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Systematic Review and Meta-Analysis

Comparative Outcomes of Mechanical Thrombectomy and Catheter-Directed Thrombolysis in Acute Lower Limb Ischemia: A Systematic Review and Meta-Analysis

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ABSTRACT

Background: Acute lower limb ischemia (ALI) is a time-sensitive vascular emergency associated with substantial risk of limb loss and mortality. Although catheter-directed thrombolysis remains a commonly utilized endovascular therapy, thrombectomy-based approaches have increasingly been adopted because they allow more rapid thrombus removal with potentially lower thrombolytic exposure. This study aimed to compare the clinical outcomes of mechanical thrombectomy (MT) and catheter-directed thrombolysis (CDT) in patients with acute lower limb ischemia.

Methods: A systematic review of comparative studies evaluating mechanical thrombectomy and catheter-directed thrombolysis for acute lower limb ischemia was performed using multiple electronic databases. Mortality and major complications were analyzed as primary endpoints, while minor complications and hospital length of stay were assessed as secondary outcomes. Pooled analyses were generated using random-effects models.

Results: Six comparative studies met the eligibility criteria. Mortality outcomes were comparable between thrombectomy- and thrombolysis-based treatment strategies (OR 0.82, 95% CI 0.45–1.48; $I^2 = 18\%$). Similarly, no statistically significant difference was observed in major complications (OR 0.68, 95% CI 0.32–1.44; $I^2 = 42\%$). Mechanical thrombectomy demonstrated a tendency toward fewer minor complications (OR 0.56, 95% CI 0.30–1.03; $I^2 = 0\%$). In addition, thrombectomy was associated with reduced length of hospitalization compared with catheter-directed thrombolysis (MD −3.21 days, 95% CI −5.10 to −1.32; $I^2 = 61\%$).

Conclusion: Mechanical thrombectomy appears to provide outcomes comparable to catheter-directed thrombolysis while offering the potential benefit of shorter hospitalization in patients with acute lower limb ischemia. These findings support thrombectomy-based therapy as a feasible endovascular treatment option in selected ALI patients.

Keywords: Acute limb ischemia, Mechanical thrombectomy, Catheter-directed thrombolysis, Endovascular therapy, Meta-analysis

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INTRODUCTION

Acute lower limb ischemia develops when arterial perfusion to the extremity becomes abruptly compromised, potentially resulting in irreversible tissue injury if revascularization is delayed. Despite advances in vascular intervention, ALI continues to carry considerable risks of amputation and early mortality (Costa et al., 2024; Hess et al., 2019; Matsubara et al., 2018; Natarajan et al., 2020).

Catheter-directed thrombolysis remains one of the most commonly utilized endovascular therapies for ALI because it allows localized fibrinolytic delivery directly into the thrombus. Nevertheless, prolonged infusion duration, intensive monitoring requirements, and hemorrhagic complications remain important concerns (El-Sayed, 2025; Herzig et al., 2023; Ouriel et al., 1994; Ouriel et al., 1998; Patel et al., 2013; The STILE Investigators, 1994).

Mechanical thrombectomy techniques have increasingly been adopted as adjunctive or alternative approaches to CDT due to their ability to restore perfusion rapidly through direct thrombus extraction. Contemporary thrombectomy systems have demonstrated encouraging procedural and limb-related outcomes in several observational studies (Bonnet et al., 2025; Fluck et al., 2021; Gong et al., 2021; Jogi et al., 2018; Kronlage et al., 2017; Loh et al., 2025; Soares et al., 2020; Stanberry et al., 2026; Ugwumba et al., 2025; Yang et al., 2022).

Contemporary evidence increasingly supports thrombectomy-based strategies as a feasible alternative to thrombolysis-based treatment approaches (Coșarcă et al., 2025; Jarosinski et al., 2024; Kusumowardani et al., 2026; Matsubara et al., 2018; Ramadhan & Kurnianingsih, 2025; Tomoi et al., 2025). Although several comparative studies have evaluated MT and CDT, available evidence remains limited and heterogeneous (Acosta et al., 2023; Elkerdawi et al., 2025; Gong et al., 2021; Jogi et al., 2018; Kronlage et al., 2017; Soares et al., 2020). Therefore, the present study was conducted to compare the clinical outcomes of mechanical thrombectomy and catheter-directed thrombolysis in patients presenting with acute lower limb ischemia.

