Received: 21 May 2025 | Accepted: 15 August 2025

DOI: 10.1002/ksa.70079

Peroneus longus tendon harvest for ACL reconstruction yields good functional outcome of the ankle: A systematic review and meta-analysis

Mehran Soleymanha[1] | **Amirali Soleymani Nejad**[1] | **Sohrab Keyhani**[2] | **Fardis Vosoughi**[3] | **Robert F. LaPrade**[4] | **Luke V. Tollefson**[5]

[1]Poursina Hospital Orthopedic Research Center, Guilan University of Medical Sciences, Rasht, Iran

[2]Bone, Joint, and Related Tissues Research Center, Akhtar Orthopedic Training and Research Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran

[3]Department of Orthopedics and Trauma Surgery, Shariati Hospital, Tehran University of Medical Sciences, Tehran, Iran

[4]Department of Complex Knee and Sport Medicine, Twin Cities Orthopedics, Edina, Minnesota, USA

[5]Twin Cities Orthopedics, Edina, Minnesota, USA

Correspondence

Mehran Soleymanha, Poursina Medical & Educational Center, Rasht, Guilan Province, Iran.
Email: mehransoleymanha@gmail.com

Abstract

Purpose: The peroneus longus tendon (PLT) has emerged as a promising autograft option for anterior cruciate ligament (ACL) reconstruction, but concerns persist regarding donor-site morbidity and ankle functional outcomes. This systematic review and meta-analysis aimed to evaluate ankle performance following PLT harvest for ACL reconstruction.

Methods: This systematic review and meta-analysis performed by searching five databases (PubMed, Embase, Web of Science, Scopus, and the Cochrane Library) up to March 2025. Inclusion criteria included: ACL reconstruction using PLT autograft, ≥6-month follow-up, and validated ankle outcomes (American Orthopaedic Foot And Ankle Society [AOFAS]/Foot and Ankle Disability Index [FADI] scores). Pooled effect sizes were calculated using random-effects models using R software (version 4.4.3). Heterogeneity was assessed via I^2 statistics, and risk of bias was evaluated using JBI checklists.

Results: Twenty articles (1024 patients) were identified, comprising eleven prospective cohort studies and nine randomised clinical trials (RCT), based on title, abstract, and quality assessments. Meta-analysis demonstrated excellent postoperative ankle function, with pooled AOFAS scores of 96.0 (95% confidence interval [CI]: 92.6–99.3) at 6 months, 96.1 (93.9–98.2) at 12 months, and 97.2 (93.9–100.6) at 24 months. FADI scores similarly improved to 97.4 (96.0–98.9) by 6 months and 99.4 (98.7–100.1) at 24 months. Meta-regression revealed no significant association between age and AOFAS outcomes ($\beta = -0.23$, $p = 0.36$). Minor complications (e.g., transient hypaesthesia) occurred in 13%–23% of patients but resolved within months. No studies reported major nerve injuries or ankle instability.

Conclusion: Peroneus longus tendon harvest for ACL reconstruction yields minimal donor-site morbidity, with consistently high AOFAS/FADI scores across all age groups. These findings support the safety of PLT autografts, though heterogeneity is evident, and the predominance of male participants and the regional focus of studies, mainly Asian populations, may affect generalisability.

Abbreviations: ACL, anterior cruciate ligament; AOFAS, American Orthopaedic Foot And Ankle Society; CI, confidence interval; FADI, Foot and Ankle Disability Index; IQR, interquartile range; PLT, peroneus longus; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; RCT, randomised controlled trial; SD, standard difference; SMD, standard mean difference.

© 2025 European Society of Sports Traumatology, Knee Surgery and Arthroscopy.

Level of Evidence: Level II.

KEYWORDS

ACL reconstruction, ankle function, donor-site morbidity, peroneus longus tendon, tendon harvest

INTRODUCTION

Anterior cruciate ligament (ACL) reconstruction is one of the most common orthopedic procedures, with favourable clinical outcomes and high patient satisfaction [17, 35, 41]. A variety of autografts are routinely used for ACL reconstruction, among which hamstring tendon (HT), bone–patellar tendon–bone (BPTB), and quadriceps tendon (QT) are well-established options with long-standing clinical evidence supporting their efficacy [34]. Peroneus longus tendon (PLT), on the other hand, is considered an emerging alternative graft that has gained attention in recent years for its biomechanical strength and minimal donor-site morbidity [9, 41]. Each of these grafts offers distinct advantages but also carries specific drawbacks.

An optimal ACL graft should closely match the native ligament in anatomical size and mechanical strength while ensuring secure integration at the reconstruction site. Additionally, it should be safe, easy to harvest, minimise donor-site complications, and remain cost-effective [21, 47, 55, 66]. The PLT has emerged as a viable autograft option for ACL reconstruction since it was first introduced by Kerimoğlu et al. in 2008 [30]. Its biomechanical properties, including tensile strength and graft thickness, closely approximate those of the native ACL, offering an appealing alternative to conventional grafts [8, 30, 52]. Studies have reported that PLT harvesting results in minimal donor-site morbidity [12, 31]. It also preserves hamstring and quadriceps strength [12, 53] and may reduce postoperative knee stiffness [24]. These advantages contribute to favourable outcomes and potentially expedited rehabilitation [65].

Despite these promising findings, long-term follow-up studies remain scarce. Some reports suggest potential functional deficits in the donor ankle after PLT harvesting, including instability, reduced range of motion, and decreased peroneal strength, particularly in short-term follow-ups [4, 29, 57]. Given the limited number of high-quality studies focusing specifically on ankle outcomes and the lack of comprehensive systematic reviews, the safety profile of PLT as a graft option remains debated [4, 52].

The purpose of this systematic review and meta-analysis was to evaluate the functional performance of the ankle and foot following PLT harvesting, using validated outcome measures such as the American Orthopaedic Foot And Ankle Society (AOFAS) score and the Foot and Ankle Disability Index (FADI).

MATERIALS AND METHODS

Study registration

This systematic review and meta-analysis were conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [44].

Search strategy

The authors searched PubMed, Embase, Web of Science, Scopus, and the Cochrane Library up to March 5, 2025. The Boolean search string used across all databases was: ('ACL' OR 'anterior cruciate ligament') AND ('peroneus longus' OR 'fibularis longus'). Database-specific syntax was adapted accordingly (e.g., TITLE-ABS-KEY in Scopus, MeSH in PubMed). The search strategy is detailed in Supporting Information: Material 1.

Eligibility criteria

This study included RCTs and cohort studies published in the English language up to 5 March 2025. Two independent reviewers thoroughly examined the search results and included studies based on predetermined criteria, and disagreements were resolved by consensus or an appeal to the third author. A total of 20 publications [1–3, 5, 10, 13, 15, 18, 20, 28, 33, 39, 46, 48, 49, 53, 54, 58, 62, 63] were included in our meta-analysis (Figure 1).

Study selection

Eligible studies met the following inclusion criteria: (1) adolescent or adult patients diagnosed with ACL tears who underwent ACL reconstruction using PLT as the sole autograft, (2) reported ankle performance outcomes assessed by validated scoring tools; (3) provided a minimum follow-up duration of six months; and (4) were designed as RCTs, non-randomised clinical trials, or prospective cohort studies. Only articles published in English were considered.

Studies were excluded if they were (1) case reports, case series, reviews, or gray literature; (2) in vitro or

