Thoracoabdominal Aortic Aneurysm: Systematic Review with ☸SAIMSARA.

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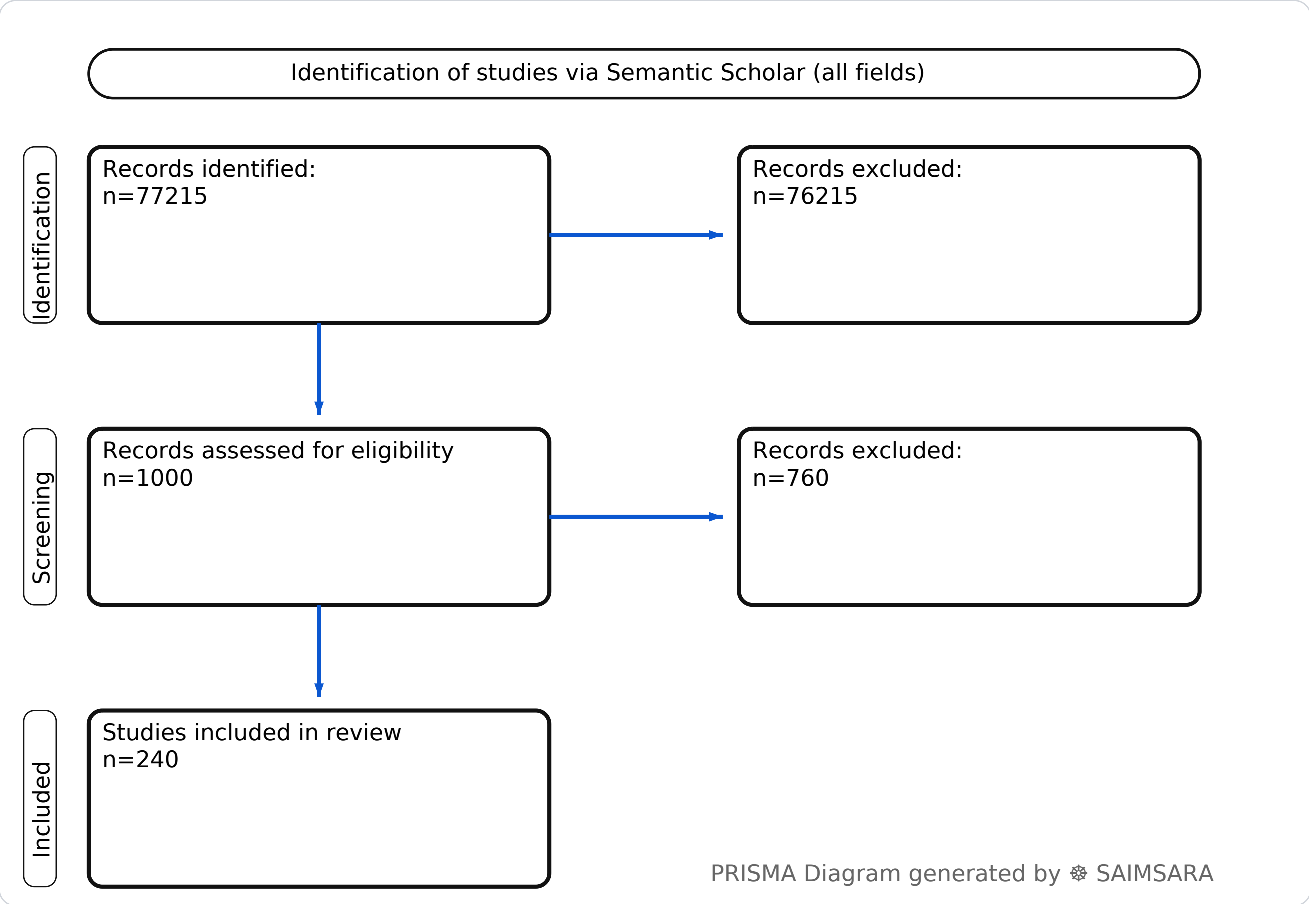
Abstract: To systematically review and synthesize the current literature on thoracoabdominal aortic aneurysms, focusing on treatment outcomes, complications, and diagnostic and management strategies. The review utilises 240 studies with 24989 total participants (naïve ΣN). For elective endovascular repair of thoracoabdominal aortic aneurysms, the 30-day mortality rate demonstrated a median of 5.0%, with a range of 0.9% to 8.0%, highlighting the improving safety of these complex procedures. While endovascular techniques offer promising outcomes, particularly in carefully selected patients, the heterogeneity in study designs and outcome reporting significantly limits the certainty of broad conclusions. A critical next step is to establish standardized outcome reporting for TAAA repair to enable more robust comparative effectiveness research.