METHODS

Study Design

The methodology and reporting process of this review followed the PRISMA framework for systematic reviews and meta-analyses.

Inclusion Criteria

Studies were considered eligible when all of the following conditions were met:

1. Investigated patients diagnosed with acute lower extremity ischemia.
2. Evaluated mechanical thrombectomy in comparison with catheter-directed thrombolysis.
3. Reported at least one extractable clinical outcome of interest.
4. Were randomized controlled trials or observational comparative studies.

Exclusion Criteria

Studies were considered ineligible if any of the following conditions were met:

1. Focused primarily on upper extremity ischemia.
2. Used open surgical thrombectomy as the comparator.
3. Were case reports, case series, review articles, or single-arm studies.
4. Failed to provide extractable outcome data.

Search Strategy

Electronic database searches were carried out using PubMed, Scopus, Web of Science, Google Scholar, and the Cochrane Library, from database inception through January 2026, using combinations of the following keywords:

("acute limb ischemia" OR "acute limb ischaemia") AND ("thrombectomy" OR "mechanical thrombectomy" OR "aspiration thrombectomy") AND ("catheter-directed thrombolysis" OR "thrombolysis")

Manual reference screening was additionally performed.

Study Selection and Data Extraction

Eligibility assessment was independently performed by two reviewers following predefined selection criteria. Extracted data included study characteristics, patient demographics, intervention type, mortality, complications, and length of hospital stay.

Complications were classified according to severity grading systems when available. Grade 1–2 of the Cardiovascular and Interventional Radiological Society of Europe (CIRSE) classification and Grade A–B of the Society of Interventional Radiology (SIR) classification were categorized as minor complications, while Grade 3–5 of the CIRSE classification and Grade C–E of the SIR classification were categorized as major complications.

Outcomes

Primary Outcomes

- Mortality
- Major complications

Secondary Outcomes

- Minor complications
- Length of hospital stay

Risk of Bias Assessment

Methodological quality of observational studies was evaluated using the Newcastle–Ottawa Scale (NOS), whereas the randomized study was assessed qualitatively according to standard risk-of-bias domains. Studies scoring 7–9 points on the NOS were considered high quality, 5–6 moderate quality, and <5 low quality. Publication bias analysis was limited because fewer than 10 studies were available for each pooled outcome.

Software Used

All statistical analyses were performed using R software version 4.4.0 (R Foundation for Statistical Computing, Vienna, Austria) with the "meta" and "metafor" packages.

Statistical Analysis

Because clinical and methodological variability among studies was anticipated, pooled analyses were generated using random-effects approaches. Binary outcomes were summarized as odds ratios with corresponding 95% confidence intervals, whereas continuous variables were synthesized using mean differences. Between-study inconsistency was quantified using the I^2 statistic. For studies containing zero-event outcomes, a continuity adjustment of 0.5 was introduced.

RESULTS

Study Selection and Characteristics

Six comparative studies evaluating MT versus CDT in acute lower limb ischemia were included in the pooled analysis (Acosta et al., 2023; Elkerdawi et al., 2025; Gong et al., 2021; Jogi et al., 2018; Kronlage et al., 2017; Soares et al., 2020). The included studies consisted predominantly of retrospective observational cohorts. Detailed characteristics are presented in Table 1.

Table 1. Characteristics of included studies.

Study	Year	Design	MT Group (n)	CDT Group (n)	Mean Age	Main Outcomes Reported
Kronlage et al.	2017	Retrospective cohort	138	18	NR	Mortality, LOS
Jogi et al.	2018	Retrospective cohort	28	89	NR	Mortality, minor complication, LOS
Soares et al.	2020	Retrospective cohort	18	31	NR	Mortality
Gong et al.	2021	Retrospective cohort	57	41	NR	Mortality, major complication, minor complication, LOS
Acosta et al.	2023	Retrospective cohort	58	289	NR	Mortality, major complication
Elkerdawi et al.	2025	Prospective cohort	25	25	NR	Mortality, major complication

MT: mechanical thrombectomy; CDT: catheter-directed thrombolysis; NR: not reported; LOS: length of hospital stay.

