Bypass OR Pta Peripheral Artery Disease: Systematic Review with ☸SAIMSARA.

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Abstract: To systematically review and synthesize the current evidence regarding percutaneous transluminal angioplasty (PTA) and bypass surgery for peripheral artery disease (PAD), identifying key outcomes, influencing factors, and areas for future research. The review utilises 177 studies with 948808 total participants (naïve ΣN). The evidence concerning the comparative effectiveness of percutaneous transluminal angioplasty (PTA) versus bypass surgery for peripheral artery disease (PAD) is varied, with some studies indicating superior outcomes for surgical revascularization in specific patient groups (e.g., CLTI with adequate saphenous vein), while others suggest lower amputation rates post-PTA in diabetic CLI, and many finding comparable outcomes for amputation. This variability underscores the need for a personalized approach to revascularization, considering the specific patient and lesion characteristics. The most significant limitation affecting certainty is the Lack of Direct Comparisons, particularly well-designed, long-term randomized controlled trials. Clinicians should consider advanced endovascular techniques (e.g., drug-coated balloons) as a superior option to plain PTA where applicable, and tailor the overall strategy based on comprehensive patient assessment and available conduits.

Keywords: Peripheral Artery Disease; Bypass Surgery; Percutaneous Transluminal Angioplasty; Revascularization; Critical Limb Ischemia; Limb Salvage; Amputation; Arterial Patency; Endovascular Interventions; Lower Extremity Arterial Disease

