Anterior cruciate ligament reconstruction using peroneus longus tendon autograft: a systematic review

Samir S. Ghonim, Mohamed A. Hemida, Ahmad H. Khater

Department of Orthopedic Surgery, Faculty of Medicine, Ain Shams University, Cairo, Egypt

Correspondence to Mohamed A. Hemida, MD, Department of Orthopedic Surgery, Faculty of Medicine, Ain Shams University, Cairo 11566, Egypt
Tel: +20 111 404 3032;
e-mail: m.amr.ortho@gmail.com

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Background
The anterior cruciate ligament is the most commonly injured ligament in the knee; controversy exists about the most suitable graft for anterior cruciate ligament reconstruction (ACLR).
Aim
This study aims to assess the efficiency of peroneus longus tendon (PLT) autograft as a good alternative graft choice for ACLR and to outline the advantages and disadvantages of its use.
Methodology
We searched the literature through PUBMED, Cochrane library, Medscape, direct science, JBJS, and Google scholar with publication date restricted to 10 years range from 2012 to 2022. English literature of prospective studies only were selected with strict inclusion criteria where human studies undergoing arthroscopic ACLR using PLT autograft, which commenting on clinical±imaging outcomes and repeated studies excluded. Eleven studies were included satisfying the predetermined inclusion criteria with a total of 564 patients. Four literatures compared ACLR using PLT autograft versus Hamstring tendon (HT), one literature versus semitendinosus graft, and another versus patellar tendon. After pooling collected data from the desired search studies, the relative risk of each of the intended outcome measures of interest was calculated and tabulated according to IKDC and AOFAS scores.
Results
In four literatures, in total, outcomes of 108 PLT versus 129 HT autografts were analyzed with mean follow-up 10.5 months, reported little difference was found between the two grafts in favor of PLT autograft, with mean score 95.58 for PLT versus 91.65 for HT. Outcomes of 15 PLT versus 15 semitendinosus autografts were analyzed. PLT autograft gave better clinical and biomechanical outcomes than semitendinosus graft as mean IKDC score was 91.58 for PLT versus 88.37 for semitendinosus graft. Outcomes of 50 PLT versus 50 patellar tendon autografts were analyzed, and reported that PLT autograft has a better IKDC score than patellar tendon autograft (96.8 vs. 95.1) and lower graft rupture rate (6 vs. 10%). In five literatures, in total, the outcomes of 189 patients had ACLR using PLT autograft, were analyzed after mean follow up 12.4 months and revealed that mean IKDC score was increased from 64.7 preoperative to 97.8 postoperative. PLT harvest does not appear to affect foot and ankle function to any clinically significant degree with slightly decreased AOFAS score (96.88±4.95).
Conclusion
PLT autograft consider a very promising and ideal graft option for ACLR with excellent functional and biomechanical outcomes. PLT harvest is easy and causes minimal donor-site morbidity.

Keywords:
anterior cruciate ligament reconstruction, knee surgery and arthroscopic surgery, peroneus longus tendon autograft

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Introduction

The anterior cruciate ligament (ACL) is the most commonly injured ligament in the knee. Most ACL tears occur in athletes by noncontact mechanisms versus contact mechanisms, such as rotational forces versus a direct hit to the knee. There is no age or sex bias; however, it has been suggested that women are at increased risk of ACL injury secondary to a multitude of factors. Some studies suggest that females may have weaker hamstrings and preferential utilize the quadriceps muscle group while decelerating [1].

Most patients complain of hearing and feeling a sudden 'pop' and feel that their knee 'gives out' from under them at the time of injury. Other symptoms include tenderness along the joint line, pain, swelling, decreased or loss of range of motion, and difficulty ambulating [1].

Although ACL injury can be diagnosed clinically, imaging with MRI is often utilized to confirm the diagnosis. MRI is the primary modality to diagnose ACL pathology, with a sensitivity of 86% and specificity of 95% [1].

ACL injuries, depending on their severity, can be managed nonoperatively or operatively. In a recent systematic review, 81% of those itreated with anterior cruciate ligament reconstruction (ACLR) returned to some athletic activity, 65% to the preinjury level of competition, and 55% of high-level athletes returned to normal play and competition [1].

The commonly used grafts include bone–patellar tendon–bone autografts, Hamstring tendon (HT) autografts, quadriceps tendon autografts, and allografts, and each has distinct advantages and disadvantages. Bone–patellar tendon–bone grafts have more complications in the donor site, but have good graft stability and motor function recovery after operation. However, allografts have a higher risk of retear, which may be due to the poor strength of grafts after undergoing the sterilization process, but it is of great value in the case of multiple ligament injury and revision surgery [1].