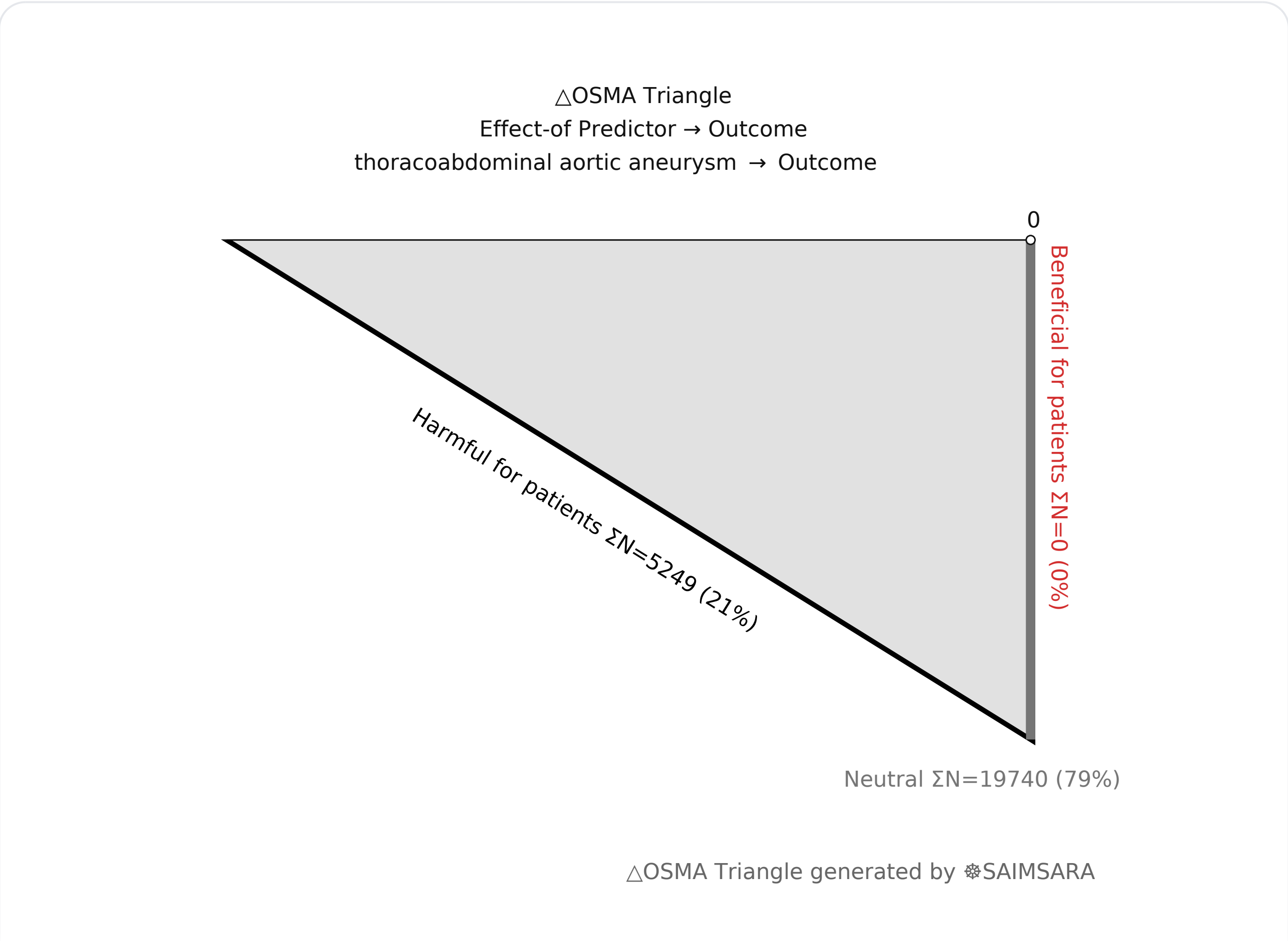
Keywords: Thoracoabdominal aortic aneurysm; Endovascular aneurysm repair; Spinal cord ischemia; Open surgical repair; Acute kidney injury; Physician modified endografts; Fenestrated branched EVAR; Aortic dissection; Aortic-related mortality; Biomarkers