Review Stats

- Generated: 2026-02-03 11:43:57 CET
- Plan: Pro (expanded craft tokens; source: Semantic Scholar)
- Source: Semantic Scholar
- Scope: All fields
- Keyword Gate: Fuzzy (≥60% of required terms, minimum 2 terms matched in title/abstract)
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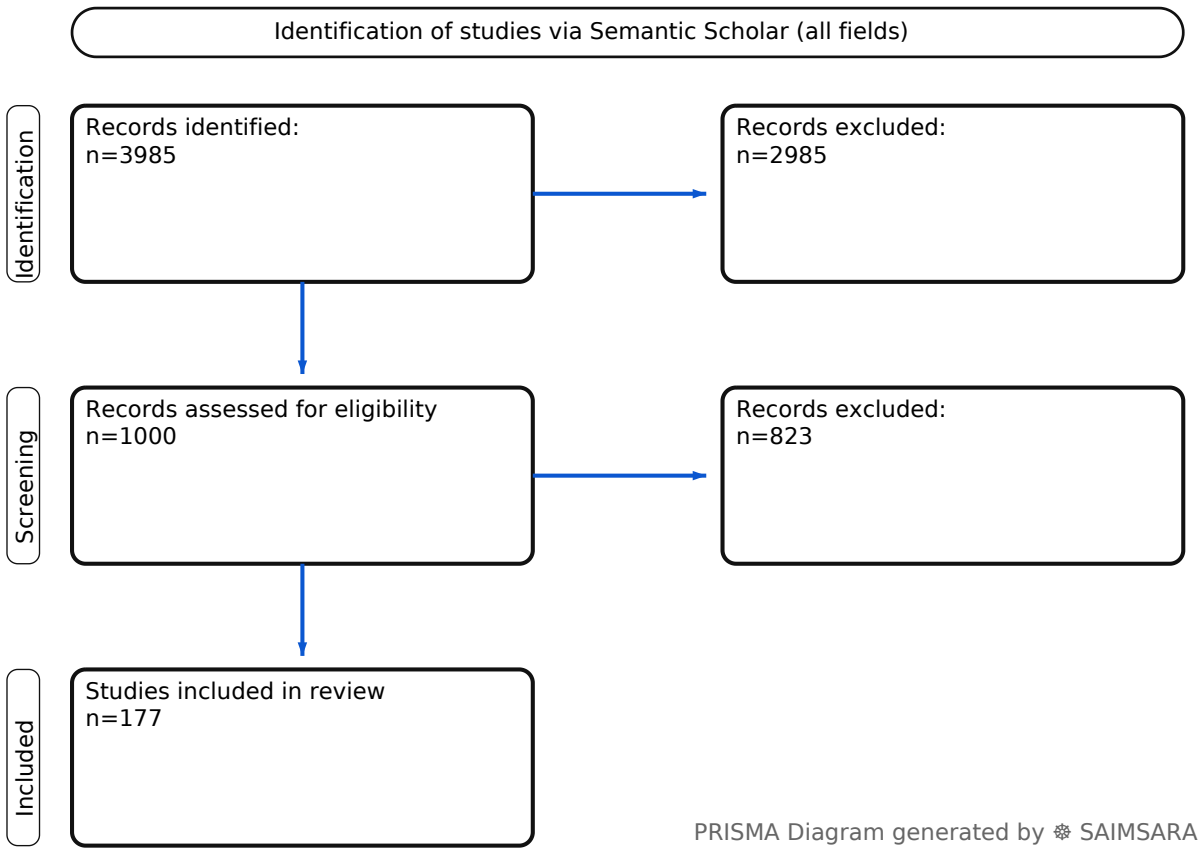
- Downloaded Abstracts/Papers: 1000
- Included original Abstracts/Papers: 177
- Total study participants (naïve ΣN): 948808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Records excluded:
n=2985
Screening
Records assessed for eligibility
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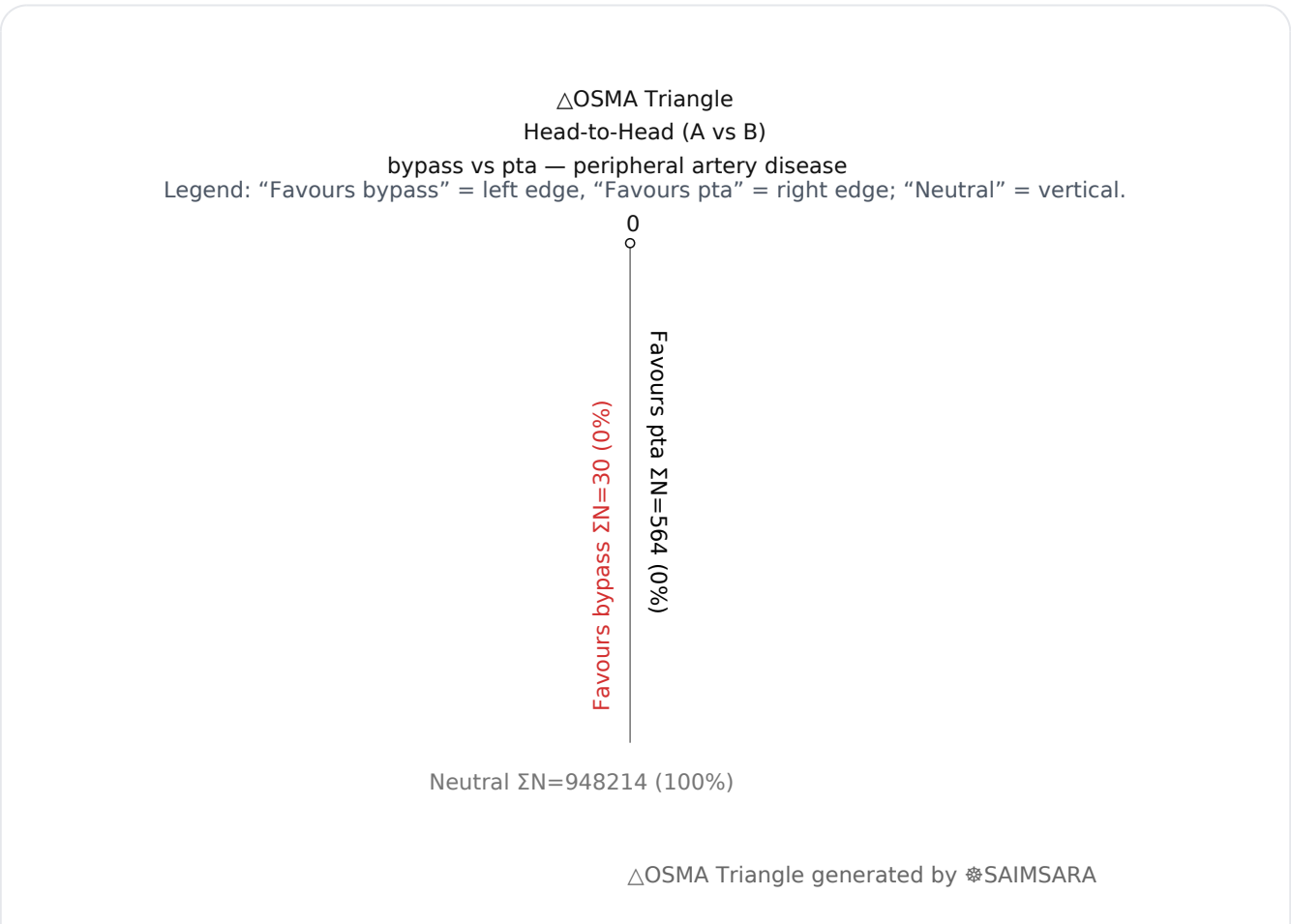
Records excluded:
n=823
Included
Studies included in review
n=177
PRISMA Diagram generated by ☸ SAIMSARA


△OSMA Triangle
Head-to-Head (A vs B)
bypass vs pta — peripheral artery disease
Legend: “Favours bypass” = left edge, “Favours pta” = right edge; “Neutral” = vertical.
0
Favours bypass ΣN=30 (0%)
Favours pta ΣN=564 (0%)
Neutral ΣN=948214 (100%)
△OSMA Triangle generated by ☸SAIMSARA

Outcome-Sentiment Meta-Analysis (OSMA): *(LLM-only)*

Frame: Head-to-Head (A vs B) • *Source*: Semantic Scholar

Comparators: A = bypass; B = pta

Outcome: peripheral artery disease Typical timepoints: peri/post-op, 1-y. Reported metrics: %, CI, p.

