Results of arthroscopic anterior cruciate ligament reconstruction using full-thickness peroneus longus tendon autograft

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Received: 26-Aug-2024
Revised: 05-Nov-2024
Accepted: 11-Nov-2024
Published: 08-Mar-2025

The Egyptian Orthopaedic Journal 2024, 59:408–415

Background
There is no consensus on the most suitable graft to replace the injured anterior cruciate ligament (ACL). A variety of grafts, such as the hamstring tendon, bone–patellar tendon–bone, and peroneus longus tendon (PLT), are available.
Aim
This study aimed to assess the practical results of ACL restoration with a PLT graft in a single bundle.
Patients and methods
This prospective study included 21 patients, ranging in age from 20 to 45 years, of both sexes, who had ACL tears identified by MRI with injuries that occurred between 4 weeks and 6 months ago. The American Orthopedic Foot and Ankle Society and the International Knee Documentation Committee (IKDC) questionnaires were used to assess all patients.
Results
There is no difference in postoperative functional results (IKDC) based on age and BMI. Age, sex, activity level, and smoking status showed no significant relationship with postoperative IKDC scores. There was no significant correlation between the injured side, trauma mode, meniscal injury association, preoperative time, or postoperative IKDC scores and complications. A significant increase (P<0.001) was noted when comparing the IKDC scores before and after the operation. Patients' scores on the American Orthopedic Foot and Ankle Society scale did not change significantly between the preoperative and postoperative periods.
Conclusions
PLT grafts have a large diameter, minimal donor site morbidity, and excellent clinical outcomes when used for reconstructing ACL. ACL reconstruction using a PLT graft led to improved knee function, as indicated by increased IKDC scores. There was a distinction between right-sided and left-sided knee injuries, with better outcomes observed in the latter group. The presence of a meniscal injury had a negative impact on postoperative scores. Graft dimensions were appropriate, and complications were relatively low.

Keywords:
anterior cruciate ligament, autograft, peroneus longus tendon, reconstruction

Egypt Orthop J 2024, 59:408–415

1110-1148

Introduction

The anterior cruciate ligament (ACL) tear is a growing concern due to its economic and social impact [1].

Noncontact deceleration injuries and contact injuries involving rotation are the most common causes of ACL tears [2].

The ACL has two main fiber bundles; the first, the anteromedial bundle, primarily prevents anterior tibial translation. The posterolateral bundle assists in knee stabilization at nearly full extension, particularly under rotatory stresses [2].

Graft morphology, tension, location, and orientation must be comparable to the native ACL for the ACL reconstruction surgery to be successful.

To preserve the strength and resistance of the original ACL structure, autografts for ACL reconstruction can be obtained from a variety of compatible muscles. Nevertheless, there is no consensus on the most suitable graft to replace the injured ACL. A variety of grafts, such as the hamstring tendon, bone–patellar tendon–bone (BPTB), and peroneus longus tendon (PLT), are available [3].

The reduced donor morbidity attributed to the harvesting of hamstring (semitendinosus and gracilis) tendon grafts is the main advantage of their use in ACL reconstruction. Also, hamstring tendon graft

causes less anterior knee pain than the patellar tendon graft. However, using a hamstring tendon graft causes a higher incidence of thigh muscle weakness and a potential decrease in hamstring power. Also, hamstring graft has unpredictable graft size [3].

Without an increased risk of graft failure, BPTB allows for early active safe rehabilitation and produces good long-term results. However, complications after graft harvesting due to BPTB include patellofemoral discomfort, decreased range of motion, and patellar fracture [4].

In certain orthopedic procedures, such as the reconstruction of the deltoid ligament and the medial patellofemoral ligament, the PLT autograft is used [5].

There is little donor site morbidity and a large-diameter graft when using PLT for ACL reconstruction, according to previous research [6,7].

The purpose of this investigation was to evaluate the functional outcome of single-bundle ACL reconstruction using a PLT graft.

Patients and methods

This prospective study extends from April 2022 to March 2023. The research was carried out with the approval of the Ethics Committee of Tanta University Hospitals in Tanta, Egypt. A formal informed permission form was obtained from each patient.

Inclusion criteria included patients with ACL tears, identified by clinical examination and MRI, and the duration of injury was measured from 4 weeks to 6 months.

Patients with skeletal injury in the ipsilateral limb, patellar instability, BMI more than 30, angular deformity elsewhere in the ipsilateral limb, previous knee injury or surgical interference in the ipsilateral knee, and medial or lateral collateral ligament injury were excluded.