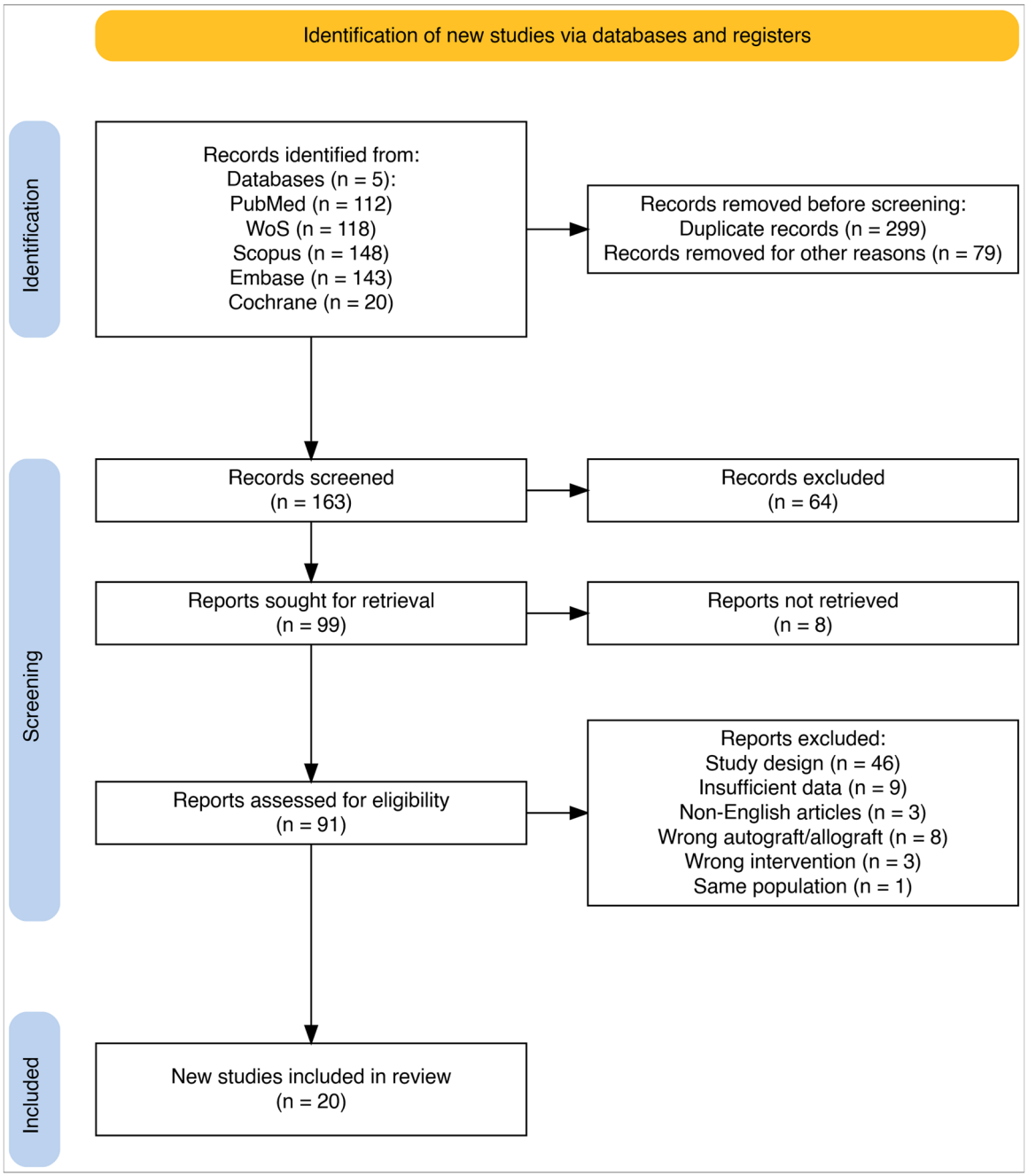


FIGURE 1 Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) flow diagram of the search process for studies.

animal-based studies; (3) involved skeletally immature individuals (<12 years of age); or (4) lacked sufficient data. Duplicate studies or those published in non-English languages were also excluded.

Data extraction

Citations were imported into EndNote (v21.0.1) for de-duplication. Two independent reviewers screened the full texts and extracted relevant data using a predesigned Microsoft Excel data extraction form. Any disagreements between the two reviewers were resolved by consensus or adjudication by a third reviewer. Extracted data included author, year, country, design, sample size, demographics, and AOFAS/FADI scores at 6–60 months postoperatively. The AOFAS score, originally created by Kitaoka et al. [32], integrates both patient-reported assessments of pain and functional status with physician-evaluated physical examination findings. The maximum achievable score is 100, reflecting the absence of pain, full sagittal and hindfoot mobility, stable ankle and hindfoot joints, and optimal anatomical alignment [32]. The clinician-assessed

components of the scale have demonstrated strong validity and reliability in previous evaluations [26]. The FADI score was developed to evaluate functional impairments associated with foot and ankle pathologies [36]. The FADI consists of 26 items, while the FADI Sport subset comprises 8 items. Responses are scored on a Likert-type scale ranging from 0 ('unable to perform') to 4 ('no difficulty'), except for the four pain-specific items, which are reverse-scored (0 = 'no pain,' 4 = 'unbearable pain'). Both instruments are converted to percentage scores, where 100% indicates optimal function and no disability [23]. For studies reporting medians/interquartile ranges (IQRs), means/standard deviations (SDs) were derived using Wan et al.'s and the Cochrane Handbook methods [14, 64].

Quality assessment

The 11 included cohort studies were assessed using the Risk of Bias in Non-randomised Studies—of Interventions (ROBINS-I V2) tool [60]. Each domain in this tool was rated, and an overall judgement of risk of bias was derived for each study. For the nine randomised controlled trials (RCTs), the Revised Cochrane Risk of Bias Tool (RoB 2.0) was employed [61]. Each domain was independently judged as 'low risk', 'some concerns', or 'high risk' and an overall assessment was assigned accordingly. Discrepancies were resolved through consensus between reviewers. To visualise the results of the quality assessment, traffic light plots and summary plots were generated for both cohort and RCT studies using the *robvis* tool [37].

Data synthesis and analysis

All statistical analyses were performed using R software (version 4.4.3; R Foundation for Statistical Computing, Vienna, Austria). Pooled effect sizes for continuous outcomes were computed using either mean difference (MD) or standardised mean difference (SMD), depending on the measurement scales. The inverse-variance method was used for weighting individual studies. Statistical heterogeneity across studies was evaluated using Cochran's Q test and quantified by the I^2 statistic, where an $I^2 \geq 50\%$ or a p-value < 0.10 was considered indicative of substantial heterogeneity. In the presence of heterogeneity, a random-effects model was employed; otherwise, a fixed-effects model was applied.

To explore potential sources of heterogeneity, subgroup analyses were conducted based on the time point at which ankle function was assessed. Sensitivity analyses were also performed using the leave-one-out method, systematically removing each study one at a time to examine its influence on the overall pooled estimate and to assess the robustness of the results. Additionally, univariate meta-regression analyses were performed to assess whether study-level variables such as sample size and mean age could explain between-study heterogeneity, in accordance with Cochrane recommendations [14].

Publication bias was assessed visually using contour-enhanced funnel plots and formally evaluated using Egger's regression test and the Trim-and-Fill method, if ten or more studies were included in the analysis. These approaches helped detect and adjust for small-study effects and potential reporting biases [16]. All p-values were two-tailed, and a p-value less than 0.05 was considered statistically significant.

RESULTS

Study selection

The PRISMA diagram illustrating the database search and study selection process is presented in Figure 1 [22, 44]. 541 studies across five databases were identified. Following the removal of duplicates, the initial set of 247 identified records was screened based on titles and abstracts. Of these, 156 records were excluded. The remaining 91 records underwent a detailed full-text assessment, leading to the inclusion of 20 studies that met the eligibility criteria [1–3, 5, 10, 13, 15, 18, 20, 28, 33, 39, 46, 48, 49, 53, 54, 58, 62, 63].

These included 11 prospective cohort studies and 9 RCTs, published between 2019 and 2025. The studies were conducted primarily in Asia (81%), most notably in India (52.3%).

Study characteristics

The included studies collectively assessed 1024 patients. Sample sizes ranged from 18 to 147 participants. Patients were predominantly in their late twenties to early thirties, with reported mean ages ranging from 23.4 ± 8.1 years to 33.5 ± 9.5 years. Most studies included both males and females, although a few did not report gender distribution explicitly.

The follow-up duration varied from six months to five years, with several studies reporting outcomes at multiple time points. Functional outcomes were commonly evaluated using the AOFAS scores, while a smaller number of studies also reported FADI scores. A summary of the studies is shown in Table 1 [1–3, 5, 10, 13, 15, 18, 20, 28, 33, 39, 46, 48, 49, 53, 54, 58, 62, 63].

Risk of bias assessment

Six randomised controlled trials were rated as having high risk of bias and three showed some concerns (Figure 2a). The primary concerns were related to inadequate reporting

TABLE 1 Study characteristics of included studies.