Common endpoints: Common endpoints: mortality, complications, patency.

Predictor: bypass vs pta — exposure/predictor.

- **1) A favored (bypass)** — peripheral artery disease with bypass vs pta — [4] — ΣN=30
- **2) B favored (pta)** — peripheral artery disease with bypass vs pta — [153] — ΣN=564
- **3) Neutral (no difference)** — peripheral artery disease with bypass vs pta — [1], [2], [3], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [25], [26], [27], [28], [29], [30], [31], [32], [33], [34], [35], [36], [37], [38], [39], [40], [41], [42], [43], [44], [45], [46], [47], [48], [49], [50], [51], [52], [53], [54], [55], [56], [57], [58], [59], [60], [61], [62], [63], [64], [65], [66], [67], [68], [69], [70], [71], [72], [73], [74], [75], [76], [77], [78], [79], [80], [81], [82], [83], [84], [85], [86], [87], [88], [89], [90], [91], [92], [93], [94], [95], [96], [97], [98], [99], [100], [101], [102], [103], [104], [105], [106], [107], [108], [109], [110], [111], [112], [113], [114], [115], [116], [117], [118], [119], [120], [121], [122], [123], [124], [125], [126], [127], [128], [129], [130], [131], [132], [133], [134], [135], [136], [137], [138], [139], [140], [141], [142], [143], [144], [145], [146], [147], [148], [149], [150], [151], [152], [154], [155], [156], [157], [158], [159], [160], [161], [162], [163], [164], [165], [166], [167], [168], [169], [170], [171], [172], [173], [174], [175], [176], [177] — ΣN=948214

1) Introduction

Peripheral artery disease (PAD) represents a significant global health burden, characterized by atherosclerotic lesions in arteries outside of the heart and brain, often leading to symptomatic claudication or critical limb ischemia (CLI). Revascularization strategies, primarily percutaneous transluminal angioplasty (PTA) and surgical bypass, are crucial for managing PAD, improving blood flow, alleviating symptoms, and preventing limb loss. The choice between these interventions is complex, influenced by lesion characteristics, patient comorbidities, and anticipated long-term outcomes. This paper synthesizes current evidence on the comparative effectiveness, safety, and influencing factors of PTA and bypass surgery in the context of PAD, drawing insights from a

comprehensive review of recent literature.

2) Aim

To systematically review and synthesize the current evidence regarding percutaneous transluminal angioplasty (PTA) and bypass surgery for peripheral artery disease (PAD), identifying key outcomes, influencing factors, and areas for future research.

3) Methods

Systematic review with multilayer AI research agent: keyword normalization, retrieval & structuring, and paper synthesis (see SAIMSARA About section for details).

- **Bias:** Qualitatively inferred from study design fields. Retrospective cohort studies and mixed designs (often retrospective) are prevalent, introducing potential selection and confounding biases. Randomized controlled trials (RCTs) offer higher certainty for specific comparisons, but are less common for broad intervention comparisons. Case series and reports provide valuable insights into rare presentations or novel techniques but have limited generalizability.

4) Results

4.1 Study characteristics:

The included studies comprise a diverse range of designs, predominantly retrospective cohort studies and mixed designs, alongside several randomized controlled trials (RCTs), prospective cohort studies, and case series/reports. Populations frequently include patients with peripheral artery disease (PAD), critical limb ischemia (CLI), diabetic foot ulcers (DFU), and those undergoing coronary artery bypass grafting (CABG) with concomitant PAD. Common arterial targets include femoropopliteal, infrapopliteal, iliac, and superficial femoral artery (SFA) lesions. Follow-up periods vary widely, ranging from in-hospital assessments to 12 months, 2 years, 3 years, 5 years, and up to 10 years.

4.2 Main numerical result aligned to the query:

Direct, broadly comparable numerical outcomes for "bypass vs. PTA" across multiple studies with consistent metrics, units, and timepoints are highly heterogeneous due to variations in intervention types (e.g., plain PTA, drug-coated balloon (DCB), drug-eluting resorbable scaffold (DRS), atherectomy, different bypass graft materials), arterial locations, and patient characteristics. However, several studies offer insights into comparative efficacy. For instance, in patients with chronic limb-threatening ischemia (CLTI) and an adequate great saphenous vein, surgical revascularization resulted in significantly fewer major adverse limb events (MALE) or death compared to endovascular therapy (hazard ratio, 0.68; 95% CI, 0.59 to 0.79; $P<0.001$) [95]. Conversely, in

diabetic patients with critical limb ischemia (CLI), major amputation rates were reported to be lower after percutaneous transluminal angioplasty (PTA) (8.2%) compared to bypass graft (BPG) (21.1%) [153]. Other studies found no significant differences in 1-year amputation rates between peripheral endovascular interventions (PVI) and lower extremity bypass surgery (LEB) [3] or between bypass surgery and angioplasty (4% vs. 6%, P=0.14) [36]. Advanced endovascular techniques, such as drug-coated balloons (DCBs) and drug-eluting resorbable scaffolds (DRSs), consistently demonstrated superior primary patency and lower revascularization rates compared to standard PTA in femoropopliteal and infrapopliteal lesions [11, 23, 32, 125].