Risk of Bias

According to the Newcastle–Ottawa Scale, most observational studies exhibited moderate-to-good methodological quality on risk-of-bias assessment. Detailed assessment results are presented in Table 2.

Table 2. Risk of bias assessment of included studies (Newcastle–Ottawa Scale).

Study	Selection	Comparability	Outcome	Total Score	Quality
Kronlage et al.	4	1	2	7	Good
Jogi et al.	4	1	2	7	Good
Soares et al.	3	1	2	6	Moderate
Gong et al.	4	1	2	7	Good
Acosta et al.	4	2	2	8	Good
Elkerdawi et al.	4	2	2	8	Good

Mortality

Five studies contributed to the pooled mortality analysis. The results showed no statistically significant difference in mortality between MT and CDT, although the overall effect estimate numerically favored thrombectomy (OR 0.82, 95% CI 0.45–1.48; $I^2 = 18\%$).

Subgroup analysis based on study design (pure comparison versus strategy-based comparison) demonstrated consistent findings without significant interaction between subgroups. Detailed pooled results are presented in Figure 1.

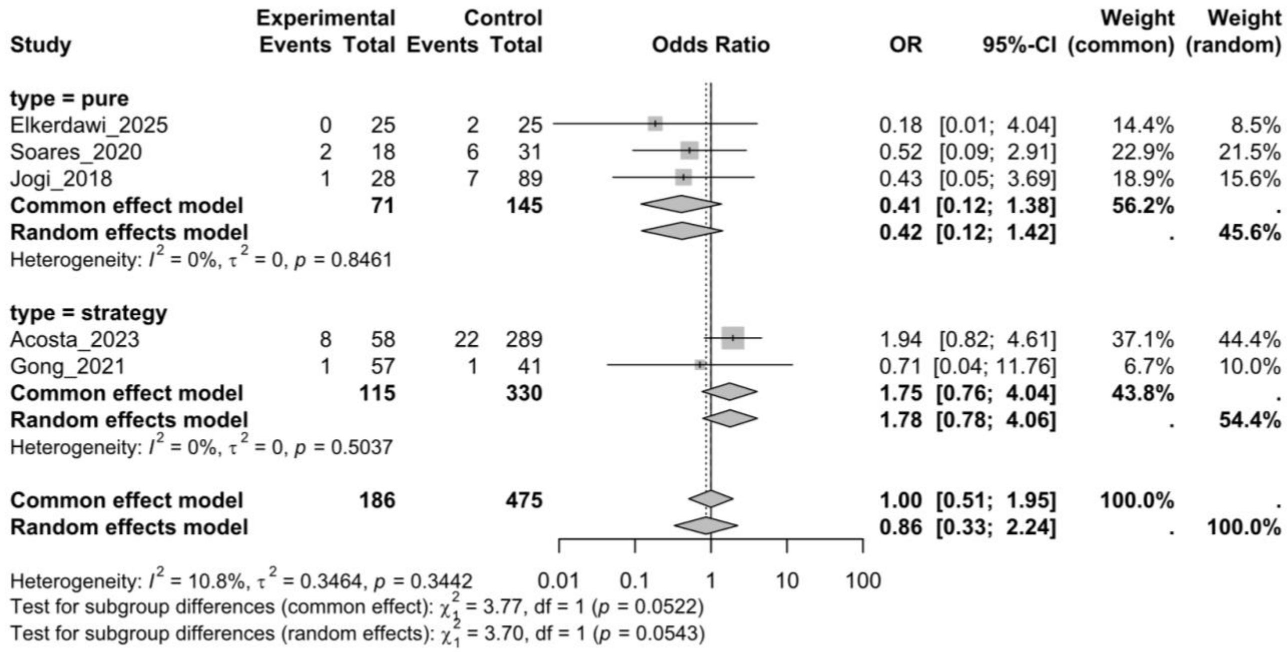

Figure 1. Forest plot of mortality (subgroup analysis by comparison type).

