Functional knee and ankle outcomes of a peroneus longus tendon autograft for primary reconstruction of the anterior cruciate ligament

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Background

Peroneus longus tendon (PLT) autograft is commonly used for anterior cruciate ligament (ACL) reconstruction because it is easily harvested and has the same size and strength as the ACL. There are few studies in the literature that discussed donor site complications after ACL reconstruction by PLT. PLT was used as an autograft for reconstructions of the medial patellofemoral ligament and deltoid ligament. We evaluated clinical and functional outcomes for knee, foot, and ankle joints after the use of PLT as an autograft in primary isolated ACL reconstruction.

Patients and methods

We retrospectively reviewed all patients who were operated for primary ACL reconstruction by PLT autograft from May 2020 to May 2021. Preoperatively and postoperatively, all patients were examined clinically for knee stability by anterior drawer, Lachman, and pivot shift tests, applying the International Knee Documentation Committee as well as the Lysholm score. American Orthopedic Foot and Ankle Score, Foot and Ankle Ability Measure, and ankle range of motion were used for the evaluation of postoperative foot and ankle functions. Return time to the sport was also evaluated.

Results

Sixty-five patients with ACL-injured knees were included. Their mean age was 29.81 ± 8.33 years and ranged from 20 to 45 years, and males were 54 (83%) and females were 11 (17%). The mean postoperative follow-up period was 32.5 ± 3.1 months. Mean of American Orthopedic Foot and Ankle Score was 99.33 and Foot and Ankle Ability Measure was 99.7 after 12 months. Postoperative Lysholm score mean±SD was 95.30 ± 4.65, and the International Knee Documentation Committee mean±SD was 93.47 ± 9.82 with *P* value less than 0.001. Return to sport ranged from 4 to 8 months with mean±SD of 5.67 ± 0.75.

Conclusion

PLT autograft for primary reconstruction of isolated ACL injury did not affect foot and ankle functions with good knee stability and restoration of knee functions postoperatively, which facilitated the return to preoperative sports activity level.

Keywords:
anterior cruciate ligament, autograft, knee, and ankle functions, peroneus longus

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Introduction

The incidence of anterior cruciate ligament (ACL) injury is 1: 3000 in all populations and usually occurs because of direct and indirect contact knee trauma during the practice of sports as well as accidents [1]. ACL restrains translational and rotational knee stability. Secondary knee stabilizers against translation and rotation like a meniscus would be injured if the ACL had not been reconstructed. So, ACL reconstructions secure knee stability and improve knee functions [2]. Many types of grafts (autograft, allograft, and synthetics) may be used to reconstruct ACL. The commonly used autografts include the hamstring tendon, patellar tendon bone (BTB), or quadriceps tendon. Although the hamstring tendon has more mechanical advantages over BTB as an autograft for ACL reconstruction, some complications were reported like knee internal rotation weakness and sensory defects [3]. The reported disadvantages after BTB and quadriceps tendon include anterior knee pain and extension knee weakness [4]. Quadriceps and hamstring muscle functions are very important to secure tibial translation, so it is better to be preserved after ACL reconstruction [5]. Allografts and synthetic grafts despite having some advantages like short operation time and no donor morbidity, still have disadvantages like additional expenses, delayed healing, transmitted diseases, and immunity side

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effects [6]. Peroneus longus tendon (PLT) autograft may be used for ACL reconstruction because it is easily harvested and has same the size and strength as the ACL [7]. There are few studies in the literature that discussed morbidity donor sites after PLT harvesting [8]. PLT was used as an autograft for reconstructions of the medial patellofemoral ligament and deltoid ligament [9,10]. To our knowledge, few reports in the literature evaluated postoperatively both knee and ankle functions in the same group of patients [11]. Besides, Foot and Ankle Ability Measure (FAAM) score was not used for the evaluation of foot and ankle functions after PLT autograft for ACL reconstruction after more than 6 months. We evaluated clinical and functional outcomes for the knee, foot, and ankle joints after using PLT as an autograft in primary ACL isolated reconstruction applying the International Knee Documentation Committee (IKDC), Lysholm score, American Orthopedic Foot and Ankle Score (AOFAS), and FAAM score with a minimal follow-up of 2 years.