4.3 Topic synthesis:

- **Comparative Efficacy and Safety of Revascularization Strategies:** Peripheral endovascular interventions (PVI) had higher rates of target lesion revascularization compared to lower extremity bypass surgery (LEB), though LEB was associated with increased complications up to 30 days post-procedure, with no differences in amputation rates [3]. Drug-coated balloons (DCBs) demonstrated superior primary patency (e.g., 83.9% vs 60.6% at 12 months, P<0.001 [23]) and lower rates of clinically driven target lesion revascularization (2.4% vs 20.6%, P<0.001 [32]) compared to standard percutaneous transluminal angioplasty (PTA) in femoropopliteal lesions. For chronic limb-threatening ischemia (CLTI) with adequate saphenous vein, surgical revascularization resulted in significantly fewer major adverse limb events or death compared to endovascular therapy [95].
- **Impact of Patient Comorbidities on Outcomes:** Hemodialysis patients undergoing bypass surgery for peripheral artery disease (PAD) had lower amputation-free survival rates (HR 2.21, 95% CI 1.65–3.01, P < .0001) but comparable amputation rates (10.5% vs 10.6%) compared to non-hemodialysis patients [10]. Peripheral vascular disease (PVD) was associated with higher inpatient mortality in young adults undergoing coronary artery bypass grafting (CABG) [48] and was an independent risk factor for perioperative stroke after CABG (OR 1.63, 95% CI 1.25–2.13 [73]). Hyperuricemia was associated with worse 5-year clinical outcomes, including higher rates of major adverse cerebral and cardiovascular events (MACCE) (HR 1.65, P=0.006) and major adverse limb events (MALE) (HR 1.62, P=0.001), in CLI patients following PTA [113].
- **Advanced Endovascular Techniques and Adjuncts:** Intravascular lithotripsy (IVL) improved ankle-brachial index (ABI) after 12 months in patients with calcified peripheral lesions [5]. Vessel preparation with longitudinal micro-incisions prior to PTA was associated with a low dissection rate and high freedom from target lesion revascularization (93.7% at 12 months) [83]. Drug-eluting resorbable scaffolds (DRS) demonstrated improved efficacy compared to PTA in maintaining arterial patency (68.8% vs 45.4%, P=0.0004) and reducing

revascularization rates in infrapopliteal CLTI [11]. The MagicTouch PTA sirolimus coated balloon showed promising 6-month primary patency (80%) and 12-month freedom from clinically driven target lesion revascularization (89.7%) [60].

- **Diagnostic and Prognostic Tools:** Vascular duplex ultrasonography (DUS) allows for optimal patient selection for direct PTA, leading to similar success rates but with reduced radioscopy time, contrast volume, hospitalization days, and costs compared to arteriography and PTA in separate sessions [12]. Machine learning models, specifically XGBoost, can accurately predict 1-year major adverse limb event or death after infrainguinal bypass (AUROC 0.94, 95% CI 0.93–0.95) [8]. Peripheral fractional flow reserve (pFFR) is reliable for predicting hemodynamic significance in iliofemoral intermediate stenosis (sensitivity 94%, specificity 50% at cut-off 0.85) [40].
- **Restenosis and Long-term Patency Challenges:** Restenosis remains a common complication after endovascular repair, including PTA and stent implantation [41]. Computational fluid dynamics studies are optimizing spiral-inducing bypass graft designs to enhance performance and potentially improve graft longevity and patency rates [84]. Notoginsenoside R1 (NGR1) inhibited vascular smooth muscle cell proliferation and neointimal hyperplasia, suggesting a potential therapeutic role in restenosis after PTA and bypass surgery [136].
- **Patient Experience and Education:** Individualized 3D holographic models significantly improved patient knowledge and the consciousness of the informed consent process for percutaneous balloon angioplasty in PAD [58]. Dexmedetomidine combined with remifentanil provided excellent patient satisfaction and attenuated postprocedural pain for femoropopliteal PTA [26].
- **Antiplatelet and Anticoagulation Therapy:** Prescription patterns for antiplatelet and anticoagulation therapy after lower limb interventions, including PTA and bypass, vary widely, with clopidogrel and dual antiplatelet therapy (DAPT) commonly prescribed after angioplasty and stenting, and vitamin K antagonists after venous bypasses [65]. High medication possession ratio (MPR) and continuous aspirin use significantly reduced the risk of PTA, surgical bypass, cardiovascular events, and all-cause mortality in hemodialysis patients with PAD [1].