Every patient underwent an evaluation that included taking their medical history, performing a physical examination, laboratory tests (including a complete blood count and coagulation profile), and radiological investigation (including a plain radiograph of the knee and an MRI).

After tearing an ACL, the knee will likely be swollen, painful, weak, and have limited mobility for the first 4 weeks leading up to surgery. The patient was directed to elevate the affected limb. Resuming regular activity and building muscular strength in preparation for surgery became easier as swelling and pain declined with mild stretching and exercise.

Surgical technique

Incisions were made throughout the body's longitudinal axis measuring 4 cm in length, plus 3 cm above and 1 cm beyond the lateral malleoli. The peroneus brevis tendon and PLT were discovered. The peroneus brevis was sutured to the distal stump using an absorbable polyglactin suture 2-0 after PLT was separated 2 cm above the tip of the malleoli. After identifying the femoral and tibial anatomical footprints, a shaver or radiofrequency ablation equipment is used to remove the ACL remnant from the notch. Use an awl or curette to mark the center of the femoral footprint and position. The anatomic footprint serves as a guide, and its usual placement is 6–7 mm anterior to the back wall, to allow 1–2 mm of the back wall after tunnel reaming. Once the proper alignment has been established, the knee is flexed at a 120° angle and a guide pin is placed into the medial aspect of the lateral femoral condyle through the medial portal. A good rule of thumb is to allow for 1–2 mm of space between the posterior wall of the femoral condyle; measuring tools for this purpose are readily available. The guide is situated at the footprint of the ACL on the tibia, parallel to the medial tibial spine, and approximately behind the anterior horn of the lateral meniscus. The exterior part of the guide should be flush with the anteromedial tibia. After the tunnel is drilled, the femoral tunnel suture can be unclamped, and the looped end can be retrieved through the tibial tunnel with the help of a probe to provide the graft passage. The passing suture is advanced into the tibial tunnel, and the femoral-sided graft sutures are inserted using the looped end.

MRI follow-up

MRI is a noninvasive imaging technology that produces three-dimensional detailed anatomical images and uses powerful magnets that produce a strong magnetic field that forces protons in the body to align with that field. Routine MRI follow-up was done after 6 months. During this period, we had to do additional MRI for four patients due to pain at 4 months postoperatively, and one patient suffered from severe mechanical pain during waking after 2 months postoperatively. All of them revealed no signs of ACL injury, no signs of graft, or soft tissue damage.

Scoring instruction

Responses were scored in reverse order, with "constant" receiving 0 points and "never" 10 points. For example,

"worst pain imaginable" received a score of 0, and "no pain" received a score of 10.

American Orthopedic Foot and Ankle Society

The examination of every patient was conducted using the ankle/hindfoot scoring method that was devised by the American Orthopedic Foot and Ankle Society (AOFAS) [8]. One hundred points constitute the AOFAS ankle/hindfoot score. This score is clinical and does not include any radiological factors. This scale was a combination of subjective and objective clinical factors. Excellent (90–100), good (80–90), fair (70–80), and poor (<70) were the categories used to classify clinical results. The scale is composed of nine items that can be divided into three subscales: alignment, function, and pain. There is a single item for pain, and a score of 40 indicates no pain at all. Seven components make up the function, and a maximum score of 50 points indicates complete function. One item measures alignment; a maximum score of 10 indicates good alignment. The maximum possible score is 100, which indicates the absence of any symptoms or impairments, as initially published by the AOFAS ankle [9]. At 6 months following peroneus longus autograft surgery, patients were evaluated using the AOFAS ankle/hindfoot score to evaluate ankle function.

Statistical analysis

SPSS, v26 (IBM Inc., Chicago, Illinois, USA) was used for statistical analysis. The two groups were compared using an unpaired Student's *t* test, which presents quantitative variables as mean and SD. When applicable, the χ^2 or Fisher's exact test was used to examine qualitative variables, which were presented as percentages and frequencies. Using the Pearson moment correlation equation, we checked for correlations between different variables. Statistical significance was determined by a two-tailed *P* value of less than 0.05.

