient knee. Am J Sports Med 2016; 44:345–354.

18 Fetto JF, Marshall JL. Injury to the anterior cruciate ligament produces the pivot shift sign. J Bone Joint Surg Am 1979; 61:7104.

19 Hewison CE, Tran MN, Kaniki N. Lateral extra-articular tenodesis reduces rotational laxity when combined with anterior cruciate ligament reconstruction: a systematic review of the literature. Arthroscopy 2015; 31:2022–2034.

20 Geeslin AG, Moatshe G, Chahla J. Anterolateral knee extra-articular stabilizers: a robotic study comparing anterolateral ligament reconstruction and modified Lemaire lateral extra-articular tenodesis. Am J Sport Med 2018; 46:607–616.

21 Ireland J, Trickey EL. Macintosh tenodesis for anterolateral instability of the knee. J Bone Joint Surg Br 1980; 62:340–345.

22 Losee RE, Johnson TR, Southwick WO. Anterior subluxation of the lateral tibial plateau. A diagnostic test and operative repair. J Bone Joint Surg Am 1978; 60:1015–1030.

23 Kittl C, Halewood C, Stephen JM. Length change patterns in the lateral extra-articular structures of the knee and related reconstructions. Am J Sports Med 2015; 43:354–362.

24 Zaffagnini S, Marcheggiani Muccioli GM, Grassi A, Roberti di Sarsina T, Raggi F, Signorelli C, *et al*. Over-the-top ACL reconstruction plus extra-articular lateral tenodesis with Hamstring tendon grafts: prospective evaluation with 20-year minimum follow-up. Am J Sports Med 2017; 45:3233–3242.

25 Williams A, Ball S, Stephen J, White N, Jones M, Amis A. The scientific rationale for lateral tenodesis augmentation of intra-articular ACL reconstruction using a modified 'Lemaire' procedure. Knee Surg Sports Traumatol Arthrosc 2017; 25:1339–1344.

26 Song GY, Hong L, Zhang H, Zhang J, Li Y, Feng H. Clinical outcomes of combined lateral extra-articular tenodesis and intra-articular anterior cruciate ligament reconstruction in addressing high-grade pivot-shift phenomenon. Arthroscopy 2016; 32:898–905.

27 Delaloye JR, Hartog C, Blatter S. Anterolateral ligament reconstruction and modified Lemaire lateral extraarticular tenodesis similarly improve knee stability after anterior cruciate ligament reconstruction: a biomechanical study. Arthroscopy 2020; 36:1942–1950.

28 Rezende FC, Moraes VY, Martimbianco A, Luzo MV, da Silveira Franciozi CE, Belloti JC. Does combined intra- and extraarticular ACL reconstruction improve function and stability? A meta-analysis. Clin Orthop Relat Res 2015; 473:2609–2618.

29 Dandy DJ. Some clinical aspects of reconstruction for chronic anterior cruciate ligament deficiency. Ann R Coll Surg Engl 1995; 77:290–298.

30 Biau DJ, Tournoux C, Katsahian S, Schranz P, Nizard R. ACL reconstruction: a meta-analysis of functional scores. Clin Orthop Relat Res 2007; 458:180–187.

31 Getgood A, Bryant D, Firth A, Stability Group. The stability study: a protocol for a multicenter randomized clinical trial comparing anterior cruciate ligament reconstruction with and without lateral extra-articular tenodesis in individuals who are at high risk of graft failure. BMC Musculoskelet Disord 2019; 20:216.

32 Hurley ET, Bloom DA, Hoberman A. There are differences in knee stability based on lateral extra-articular augmentation technique alongside anterior cruciate ligament reconstruction. Knee Surg Sports Traumatol Arthrosc 2021; 29:3854–3863.

33 Ra HJ, Kim JH, Lee DH. Comparative clinical outcomes of anterolateral ligament reconstruction versus lateral extraarticular tenodesis in combination with anterior cruciate ligament reconstruction: systematic review and meta-analysis. Arch Orthop Trauma Surg 2020; 140:923–931.

34 Rayes J, Ouanezar H, Haidar IM. Revis ion anterior cruciate ligament reconstruction using bone-patellar tendon-bone graft combined with modified Lemaire technique versus hamstring graft combined with anterolateral ligament reconstruction: a clinical comparative matched study with a mean follow-up of 5 years from The SANTI Study Group. Am J Sports Med 2022; 50:395–403.

35 Feller JA, Devitt BM, Webster KE, Klemm HJ. Augmentation of primary ACL reconstruction with a modified ellison lateral extra-articular tenodesis in high-risk patients: a pilot study. Orthop J Sports Med 2021; 9:23259671211021351.