5) Discussion

5.1 Principal finding:

The evidence concerning the comparative effectiveness of percutaneous transluminal angioplasty (PTA) versus bypass surgery for peripheral artery disease (PAD) is varied, with some studies indicating superior outcomes for surgical revascularization in specific patient groups (e.g., CLTI with adequate saphenous vein [95]), while others suggest lower amputation rates post-PTA in diabetic CLI

[153], and many finding comparable outcomes for amputation [3, 36]. Advanced endovascular techniques, such as drug-coated balloons (DCBs) and drug-eluting resorbable scaffolds (DRSs), consistently demonstrate superior patency and reduced reintervention rates compared to standard PTA [11, 23, 32, 125].

5.2 Clinical implications:

- **Personalized Treatment Approach:** The choice between PTA and bypass should be individualized, considering lesion complexity, patient comorbidities (e.g., hemodialysis [10], diabetes [151]), and the availability of suitable conduits [95].
- **Role of Advanced Endovascular Technologies:** Drug-coated balloons (DCBs) and drug-eluting resorbable scaffolds (DRSs) offer improved patency and reduced reintervention rates over plain PTA, suggesting their preferential use in appropriate femoropopliteal and infrapopliteal lesions [11, 23, 32, 125].
- **Comorbidity Management:** Aggressive management of comorbidities, such as continuous aspirin use and high medication possession ratio (MPR) in hemodialysis patients, can significantly reduce adverse events following revascularization [1]. Peripheral vascular disease (PVD) is a significant risk factor for adverse cardiovascular and cerebrovascular events in patients undergoing coronary artery bypass grafting (CABG) [48, 73, 121], necessitating careful preoperative assessment.
- **Diagnostic Guidance:** Vascular duplex ultrasonography (DUS) can optimize patient selection for direct PTA, potentially reducing procedural time and costs [12]. Peripheral fractional flow reserve (pFFR) provides reliable assessment of hemodynamic significance in intermediate stenoses [40].
- **Post-Procedural Care:** Given the high rates of reintervention and restenosis, particularly after plain PTA [41], active follow-up and timely reinterventions are crucial for improving limb salvage and survival in diabetic CLI patients [163].

5.3 Research implications / key gaps:

- **Long-term Comparative Effectiveness:** There is a need for more long-term (e.g., >5 years) randomized controlled trials directly comparing plain PTA, advanced endovascular therapies (e.g., DCB, DRS), and surgical bypass for specific lesion types and anatomical locations, with standardized outcome metrics [127].
- **Patient-Specific Predictors of Success:** Further research is needed to identify robust biomarkers (e.g., neutrophil-to-lymphocyte ratio [28], RDW [156]) and develop advanced machine learning models to predict individual patient outcomes (e.g., major adverse limb events (MALE) [8, 132]) for different revascularization strategies, especially in complex

patient populations like those with diabetes or end-stage renal disease [1, 10, 151].

- **Optimizing Restenosis Prevention:** Research into novel therapeutic agents (e.g., Notoginsenoside R1 [136]), scaffold designs (e.g., spiral-inducing grafts [84]), and procedural techniques (e.g., vessel preparation with micro-incisions [83]) is crucial to address the persistent challenge of restenosis following endovascular interventions.
- **Impact of Antiplatelet/Anticoagulation Regimens:** Standardized randomized trials are required to determine optimal antiplatelet and anticoagulation regimens following various endovascular and surgical revascularization procedures, given the wide variation in current practice [65].
- **Role of Imaging Guidance:** Further investigation into advanced imaging modalities (e.g., interventional magnetic particle imaging (iMPI) for real-time guidance [120], subtraction CTA for calcified lesions [19]) is needed to improve procedural precision and reduce radiation exposure during endovascular interventions.

5.4 Limitations:

- **Heterogeneous Study Designs** — The diverse study designs, including retrospective cohorts, RCTs, and case reports, limit the ability to draw definitive, pooled conclusions due to varying levels of evidence.
- **Varied Follow-up Durations** — Inconsistent follow-up periods across studies (from in-hospital to 10 years) make it challenging to compare long-term outcomes and patency rates reliably.
- **Inconsistent Outcome Metrics** — Different definitions and reporting of outcomes such as patency, reintervention, and major adverse limb events hinder direct comparisons between studies.
- **Specific Patient Cohorts** — Many studies focus on highly specific patient populations (e.g., hemodialysis, diabetic CLI, specific arterial occlusions), limiting the generalizability of findings to the broader PAD population.
- **Lack of Direct Comparisons** — There is a scarcity of head-to-head randomized trials directly comparing plain PTA with surgical bypass across various lesion types and patient subgroups, leading to mixed evidence.

5.5 Future directions:

- **Standardize Outcome Reporting** — Implement standardized definitions for patency, reintervention, and limb salvage in future PAD revascularization trials.