Results

The age range was from 20 to less than 30 years with mean±SD 25.4±1.2 years, ranging from 30 to less than 40 with mean±SD 33±1.4, and ranged from 40 to less than 45 with mean±SD 45.2±1.8. There were 12 (57.1%) males and nine (42.8%) females. Mean±SD of BMI was 23.09524±1.600737 kg/m^2. The level of activity was heavy in 11 (52.3%) patients, moderate in three (14.3%) patients, and light in seven (33.3%) patients. There were two (10.0%) smokers. The injured side was right in 17 (81.0%) patients and left in four (19.0%) patients. Mode of trauma was direct (42.8%) in nine patients and indirect (42.8%) in nine patients. Time lag before surgery ranged from 1 to less than 2 in 12 (57.1%) patients, ranged from 2 to less than 4 in five (23.9%) patients, ranged from 2 to less than 4 was in four (19.0%) patients. Meniscal injury was present in three (14.2%) patients (Table 1).

There was a significant increase in postoperative International Knee Documentation Committee (IKDC) score compared with preoperative (P<0.001). There was no significant difference between preoperative and postoperative AOFAS scores in the studied patients (Table 1).

There was no significant relationship between postoperative IKDC score and age, sex, level of activity, and smoking (Table 2).

There was no significant relationship between postoperative IKDC score and injured side, mode

Table 1 Demographic data of the studied patients, including graft diameter, graft length, and International Knee Documentation Committee and American Orthopedic Foot and Ankle Society scores in studied patients

	***N*=21**	
Age (years)		
20–<30	25.4±1.2	
30–<40	33±1.4	
40–<45	45.2±1.8	
Total	32.95±7.31	
Range (minimum–maximum)	20–43	
Sex		
Male	12 (57.1)	
Female	9 (42.8)	
BMI (kg/m^2)	23.09524±1.600737	
Level of activity		
Heavy	11 (52.3)	
Moderate	3 (14.3)	
Light	7 (33.3)	
Smoking	2 (10.0)	
Injured side		
Right	17 (81.0)	
Left	4 (19.0)	
Mode of trauma		
Direct	9 (42.8)	
Indirect	12 (57.1)	
Meniscal injury	3 (14.2)	
Time lag before surgery		
1–<2 (months)	12 (57.1)	
2–<4 (months)	5 (23.9)	
4–<6 (months)	4 (19.0)	
Graft diameter (mm)	8.44±0.1	
Graft length (mm)	13.08±0.12	
Preoperative	Postoperative	*P*
IKDC		
46.09±7.39	96.09±6.53	<0.001*
AOFAS		
98.23±2.34	97.47±1.36	0.114

Data are presented as mean±SD or frequency (%).
AOFAS, American Orthopedic Foot and Ankle Society; IKDC, International Knee Documentation Committee.

Table 2: Relationship between postoperative International Knee Documentation Committee score and age, sex, level of activity, smoking, injured side, mode of trauma, an association of meniscal injury, time lag before surgery, and complications

	N	Functional result postoperative (IKDC)	*P*
Age (years)			
20–<30	7	91.83±7.83	
30–<40	9	96.60±5.19	^{F}P=0.339
40–<45	5	94.0±5.87	
Sex			
Male	12	93.08±7.89	^{T}P=0.152
Female	9	96.67±1.73	
Level of activity			
Heavy	11	96.73±4.98	
Moderate	3	95.33±2.31	^{F}P=0.269
Light	7	91.0±7.90	
Smoking			
Smoker	2	92.5±3.53	^{T}P=0.284
Nonsmoker	19	95.36±6.77	
Injured side			
Right	17	93.88±6.73	^{T}P=0.035*
Left	4	97.75±0.96	
Mode of trauma			
Direct	9	94.11±6.95	^{T}P=0.755
Indirect	12	95.0±5.91	
Meniscal injury			
Present	3	81.66±2.88	^{T}P<0.001*
Not present	18	97.33±3.48	
Time lag before surgery			
1–<2 (months)	–	98.5±2.27	
2–<4 (months)	–	96±4.18	^{F}P<0.001*
4–<6 (months)	–	83.75±3.24	
Complications			
Loss of terminal flexion	2	81.50±0.71	
Transient apraxia sural nerve	1	83.0	
Surgical site pain	4	92.25±5.68	

Data are presented as mean±SD.
^{T}P, *P* value for Student *t* test for comparing between the studied categories; ^{F}P, *P* value for one-way analysis of variance test for comparing between the studied categories, IKDC, International Knee Documentation Committee.
*Significant *P* value less than 0.05.

of trauma, an association of meniscal injury, time lag before surgery, and complications (Table 2).

There was no correction between IKDC and age and BMI (Table 3).

