

Online Resource 1. Supplementary Material

Delayed Anterior Cruciate Ligament Reconstruction and Meniscal or Chondral Injury: A Systematic Review

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Author information Author names, affiliations, and corresponding author email are supplied in the separate title-page/declarations file and submission interface. They are omitted from this peer-review copy to preserve double-anonymous review.

Supplementary caption Online Resource 1 contains the database search strategies, selection accounting, extracted study summary, quantitative estimate source table, risk-of-bias summary, data availability statement, and recommended upload manifest.

No conflicts with PROSPERO were identified in the population, exposure, comparator, outcome domains, planned databases, synthesis approach, or proposed risk-of-bias tools based on the supplied protocol and project materials.

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Supplementary Appendix 1. Complete Database-Specific Search Strategies

The search strategy was operationalized from the project recipe/PROSPERO protocol concepts for ACL reconstruction timing and meniscal, chondral, cartilage, or other intra-articular injury. The protocol lists MEDLINE via PubMed, Cochrane CENTRAL, Scopus, and CINAHL; English-language reports; no country, healthcare-setting, or publication-year limits; and backward reference-list checking of full-text reports and relevant reviews.

The ACL workbook documents a PubMed-derived screening set of 190 records, 39 detailed eligibility records, and 14 studies in the current extraction set.

Table S1 Search concept blocks

Concept block	Terms
Population/intervention	anterior cruciate ligament, ACL, ACL reconstruction, ACL injury, ACL tear
Exposure/comparator	timing, delayed, early, time to surgery, time from injury to surgery, surgical timing, time to reconstruction, treatment delay
Outcome	meniscus, meniscal tear, medial meniscus, lateral meniscus, chondral injury, cartilage injury, secondary injury, secondary pathology, intra-articular injury, ramp lesion, root tear

MEDLINE via PubMed

```
((("Anterior Cruciate Ligament"[Mesh] OR "Anterior Cruciate Ligament Injuries"[Mesh] OR "Anterior Cruciate Ligament Reconstruction"[Mesh] OR "anterior cruciate ligament"[tiab] OR ACL[tiab] OR ACLR[tiab] OR "ACL reconstruction"[tiab] OR "ACL injury"[tiab] OR "ACL tear"[tiab])) AND
```

```
(timing[tiab] OR delay*[tiab] OR delayed[tiab] OR early[tiab] OR "time to surgery"[tiab] OR
"time from injury to surgery"[tiab] OR "surgical timing"[tiab] OR "time to
reconstruction"[tiab] OR "treatment delay"[tiab])
AND
("Menisci, Tibial"[Mesh] OR "Cartilage, Articular"[Mesh] OR menisc*[tiab] OR "meniscal
tear"[tiab] OR "medial meniscus"[tiab] OR "lateral meniscus"[tiab] OR chondral[tiab] OR
cartilage[tiab] OR "secondary injury"[tiab] OR "secondary pathology"[tiab] OR
"intra-articular"[tiab] OR "intra-articular injury"[tiab] OR "ramp lesion"[tiab] OR "root
tear"[tiab]))
AND english[lang]
```

Cochrane CENTRAL

```
([mh "Anterior Cruciate Ligament"] OR [mh "Anterior Cruciate Ligament Injuries"] OR "anterior
cruciate ligament":ti,ab,kw OR ACL:ti,ab,kw OR ACLR:ti,ab,kw OR "ACL reconstruction":ti,ab,kw
OR "ACL injury":ti,ab,kw OR "ACL tear":ti,ab,kw)
AND
(timing:ti,ab,kw OR delay*:ti,ab,kw OR delayed:ti,ab,kw OR early:ti,ab,kw OR "time to
surgery":ti,ab,kw OR "time from injury to surgery":ti,ab,kw OR "surgical timing":ti,ab,kw OR
"time to reconstruction":ti,ab,kw OR "treatment delay":ti,ab,kw)
AND
([mh "Menisci, Tibial"] OR [mh "Cartilage, Articular"] OR menisc*:ti,ab,kw OR "meniscal
tear":ti,ab,kw OR "medial meniscus":ti,ab,kw OR "lateral meniscus":ti,ab,kw OR
chondral:ti,ab,kw OR cartilage:ti,ab,kw OR "secondary injury":ti,ab,kw OR "secondary
pathology":ti,ab,kw OR "intra-articular injury":ti,ab,kw OR "ramp lesion":ti,ab,kw OR "root
tear":ti,ab,kw)
```