Author (year)	Country	Design	Sample size	Mean age (SD/range)	M/F	Last follow-up	Mean AOFAS score (SD)	Mean FADI score (SD)
Butt et al. [10], 2025	Pakistan	Clinical trials	30	29.1 (5)	30/0	5 Years	60 Mo: 98.8 (4)	NR
Dwidmuthe et al. [18], 2024	India	Clinical trials	18	29.2 (3.5)	NR	6 Months	NR	6 Mo: 98.9 (3.3)
Saeed et al. [53], 2023	Pakistan	Clinical trials	85	NR	NR	2 Years	24 Mo: 93.6 (2.9)	NR
Agarwal et al. [1], 2023	India	Clinical trials	98	28 (4.9)	68/3	1 Year	12 Mo: 99.0 (3.5)	NR
Waly and Gawish [63], 2022	Egypt	Clinical trials	25	33.3 (6.4)	19/6	1 Year	12 Mo: 94.0 (2.8)	12 Mo: 93.3 (17.6)
Vijay et al. [62], 2022	India	Clinical trials	22	33.5 (9.5)	17/6	1 Year	12 Mo: 96.4 (3.1)	NR
Shair et al. [58], 2022	Pakistan	Clinical trials	40	25.8 (8.6)	34/6	9 Months	9 Mo: 96.4 (5.1)	9 Mo: 97.6 (3.6)
Joshi et al. [28], 2021	India	Clinical trials	48	27.2 (4)	36/1	2 Years	24 Mo: 98.4 (1.2)	NR
Goncharov et al. [20], 2022	Russia	Clinical trials	50	33.4 (8.9)	36/1	2 Years	24 Mo: 95.3 (7.5)	NR
Pilar et al. [46], 2024	India	Prospective cohort studies	44	27.6 (7.9)	0/4	1 Years	12 Mo: 92.8 (2.7)	NR
Agrawal et al. [2], 2023	India	Prospective cohort studies	27	31.7 (7.7)	20/7	2 Years	12 Mo: 95.6 (6.3)	24 Mo: 99.1 (3.4)
Sahu et al. [54], 2021	India	Prospective cohort studies	63	29.2 (7.3)	52/1	2 Years	6 Mo: 99.3 (2.3)	NR
Rhatomy et al. [49], 2019	Indonesia	Prospective cohort studies	24	23.4 (8.1)	20/4	1 Year	12 Mo: 97.3 (4.2)	24 Mo: 98 (3.4)
de Oliveira et al. [15], 2024	Brazil	Prospective cohort studies	147	27.3 (7.4)	NR	2 Years	24 Mo: 99.9 (0.0)	24 Mo: 99.9 (0.0)
Rhatomy et al. [51], 2020	Indonesia	Prospective cohort studies	75	26.7 (2.7)	59/1	2 Years	24 Mo: 98.9 (3.1)	24 Mo: 99.7 (0.5)
Ali et al. [3], 2024	Egypt	Prospective cohort studies	30	26.3 (2.2)	26/4	14 Months	12 Mo: 93.4 (1.8)	NR
Kumar et al. [33], 2023	India	Prospective cohort studies	27	27.7 (7)	NR	6 Months	6 Mo: 95.5 (3.9)	NR
Rajani et al. [48], 2022	India	Prospective cohort studies	113	26.2 (5.7)	78/3	36 Months	NR	36 Mo: 94.8 (3)
Chaudhari et al. [13], 2023	India	Prospective cohort studies	38	NR	23/1	18 Months	18 Mo: 94.5 (1.5)	18 Mo: 94.2 (1.1)
Mirza et al. [39], 2024	India	Prospective cohort studies	20	32.7 (10.5)	14/6	6 Months	6 Mo: 95.6 (9.4)	NR

Abbreviations: AOFAS, American Orthopaedic Foot and Ankle Society; F, female; FADI, the Foot and Ankle Disability Index; M, male; Mo, month; NR, data non reported; SD, standard deviation.

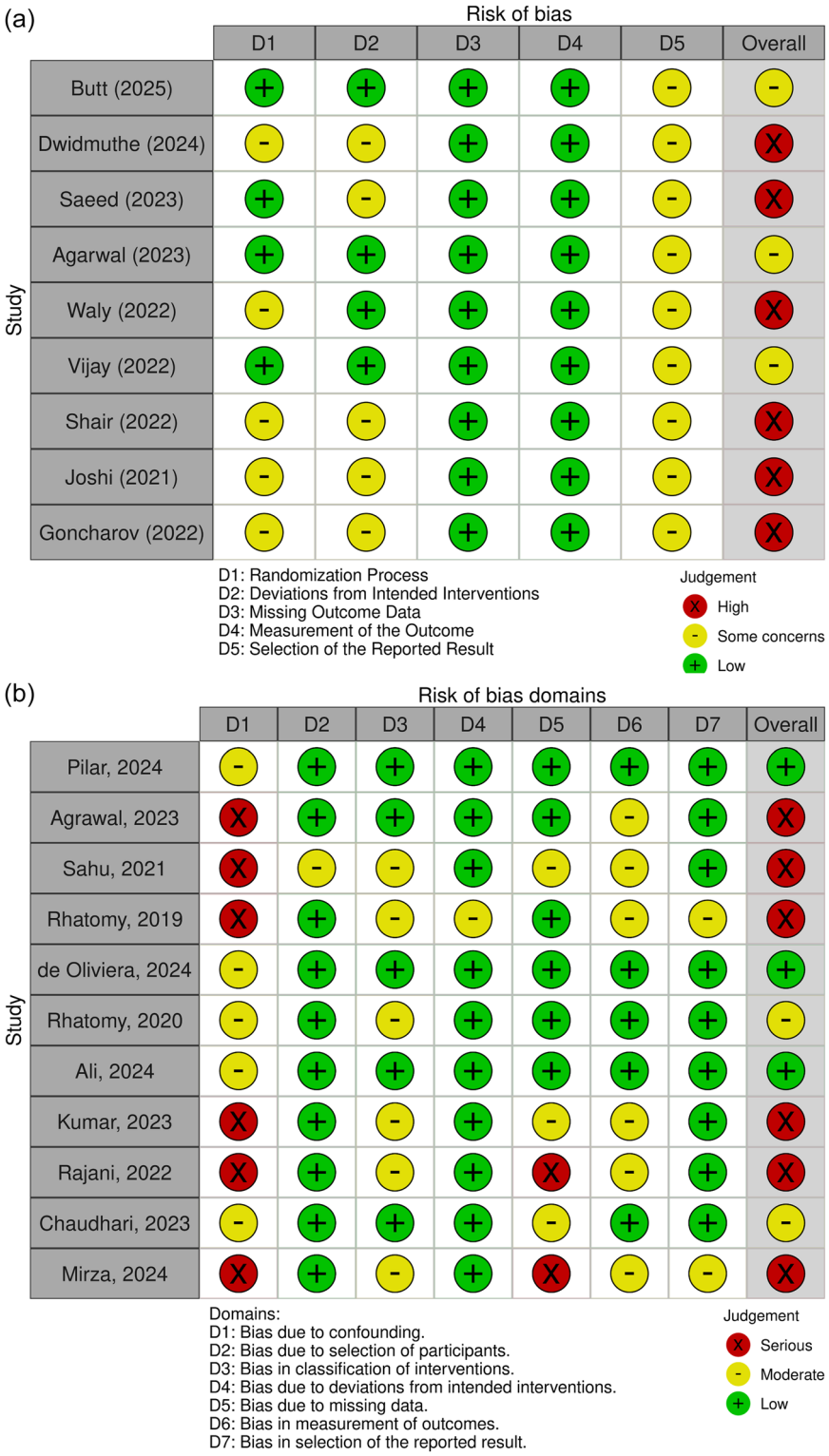


FIGURE 2 Risk of bias assessment for included studies using the Cochrane collaboration's tool [37]. (a) Risk of bias assessment for clinical trials; (b) risk of bias assessment for cohort studies. +, low risk; -, some concerns/moderate risk; ×, serious/high risk.

of randomisation procedures (e.g., Shair et al. [58]; Joshi et al. [28]), lack of allocation concealment, and insufficient blinding of participants or outcome assessors. In some trials, deviations from the intended intervention were either not clearly reported or potentially imbalanced across groups, raising concerns about performance and detection bias.

Among the 11 cohort studies, three were judged to be at low risk of bias, two at moderate risk, and six at serious risk (Figure 2b). Common sources of bias

included inadequate control for confounding variables and incomplete follow-up data. Several studies (e.g., Rajani et al. [48]; Mirza et al. [39]) lacked clear strategies to handle missing data, and some earlier studies did not sufficiently report methods for participant selection or intervention classification. Overall, the risk of bias varied across studies and domains, but the majority of included research was considered moderate to high risk, warranting cautious interpretation of pooled estimates. These findings highlight the need for careful interpretation of results from cohort studies and improved transparency in RCTs reporting to mitigate potential biases. A summary plot of cohort studies and RCTs is presented in Supporting Information: Material 1.

AOFAS scores

AOFAS score before and after harvest difference

The pooled SMD showed no significant change in the AOFAS score before and after graft harvest (Figure 3; Table 2). Unlike other studies, Saeed et al. [53] showed a significant decline (SMD: –0.3, 95% confidence interval [CI]: –0.5 to –0.1, *p*: 0.0038).

AOFAS score at 12-month and beyond

The pooled mean AOFAS score exhibited excellent functional outcomes at long-term follow-up (Figure 4a; Table 2). Individual study means ranged from 90.4 to 99.8, with the majority reporting scores above 94.0, suggesting consistent high performance across studies. Notably, the study by Ali et al. [3] reported the lowest mean score (90.4, 95% CI: 92.7–94.0), potentially contributing to the observed heterogeneity.