Review Stats

- Generated: 2026-02-12 23:53:26 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)
- Total Abstracts/Papers: 77215
- Downloaded Abstracts/Papers: 1000
- Included original Abstracts/Papers: 240
- Total study participants (naïve ΣN): 24989



Identification of studies via Semantic Scholar (all fields)
Identification
Records identified:
n=77215
Records excluded:
n=76215
Screening
Records assessed for eligibility
n=1000
Records excluded:
n=760
Included
Studies included in review
n=240
PRISMA Diagram generated by ☸ SAIMSARA



△OSMA Triangle
Effect-of Predictor → Outcome
thoracoabdominal aortic aneurysm → Outcome
0
Beneficial for patients ΣN=0 (0%)
Harmful for patients ΣN=5249 (21%)
Neutral ΣN=19740 (79%)
△OSMA Triangle generated by ☸SAIMSARA

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

Frame: Effect-of Predictor → Outcome • *Source*: Semantic Scholar

Outcome: Outcome Typical timepoints: 30-day, 5-y. Reported metrics: %, CI, p.

Common endpoints: Common endpoints: mortality, complications, survival.

Predictor: thoracoabdominal aortic aneurysm — exposure/predictor. Routes seen: iv, intravenous. Typical comparator: control, continuous positive airway, computed tomography, those who did not….

- **1) Beneficial for patients** — Outcome with thoracoabdominal aortic aneurysm — — — ΣN=0
- **2) Harmful for patients** — Outcome with thoracoabdominal aortic aneurysm — [37], [50], [52], [102], [154], [156], [160], [164], [179], [207], [208], [211], [220], [229], [231], [236], [239] — ΣN=5249
- **3) No clear effect** — Outcome with thoracoabdominal aortic aneurysm — [1], [2], [3], [4], [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], [38], [39], [40], [41], [42], [43], [44], [45], [46], [47], [48], [49], [51], [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], [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], [153], [155], [157], [158], [159], [161], [162], [163], [165], [166], [167], [168], [169], [170], [171], [172], [173], [174], [175], [176], [177], [178], [180], [181], [182], [183], [184], [185], [186], [187], [188], [189], [190], [191], [192], [193], [194], [195], [196], [197], [198], [199], [200], [201], [202], [203], [204], [205], [206], [209], [210], [212], [213], [214], [215], [216], [217], [218], [219], [221], [222], [223], [224], [225], [226], [227], [228], [230], [232], [233], [234], [235], [237], [238], [240] — ΣN=19740

1) Introduction

Thoracoabdominal aortic aneurysms (TAAAs) represent a complex and life-threatening vascular pathology, characterized by dilation spanning both the thoracic and abdominal aorta, often involving major visceral and renal arteries [138]. Repair of TAAAs, whether through open surgical or endovascular techniques, presents significant challenges due to the extensive nature of the disease and the critical structures involved, leading to a high risk of morbidity and mortality [11, 231]. Complications such as spinal cord ischemia (SCI), acute kidney injury (AKI), and major adverse events remain prevalent, necessitating continuous advancements in surgical techniques, endovascular devices, and perioperative management strategies [5, 23, 145]. This paper synthesizes current evidence on TAAA treatment outcomes, associated complications, and emerging therapeutic and diagnostic approaches.

2) Aim

To systematically review and synthesize the current literature on thoracoabdominal aortic aneurysms, focusing on treatment outcomes, complications, and diagnostic and management strategies.

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. The included studies comprise a mix of cohort studies, retrospective analyses, prospective studies, and randomized controlled trials (RCTs), with a notable presence of non-specified or mixed designs, suggesting variability in methodological rigor and potential for reporting bias. Many studies are single-center or report on specific techniques, which may introduce selection bias.

4) Results

4.1 Study characteristics:

The reviewed literature primarily consists of cohort studies, often retrospective or prospective, alongside mixed-design studies and a few randomized controlled trials. Populations range from general TAAA patients to specific subgroups such as those with post-dissection aneurysms, connective tissue disorders, or advanced age. Follow-up periods vary widely, from immediate post-operative (e.g., 72 hours [2]) to short-term (e.g., 30 days [5]), mid-term (e.g., 21 months [1]), and long-term (e.g., 5 years [8] or even 10 years [33]).