With donor site risk of different graft options such as anterior knee pain with patellar tendon, numbness around surgical site of HT graft harvesting, the idea of looking for another graft option with proper biomechanical advantage and lesser donor site morbidity becomes mandatory. The use of peroneus longus tendon (PLT) autograft is a recent development in the field of ACLR. The advantages are that its strength and mean thickness are nearly the same as that of the native ACL, and it is very easy to harvest [2].

PL harvesting was done through a 3 cm longitudinal incision behind the distal fibula, followed by an incision of the peroneus sheath. Identification of PL tendon, which is more superficial, while peroneus brevis is deeper and has more fleshy fibers. After harvesting PLT, tenodesis of the distal end of PL to the peroneus brevis tendon was done using no. 1.0 Vicryl suture after the incision of PL tendon and preparation of the graft.

Aim

To assess the efficiency of PLT autograft as a good alternative graft choice for ACLR and to outline the advantages and disadvantages of its use. Postoperative biomechanical outcomes were evaluated using IKDC and AOFAS scores.

Methodology

The search was conducted by using the database PUBMED, Cochrane library, Medscape, direct science, and JBJS (Journal of Bone and Joint Surgery), and Google scholar using the following keywords:

(1) ACLR.
(2) PLT autograft.
(3) Knee surgery.
(4) Arthroscopic surgery.

The literature extraction process involved four phases (Fig. 1):

(1) Identification.
(2) Screening.
(3) Eligibility.
(4) Inclusion.

Statistical considerations

Outcomes from included studies were combined using the systematic review manager software and manually screened for eligibility to be included.

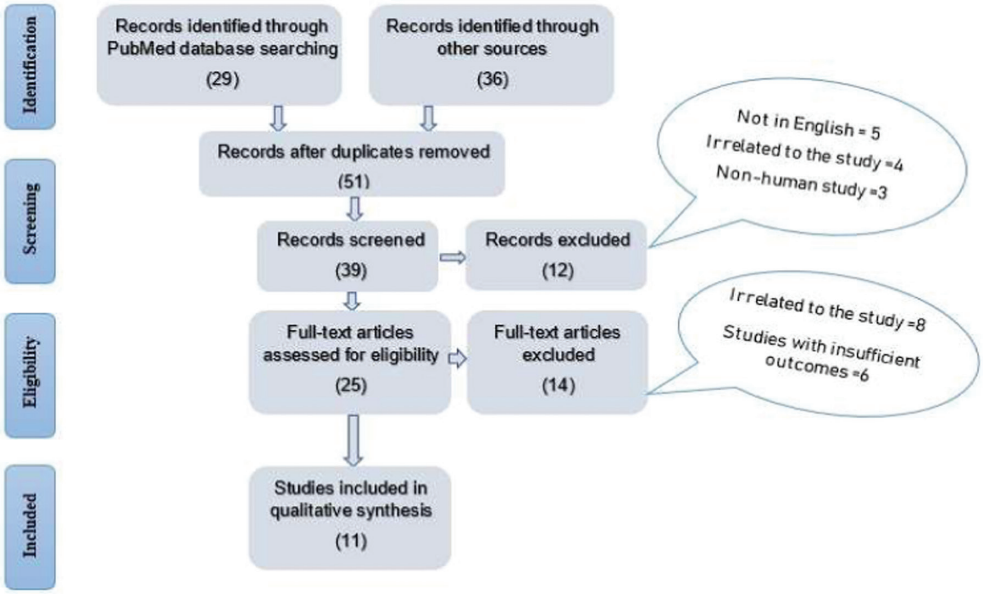
PRISMA flowchart was produced based on the search results and the inclusion and exclusion criteria. To facilitate the assessment of possible risk of bias for each study, information was collected using the Cochrane collaboration tool for assessing the risk of bias.

After pooling collected data from the desired search studies, the relative risk of each of the intended outcome measures of interest was calculated and tabulated according to IKDC and AOFAS scores.

Results

The initial search retrieved 65 papers between 2012 and 2022, but only 11 of them met the selection criteria reporting on 564 patients, with a mean follow-up 13.8 months, four studies compared ACLR using PLT autograft versus HT, one study versus semitendinosus graft and another versus patellar tendon (Table 1).

Figure 1:



PRISMA flow chart according to inclusion and exclusion criteria.

Table 1: Summary of included studies with basic parameters [2–12].