The mean graft diameter was 8.44±0.1; the graft length was 13.08±0.12, and regarding postoperative complications, there was one (4.8%) patient who had a transient neurapraxia sural nerve, two (9.54%) who had loss of terminal flexion, four (19.0%) who had surgical site pain, and 14 (66.66%) had no complications (Table 4).

Case 1: a 26-year-old male hard worker presented with indirect contact injury to the left knee for 3 months. Preoperative MRI showed ACL tear with posterior horn medial meniscus injury; the preoperative IKDC score was 49. The patient undergoes arthroscopic ACL reconstruction with a full-thickness PLT autograft and partial meniscectomy with a follow-up MRI at 6 months (Fig. 1).

Table 3: Correlation between functional result postoperatively (International Knee Documentation Committee) and BMI

	Functional result postoperative (IKDC)	
	r	*P*
Age (years)	0.253	0.268
BMI (kg/m^2)	–0.061	0.793

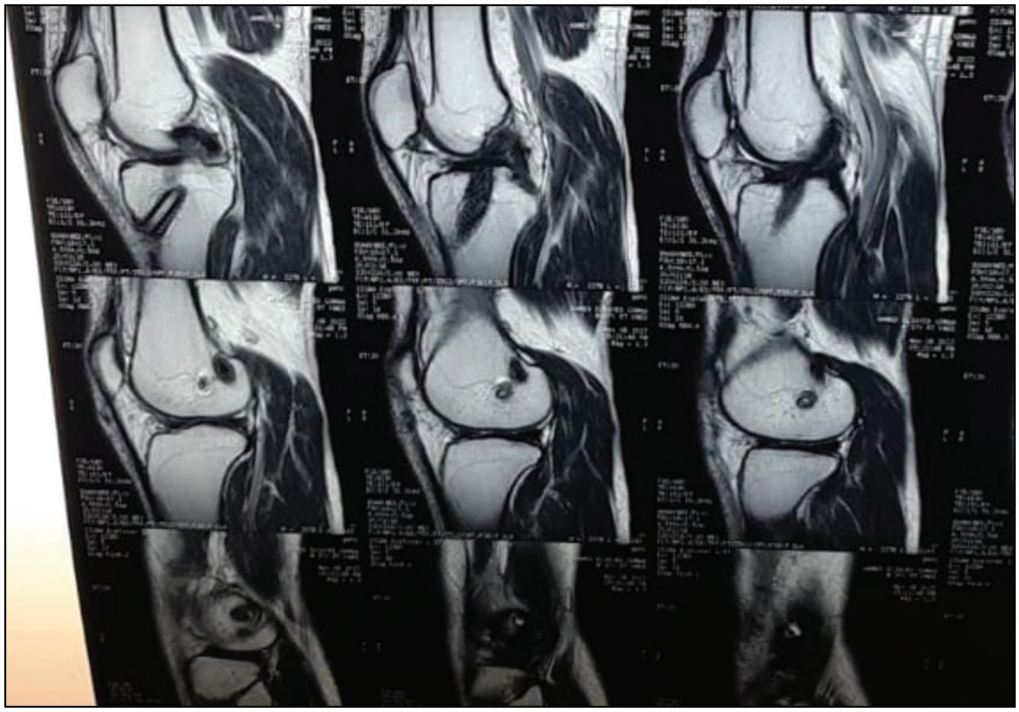
IKDC, International Knee Documentation Committee; *r*, Pearson coefficient.

Table 4: Postoperative complications of studied patients

Postoperative complications	
Transient apraxia sural nerve	1 (4.8)
Loss of terminal flexion	2 (9.54)
Surgical site pain	4 (19.0)
No complications	14 (66.66)

Data are presented as frequency (%).

Figure 1



Preoperative MRI sagittal cuts show anterior cruciate ligament tear and anterior cruciate ligament tear with posterior horn medial meniscus.

The postoperative IKDC score after 6 months was 81. Postoperative MRI sagittal cuts show ACL reconstruction using peroneus longus autograft and partial meniscectomy (Fig. 2).