4.2 Main numerical result aligned to the query:

For elective endovascular repair of thoracoabdominal aortic aneurysms, the 30-day mortality rate demonstrated a median of 5.0% [160] across various studies. The reported range for this outcome was 0.9% to 8.0% [183, 5], indicating some heterogeneity in outcomes depending on the specific endovascular technique and patient cohort.

4.3 Topic synthesis:

- **Endovascular Repair Efficacy and Safety:** Physician-modified endografts (PMEGs) and fenestrated-branched endovascular aortic repair (FB-EVAR) show high technical success (median 96% [21, 102, 167]; range 94-100% [1, 13, 102, 133, 167]) and favorable mid-term outcomes, with 5-year overall survival ranging from 45.7% to 55.0% [8, 1].
- **Spinal Cord Ischemia (SCI) Risk and Mitigation:** SCI remains a significant complication (median 8.1% [134]; range 0-18% [6, 163]), with permanent paraplegia rates around 2-3% [23, 179]. Adjuncts like cerebrospinal fluid (CSF) drainage [17, 84], segmental artery coil embolisation (MISACE) [6], cryoablation of intercostal nerves [3], and specific clinical protocols [178] are explored for prevention.
- **Acute Kidney Injury (AKI) and Biomarkers:** AKI is a notable post-operative complication (18.6% [11], 13% deteriorated renal function [4], 0-41% [145]), with secretory leucocyte peptidase inhibitor (SLPI) identified as a potential biomarker for AKI prediction (AUC = 0.838) [2].
- **Anatomical Feasibility and Patient Selection:** Anatomical limitations, particularly in women, can negatively impact the feasibility of certain endovascular devices like the Zenith t-Branch (22% in women vs. 45% in men) [168, 237] and overall technical success (86.2% in women vs. 96.6% in men) [164]. Connective tissue diseases also pose challenges, requiring lifelong surveillance [133, 134, 229].
- **Open Surgical Repair (OSR) Evolution:** OSR has seen improved in-hospital mortality (from 13.4% to 8.1%) and reduced permanent SCI (from 11.9% to 7.8%) with contemporary adjuncts [10]. Long-term survival for OSR can reach 53% at 5 years and 19% at 10 years [50].
- **Emergency vs. Elective Repair Outcomes:** Non-elective FB-EVAR is associated with significantly higher early mortality (17% vs. 5%, $P<0.001$) and major adverse events (34% vs. 20%, $P<0.001$) compared to elective repair [160]. Emergency TAAA treatment generally carries high mortality (43.1%) and morbidity [11].
- **Device Innovation and Customization:** Physician-modified endografts (PMEGs) [1, 4, 140], fenestrated/branched stent grafts (F/BEVAR) [5, 8, 13, 14, 102, 114, 128, 135, 161, 162, 163, 164, 167, 169, 170, 172, 173, 174, 180, 183, 203, 220, 221, 223, 227], and 3D printing for planning and customization [18, 130, 234] are advancing endovascular treatment options, extending applicability and improving outcomes.
- **Neuromonitoring and Imaging:** Preoperative visualization of the artery of Adamkiewicz (AKA) using MRA or CTA is crucial [28, 55, 72, 116, 125, 214, 240], with intra-arterial contrast being more sensitive [240]. Intraoperative neuromonitoring (e.g., SEPs, MEPs) is vital for spinal cord integrity assessment [34, 37, 58, 67, 68, 71, 77, 88, 96, 99, 194].

- **Inflammatory and Systemic Responses:** TAAA repair can induce systemic inflammation [27, 31, 43, 57, 62] and impact cardiac function [45, 117], requiring careful perioperative management.
- **Long-term Device Stability and Reinterventions:** While endovascular approaches show good initial patency (e.g., 96.9% at 1 year for target vessels [1]), reintervention rates can be substantial (40.3% at 5 years for FB-EVAR [8], 23% overall [221]), particularly for post-dissection aneurysms (67% freedom from unplanned reintervention at 1 year vs. 89% for degenerative) [220].

5) Discussion

5.1 Principal finding:

For elective endovascular repair of thoracoabdominal aortic aneurysms, the 30-day mortality rate demonstrated a median of 5.0% [160], with a range of 0.9% to 8.0% [183, 5].