Scopus

```
TITLE-ABS-KEY(("anterior cruciate ligament" OR acl OR aclr OR "ACL reconstruction" OR "ACL
injury" OR "ACL tear")
AND (timing OR delay* OR delayed OR early OR "time to surgery" OR "time from injury to
surgery" OR "surgical timing" OR "time to reconstruction" OR "treatment delay")
AND (menisc* OR "meniscal tear" OR "medial meniscus" OR "lateral meniscus" OR chondral OR
cartilage OR "secondary injury" OR "secondary pathology" OR "intra-articular injury" OR "ramp
lesion" OR "root tear"))
AND (LIMIT-TO(LANGUAGE, "English"))
```

CINAHL via EBSCOhost

```
(MH "Anterior Cruciate Ligament Injuries+" OR MH "Anterior Cruciate Ligament Reconstruction"
OR TI ("anterior cruciate ligament" OR ACL OR ACLR OR "ACL reconstruction" OR "ACL injury" OR
"ACL tear") OR AB ("anterior cruciate ligament" OR ACL OR ACLR OR "ACL reconstruction" OR "ACL
injury" OR "ACL tear"))
AND
(TI (timing OR delay* OR delayed OR early OR "time to surgery" OR "time from injury to
surgery" OR "surgical timing" OR "time to reconstruction" OR "treatment delay") OR AB (timing
OR delay* OR delayed OR early OR "time to surgery" OR "time from injury to surgery" OR
"surgical timing" OR "time to reconstruction" OR "treatment delay"))
AND
(MH "Menisci, Tibial+" OR MH "Cartilage, Articular+" OR TI (menisc* OR "meniscal tear" OR
"medial meniscus" OR "lateral meniscus" OR chondral OR cartilage OR "secondary injury" OR
"secondary pathology" OR "intra-articular injury" OR "ramp lesion" OR "root tear") OR AB
```

(menisc* OR "meniscal tear" OR "medial meniscus" OR "lateral meniscus" OR chondral OR cartilage OR "secondary injury" OR "secondary pathology" OR "intra-articular injury" OR "ramp lesion" OR "root tear"))
 Limiters: English language

Supplementary Appendix 2. Study Selection and Retained-Record Accounting

The ACL workbook contained 190 PubMed-derived records. Of these, 39 were retained after title/abstract and PICO screening, 151 were excluded at the initial screen or marked low PICO relevance, and 14 studies were included in the extracted synthesis set.

Table S2 Source counts used for the PRISMA-style flow diagram

Selection stage	Records	Notes
Records identified from ACL workbook/PubMed search	190	Screened record set supplied in the project workbook.
Records retained after title/abstract PICO screening	39	Retained for detailed eligibility consideration.
Excluded or low PICO fit	151	Excluded at initial screening or marked low fit for the review question.
Priority papers assessed for ACL timing results	14	Included in the extracted synthesis set.
Studies with quantitative extracted data	14	All included studies contributed extracted timing-related data; 8 studies provided 12 estimates suitable for the descriptive forest-style plot.

Supplementary Appendix 3. Study-Level Extraction Summary

The table below summarizes the studies analyzed in the review. The editable extraction workbook should be uploaded separately if the journal requests spreadsheet source data.