Patients and methods

We retrospectively reviewed all patients operated for ACL reconstruction at the Sport Unit, Orthopedic Department, Minia University Hospital between May 2020 and May 2021. Inclusion criteria included patients with isolated primary acute and chronic (>12 months) ACL injuries and aged between 20 and 45 years. Multligamentous knee injuries, fractures around the knee, previous knee and ankle surgeries with foot or ankle deformities, paralytic conditions, previous bony or ligamentous injuries to the ankle and foot, and those older than 45 years were excluded. All patients were followed up at 2, 4, and 6 weeks and 3, 6, 12, and 24 months postoperatively. Preoperatively and postoperatively, all patients were examined clinically for knee stability by the anterior drawer test, Lachman test, and pivot shift test. The subjective and objective IKDC and Lysholm scores were used for the evaluation of knee functions. AOFAS, FAAM, and ankle range of motion were used for postoperative evaluation of foot and ankle functions. Preoperatively, plain radiograph and MRI for the knee joint were documented. Operative time and return to sport were documented. 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 and return to nonpivoting sports was allowed after 4 months; and return to pivoting contact sports was allowed after 10–12 months. Preoperative informed consent from the patients and our Institutional Research Ethics Committee approval was obtained.

Surgical technique

Patient position and surgical landmarks

The patient was placed in the supine position and the operation was either under spinal or general anesthesia. The knee was examined under anesthesia and a pivot shift test was applied. The patient was prepared and draped in the usual manner after a high thigh nonsterile padded tourniquet was applied.

Graft preparation and harvesting

The skin was incised vertically from the distal tip of the lateral malleolus and extended proximally about 3–4 cm. Subcutaneous tissue was dissected to expose PLT, and behind its peroneus the brevis tendon was found (Fig. 1); the distal part of PLT was knitted after foot eversion and then distal 2 cm of it was tendered and sutured end to side with peroneus brevis by Vicryl sutures (Fig. 2). PLT was cut proximal to the tenodesed distal part, and then was stripped proximally with a closed tendon stripper up to 5 cm distal to the fibular head to avoid peroneal nerve injury (Fig. 3). After cleaned harvested tendon from muscle fibers make it quadrable and stitched by Vicryl, the diameter is measured, which ranged from 8 to 10 mm, and the length ranged from 6 to 8 mm and then the PLT autograft is pretensioned for ~5 min after a u loop is attached at the tibial end and tight rope end button at the femoral end and then kept in a physiological saline solution containing Vancomycin (Fig. 4).

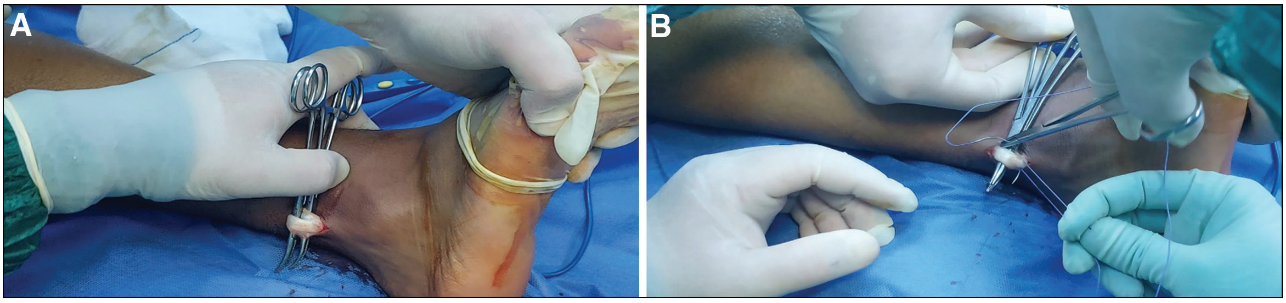
Arthroscopic intra-articular anterior cruciate ligament reconstruction

Routine knee scope was performed by standard anterolateral and anteromedial portals. Any meniscal pathology was managed. Through a high anteromedial portal viewing the medial aspect of the lateral femoral condyle and inserting a guide wire just proximal to the bifurcate ridge and posterior to the resident ridge to drill the anatomic femoral point of ACL according to the diameter of the prepared graft then clean tunnel and joint from any bony debris, then passed suture loop by guide wire to femoral tunnel and pulled it from anteromedial portal then drill tibial tunnel at