References	Study type	Level of evidence	Country	Peroneus longus group	Control group	Mean follow-up (months)
Sakti *et al*. [2]	Cross-sectional	II	Indonesia	33	51 (Hamstring)	9
Saeed *et al*. [3]	Randomized control	II	Pakistan	28	28 (Hamstring)	12
Vijay *et al*. [4]	Prospective randomized	III	India	23	22 (Hamstring)	9
Rhatomy *et al*. [5]	Prospective cohort	II	Indonesia	24	28 (Hamstring)	12
Kumar *et al*. [6]	Prospective	III	India	15	15 (semitendinosus)	24
Goncharov *et al*. [7]	Prospective randomized	III	Russia	50	50 (patellar)	24
Nazem *et al*. [8]	Randomized control	II	Iran	16	No	6
Kumar *et al*. [9]	Prospective randomized	III	India	25	No	6
Chandra and Girotra [10]	Prospective randomized	III	India	24	No	13
Kumar *et al*. [11]	Prospective cohort	III	India	100	No	24
Angthong *et al*. [12]	Prospective randomized	III	Thailand	24	No	12.8

Peroneus longus tendon versus Hamstring tendon outcomes

In four studies, in total, results of 108 PLT versus 129 HT autografts were analyzed with average follow-up 10.5 months.

Four studies compared IKDC scores between 108 patients after PLT autograft and 129 patients after HT autograft, and little difference was found between both grafts in favor of PLT autograft, with a mean score of 95.58 for PLT versus 91.65 for HT [2–5] (Table 2).

Rhatomy *et al*. [5] reported no significant difference in tensile strength between the PL and a four-strand Hamstring. The ultimate tensile strength of the PLT was 2500 N, while the ultimate tensile strength of the native ACL was 1725 N.

Table 2: IKDC score comparison after peroneus longus tendon and Hamstring tendon (*P*=0.001) [2–5]

References	IKDC	
	PLT	HT
Sakti *et al*. [2]	97.5	92.2
Saeed *et al*. [3]	95.7	91.4
Vijay *et al*. [4]	96.6	94.2
Rhatomy *et al*. [5]	92.5	88.8

HT, Hamstring tendon; PLT, peroneus longus tendon.

If a *P* value reported from a *t* test is less than 0.05, then that result is said to be statistically significant. If a *P* value is greater than 0.05, then the result is insignificant.

Peroneus longus autograft versus semitendinosus autograft

According to Kumar *et al*. [6], the outcomes of 15 PLT versus 15 semitendinosus autografts were analyzed. The

Table 3: Comparison between semitendinosus and peroneus longus grafts according to IKDC score [6] (*P*=0.02)

Graft	Normal	Near normal	Abnormal
PLT graft	*N*=10 (mean 93.42)	*N*=5 (mean score 87.91)	*N*=0
Semitendinosus graft	*N*=8 (mean 90.56)	*N*=6 (mean score 86.17)	*N*=1 (score 84)

PLT, peroneus longus tendon.

Table 4: Comparison between peroneus longus tendon versus patellar tendon according to IKDC score [7] (*P*=0.0004)

Grafts	Preoperative score	Postoperative score
PLT	68.2	96.8
Patellar tendon	68.6	95.1

PLT, peroneus longus tendon.

tensile strength of four stranded semitendinosus graft (4090 N) and double-stranded PLT graft (4268 N) is more or less comparable, and they are superior to the tensile strength of the native ACL (2160 N) (Table 3).

Peroneus longus autograft versus patellar tendon autograft

According to Goncharov *et al*. [7], outcomes of 50 PLT versus 50 patellar tendon autografts were analyzed. According to IKDC score, the mean score after PLT autograft was 96.8, while after patellar tendon autograft was 95.1. Autograft rupture within 2 years after patellar tendon autograft surgery was detected in five (10%) out of 50 patients versus three (6%) patients after PTL autograft (Table 4).

Peroneus longus tendon autograft outcomes

In five literatures, the outcomes of 189 patients who had ACLR using PLT autograft, were analyzed after mean follow-up 12.4 months. According to Chandra and Girotra, PLT is as strong as native ACL. The maximum tensile load of the native ACL is 1725 N, and the maximum tensile load of single-strand PLT is 1950 N. According to five literatures, the mean IKDC score increased from 64.7 preoperative to 97.8 postoperative as shown in Table 5 [8–12].

Donor-site morbidity associated with peroneus longus tendon autograft

Out of 362 patients, only three (0.8%) patients developed graft sural nerve neurapraxia, which got cured with 2 months of methylcobalamine treatment. Pressure pain could be elicited in only two (0.6%) patients. There were several complaints which were resolved in 1–6 months after the operation as ankle stiffness two (0.6%) patients, and inversion sprain of an ankle one (0.3%) patient. Most patients experienced edema of the donor-site with exercise, which resolved with a second day with rest or maximally with 2 months of follow-up [13].