Publication bias and meta-regression

Publication bias was assessed using both Egger's test [19] and Duval and Tweedie's trim-and-fill method. Egger's regression test indicated significant funnel plot asymmetry ($t = -4.05$, $df = 10$, $p = 0.002$), implying a potential small-study effect. However, The Duval and Tweedie's trim-and-fill

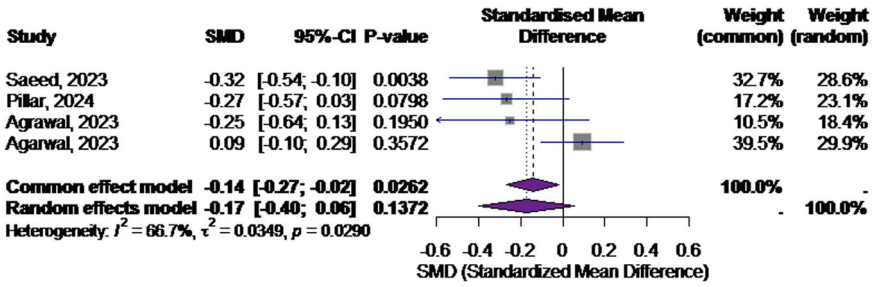


FIGURE 3 A forest plot of pooled SMD analysis of AOFAS score before and after PLT graft harvest was created. AOFAS, American Orthopaedic Foot and Ankle Society; CI, confidence interval; PLT, peroneus longus tendon; SMD, standard mean difference.

TABLE 2 Results of meta-analysis for AOFAS scores and FADI scores after peroneus longus tendon harvest for ACL reconstruction.

	Number of included studies	I^2	Model	Pooled result (95% CI)	*p* value
American Orthopaedic Foot and Ankle Society (AOFAS) score					
AOFAS score at 6-month	7	98.9	Random	96 (92.6–99.3)	-
AOFAS score at 12-month	8	99.1	Random	96.1 (93.9–98.2)	-
AOFAS score at 24-month	5	99.2	Random	97.3 (93.9–100.6)	-
AOFAS score at 12-month and beyond	12	99.1	Random	96.2 (94.8–97.6)	-
AOFAS score before and after harvest difference	4	66.7	Random	SMD: –0.2 (–0.4 to 0.06)	0.13
Foot and Ankle Disability Index (FADI) score					
FADI score at 6-month and beyond	9	99.2	Random	97.5 (96.0–98.9)	-
FADI score at 24-month	4	76.2	Random	99.5 (98.7–100.2)	-

Abbreviations: ACL, anterior cruciate ligament; CI, confidence interval.

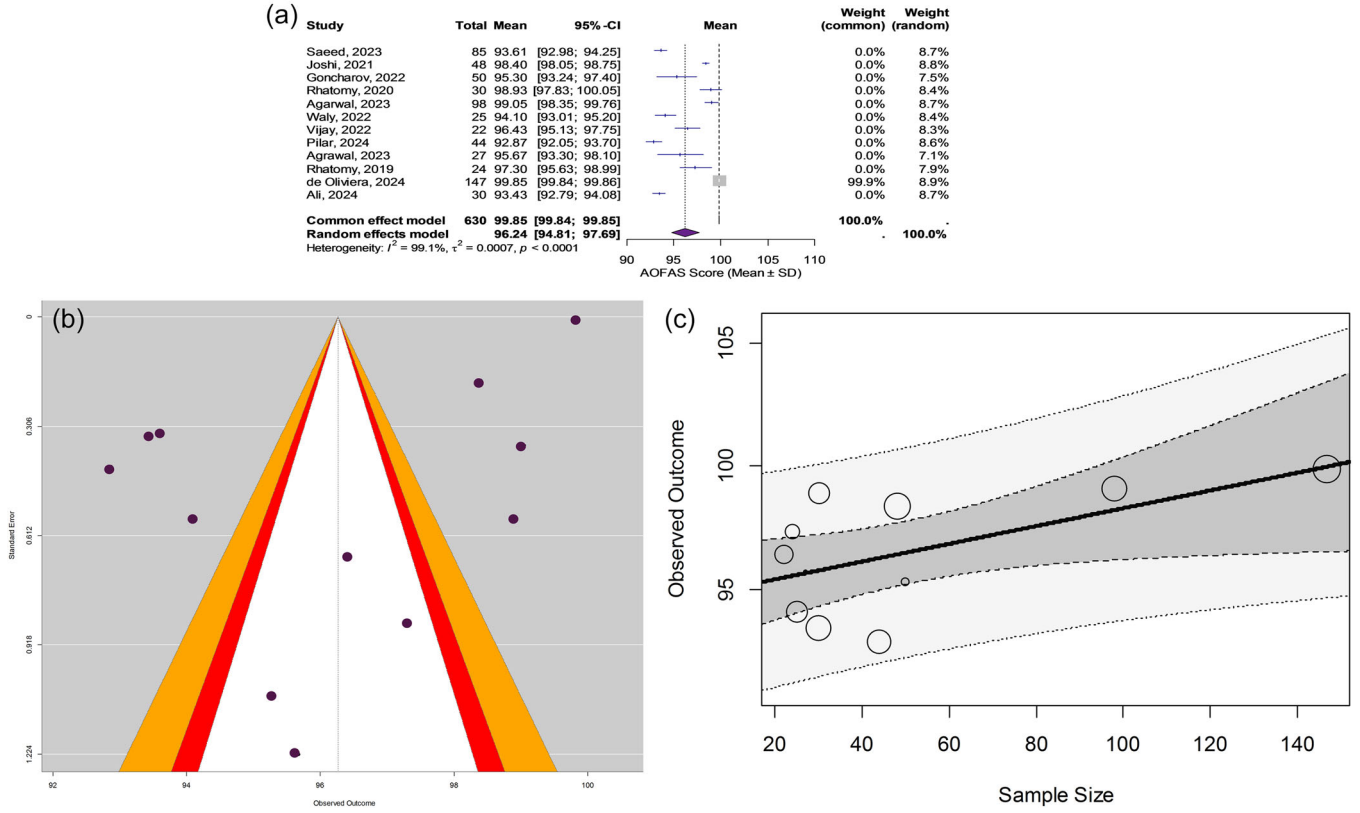


FIGURE 4 (a) Pooled meta-analysis of AOFAS score at 12 months and beyond has been demonstrated by a forest plot. (b) A contour-enhanced funnel plot was drawn to explore potential sources of heterogeneity. Each dot represents a study; x-axis is the observed outcome which was the AOFAS score at 12 months and beyond and y-axis is the standard error. (c) A scatter plot of sample size versus the observed outcome, x-axis is sample size and y-axis is the observed outcome that was the AOFAS score at 12 months and beyond. AOFAS, American Orthopaedic Foot and Ankle Society; CI, confidence interval.

analysis using the random effects model did not identify any missing studies to be imputed ($Q = 1275.5$). The funnel plot (Figure 4b) appeared mostly symmetric, and the absence of imputed studies supports the robustness of the pooled estimate despite the Egger's test findings.

A meta-regression was conducted to assess whether sample size explained heterogeneity in AOFAS scores at 12 months and beyond across 12 studies. The association between sample size and AOFAS score was not statistically significant ($\beta = 0.03$, SE = 0.02, $p = 0.13$). The regression plot was drawn (Figure 4c).

To evaluate the potential impact of patient age on long-term functional outcomes, a random-effects meta-regression was conducted using mean age as a covariate. The regression model included 11 studies and revealed a non-significant association between age and AOFAS scores at 12 months and beyond ($\beta = -0.2$, 95% CI: −0.7 to 0.2; $p = 0.36$). The scatter plot (Figure 5) visually supports the lack of a strong trend, with wide confidence intervals around the regression line. These findings suggest that age, within the examined range, is unlikely to be a major moderator of long-term AOFAS outcomes following the procedures under study.

Subgroup analysis

A subgroup meta-analysis of AOFAS scores was performed at multiple follow-up durations, ranging from 6 to 60 months postoperatively, involving 1235 patients. The pooled overall mean AOFAS score across all timepoints was 96.4 (95% CI: 95.2–97.6), with substantial heterogeneity ($I^2 = 99.2\%$, $p < 0.0001$). The test for subgroup differences was significant ($p < 0.0001$), indicating that time since surgery significantly influenced AOFAS outcomes. The pooled result for each subgroup is presented in Table 2.

Sensitivity analysis

The sensitivity analysis confirmed the robustness of the 6-, 12-, and 24-month pooled estimate, regardless of which study was excluded. This highlights that no single study significantly alters the outcome (Figure 6a–d).