Figure 1

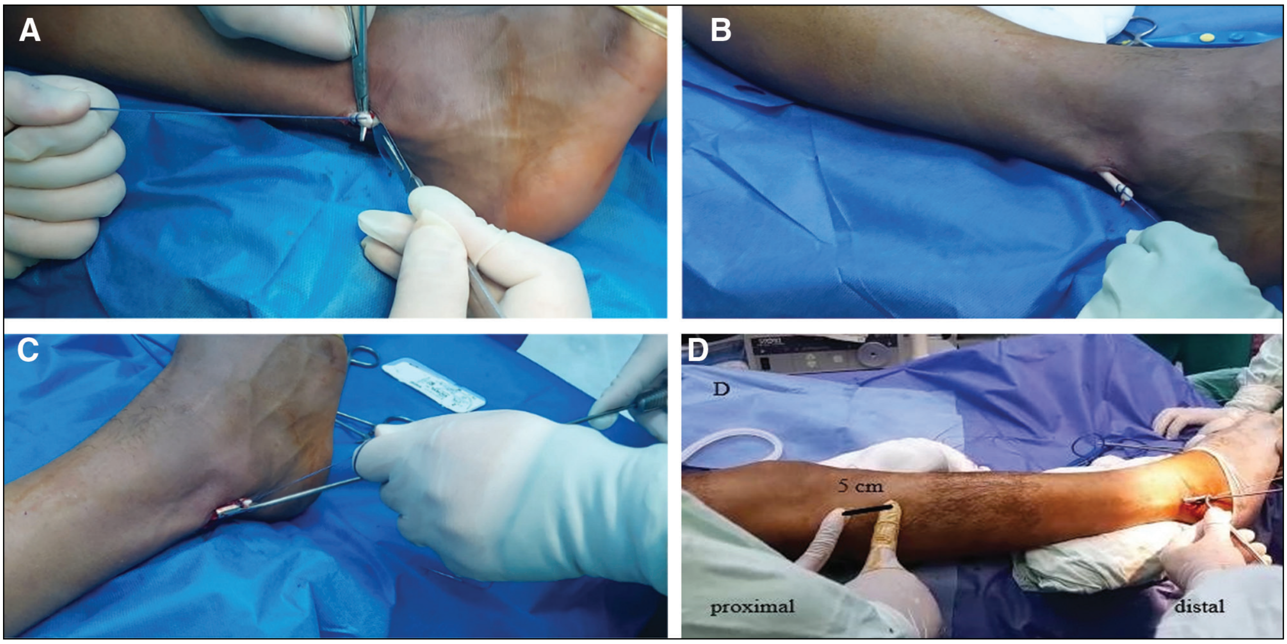
Exposure of both peroneus longus and peroneus brevis tendon.

Figure 2



(a) Photo showing foot eversion and identifying peroneus longus and peroneus brevis tendon right side. (b) Photo showing suture end to side peroneus longus with peroneus brevis right side.

Figure 3



(a) Suture knitted distal part of the peroneus longus then cut proximal to tenodesis with peroneus brevis. (b) Photo showing prepared peroneus longus tendon for stripper right side. (c) Photo showing closed tendon stripper on the right side. (d) Photo showing the stripper was stopped at least 5 cm from the fibular head right side.