- **Long-term Comparative Trials** — Conduct large-scale, pragmatic randomized controlled trials comparing modern endovascular techniques (e.g., DCB, DRS) with surgical bypass over 5+ years.
- **Personalized Treatment Algorithms** — Develop and validate algorithms incorporating patient comorbidities, lesion characteristics, and genetic factors to guide optimal revascularization strategy.
- **Advanced Imaging Integration** — Integrate novel, radiation-free imaging modalities (e.g., iMPI) for real-time guidance during endovascular procedures to improve safety and efficacy.
- **Comorbidity-specific Interventions** — Design studies specifically evaluating revascularization outcomes and optimal adjunctive therapies in high-risk subgroups such as hemodialysis or diabetic patients.

6) Conclusion

The evidence concerning the comparative effectiveness of percutaneous transluminal angioplasty (PTA) versus bypass surgery for peripheral artery disease (PAD) is varied, with some studies indicating superior outcomes for surgical revascularization in specific patient groups (e.g., CLTI with adequate saphenous vein [95]), while others suggest lower amputation rates post-PTA in diabetic CLI [153], and many finding comparable outcomes for amputation [3, 36]. This variability underscores the need for a personalized approach to revascularization, considering the specific patient and lesion characteristics. The most significant limitation affecting certainty is the **Lack of Direct Comparisons**, particularly well-designed, long-term randomized controlled trials. Clinicians should consider advanced endovascular techniques (e.g., drug-coated balloons) as a superior option to plain PTA where applicable, and tailor the overall strategy based on comprehensive patient assessment and available conduits.