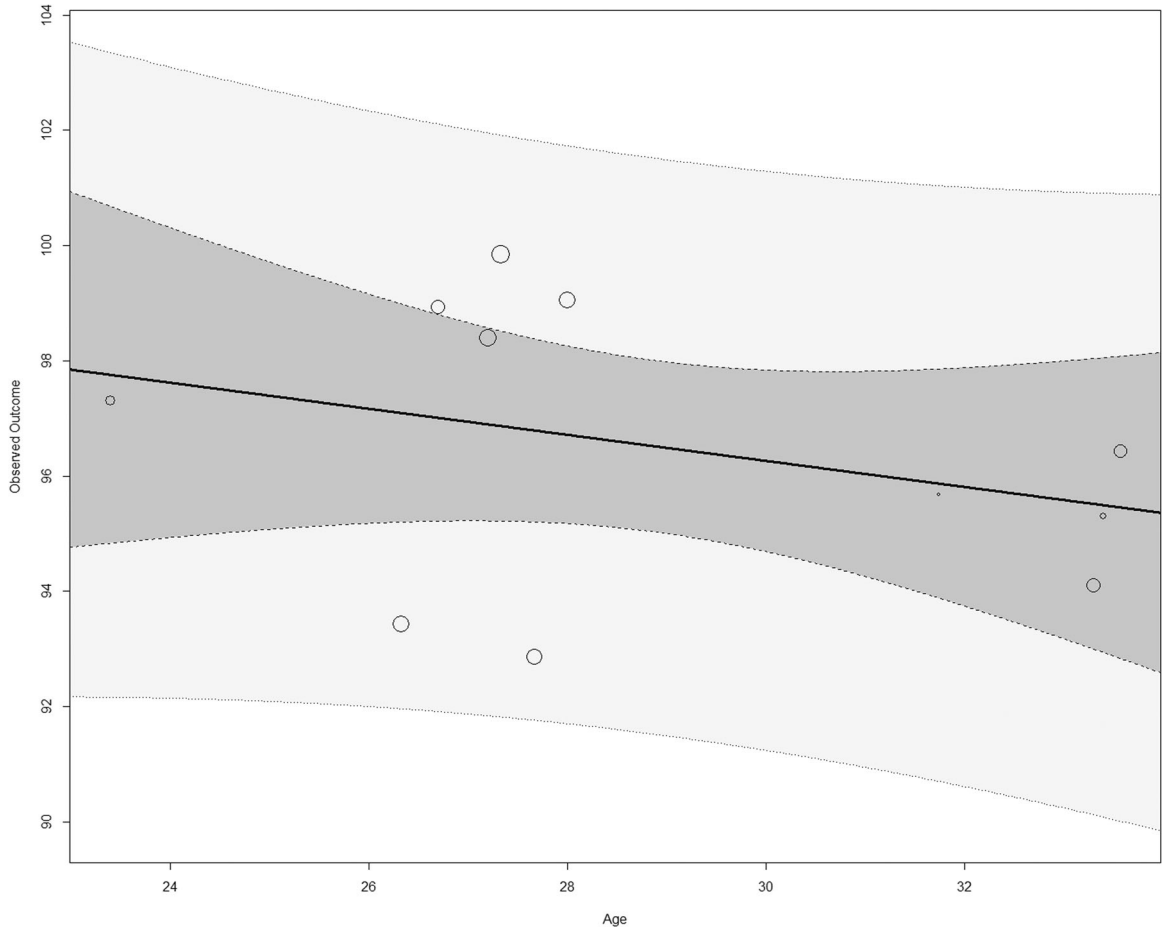


FIGURE 5 A scatter plot of AOFAS score at 12 months and beyond versus mean age. X-axis is age and y-axis is the observed outcome that was the AOFAS score at 12 months and beyond. AOFAS, American Orthopaedic Foot and Ankle Society.

Heterogeneity and consistency

High heterogeneity persisted across all intervals, likely reflecting differences in surgical techniques, patient demographics, or rehabilitation protocols. Despite this, sensitivity analyses confirmed the stability of the findings.

FADI score

The pooled analysis of 6-month and beyond FADI score (Figure 7a), revealed high overall mean scores shown in Table 2. At 24-month, the pooled FADI score remained consistently high (Figure 7b). Overall, the findings indicate that patients who underwent surgery demonstrated excellent functional ankle recovery, as measured by FADI scores. However, the presence of moderate to high heterogeneity warrants cautious interpretation and may reflect clinical or methodological diversity across studies (Table 2).

DISCUSSION

The most notable finding of this study was the absence of significant pooled AOFAS score changes before and after PLT harvest. This contrasts with a prior review reporting minimal but statistically significant differences in AOFAS and FADI scores [56]. Interestingly, among the included studies, Saeed et al. reported a significant decrease in AOFAS scores postoperatively compared to pre-harvest values [53]. This contrasts with the non-significant outcomes observed in other studies. This decline warrants careful interpretation, as the surgical approach followed the standardised technique described by Budhiparama et al. [8], consistent with other studies in this analysis. Therefore, the observed decline may be influenced by patient selection factors, variations in postoperative rehabilitation protocols, or other unreported contextual elements rather than deviations in surgical technique.

In addition, the included studies exhibited an overall gender imbalance, with male participants predominating, potentially limiting the generalisability of results

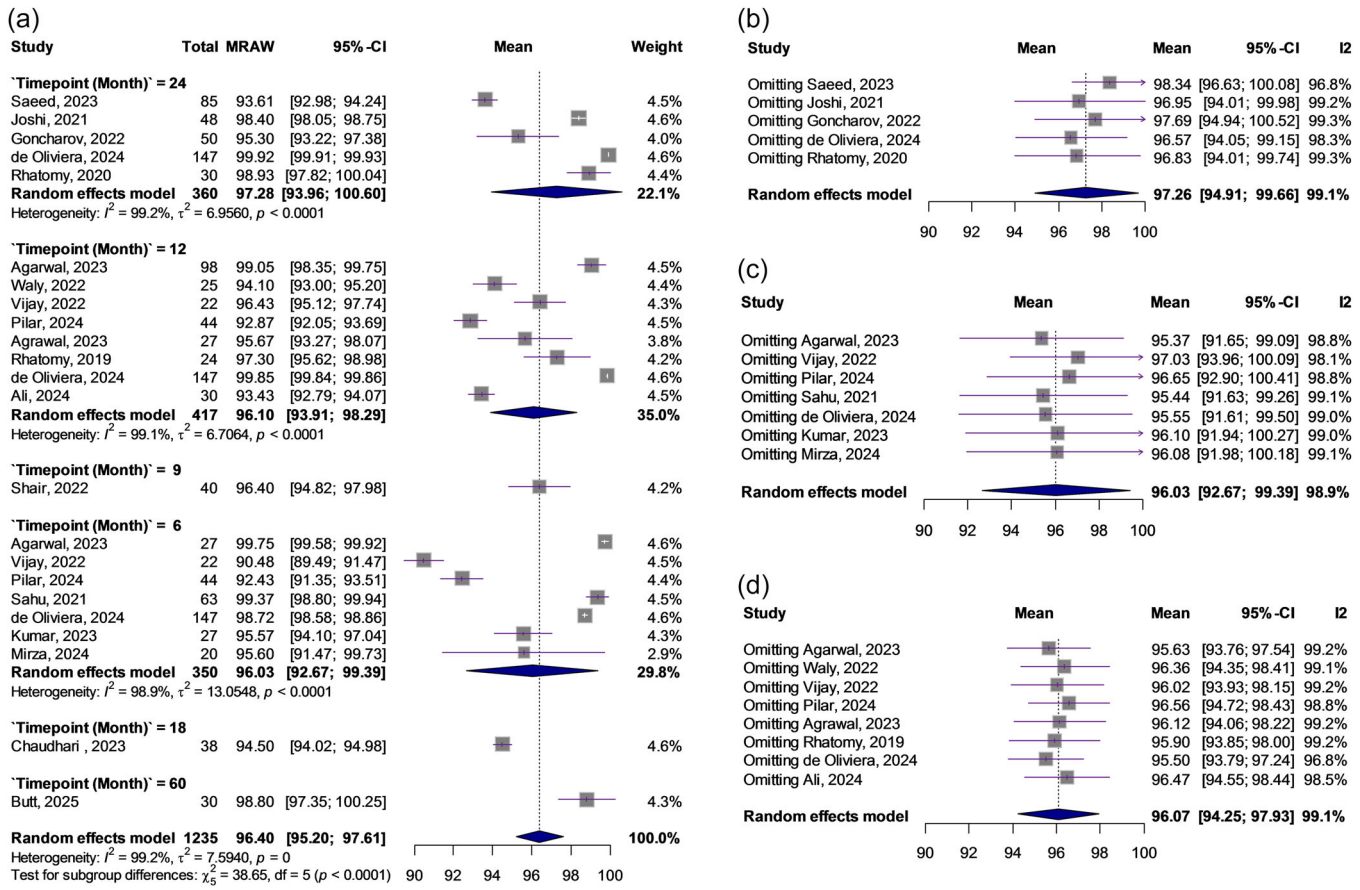


FIGURE 6 Pooled AOFAS score at different timepoints. (a) Subgroup analysis of AOFAS score. (b) Leave-one-out analysis of AOFAS score at 24 months. (c) Leave-one-out analysis of AOFAS score at 6 months. (d) Leave-one-out analysis of AOFAS score at 12 months. AOFAS, American Orthopaedic Foot and Ankle Society; CI, confidence interval; MRAW, raw mean.

across sexes. Moreover, most studies originated from Asia, which may affect the applicability of findings to non-Asian populations due to differences in physical activity levels, surgical practices, and patient characteristics.