Figure 4

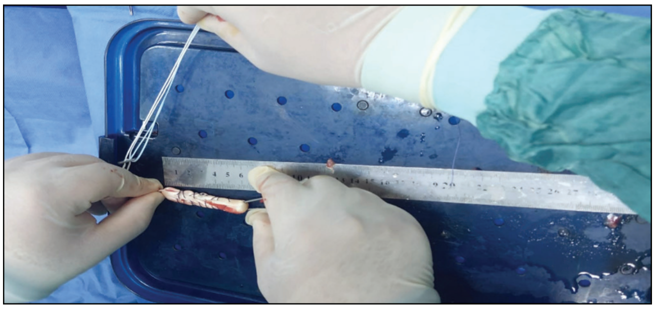
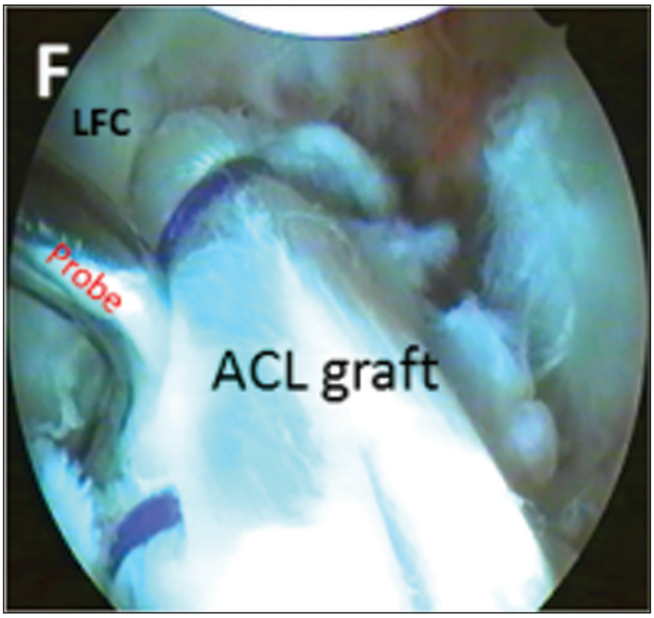


Photo showing final tendon graft preparation.

the anatomic tibial footprint and clean it then pulled suture loop from the tibial tunnel, the graft was passed from tibial tunnel to femoral tunnel by suture loop and assistant pulled suture till the attached U loop rest on the tibial outer cortex. Then tight sutures of tight rope till feel locking/flipping of the tightrope end button rests on the outer cortex of the lateral femoral condyle. Finally, cycling was done, and tight ropes were tightened in knee extension. After finishing the procedure arthroscopic ACL examination was done to check its tension, and joint irrigation was done with normal saline and then intra-articular suction drain was inserted with closure of portal skin(Fig. 5). No anticoagulant therapy was used because immediately postoperatively gradual weight-bearing was allowed in a brace, and progressive knee rehabilitation exercises were allowed. The surgical drain was removed after 24 h postoperatively. A knee brace was used for the first 3 weeks. Return to nonpivoting sports was allowed after 4 months, return to pivoting contact sports was allowed after 10–12 months.

Figure 5



Final arthroscopic view after graft fixation of the right knee.

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 of less than 0.05 was considered statistically significant and less than 0.001 was considered highly significant.

Results

Sixty-five patients fulfilled the inclusion criteria. Their mean age was 29.81 ± 8.33 years (range, 20–45 years). Males were 54 (83%) and females were 11 (17%). Dominant right-sided patients were 38, while nondominant left-sided patients were 27. Time from injury to the operation were eight (12.5%) patients, who got injured 1 month before the surgery followed by the most 33 (50%) patients, who were injured before 2–3 months, 16 (25%) patients before 3–6 months, and eight (12.5%) patients before more than 6 months. The mean duration from injury to operation was 1.2 ± 0.6 months.

Trauma type

Sports injury in 50% (33 cases), road traffic accidents represent 22% (14 cases), and fall from height in 28% (18 cases).

Contact trauma represented 45%, noncontact trauma represented50%, and 5% hyperextension injury.

Table 1 Thickness of the graft

Thickness (mm)	Cases [*N*=65, *n* (%)]
7.5–8	14 (22)
8.1–8.5	20 (31)
8.6–9	15 (23)
>9	16 (24)

Table 2 Length of the graft

Length (mm)	Cases [*N*=65, *n* (%)]
275–285	18 (28)
286–295	22 (34)
296–305	16 (24)
>305	9 (14)

Sports activity

Thirty-three (50%) patients were athletes and 32 (50%) patients were nonathletes.

Operative time

Operative time ranged from 60 to 90 min with a mean of 59 ± 8.44 min.

Associated injuries

There were 32 (49%) patients with isolated ACL injury, 23 (35%) patients with medial meniscal tears, 20 (31%) patients were treated by partial meniscectomy, and three (5%) patients were treated by repair, 10 (16%) patients with lateral meniscal tears, seven (11%) patients were treated by partial meniscectomy, and three (5%) patients were treated by repair (Tables 1–6).