References

SAIMSARA Session Index — session.json

Figure 1. Publication-year distribution of included originals

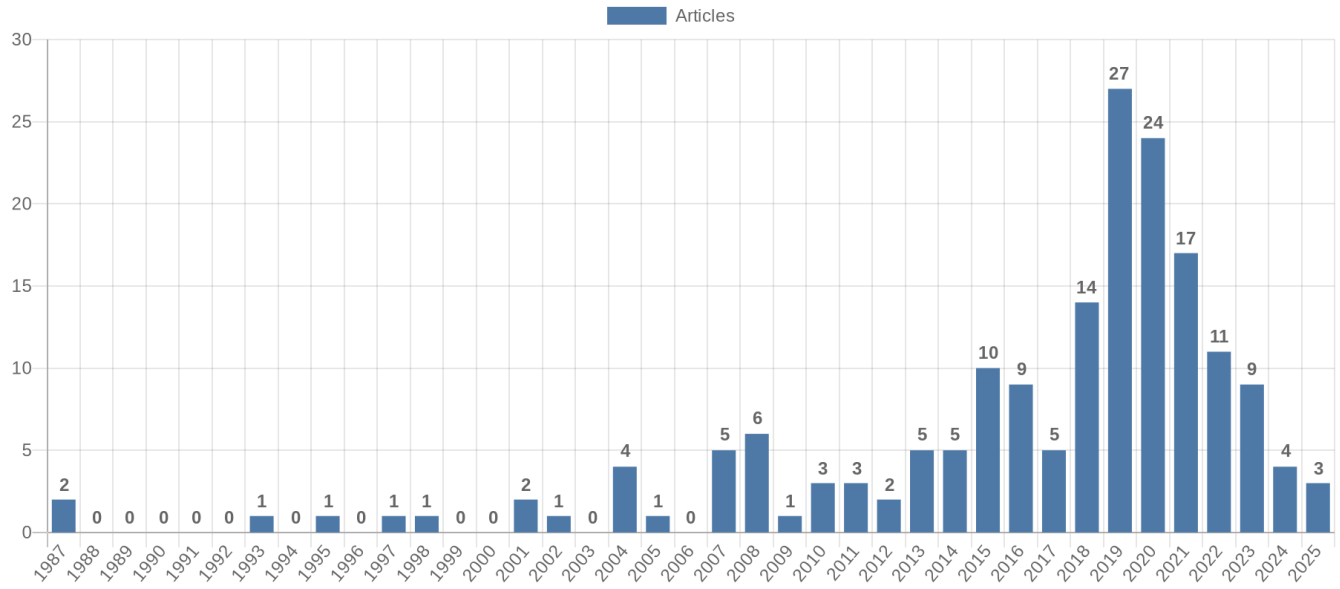


Figure 2. Study-design distribution of included originals

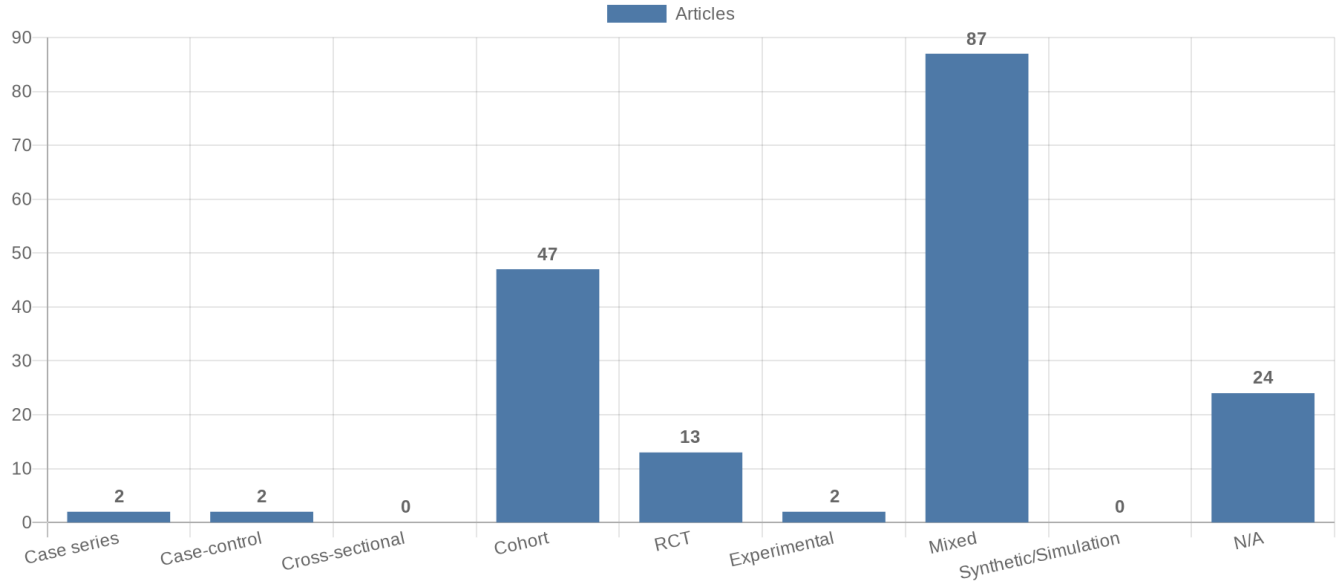


Figure 3. Study-type (directionality) distribution of included originals

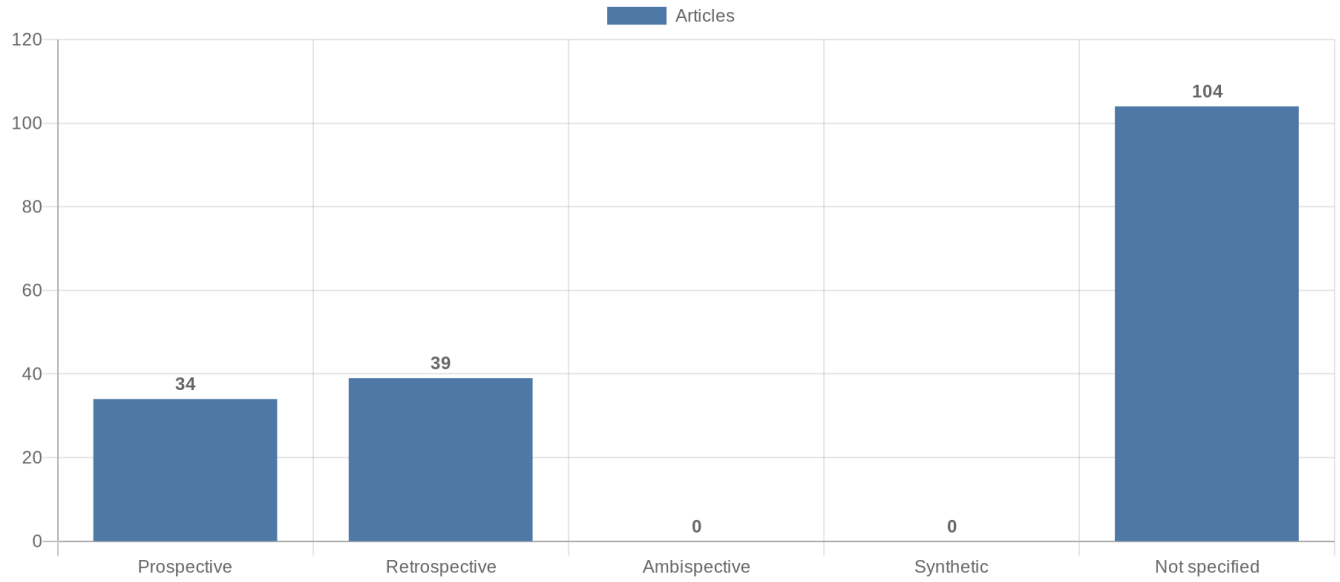


Figure 4. Main extracted research topics