A large portion of ACL reconstruction success depends on graft choice. While traditional grafts risk donor-site morbidity, the PLT offers similar strength with fewer complications [9, 13, 21, 24, 31, 41, 45, 59, 66]. This systematic review and meta-analysis aimed to evaluate the impact of PLT harvesting for ACL reconstruction on ankle function, using validated outcomes such as the AOFAS and FADI scores. The AOFAS score comprises nine items grouped into three subdomains: pain, function, and alignment [32]. This scale served as a valid assessment for ankle performance across included studies. Data from 12 studies evaluating AOFAS scores at ≥ 12 months in this review yielded excellent functional recovery. Rhatomy et al. supported these findings and reported that PLT harvesting does not compromise ankle eversion or plantar flexion strength compared to the unaffected contralateral side [50, 51]. The PLT and peroneus brevis are situated in the lateral compartment of the lower leg, where they serve crucial functions in foot and ankle eversion and plantar flexion [38]. Nonetheless, the existing results may be attributed to the relatively greater mechanical advantage of the peroneus brevis tendon (PBT) in maintaining lateral ankle stability [43]. Furthermore, just the proximal segment of the PLT, which is placed above the lateral malleolus, is frequently harvested during ACL reconstruction. The remaining distal portion is sutured to the PBT, potentially preserving some PLT function [40]. All included studies reported suturing the distal portion of the PLT to the PBT following graft harvest. In addition, tendon-like regeneration has been observed in the anatomical region of the PLT during long-term follow-up, particularly among younger patients [57]. A clinical trial conducted by Nazem et al. [42] found that PLT removal does not significantly alter gait parameters or contribute to ankle instability.

Outstanding outcomes of ankle performance were observed in the pooled FADI score analysis across included studies. A key component of this scale is the pain assessment [23]. While postoperative pain is common, it typically resolves

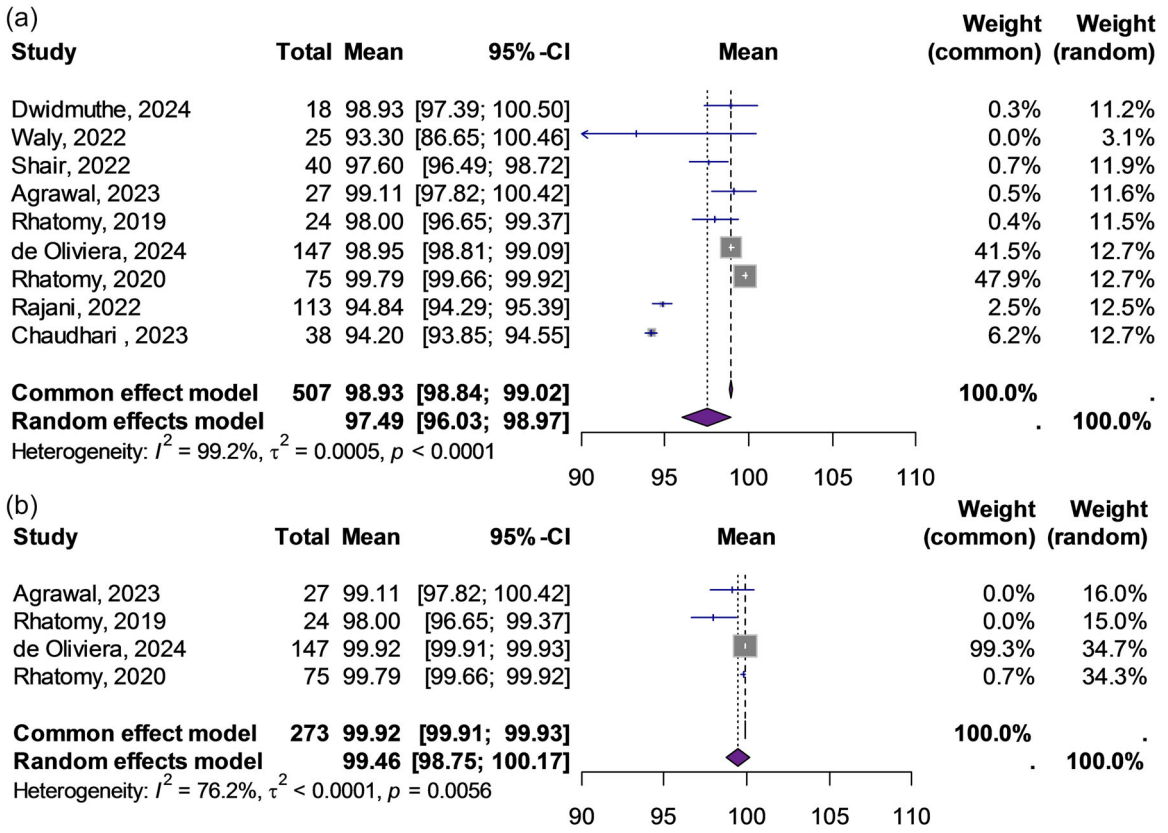


FIGURE 7 (a) A forest plot of FADI score at 6 months and beyond was generated. (b) FADI score at 24 months was visualised by a forest plot. CI, confidence interval; FADI, Foot and Ankle Disability Index.

within weeks to months. This transient pain likely originates from sensory disturbances (e.g., hypaesthesia and hyperalgesia), affecting 13%–23% of patients. Persistent pain (>6 months) has been reported to occur in fewer than 3% of cases [6], primarily due to intraoperative irritation of the sural or superficial peroneal nerve during graft harvesting [11, 25]. Notably, Agrawal et al. [2], de Oliveira et al. [15], and Bi et al. [5] reported no cases of nerve injury following PLT harvest, suggesting surgical technique may mitigate this risk.

When making clinical decisions regarding graft choice, the PLT may be particularly advantageous in patients where hamstring or patellar tendon autografts are contraindicated, such as individuals with prior harvests, anterior knee pain, or open physes. However, caution may be warranted in high-level athletes or individuals with preexisting lateral ankle instability, where harvesting from the lateral compartment could theoretically compromise performance or stability.

Overall, the findings of this study support the safety of PLT autograft harvest, demonstrating excellent ankle performance at both short- and long-term follow-up. This finding may resolve concerns about PLT harvest donor-site morbidities. Future research should address several key questions raised by our findings. Prospective studies comparing different harvest techniques using standardised outcome measures at fixed timepoints would help optimise surgical methodology. Incorporation of advanced imaging to correlate tendon regeneration with functional outcomes could provide mechanistic insights into the recovery process. Until such data are available, our findings suggest that when the PLT is present, it represents a functionally low-risk autograft option that deserves consideration in the ACL reconstruction graft selection algorithm.

Several limitations must be taken into account when interpreting these results. First, limitations related to the review itself include the restriction to English-language articles, which could introduce publication bias, and the substantial heterogeneity observed in our analyses (I^2 = 66%–99%). This heterogeneity likely reflects differences in study design, surgical techniques, and rehabilitation protocols, which is a common challenge in proportion meta-analyses [7]. Additionally, the predominance of Asian studies (80%) highlights a regional focus on PLT autografts for ACL reconstruction, possibly due to cultural or surgical preferences, greater acceptance of PLT harvesting in Asian populations, or regional research priorities. Second, limitations inherent to the primary studies must be noted. The anatomical variability of the PLT, which is occasionally

absent, may affect the generalisability of the findings [27]. The methodological quality of the included RCTs was inconsistent, with a scarcity of rigorously designed studies, potentially influencing the reliability of the pooled results.

None of the included studies achieved a low risk of bias across all domains, which may reduce the reliability of our pooled results and requires cautious interpretation.

Moreover, both AOFAS and FADI have certain limitations. The AOFAS score combines subjective and objective measures, which can introduce rater bias as it is partly clinician-reported rather than entirely patient-reported. Additionally, it may exhibit ceiling effects, where patients with mild symptoms achieve near-maximum scores, limiting its sensitivity in detecting subtle functional impairments. Similarly, the FADI, while patient-reported, can also be influenced by recall bias and may not fully capture complex ankle kinematics. Despite these limitations, our rigorous sensitivity analyses confirm the robustness of the primary findings, and the consistency between AOFAS and FADI results strengthens our conclusions.