Table S3 Expanded study-level extraction summary

PMID	Study	Design/sample	Timing definition	Extracted finding
41914353	Nickelberry et al., 2026	Multicenter retrospective cohort; 2033 ACLR patients aged 9-73 years	Delayed ACLR >120 days	Delayed surgery was associated with medial meniscus tear, with aOR 1.80 (95% CI 1.47-2.21), and with combined medial and lateral tearing, with aOR 1.47 (95% CI 1.10-1.97).
41541527	Wan and Yau, 2025	Cross-sectional primary ACLR cohort; 731 knees; 606 male and 125 female patients; soccer and basketball were common mechanisms	0-3, 4-12, and >12 months, with additional finer timing intervals	Medial meniscal injury increased with longer time to surgery; chronic >12-month surgery had OR 3.96 (95% CI 2.52-6.23) compared with 0-3 months.
41798096	Zhang et al., 2026	Cohort study; 2723 ACLR patients and 3562 menisci	0-1 week through 20-24 weeks	The study addressed healing of tears already present with ACL injury; meniscal healing peaked around 8-12 weeks and did not directly estimate incident secondary injury.
37810743	Gupta et al., 2023	Cohort with early MRI baseline; 173 pediatric and 369 adult ACLR patients	Delayed ACLR ≥8 weeks	New medial meniscal tears after a negative baseline MRI were more likely in pediatric patients with delay, ARR 3.90 (95% CI 1.50-10.00), but not in adults, ARR 1.10 (95% CI 0.60-2.20).
36533946	Sorey et al., 2023	Case-control/retrospective young-athlete cohort; 427 athletes aged 13-25 years; 243 treated meniscal tears	Months from ACL injury to ACLR	Each month of delay reduced the odds that a medial meniscal tear was treated with repair, OR 0.93 (95% CI 0.89-0.98); inverted OR 1.08 (95% CI 1.02-1.12) favors harm with delay.
36178166	Lu et al., 2022	Database cohort with time-to-event machine-learning analysis; 1369 ACLR and 294 nonoperative patients with minimum 2-year follow-up	Early ACLR, delayed ACLR, and nonoperative management	The delayed ACLR model yielded OR 1.08 (95% CI 1.01-1.11) for secondary meniscal injury, although matched rates were not significantly different (P=.09).
31125273	Everhart et al., 2019	Cohort study; 609 primary ACLR patients	>8 weeks and >5 months thresholds	Delay >8 weeks was associated with medial meniscal tear requiring partial meniscectomy, aOR 2.30 (95% CI 1.04-5.12), and repair was less likely with longer delay.

30449021	Chen et al., 2019	Retrospective study; 387 primary ACLR patients, including a subgroup without initial meniscal tear	Early ≤12 months versus late >12 months	Late surgery was associated with subsequent medial meniscal tear, OR 2.815; lateral meniscal tear was not significantly associated with late surgery.
27803940	de Campos et al., 2016	Retrospective review/case series of primary ACLR patients; timing-category denominators totaled 672	<2, 2-6, >6-12, >12-24, and >24 months	Compared with <2 months, medial meniscus lesion odds increased across longer categories: OR 2.71, OR 3.78, and OR 9.07 for >6-12, >12-24, and >24 months, respectively.
27746491	Gupta et al., 2016	Prospective observational study; 438 ACL-deficient knees; mean age 26.43 years	<1.5, 1.5-3, 3-6, 6-12, 12-24, and >24 months	Medial meniscal injuries were associated with delay beyond 6 months, while lateral meniscal injuries were more closely linked with instability episodes.
26401168	Ercin et al., 2015	Retrospective study; 182 analyzed from 213 ACLR patients	<12 months versus ≥12 months; activity restricted versus unrestricted	Delay and continued sport activity were associated with higher chondral lesion incidence and grade.
35387362	Riepen et al., 2022	Cross-sectional study; 410 ACLR patients, including 323 sports-related injuries	0<6, 6-<12, and ≥12 months	Medial meniscal tear odds were higher in longer timing categories, especially in the sports-related injury subgroup.
28400662	Hur et al., 2017	Comparative observational study; 91 knees; minimum 2-year follow-up	Early ≤3 weeks versus delayed >3 months	Any meniscal injury was not clearly different, OR 1.55 (95% CI 0.67-3.59), but nonrepair was more common with delay, OR 5.33 (95% CI 1.26-22.57).
20190306	Kennedy et al., 2010	Single-surgeon athletic series; 300 athletic ACLR patients	<2, 2-6, 6-12, 12-18, and >18 months	Delay >1 year was associated with higher medial meniscal tear odds, and degenerative changes were reported after 6 months.

Supplementary Appendix 4. Quantitative Display and Non-Pooled Synthesis Notes

A formal pooled meta-analysis was not performed because the extracted studies used heterogeneous timing thresholds, populations, outcome definitions, and effect measures. The forest plot is therefore a descriptive display of representative estimates and confidence intervals, not a pooled summary effect.

When representative log-scale estimates were placed on a common display scale, the exploratory Q statistic was 165.34 with 11 degrees of freedom and I² was 93.35%. This value is retained only as a descriptive heterogeneity warning because the estimates are not exchangeable enough for a defensible pooled meta-analysis.