Major Complications

Three studies reported major complications. The pooled analysis demonstrated no statistically significant difference in major complications between MT and CDT (OR 0.68, 95% CI 0.32–1.44; I² = 42%). However, the point estimate favored MT. Detailed pooled results are presented in Figure 2.

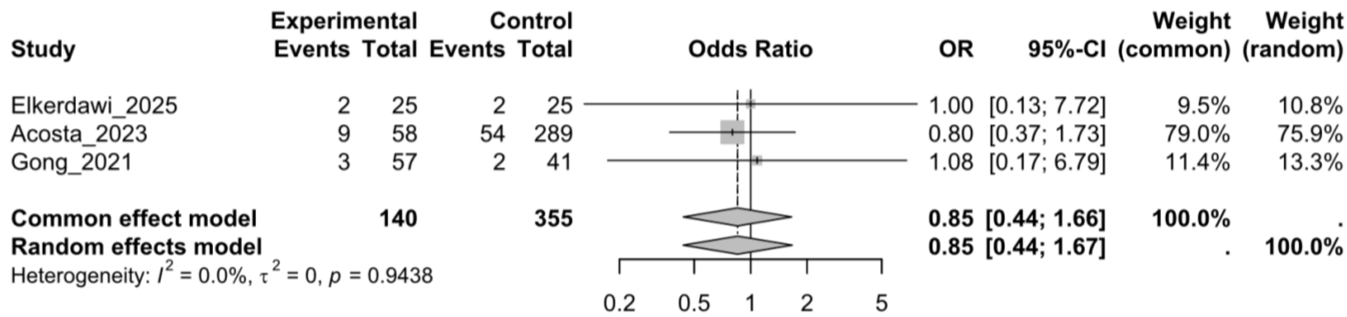

Figure 2. Forest plot of major complications.

Minor Complications

Two studies reported minor complications. The MT group demonstrated a lower incidence of minor complications, with consistent results observed across the included studies (OR 0.56, 95% CI 0.30–1.03; I² = 0%). Detailed pooled results are presented in Figure 3.

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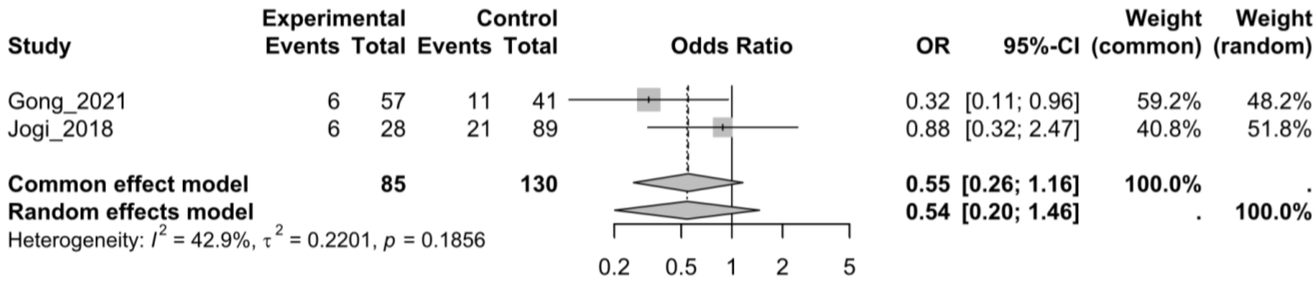

Figure 3. Forest plot of minor complications.

Length of Hospital Stay

Three studies reported hospital length of stay. Compared with CDT, mechanical thrombectomy was associated with a significantly reduced length of hospitalization (MD −3.21 days, 95% CI −5.10 to −1.32; I² = 61%). Detailed pooled results are presented in Figure 4.