CONCLUSION

The present study suggested that PLT harvest for ACL reconstruction yields minimal donor-site morbidity, with consistently high AOFAS/FADI scores across all age groups. These findings support the safety of PLT autografts, though heterogeneity in surgical techniques warrants standardisation. In addition, the overall predominance of male participants and the fact that most included studies originated from Asia may limit the generalisability of these findings to female patients or non-Asian populations. Also, given the observed heterogeneity among the included studies, the findings should be interpreted with caution.

AUTHOR CONTRIBUTIONS

Original idea and design: Mehran Soleymanha. *Developing the drafting, data acquisition, and analysis*: Amirali Soleymani Nejad. *Contribution to the development of the protocol and revision of the manuscript*: Sohrab Keyhani and Fardis Vosoughi. *Final edition*: Robert F LaPrade, Luke Tollefson. All authors read and approved the final manuscript.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data sets used and analysed during the current study are available from the corresponding author on reasonable request.

ETHICS STATEMENT

This study was approved by the Poursina Hospital Orthopedic Research Ethic Committee in Rasht, Iran. The study protocol was prospectively registered in the PROSPERO international database (Registration ID: CRD420251007301).

ORCID

Mehran Soleymanha https://orcid.org/0000-0002-5891-1208
Amirali Soleymani Nejad https://orcid.org/0000-0002-3418-0818
Sohrab Keyhani https://orcid.org/0000-0002-4455-5214
Fardis Vosoughi https://orcid.org/0000-0002-9136-0479

REFERENCES

1. Agarwal A, Singh S, Singh A, Tewari P. Comparison of functional outcomes of an anterior cruciate ligament (ACL) reconstruction using a peroneus longus graft as an alternative to the hamstring tendon graft. Cureus J Med Sci. 2023; 15(4):e37273.
2. Agrawal S, Hegde AS, Rao BS, Mane PP, Shetty CB, Khanna V, et al. Peroneus longus tendon autograft for primary arthroscopic reconstruction of the anterior cruciate ligament. Muscle Lig Tendons J. 2023;13(2):252–8.
3. Ali M, El-Shafie M, El-Sheikh M, Waly A. Prospective comparative study between peroneus longus tendon autograft and hamstring tendons autograft in single bundle ACL reconstruction. Alex J Med. 2024;60(1):355–62.
4. Angthong C, Chernchujit B, Apivatgaroon A, Chaijenkit K, Nualon P, Suchao-in K. The anterior cruciate ligament reconstruction with the peroneus longus tendon: a biomechanical and clinical evaluation of the donor ankle morbidity. J Med Assoc Thailand. 2015;98(6):555–60.
5. Bi M, Zhao C, Zhang S, Yao B, Hong Z, Bi Q. All-inside single-bundle reconstruction of the anterior cruciate ligament with the anterior half of the peroneus longus tendon compared to the semitendinosus tendon: a two-year follow-up study. J Knee Surg. 2018;31(10):1022–30.
6. Bimadi MH, Phatama KY, Mustamsir E. Does the peroneus longus tendon autograft affect the ankle function? A case series. Hip Knee J. 2020;1:57–62.
7. Borges Migliavaca C, Stein C, Colpani V, Hugh Barker T, Munn Z, Falavigna MI-square statistic in meta-analysis of prevalence: worthwhile or worthless? Cochrane Colloquium Abstracts, 2020.
8. Budhiparama NC, Rhatomy S, Phatama KY, Chandra W, Santoso A, Lumban-Gaol I. Peroneus longus tendon autograft: a promising graft for ACL reconstruction. Video J Sports Med. 2021;1:26350254211009888.
9. Buerba RA, Boden SA, Lesniak B. Graft selection in contemporary anterior cruciate ligament reconstruction. JAAOS Glob Res Rev. 2021;5(10):e21.00230.
10. Butt U, Vuletic F, Shaikh MAA, Rehman GU, Shah IA, Stålman A, et al. 5-years outcomes following arthroscopic anterior cruciate ligament reconstruction comparing quadruple hamstring and peroneus longus tendon autografts: a randomized control trial. Arch Orthop Trauma Surg. 2025;145(1):C7–C85.
11. Cakar A, Kose O, Selcuk H, Egerci OF, Tasatan E, Dogruoz F. Complications of peroneus longus tendon harvesting: a retrospective review of 82 cases. Arch Orthop Trauma Surg. 2023; 143(11):6675–84.

12. Teja KVC, Kumar S, Kumar A, Haripriya H. Long-term outcomes of anterior cruciate ligament reconstruction: peroneus longus versus hamstring tendons. J Arthrosc Surg Sports Med. 2025;6:174–8.
13. Chaudhari K, Desai N. A study of use of peroneus longus as graft in primary ACL reconstruction as an alternative in non-athletic patients. Int J Life Sci Biotechnol Pharma Res. 2023; 12(3):209–13.
14. Cochrane Handbook for Systematic Reviews of Interventions. 2023. Cochrane Training. Accessed January 17, 2023, https://training.cochrane.org/handbook/current
15. de Oliveira DE, Horita MM, Malpaga JMD, de Padua VB, de Gusmão Canuto SM, Jorge PB. Evaluation of the peroneus longus tendon as an autologous graft in knee surgery. Sci Rep. 2024;14(1):26341.
16. Mavridis D, Salanti G. How to assess publication bias: funnel plot, trim-and-fill method and selection models. Evid Based Ment Health. 2014;17:30.
17. Drogset JO, Størset KH, Nitteberg TM, Gifstad T. Clinical outcome after knee ligament reconstruction with tendon allografts. J Exp Orthop. 2021;8(1):11.
18. Dwidmuthe S, Roy M, Bhikshavarthi Math SA, Sah S, Bhavani P, Sadar A. Functional outcome of single-bundle arthroscopic anterior cruciate ligament reconstruction using peroneus longus graft and hamstring graft: an open-label, randomized, comparative study. Cureus. 2024;16(5):e60239.
19. Egger M, Smith GD, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. BMJ. 1997; 315(7109):629–34.
20. Goncharov EN, Goncharov NG, Bezuglov EN, Vetoshkin AA, Rezunenko IA, Oganesyan SK, et al. Comparison of results of the anterior cruciate ligament reconstruction of the knee joint using peroneus longus tendon autograft or patellar tendon autograft with two bone blocks. Genij Ortopedii. 2022;28(1): 53–61.
21. Goyal T, Paul S, Choudhury AK, Sethy SS. Full-thickness peroneus longus tendon autograft for anterior cruciate reconstruction in multi-ligament injury and revision cases: outcomes and donor site morbidity. Eur J Orthop Surg Traumatol. 2021;33:21–7.
22. Haddaway NR, Page MJ, Pritchard CC, McGuinness LA. PRISMA2020: an R package and Shiny app for producing PRISMA 2020-compliant flow diagrams, with interactivity for optimised digital transparency and open synthesis. Campbell Syst Rev. 2022;18:e1230.
23. Hale SA, Hertel J. Reliability and sensitivity of the foot and ankle disability index in subjects with chronic ankle instability. J Athl Train. 2005;40(1):35–40.
24. He J, Tang Q, Ernst S, Linde MA, Smolinski P, Wu S, et al. Peroneus longus tendon autograft has functional outcomes comparable to hamstring tendon autograft for anterior cruciate ligament reconstruction: a systematic review and meta-analysis. Knee Surg Sports Traumatol Arthrosc. 2021;29: 2869–79.
25. Ibrahim MF, Abouzied MS, Halawa AM, Bassiony HA. Evaluation of ankle and foot function following peroneus longus tendon graft harvest. Benha Med J. 2024;1:2143.
26. Ibrahim T, Beiri A, Azzabi M, Best AJ, Taylor GJ, Menon DK. Reliability and validity of the subjective component of the American Orthopaedic Foot and Ankle Society clinical rating scales. J Foot Ankle Surg. 2007;46:65–74.
27. Ioannis D, Anastasios K, Konstantinos N, Lazaros K, Georgios N. Palmaris longus muscle's prevalence in different nations and interesting anatomical variations: review of the literature. J Clin Med Res. 2015;7(11):825–30.
28. Joshi S, Shetty U, Salim M, Meena N, Kumar R, Rao VV. Peroneus longus tendon autograft for anterior cruciate ligament reconstruction: a safe and effective alternative in nonathletic patients. Nig J Surg. 2021;27(1):42–7.
29. Karimi M, Fatoye F, Mirbod SM, Omar H, Nazem K, Barzegar MR, et al. Gait analysis of anterior cruciate ligament reconstructed subjects with a combined tendon obtained from hamstring and peroneus longus. Knee. 2013;20(6):526–31.
30. Kerimoğlu S, Aynaci O, Saraçoğlu M, Aydin H, Turhan AU. Anterior cruciate ligament reconstruction with the peroneus longus tendon. Acta Orthop Traumatol Turc. 2008;42(1):38–43.
31. Keyhani S, Qoreishi M, Mousavi M, Ronaghi H, Soleymanha M. Peroneus longus tendon autograft versus hamstring tendon autograft in anterior cruciate ligament reconstruction: a comparative study with a mean follow-up of two years. Arch Bone Jt Surg. 2022;10(8):695–701.
32. Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M. Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. Foot Ankle Int. 1994;15:349–53.
33. Kumar R, Sheoran A, Devgan A, Yadav U, Yadav N, Bishnoi S. Evaluation of functional outcome following arthroscopic anterior cruciate ligament reconstruction using peroneus longus graft. Int J Life Sci Biotechnol Pharma Res. 2023;12(3):399–406.
34. Lin KM, Boyle C, Marom N, Marx RG. Graft selection in anterior cruciate ligament reconstruction. Sports Med Arthrosc. 2020; 28(2):41–8.
35. Lopes TJA, Simic M, Pappas E. Epidemiology of anterior cruciate ligament reconstruction in Brazil's public health system. Rev Bras Med Esporte. 2016;22:297–301.
36. Martin RL, Burdett RG, Irrgang JJ. Development of the foot and ankle disability index (FADI). J Orthop Sports Phys Ther. 1999; 29:32–3.
37. McGuinness LA, Higgins JPT. Risk-of-bias VISualization (robvis): an R package and Shiny web app for visualizing risk-of-bias assessments. Res Synth Methods. 2020;1:1–7.
38. Mendez-Rebolledo G, Guzmán-Venegas R, Valencia O, Watanabe K. Contribution of the peroneus longus neuromuscular compartments to eversion and plantarflexion of the ankle. PLoS One. 2021;16(4):e0250159.
39. Mirza K, Menezes RJ, Acharya PU, Austine J, d'Almeida VR, Kamath A. Donor-site morbidity following arthroscopic anterior cruciate ligament reconstruction using peroneus longus tendon autograft. Eur J Orthop Surg Traumatol. 2024;34(6):3171–80.
40. Molloy R, Tisdel C. Failed treatment of peroneal tendon injuries. Foot Ankle Clin. 2003;8(1):115–29.
41. Mouarbes D, Menetrey J, Marot V, Courtot L, Berard E, Cavaignac E. Anterior cruciate ligament reconstruction: a systematic review and meta-analysis of outcomes for quadriceps tendon autograft versus bone–patellar tendon–bone and hamstring-tendon autografts. Am J Sports Med. 2019;47(14):3531–40.
42. Nazem K, Barzegar M, Hosseini A, Karimi M. Can we use peroneus longus in addition to hamstring tendons for anterior cruciate ligament reconstruction? Adv Biomed Res. 2014;3:115.
43. Otis JC, Deland JT, Lee S, Gordon J. Peroneus brevis is a more effective evertor than peroneus longus. Foot Ankle Int. 2004;25: 242–6.
44. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71.
45. Phatama KY, Hidayat M, Mustamsir E, Pradana AS, Dhananjaya B, Muhammad SI. Tensile strength comparison between hamstring tendon, patellar tendon, quadriceps tendon and peroneus longus tendon: a cadaver research. J Arthrosc Jt Surg. 2019;6(2):114–6.
46. Pilar A, Gm S, Nedumparampil MM, Kodi H, Amravathi R, Muniswamy MM. Evaluating the efficacy of peroneus longus tendon as an autograft for anterior cruciate ligament reconstruction in Indian female patients: a prospective cohort study. Cureus. 2024;16(10):e71665.
47. Prodromos CC, Fu FH, Howell SM, Johnson DH, Lawhorn K. Controversies in soft-tissue anterior cruciate ligament reconstruction: grafts, bundles, tunnels, fixation, and harvest. J Am Acad Orthop Surg. 2008;16(7):376–84.