5.2 Clinical implications:

- **Personalized Treatment Approach:** Given the variability in outcomes and anatomical feasibility, particularly between sexes [164, 168, 237], a tailored approach considering patient comorbidities, aneurysm morphology, and center experience is crucial [126].
- **Enhanced Spinal Cord Protection:** The persistent risk of SCI necessitates the systematic use of adjuncts such as CSF drainage [17, 84, 189], segmental artery embolization [6], and potentially cryoablation [3], especially in extensive repairs.
- **Biomarker-Guided Monitoring:** The use of biomarkers like SLPI for early AKI detection [2] could enable timely intervention, improving renal outcomes which are a significant concern [5, 11, 32, 57, 80, 92, 93, 145].
- **Preoperative Imaging Optimization:** High-resolution imaging, including MRA and CTA, is essential for precise localization of critical spinal cord arteries (e.g., Adamkiewicz artery) to inform surgical planning and minimize neurological complications [28, 55, 72, 116, 125, 214, 240].
- **Careful Consideration for Non-Elective Cases:** Non-elective repairs carry substantially higher mortality and morbidity [160], emphasizing the need for robust protocols and rapid deployment of physician-modified grafts when custom devices are unavailable [140, 222].

5.3 Research implications / key gaps:

- **Long-Term Device Durability:** Further investigation is needed into the long-term patency, reintervention rates, and structural integrity of newer endovascular devices, especially beyond 5 years [24, 120, 221].
- **Comparative Effectiveness Studies:** Head-to-head comparisons of different endovascular techniques (e.g., PMEGs vs. off-the-shelf branched grafts) and open vs. endovascular repair in specific patient subgroups are warranted [166, 224].
- **Optimal SCI Prevention Strategy:** Randomized controlled trials are needed to definitively establish the most effective combination of spinal cord protection adjuncts for different TAAA extents and patient risk profiles [7, 153].
- **Predictive Modeling Refinement:** Development and validation of more sophisticated predictive models, potentially using machine learning, to forecast complications and guide personalized treatment strategies [165, 79].
- **Impact of Aortic Remodeling:** Research into the long-term effects of aortic main body remodeling after EVAR and its association with bridging stent-graft stability and clinical outcomes [146].

5.4 Limitations

- **Heterogeneous Study Designs** — The variability in study designs (cohort, retrospective, mixed) limits the ability to draw definitive causal conclusions and pool data for meta-analysis.
- **Inconsistent Outcome Reporting** — Differences in reported metrics, definitions of complications (e.g., transient vs. permanent SCI), and follow-up durations hinder direct comparisons across studies.
- **Selection Bias in Cohorts** — Many studies are from specialized centers or focus on specific techniques, potentially overestimating success rates and underestimating complications in broader practice.
- **Limited Long-Term Data** — While some studies report 5-year outcomes, comprehensive long-term data on durability and reinterventions for newer endovascular devices are still evolving.
- **Small Sample Sizes** — Several studies, particularly those on novel techniques or specific patient groups, have small sample sizes, limiting statistical power and generalizability.

5.5 Future directions

- **Standardize Outcome Reporting** — Develop universal definitions and reporting standards for TAAA repair outcomes and complications.
- **Longitudinal Registry Data** — Establish large, multicenter registries to track long-term outcomes and device performance.
- **Randomized Controlled Trials** — Conduct more RCTs comparing different repair techniques and adjuncts for specific TAAA types.
- **Advanced Imaging Integration** — Integrate 3D printing and advanced imaging for highly personalized preoperative planning and device customization.
- **Biomarker Validation Studies** — Validate novel biomarkers for early detection of complications like AKI and SCI in larger cohorts.

6) Conclusion

For elective endovascular repair of thoracoabdominal aortic aneurysms, the 30-day mortality rate demonstrated a median of 5.0% [160], with a range of 0.9% to 8.0% [183, 5], highlighting the improving safety of these complex procedures. While endovascular techniques offer promising outcomes, particularly in carefully selected patients, the heterogeneity in study designs and outcome reporting significantly limits the certainty of broad conclusions. A critical next step is to establish standardized outcome reporting for TAAA repair to enable more robust comparative effectiveness research.