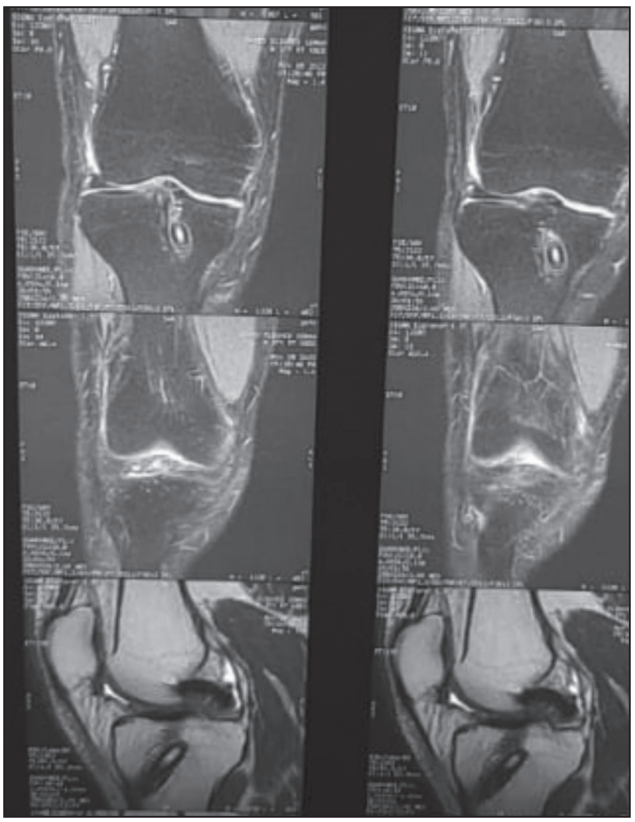
Loss of terminal flexion postoperative ACL reconstruction (Fig. 3).

Discussion

An ACL rupture is one of the most prevalent knee conditions. A damaged ACL compromises the knee's stability by preventing internal rotation and anterior tibial translation, leading to anterior and rotatory instability. The most common noncontact injuries can happen while jumping, turning, or with a slightly flexed knee in a valgus position [10].

In our investigation, the postoperative IKDC score was significantly higher than the preoperative score. This is in agreement with Rhatomy *et al.* [11] who found that the result of the mean IKDC score preoperatively was 54.66 and postoperatively was 95.69 with substantial variations in IKDC and Tegner Lysholm score between preoperative and postoperative scores (P<0.05). This is consistent with the research of Singh and Patel [12], who reported that the mean IKDC subjective score before surgery was 47.77, while the mean score following surgery was 87.9

Figure 2



Postoperative anterior cruciate ligament reconstruction shows sagittal cuts anterior cruciate ligament reconstruction and anterior cruciate ligament reconstruction using peroneus longus autograft and partial meniscectomy.

Figure 3

Postoperative ACL reconstruction. ACL, anterior cruciate ligament.

with a considerable increase in both preoperative and postoperative IKDC scores. There were no significant differences in dorsiflexion strength of the donor ankle before and after the operation at either 12 or 24 months postoperatively. At 12 months postoperation, there were no significant differences between the donor ankle's preoperation and postoperation plantar flexion strengths.

No significant difference was observed in the patients' AOFAS scores before and after operation in our study. This is in accordance with Trung *et al.* [13], who reported that before surgery, the ankle joint's function based on the AOFAS score is 97.3 (SD 1.67), and after surgery is 97.3 (SD 1.54); the smallest is 93 and the highest is 100 scoring. In the Angthong *et al.* [14] study, it was determined that the peroneus longus graft might be the best option for ACL reconstruction. Research has shown that ankle eversion function remains intact following PLT harvesting because the peroneus brevis is the superior evertor [15].

Concerning strength, safety, and donor site morbidity, PLT is recognized as an efficient autograft option for ACL repair because complete removal of the PLT has no impact on gait or ankle stability [16].

In our study, patients without complications have the highest mean IKDC score of 98.0±1.11, indicating excellent postoperative knee function.

Mohammed *et al.* [17] showed that 13 (72.2%) cases were noncomplicated and 27.8% were complicated (hemarthrosis, loss of terminal flexion, pain, superficial infection, and transient apraxia sural nerve).

In our study, postoperative functional results were measured by IKDC score for patients categorized into three age groups: from 20 to less than 30 years, 30 to less than 40 years, and 40 to less than 45 years. The correlation between age and postoperative IKDC score is not significantly different. Mohammed *et al.* [18] reported that they had patients averaging 27.39 years old. Rhatomy *et al.* [19] found that the ages of the patients ranged from 18 to 45 years, with an average of 26.7 years.

In our study, regarding the relationship between postoperative IKDC scores and sex. The data is divided into two categories: male (n=12) and female (n=9). On average, males have a mean postoperative IKDC score of 93.08±7.89, while females have a slightly higher mean score of 96.67±1.73. The P value (^{T}P=0.152) suggests a lack of statistically significant difference in IKDC scores between males and females. Mohammed *et al.* [18] reported that there were 13 (72.2%) males and five (27.8%) females. Rhatomy *et al.* [19] found that among the 75 patients in their study, 59 (78.7%) patients were males and 16 (21.3%) patients were women.