The time from surgery to PR injury sport level ranged from 4 to 8 months with mean±SD of 5.67 ± 0.75.

The mean postoperative follow-up period was 32.5 ± 3.1 months.

Postoperative complications

Three patients had minimal to mild knee effusion which gradually spontaneously subsided after 4 months. One patient had a superficial skin infection at the site of graft harvesting and recovered after a 3-week course of antibiotics. One patient had paresthesia at the site of the graft, which gradually subsided after 3 months.

Discussion

This study found good clinical and functional results after using PLT autograft for primary reconstruction of isolated ACL injury without any hazardous effects on ankle and foot joints and early postoperative restoration of knee functions as knee donor site morbidity was avoided. PLT's function is to control plantar flexion and foot valgus, so it has not been commonly used as an autograft for ligament reconstructions to avoid any side effects on ankle and foot functions [12].

Table 3 Clinical outcomes of knee tests 6 weeks postoperatively

	Patients Cases [*N*=65, *n* (%)]		*P* value
	Preoperative	Postoperative	
Anterior drawer test			<0.001
Negative	0	60 (92)	
Grade I	0	4 (6)	
Grade II	1 (2)	1 (2)	
Grade III	64 (98)	0	
Lachman test			<0.001
Negative	0	63 (96)	
Grade I	0	2 (4)	
Grade II	2 (4)	0	
Grade III	63 (96)	0	
Pivot shift test			<0.001
Negative	0	63 (96)	
Grade I	0	2 (4)	
Grade II	2 (4)	0	
Grade III	63 (96)	0	

Table 4 Functional outcome of knee scores 6 weeks postoperatively

Score	Patients [N=65, n (%)]		*P* value
	Preoperative	Postoperative	
Lysholm score			
Excellent (95–100)	0	61 (93)	
Good (84–94)	0	3 (4)	
Fair (65–83)	50 (76)	1 (3)	
Poor (≤64)	15 (24)	0	
Mean±SD	63.52±3.32	95.30±4.65	<0.001
Range	60–76	83–99	
IKDC			
Grade I	0	60 (92)	
Grade II	0	4 (6)	
Grade III	49 (75)	1 (2)	
Grade IV	16 (25)		
Mean±SD	55.81±8.45	93.47±9.82	<0.001

IKDC, International Knee Documentation Committee.

Table 5 Functional outcome postoperative foot and ankle scores

Variables (duration)	Mean	SD	*P* value
AOFAS (3 months)	90.2	6.450	
AOFAS (6 months)	95.77	5.678	<0.001
AOFAS (12 months)	99.33	2.321	
FAAM (3 months)	98.22	6.443	
FAAM (6 months)	99.11	6.266	<0.001
FAAM (12 months)	99.74	1.244	

AOFAS, American Orthopedic Foot and Ankle Score; FAAM, Foot and Ankle Ability Measure.

Table 6 Range of ankle motion 6 weeks postoperatively

Degree of motion	Affected side	Contralateral side	*P* value
Dorsiflexion	20.7±6.6	20.8±6.1	0.725
Plantarflexion	36.9±8.2	37.7±3.1	0.565
Inversion	29.9±5.5	30±4.1	0.432
Eversion	24.9±8.23	25.7±3.6	0.443

Kerimoğlu *et al*. [8] was the first one to use PLT as an autograft for ACL reconstruction and found that no hazardous effects on ankle joint functions. Rhatomy *et al*. [13] reported that no effects of PLT harvesting on ankle eversion and first ray plantarflexion strength as compared with contralateral ankle that was attributed to compensation of PLT function by peroneus brevis tendon and posterior tibial tendons. Hamstring tendon autograft has good strength, but there were some drawbacks like weak flexion and internal rotation of the knee, saphenous nerve damage, and hamstring muscle strength weakness that might lead to a delayed return to sports activity [14]. The bone–patellar tendon–bone autograft has good bone-to-bone healing and tunnel graft incorporation; however, it has some drawbacks like anterior knee pain, weak graft, fracture patella, and large skin incision [15].

PLT has many advantages: good strength, larger diameter, avoiding drawbacks of graft harvesting from the knee region, no effects on knee functions, and might facilitate rapid return to sports activities [16].