48. Rajani AM, Shah UA, Mittal AR, Rajani A, Punamiya M, Singhal R. Functional and clinical outcome of anterior cruciate ligament reconstruction with peroneus longus autograft and correlation with MRI after 3 years. J Orthop. 2022;34:215–20.
49. Rhatomy S, Asikin AIZ, Wardani AE, Rukmoyo T, Lumban-Gaol I, Budhiparama NC. Peroneus longus autograft can be recommended as a superior graft to hamstring tendon in single-bundle ACL reconstruction. Knee Surg Sports Traumatol Arthrosc. 2019;27(11):3552–9.
50. Rhatomy S, Hartoko L, Setyawan R, Soekarno NR, Zainal Asikin AI, Pridianto D, et al. Single bundle ACL reconstruction with peroneus longus tendon graft: 2-years follow-up. J Clin Orthop Trauma. 2020;11:S332–6.
51. Rhatomy S, Wicaksono FH, Soekarno NR, Setyawan R, Primasara S, Budhiparama NC. Eversion and first ray plantarflexion muscle strength in anterior cruciate ligament reconstruction using a peroneus longus tendon graft. Orthop J Sports Med. 2019;7(9):2325967119872462.
52. Rudy L, Mustamsir E, Phatama KY. Tensile strength comparison between peroneus longus and hamstring tendons: a biomechanical study. Int J Surg Open. 2017;9:e2–e44.
53. Saeed UB, Ramzan A, Anwar M, Tariq H, Tariq H, Yasin A, et al. Earlier return to sports, reduced donor-site morbidity with doubled peroneus longus versus quadrupled hamstring tendon autograft in ACL reconstruction. JBJS Open Access. 2023;8(4):e23.00051.
54. Sahu MM, Pragassame AS, Mohanty P, Sahoo PK. Evaluation of donor ankle function after harvesting peroneus longus tendon graft for anterior cruciate ligament reconstruction-a prospective cohort study. J Clin Diagn Res. 2021;15(9):YC13–7.
55. Sakti M, Biakto KT, Usman MA, Tedjajuwana MJ, Pasallo P, Subagio ES. Predicting the peroneus longus tendon autograft size in ACL reconstruction by using anthropometric parameters: a study in South Sulawesi population. J Orthop. 2020;22:1–4.
56. Saoji A, Arora M, Jain G, Shukla T. There is a minimal difference in ankle functional outcomes after peroneus longus harvest: systematic review and meta-analysis. Indian J Orthop. 2023;57(12):1993–9.
57. Shao X, Shi LL, Bluman EM, Wang S, Xu X, Chen X, et al. Satisfactory functional and MRI outcomes at the foot and ankle following harvesting of full thickness peroneus longus tendon graft. Bone Jt J. 2020;102:205–11.
58. Shair NA, Siddiq UA, Tariq A, Khalid M, Mian MH. Anterior cruciate ligament reconstruction with hamstring tendon auto grafts versus peroneus longus tendon auto grafts in isolated anterior cruciate ligament injury. Rawal Med J. 2022;47(2):362–6.
59. Shi FD, Hess DE, Zuo JZ, Liu SJ, Wang XC, Zhang Y, et al. Peroneus longus tendon autograft is a safe and effective alternative for anterior cruciate ligament reconstruction. J Knee Surg. 2019;32(8):804–11.
60. Sterne JA, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. BMJ. 2016;355:i4919.
61. Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. BMJ. 2019;366:l4898.
62. Vijay C, Santosh MS, Avinash C, Adarsh T. Is peroneus longus autograft a better alternative to the hamstring autograft for anterior cruciate ligament reconstruction? – A randomised control study. J Orthop Trauma Rehabil. 2022;29(1):22104917221088.
63. Waly AH, Gawish HM. Comparative study between peroneus longus, semitendinosus tendon, and quadriceps tendon graft for anterior cruciate ligament reconstruction: short-term results. Egyp Orthop J. 2022;57(2):109–21.
64. Wan X, Wang W, Liu J, Tong T. Estimating the sample mean and standard deviation from the sample size, median, range and/or interquartile range. BMC Med Res Methodol. 2014;14:135.
65. Wiradiputra AE, Febyan F, Aryana GNW. Peroneus longus tendon graft for anterior cruciate ligament reconstruction: a case report and review of literature. Int J Surg Case Rep. 2021;83:106028.
66. Zhao J, Huangfu X. The biomechanical and clinical application of using the anterior half of the peroneus longus tendon as an autograft source. Am J Sports Med. 2012;40(3):662–71.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Soleymanha M, Soleymani Nejad A, Keyhani S, Vosoughi F, LaPrade RF, Tollefson LV. Peroneus longus tendon harvest for ACL reconstruction yields good functional outcome of the ankle: a systematic review and meta-analysis. Knee Surg Sports Traumatol Arthrosc. 2026;34:3233–46. https://doi.org/10.1002/ksa.70079