In our study, regarding the relationship between postoperative IKDC scores and the presence of a meniscal injury, patients are categorized into two groups: "present" (n=3) indicating the presence of a meniscal injury and "not present" (n=18) indicating the absence of a meniscal injury. On average, patients with a meniscal injury have a significantly lower mean postoperative IKDC score of 81.66±2.88, while those without a meniscal injury have a notably higher mean score of 97.33±3.48. P value less than 0.001 indicates that IKDC results showed a significant difference among the two groups. Mohammed *et al.* [20] concluded that meniscal resection or repair had no impact on the result. Lewis *et al.* [21] concluded that meniscal resection or repair had no impact on the result.

The average graft length was 13 cm and the average graft diameter was 8.44 mm in our study. The range for graft diameter falls within a tight interval of 8.3–8.6 mm, while the graft length falls within the range of 12.9–13.2 cm. Rhatomy *et al.* [19] suggests that a peroneus longus autograft could be an option for repairing an ACL and reducing the risk of future ruptures. Unlike alternative methods, for example, a study by Dang [22] used a semitendinosus-gracilis graft with a diameter of 7.25.

In our study, regarding the relationship between postoperative IKDC scores and time lag before surgery,

patients were categorized into three age groups: Time lag before surgery 1–less than 2 months with a mean IKDC score of 98.5±2.27, time lag before surgery 2–less than 4 months with a mean IKDC score of 96±4.18, time lag before surgery 4–less than 6 months with a mean IKDC score of 83.75±3.24. *P* value less than 0.001 indicates a highly significant difference in IKDC scores between groups. Mohammed *et al.* [18] reported that the time before surgery was from 4 months to 1 year with no significant difference. Smith *et al.* [23] reported no statistically significant difference in results between patients who underwent ACL repair earlier compared with those who underwent the procedure later.

In agreement with our results about complications, Mohammed *et al.* [18] showed that 13 (72.2%) cases were noncomplicated and 27.8% were complicated (hemarthrosis, loss of terminal flexion, pain, superficial infection, and transient apraxia sural nerve). Khajotia *et al.* [24] found that regarding difficulties, one patient experienced knee joint stiffness that required mobilization under anesthesia 10 days after surgery.

In our study, regarding the relationship between postoperative IKDC scores and the presence of a meniscal injury. Patients are categorized into two groups: "present" (*n*=3) indicating the presence of a meniscal injury and "not present" (*n*=18), indicating the absence of a meniscal injury. On average, patients with a meniscal injury have a significantly lower mean postoperative IKDC score of 81.66±2.88, while those without a meniscal injury have a notably higher mean score of 97.33±3.48. *P* value less than 0.001 indicates a highly significant difference in IKDC scores between these two groups.

Mohammed *et al.* [17] showed that on investigating about associated injuries, only six (33.3%) patients had no injuries (33.3%) and three (16.7%) patients had medial meniscus lesions. They concluded that meniscal resection or repair had no impact on the result.

The study had some limitations, such as a limited sample size, the fact that it was conducted in just one location, patients were only followed up for a short time, and the absence of a control group receiving a different graft type or surgical technique makes it difficult to compare the outcomes directly.

Conclusions

ACL reconstruction using a PLT graft led to improved knee function, as indicated by increased IKDC scores. The absence of significant differences in AOFAS scores suggests that the improvement was specific to knee-related parameters. There was a distinction between right-sided and left-sided knee injuries, with better outcomes observed in the latter group. The presence of a meniscal injury had a negative impact on postoperative scores. Graft dimensions were appropriate, and complications were relatively low. Overall, the study emphasizes the effectiveness of ACL reconstruction, the importance of addressing meniscal injuries, and the influence of complications on postoperative outcomes.

Author contributions

Study concept and design: M.A.H., and A.M.S.; analysis and interpretation of data: A.M.E. and E.M.E.F.; drafting of the manuscript: M.A.H.; critical revision of the manuscript for important intellectual content: E.M.E.F. and M.A.H.; statistical analysis: A.M.E.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Abbreviations

ACL	anterior cruciate ligament
AOFAS	The American Orthopedic Foot and Ankle Society
BPTB	bone–patellar tendon–bone
IKDC	International Knee Documentation Committee
PLT	peroneus longus tendon

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