We used the FAAM scale for the assessment of foot and ankle functions postoperatively, and it is a modified new version of the Foot Ankle Disability Index (FADI) scale. Our results reported marked improvement in FAAM score, the mean of FAAM at 3 months was 98.22, FAAM at 6 months was 99.11, and FAAM at 12 months was 99.74, *P* value less than 0.001. A prospective study included 63 patients of PLT autograft for ACL reconstruction by Sahu and colleagues, who found that the mean FAAM score of the affected side ranged from 95.11 at 6 weeks to 97.26 and 99.50 at 3 and 6 months, respectively. The mean of AOFAS at 6 weeks was 89.05, at 3 months was 95.87, and at 6 months was 99.37 without any drawbacks to foot and ankle functions [17]. According to our results, we found a marked improvement in AOFAS score from 6 to 12 months postoperatively with a mean of AOFAS at 3 months (90.3), at 6 months (95.77), and 12 months (99.33) with *P* value less than 0.001 and normal functions of foot and ankle after 12 months follow-up. Kusumastutia *et al.* [18] observed that the mean scores of AOFAS and FADI were 98.93 ± 3.11 and 99.80 ± 0.59 at 6 months after ACL reconstruction by the PLT autograft. Trung *et al.* [16], in a comparison study, reported that the mean AOFAS scores were 97.3 ± 1.67 preoperatively, and 97.3 ± 1.54 postoperatively without any significant differences in the ankle donor side.

A systematic review by He *et al.* [19] observed no significant difference in FADI score in the donor's ankle as compared with the sound one, and AOFAS was minimally diminished with a mean difference of 0.31, *P* value of 0.01; finally, they found that the PLT autograft gave better functional outcomes as compared with hamstring tendons, which led to quadriceps hamstring imbalance and affected the knee functions.

Otis *et al.* [20] found that the peroneus brevis is a more effective evertor of the ankle than the peroneus longus, so no ankle functions were affected after harvesting the PLT.

Rudy Mustamsir and Phatama [21], in a biomechanical study regarding tensile strength, reported no significant difference between PLT and hamstring tendon. Marín Fermín *et al.* [22] in a systematic review study at a short-term follow-up reported similar clinical and stability outcomes with PLT autograft as compared with the hamstring tendon. In our study, we did not observe any significant knee clinical laxity as the anterior drawer test was negative at 60 (92%) patients, and Lachman and pivot shift tests were negative at 63 (96%) patients. Aglietti *et al.* [23] reported a slight loss of extension in 3% of patients and manual laxity according to the pivot shift test and Lachman test after using the semitendinosus tendon. In our study, minimal graft thickness ranged from 7.5 to 8 mm in 14 patients, more than 9 mm in 16 patients, and 35 patients ranged from 8 to 9 mm. Magnussen *et al.* [24] found that the ideal minimum graft thickness of 7 mm was the best to avoid rupture graft. In our study, we reported that the mean±SD of the Lysholm score postoperatively was 95.30 ± 4.65 and the IKDC postoperative mean±SD was 93.47 ± 9.82 without any significant differences.

Park *et al.* [25] in a comparative study between hamstring tendon and PLT grafts reported that regarding the IKDC, modified Cincinnati, and Lysholm score there were no significant differences between preoperatively and postoperatively at1-year follow-up. The PLT autograft had advantages due to its large diameter and no side effects on knee and ankle functions. As regards the range of ankle motions, we did not report any limitations of ankle and foot motions. Trung *et al.* [16] reported no limitations of ankle plantar flexion and foot eversion after using the anterior half of the PLT autograft. Our study has several points of strength: clinical and function evaluation of both knee, foot, and ankle in the same patient groups and applying the IKDC, Lysholm score, AOFAS, and FAAM score with minimal 2-year follow-up. Limitations of our study are small samples of patients, retrospective study, no control group, no comparison between other autografts, and a short follow-up period.

Conclusion

Using the PLT autograft for primary reconstruction of isolated ACL injury did not affect foot and ankle functions with good knee stability and restoration of knee functions postoperatively, which facilitated the return to preoperative sports activity level.

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Nil

Conflicts of interest

There are no conflicts of interest.

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