References

SAIMSARA Session Index — session.json

Figure 1. Publication-year distribution of included originals

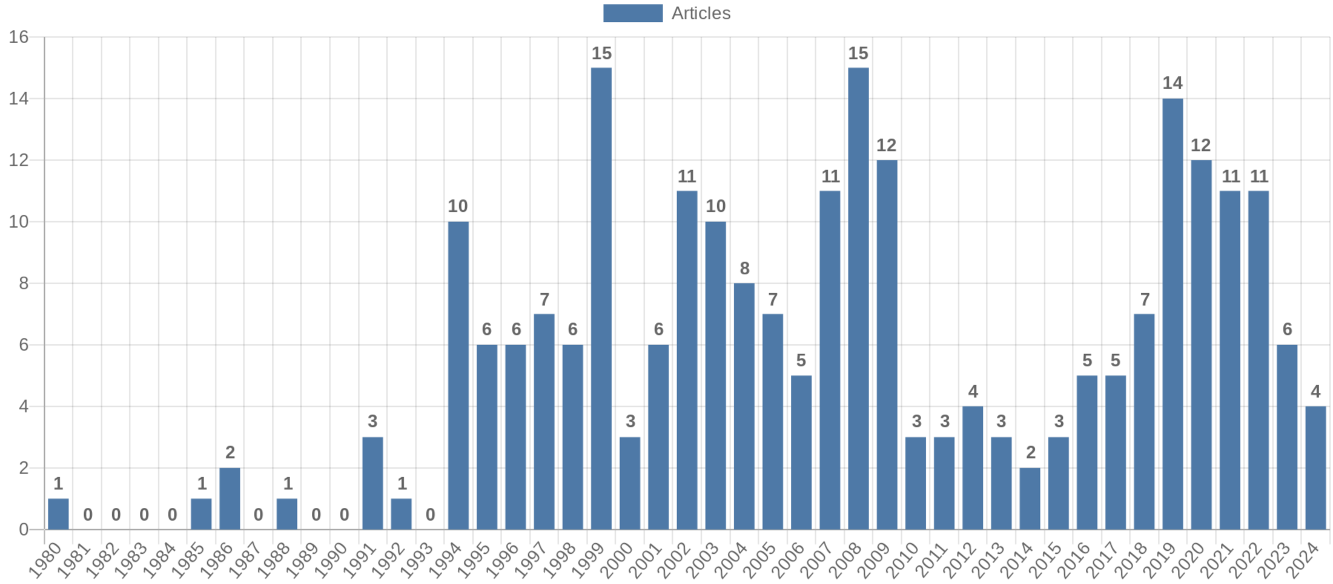


Figure 2. Study-design distribution of included originals

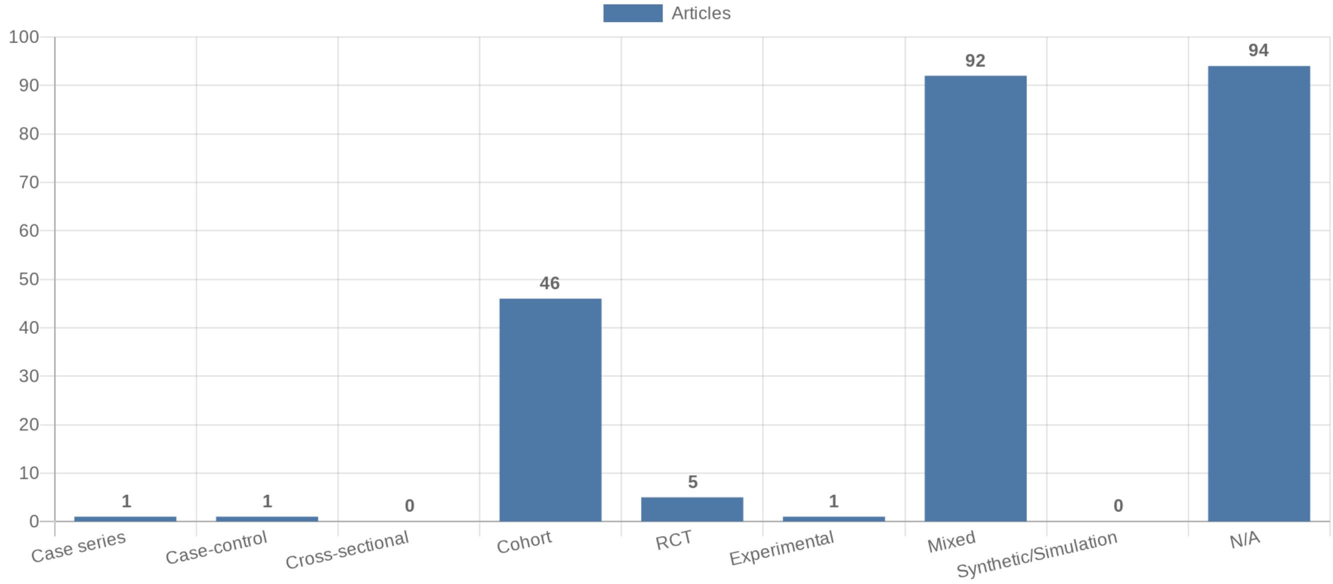


Figure 3. Study-type (directionality) distribution of included originals

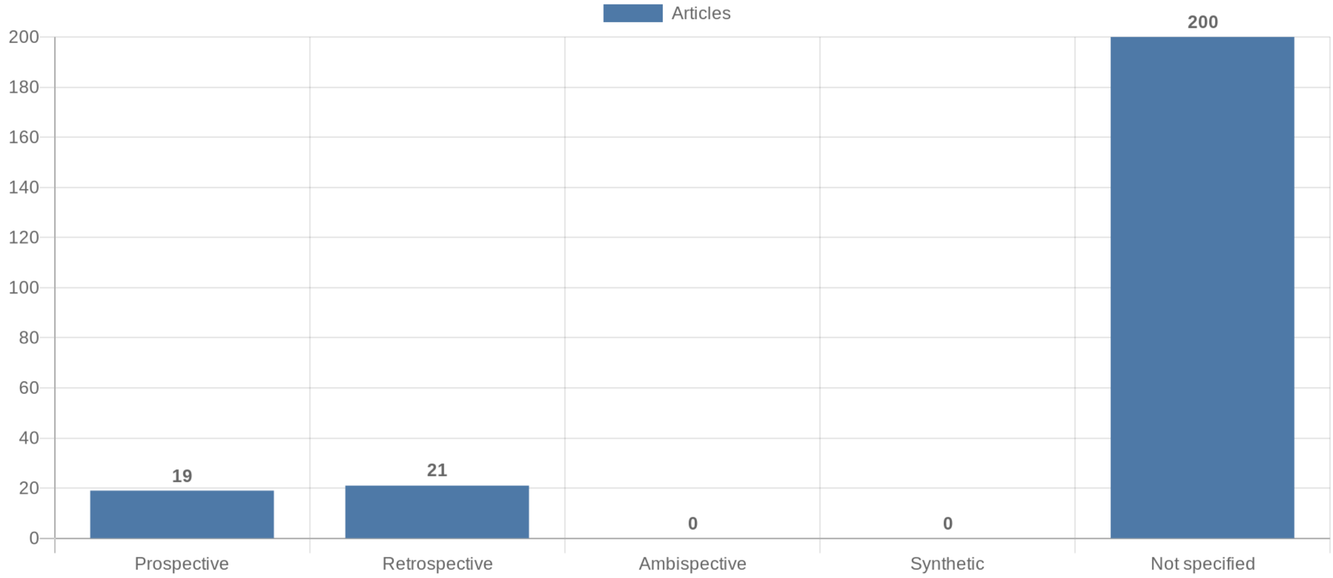


Figure 4. Main extracted research topics

- ENDOVASCULAR REPAIR EFFICACY AND SAFETY
- SPINAL CORD ISCHEMIA SCI RISK AND MITIGATION
- ACUTE KIDNEY INJURY AKI AND BIOMARKERS
- ANATOMICAL FEASIBILITY AND PATIENT SELECTION
- OPEN SURGICAL REPAIR OSR EVOLUTION
- EMERGENCY VS. ELECTIVE REPAIR OUTCOMES
- DEVICE INNOVATION AND CUSTOMIZATION

Figure 5. Limitations of current studies (topics)

- HETEROGENEOUS STUDY DESIGNS
- INCONSISTENT OUTCOME REPORTING
- SELECTION BIAS IN COHORTS
- LIMITED LONG-TERM DATA
- SMALL SAMPLE SIZES

Figure 6. Future research directions (topics)

- LONG-TERM DEVICE DURABILITY
- COMPARATIVE EFFECTIVENESS STUDIES
- OPTIMAL SCI PREVENTION STRATEGY
- PREDICTIVE MODELING REFINEMENT
- IMPACT OF AORTIC REMODELING
- STANDARDIZE OUTCOME REPORTING
- LONGITUDINAL REGISTRY DATA