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Review Article

Systematic Review on Perioperative Management of Anticoagulation Therapy in Patients with Ischemic Heart Disease Undergoing Surgery

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ABSTRACT

Background: Patients with ischemic heart disease undergoing surgery frequently receive long-term antiplatelet or anticoagulant therapy, creating a perioperative dilemma between thrombotic protection and bleeding safety. Premature interruption of antithrombotic therapy may increase myocardial infarction, stent thrombosis, or ischemic stroke risk, whereas continuation or bridging may increase surgical bleeding, transfusion requirement, and reoperation risk. Objective: This systematic review aimed to synthesize evidence on perioperative antithrombotic management strategies in adult patients with ischemic heart disease or clinically relevant cardiovascular comorbidity undergoing surgery, focusing on continuation, interruption without bridging, and heparin-based bridging. Methods: A structured search was conducted across PubMed, Scopus, the Cochrane Library, BMJ Heart, and major cardiology and perioperative medicine sources for studies published between 2001 and 2024. Eligible sources included randomized trials, systematic reviews, meta-analyses, clinical studies, and guideline documents evaluating perioperative antiplatelet or anticoagulant management. Eighteen sources were included from 312 identified records. Findings were synthesized narratively because of heterogeneity in populations, surgical settings, antithrombotic indications, and outcome definitions. Results: Interruption without bridging showed the most favorable descriptive balance between thromboembolic events and major bleeding, particularly for direct oral anticoagulant-based protocols. Aspirin continuation appeared cardioprotective in selected high-risk ischemic heart disease patients but increased bleeding risk. Bridging anticoagulation showed the highest major bleeding burden without clear thromboembolic reduction and was most defensible only in narrowly defined very high-risk thrombotic indications. Conclusion: Perioperative antithrombotic management in ischemic heart disease should be individualized according to cardiac risk, surgical bleeding risk, antithrombotic agent, renal function, and timing of postoperative hemostasis. Routine bridging should be avoided in most patients, while structured interruption and selective aspirin continuation offer more favorable risk–benefit profiles. Keywords: Antithrombotic Therapy; Anticoagulants; Antiplatelet Agents; Ischemic Heart Disease; Perioperative Care; Bridging Anticoagulation; Direct Oral Anticoagulants; Surgical Bleeding.

INTRODUCTION

Ischemic heart disease remains one of the leading contributors to perioperative morbidity and mortality, particularly among adults who require elective or urgent surgical intervention while receiving long-

term antithrombotic therapy. The perioperative period is characterized by sympathetic activation, systemic inflammation, endothelial injury, platelet activation, and transient hypercoagulability, all of which may increase the risk of myocardial infarction, stent thrombosis, ischemic stroke, and other major adverse cardiovascular events in susceptible patients (1). These risks are clinically important because many patients with ischemic heart disease receive aspirin, P2Y12 inhibitors, vitamin K antagonists, direct oral anticoagulants, or combined antithrombotic regimens for secondary prevention after acute coronary syndrome, percutaneous coronary intervention, atrial fibrillation, mechanical valve replacement, or other cardiovascular indications (2,3).

Perioperative management of antithrombotic therapy requires careful balancing of two competing hazards: thrombotic complications caused by premature discontinuation and bleeding complications caused by continued pharmacological inhibition of coagulation or platelet function. Discontinuation of antiplatelet therapy, particularly after recent percutaneous coronary intervention or acute coronary syndrome, may expose patients to preventable ischemic events, including perioperative myocardial infarction and stent thrombosis. Conversely, continuation of antiplatelet or anticoagulant therapy may increase surgical-site bleeding, hematoma formation, transfusion requirements, delayed wound healing, and reoperation risk, especially in operations involving closed anatomical spaces, major vascular structures, neuraxial procedures, or extensive tissue dissection (4,5). The clinical dilemma is therefore not whether antithrombotic therapy is beneficial in general, but how it should be continued, interrupted, or modified during the short perioperative window for different patient and procedure risk profiles.

Historically, perioperative anticoagulation decisions often relied on empiric bridging with unfractionated heparin or low-molecular-weight heparin when oral anticoagulation was interrupted. However, contemporary evidence has challenged the routine use of bridging because several studies and guideline-based syntheses have shown that bridging may increase major bleeding without producing a proportional reduction in perioperative thromboembolic events in many patients (6). At the same time, direct oral anticoagulants have changed perioperative practice because their predictable pharmacokinetic profiles allow structured interruption and postoperative resumption without the need for heparin substitution in most clinical scenarios (7). Aspirin management remains more nuanced, as continuation may be beneficial in patients with high cardiac risk, recent coronary stenting, or recent acute coronary syndrome, but this benefit must be weighed against the bleeding risk of the planned surgical procedure (4,5).