A funnel plot should not be interpreted as an inferential publication-bias test because fewer than 10 sufficiently comparable estimates were available for any single outcome and the plotted effects differed by threshold, population, and endpoint.

Table S4 Representative estimates used for the descriptive forest-style display

Study/comparison	Outcome	Estimate (95% CI)	P value
Nickelberry 2026, delayed >120 d	Medial meniscus tear	aOR 1.80 (1.47-2.21)	P<.001
Wan/Yau 2025, >12 mo vs 0-3 mo	Medial meniscus tear	OR 3.96 (2.52-6.23)	Calculated
Gupta 2023 pediatric, ≥8 wk delay	New medial tear after negative MRI	ARR 3.90 (1.50-10.00)	P=.01
Gupta 2023 adult, ≥8 wk delay	New medial tear after negative MRI	ARR 1.10 (0.60-2.20)	P=.71
Sorey 2023, per month delay	Lower medial meniscus repairability	Inverted OR 1.08 (1.02-1.12)	P=.006
Lu 2022, delayed vs early ACLR	Secondary meniscal injury model	OR 1.08 (1.01-1.11)	P=.03
Everhart 2019, >8 wk delay	MM tear requiring partial meniscectomy	aOR 2.30 (1.04-5.12)	P=.04
de Campos 2016, >6-12 mo vs <2 mo	Medial meniscus lesion	OR 2.71 (1.55-4.72)	P<.001
de Campos 2016, >12-24 mo vs <2 mo	Medial meniscus lesion	OR 3.78 (2.17-6.57)	P<.001
de Campos 2016, >24 mo vs <2 mo	Medial meniscus lesion	OR 9.07 (5.49-15.00)	P<.001
Hur 2017, >3 mo vs ≤3 wk	Any meniscal injury	OR 1.55 (0.67-3.59)	P=.06 reported; calculated Fisher P=.40
Hur 2017, >3 mo vs ≤3 wk	Meniscal tear not repaired	OR 5.33 (1.26-22.57)	P=.04

Supplementary Appendix 5. Risk-of-Bias Criteria and Study-Level Judgments

Fourteen included studies were assessed: 12 with ROBINS-I and 2 with the JBI analytical cross-sectional checklist. No randomized trials were included, so RoB 2 was not applied. Overall harmonized judgments were 0 low, 9 moderate, and 5 serious risk of bias.

The chart and table represent a completed single-reviewer assessment based on the extracted data available in the project files. Before final submission, best practice is to have a second reviewer independently verify each judgment and adjudicate disagreements.

Table S5 Harmonized overall risk-of-bias judgments

Study	Tool applied	Overall judgment
Nickelberry 2026	ROBINS-I	Moderate
Wan & Yau 2025	JBI analytical cross-sectional checklist	Moderate
Zhang 2026	ROBINS-I	Moderate
Gupta A. 2023	ROBINS-I	Moderate
Sorey 2023	ROBINS-I	Moderate
Lu 2022	ROBINS-I	Moderate
Everhart 2019	ROBINS-I	Moderate
Chen 2019	ROBINS-I	Serious
de Campos 2016	ROBINS-I	Serious
Gupta R. 2016	ROBINS-I	Moderate
Ercin 2015	ROBINS-I	Serious
Riepen 2022	JBI analytical cross-sectional checklist	Moderate
Hur 2017	ROBINS-I	Serious
Kennedy 2010	ROBINS-I	Serious

Primary risk-of-bias concerns included confounding by patient age, sex, sport/activity level, recurrent instability, surgical indication, baseline meniscal status, and access to care; selection into surgical cohorts; variation in post-injury activity restriction or rehabilitation; and incomplete reporting of missing data. Outcome measurement was generally stronger because meniscal and chondral outcomes were often identified by arthroscopy, operative report, MRI, or registry coding.

EJOST Submission Readiness Notes

This supplementary file was prepared to align with the journal requirements for review articles, numbered figures/tables, PRISMA reporting, and transparent data availability.

Because the journal uses double-anonymous peer review guidance, author-identifying information has been omitted from the anonymized manuscript and this peer-review supplementary file. If the submission system requests non-anonymized supplementary material, the author information from the title-page/declarations file can be added to the first page of this Online Resource.