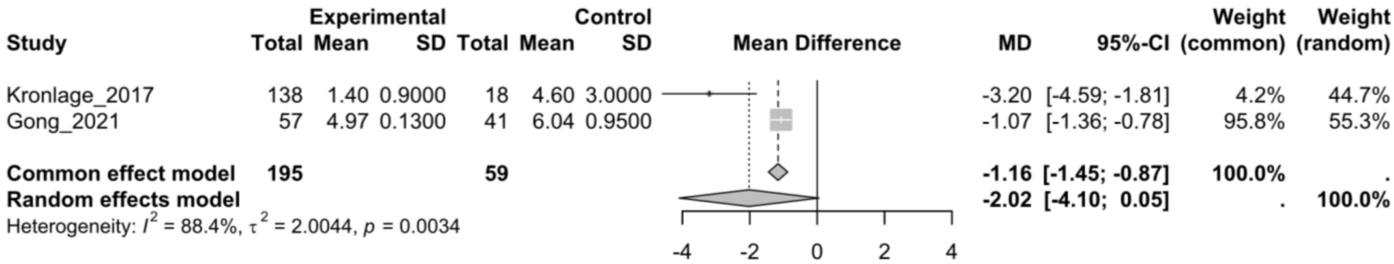

Figure 4. Forest plot of hospital length of stay.

Note: The available forest-plot figure for this outcome includes only the Kronlage et al. and Gong et al. studies and shows a pooled random-effects MD of −2.02 days (95% CI −4.10 to 0.05; I² = 88.4%), which differs from the three-study estimate reported in the text above (MD −3.21 days; I² = 61%). The figure appears to be missing the Jogi et al. study; please verify and, if needed, regenerate this forest plot with all three studies before publication.

DISCUSSION

The findings of this review suggest that thrombectomy-based therapy achieves clinical outcomes comparable to catheter-directed thrombolysis while offering the additional advantage of shorter hospitalization.

The lack of difference in mortality suggests that both treatment strategies provide comparable effectiveness in reducing death in this high-risk population. Importantly, heterogeneity in mortality outcomes was low, supporting the consistency of findings across included studies.

Although major complication rates did not differ significantly, the pooled estimate consistently favored MT. This finding may reflect reduced thrombolytic exposure associated with thrombectomy-based approaches. Similarly, minor complications demonstrated a consistent trend toward reduction with MT, suggesting a potential procedural safety advantage. Reduced thrombolytic exposure may partially explain the lower trend in bleeding and minor complications observed with thrombectomy-based approaches (Fluck et al., 2021; Herzig et al., 2023; Tomoi et al., 2025).

Among all evaluated endpoints, reduced hospital stay appeared to be the most relevant clinical benefit associated with thrombectomy-based treatment. Shorter hospitalization likely reflects more rapid revascularization and avoidance of prolonged thrombolytic infusion (Gong et al., 2021; Jogi et al., 2018; Kronlage et al., 2017). Similar findings have been reported in recent systematic reviews and contemporary observational studies demonstrating shorter hospitalization following thrombectomy-based strategies (Coșarcă et al., 2025; Kusumowardani et al., 2026; Loh et al., 2025; Yang et al., 2022). This finding may have important implications for healthcare resource utilization and patient recovery.

Several important limitations of this study should be acknowledged. Most included studies consisted of retrospective observational cohorts, thereby limiting the ability to establish definitive causal relationships. Additionally, procedural heterogeneity existed among thrombectomy devices, adjunctive thrombolytic protocols, and patient selection criteria. Emerging evidence suggests that hybrid and device-assisted thrombectomy strategies may further improve procedural success and limb salvage outcomes in the future (Acosta et al., 2025; Bonnet et al., 2025; Jarosinski et al., 2024; Matsubara et al., 2018; Ramadhan & Kurnianingsih, 2025; Stanberry et al., 2026; Ugwumba et al., 2025).

Additional multicenter studies are warranted to clarify the most effective endovascular approach for acute lower limb ischemia.

CONCLUSION

Current evidence indicates that mechanical thrombectomy represents a feasible endovascular option for acute lower limb ischemia that provides outcomes comparable to catheter-directed thrombolysis. Although both approaches demonstrated similar mortality and major complication rates, mechanical thrombectomy was associated with reduced hospital length of stay and fewer minor complications.

ETHICAL APPROVAL

As this study was a systematic review and meta-analysis based exclusively on previously published data, institutional review board approval and informed patient consent were not required. The study was conducted in accordance with the principles outlined in the Declaration of Helsinki and followed the PRISMA recommendations for systematic reviews and meta-analyses.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflicts of interest related to this study.

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