In view of cosmetic concerns, the harvesting of a PLT graft conceals the tendon harvesting scar behind the lateral malleolus, and also the scar around the tibial tunnel is significantly smaller. According to AOFAS scores, PLT harvest was not affect ankle functions, as shown in Table 6 [3–5,7,11,12].

Table 5: Mean IKDC score of anterior cruciate ligament reconstruction using peroneus longus tendon autograft (preoperative and postoperative) [8–12] (*P*=0.04)

References	Preoperative score	Postoperative score
Nazem *et al*. [8]	62.1	98.5
Kumar *et al*. [9]	65.5	97.7
Chandra and Girotra [10]	72.2	97.9
Kumar *et al*. [11]	55.7	96.1
Angthong *et al*. [12]	68.1	98.6

Table 6: Mean±SD AOFAS scores of operated ankles [3–5,7,11,12]

References	AOFAS score	*P* value
Saeed *et al*. [3]	98.4±2.1	*P*>0.05
Vijay *et al*. [4]	96.43±3.13	*P*=0.004
Rhatomy *et al*. [5]	97.3±4.2	*P*>0.05
Goncharov *et al*. [7]	95.3±7.5	*P*=0.008
Kumar *et al*. [11]	97.87±3.21	*P*>0.05
Angthong *et al*. [12]	96.0±9.6	*P*=0.04

Discussion

ACLR surgery is considered the gold standard management for patients with ACL tear to avoid knee instability and further chondral meniscal damage with the usage of either auto or allograft.

Recently, most autografts are harvested from the knee region, which carries possible hazards such as anterior knee pain with PTB or hamstring weakness with HT grafts.

Analysis of comparative studies revealed significantly better patient-reported functional outcomes (IKDC subjective score). In comparison to HT autograft, PLT autograft got a mean IKDC score 95.58 versus 91.65 for HT autograft with better biomechanical properties as stronger ultimate tensile strength (2500 N) and wider graft diameter (8.8 vs. 8.2 mm) [2–5].

According to Kumar *et al*. [6], PLT autograft gave better clinical and biomechanical outcomes than semitendinosus graft as the mean IKDC score was

91.58 for PLT versus 88.37 for semitendinosus graft. The tensile strength of four stranded semitendinosus graft (4090 N) and double-stranded PLT graft (4268 N).

According to Goncharov *et al.* [7], PLT autograft has a better IKDC score than patellar tendon autograft (96.8 versus 95.1) and a lower graft rupture rate (6 vs. 10%).

According to this systematic review, we found that PLT seemed to be a good possible graft alternative choice for ACLR. Analysis of clinical studies reporting PLT autograft demonstrates satisfactory outcomes for ACLR, with stable and functional knee with less morbidity and low graft failure rates. Functional outcomes using PLT autograft were satisfactory, with a mean IKDC score 97.8; PLT (1950 N) is as strong as native ACL (1725 N).

In this systematic review, we found that the mean of PLT graft diameter was 8.83 mm. This result indicates that PL autograft is an ideal choice for ACLR and minimizing risks of rerupture incidence in the future, as there is a significant positive correlation between 1 mm increase in graft diameter, with higher IKDC score and functional outcomes, and also higher revision rate with graft size of less than 8 mm.

In contrast to previous concerns, PLT harvest does not appear to affect function of foot and ankle to any clinically significant degree. Slightly decreased AOFAS scores (96.88 ± 4.95) were found upon follow-up of PLT harvest patients compared with preoperation values. PLT has minimal effect on the maintenance of the arch of the foot. The stability of the foot will not be much affected by using a PL graft.

PLT harvest provides a cosmetic advantage to athletes who often need to have their legs exposed in their profession.

There were several complaints that were resolved in 1–6 months after the operation, such as ankle stiffness (0.6%), inversion sprain of an ankle (0.3%), 0.8% developed graft sural nerve neurapraxia, pressure pain could be elicited (0.6%).

The main limitations of this review related to the selection of studies included as per the strict inclusion criteria: there is no other outcomes score except for IKDC and AOFAS scores, and only studies published in the English language were included, which introduces a potential selection bias.

Conclusion

Despite controversy about the most suitable graft for ACLR, PLT autograft consider a very promising and ideal graft option for ACLR with excellent functional and biomechanical outcomes. PLT harvest is easy and causes minimal donor-site morbidity, unlike other graft options.

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Conflicts of interest

All parties including the contributing authors and corresponding authors denied any conflict of interests as well as any financial disclosures.

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