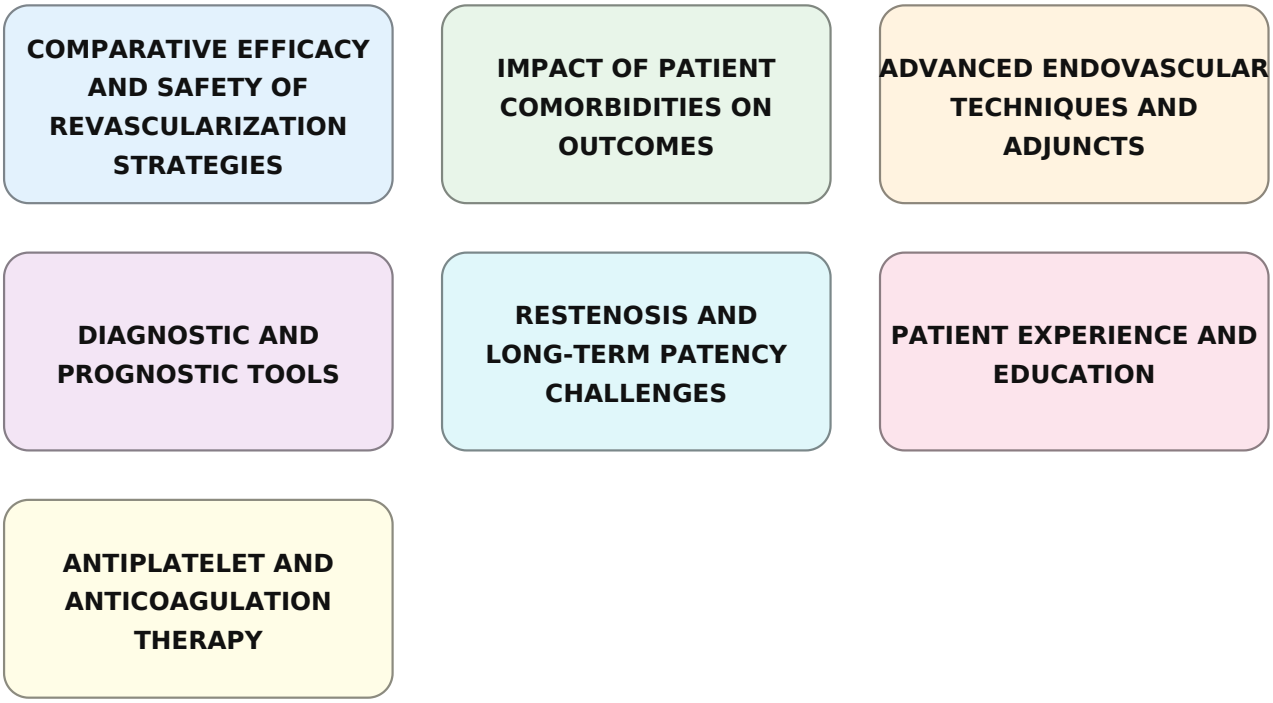


Figure 5. Limitations of current studies (topics)

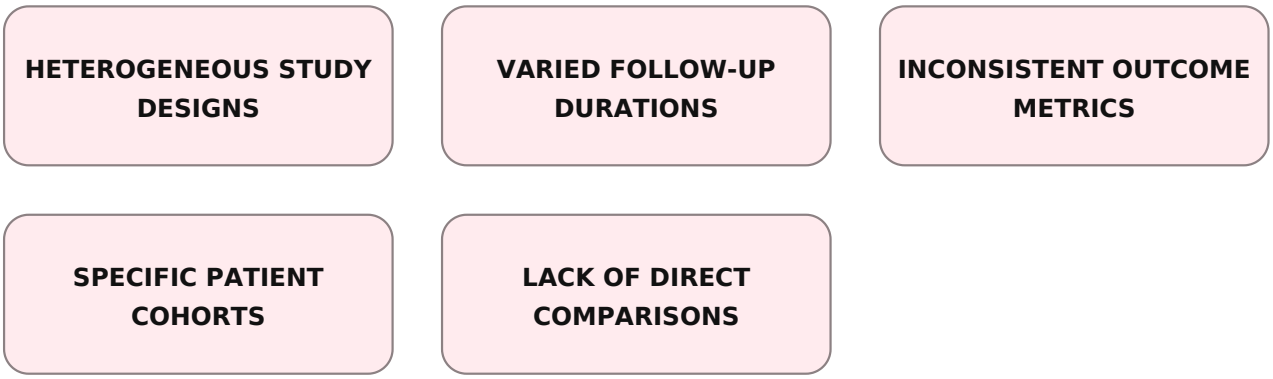


Figure 6. Future research directions (topics)

LONG-TERM COMPARATIVE EFFECTIVENESS

PATIENT-SPECIFIC PREDICTORS OF SUCCESS

OPTIMIZING RESTENOSIS PREVENTION

IMPACT OF ANTIPLATELET/ANTICOAGULATION REGIMENS

ROLE OF IMAGING GUIDANCE

STANDARDIZE OUTCOME REPORTING

LONG-TERM COMPARATIVE TRIALS