Despite the availability of international guidance, perioperative antithrombotic management remains variable across surgical, anesthesia, cardiology, and internal medicine practice. Variation is partly explained by differences in surgical bleeding risk, urgency of operation, renal function, type of antithrombotic agent, time since coronary intervention, and the presence of additional thrombotic indications such as atrial fibrillation, mechanical heart valves, or recent venous thromboembolism. Existing literature includes randomized trials, systematic reviews, meta-analyses, perioperative guidelines, and expert consensus documents, but direct evidence focused specifically on patients with ischemic heart disease undergoing surgery remains dispersed across heterogeneous clinical populations and procedural contexts (6–8). A structured synthesis is therefore needed to clarify the relative safety and clinical utility of continuation, temporary interruption without bridging, and bridging-based perioperative strategies.

This systematic review aimed to synthesize evidence on perioperative antithrombotic management in adult patients with ischemic heart disease undergoing surgery. Using a PICO framework, the population comprised adult surgical patients with ischemic heart disease or clinically relevant cardiovascular comorbidity receiving antiplatelet or anticoagulant therapy; the interventions were perioperative continuation, interruption without bridging, and bridging with heparin-based regimens; the comparators were alternative perioperative antithrombotic strategies; and the primary outcomes were thromboembolic events and major bleeding, with secondary consideration of myocardial infarction,

stent thrombosis, postoperative anticoagulant resumption, transfusion requirement, and overall clinical risk–benefit. The objective was to determine which perioperative antithrombotic strategies provide the most favorable balance between cardiovascular protection and bleeding safety across clinically relevant patient and surgical-risk categories.

MATERIAL AND METHODS

This systematic review was designed to synthesize evidence on perioperative management of antithrombotic therapy in patients with ischemic heart disease or clinically relevant cardiovascular comorbidity undergoing surgery. The review followed the principles of PRISMA 2020 reporting, with a structured approach to information retrieval, eligibility assessment, study selection, and narrative synthesis (9). Because the available evidence was expected to include randomized trials, systematic reviews, meta-analyses, clinical guidelines, and perioperative consensus documents rather than a homogeneous set of directly comparable primary studies, the review was planned as a systematic review without meta-analysis, using structured narrative synthesis rather than statistical pooling.

A structured literature search was conducted across PubMed, Scopus, the Cochrane Library, BMJ Heart, and major cardiology and perioperative medicine sources for studies published between 2001 and 2024. Search terms were developed around four core concepts: perioperative care, antithrombotic therapy, ischemic heart disease, and surgery. The search combined terms and synonyms including “perioperative anticoagulation,” “perioperative antithrombotic management,” “ischemic heart disease,” “coronary artery disease,” “surgery,” “bridging therapy,” “heparin bridging,” “antiplatelet management,” “aspirin continuation,” “dual antiplatelet therapy,” “direct oral anticoagulants,” “warfarin interruption,” “major bleeding,” and “thromboembolism,” using Boolean operators appropriate to each database. The search strategy was supplemented by screening the reference lists of relevant reviews, guidelines, and consensus documents to identify additional eligible studies.

Eligible records included systematic reviews, meta-analyses, randomized controlled trials, prospective or retrospective clinical studies, and international or specialty-specific clinical guidelines evaluating perioperative antiplatelet or anticoagulant management in adult patients with ischemic heart disease, coronary artery disease, previous acute coronary syndrome, previous percutaneous coronary intervention, or related cardiovascular indications requiring antithrombotic therapy. Studies were considered eligible if they evaluated at least one perioperative antithrombotic strategy, including continuation of therapy, temporary interruption without bridging, or bridging with unfractionated heparin or low-molecular-weight heparin. Outcomes of interest included thromboembolic events, myocardial infarction, stent thrombosis, ischemic stroke, major bleeding, clinically relevant non-major bleeding, transfusion requirement, timing of preoperative discontinuation, timing of postoperative restart, and overall net clinical benefit. Studies were excluded if they focused exclusively on non-surgical settings, pediatric populations, patients without cardiovascular or antithrombotic indications, non-clinical pharmacological models, or reports without extractable perioperative management or outcome data.

The selection process involved removal of duplicate records followed by screening of titles and abstracts for relevance to perioperative antithrombotic management. Potentially eligible records were then reviewed in full text against the predefined eligibility criteria. The review identified 312 records through database and supplementary searching. After duplicate removal, 260 records remained for screening; 42 full-text articles were assessed for eligibility, and 18 studies were included in the final synthesis. The study selection process was summarized using a PRISMA-style flow structure, including the number of identified, deduplicated, screened, full-text reviewed, and included records.

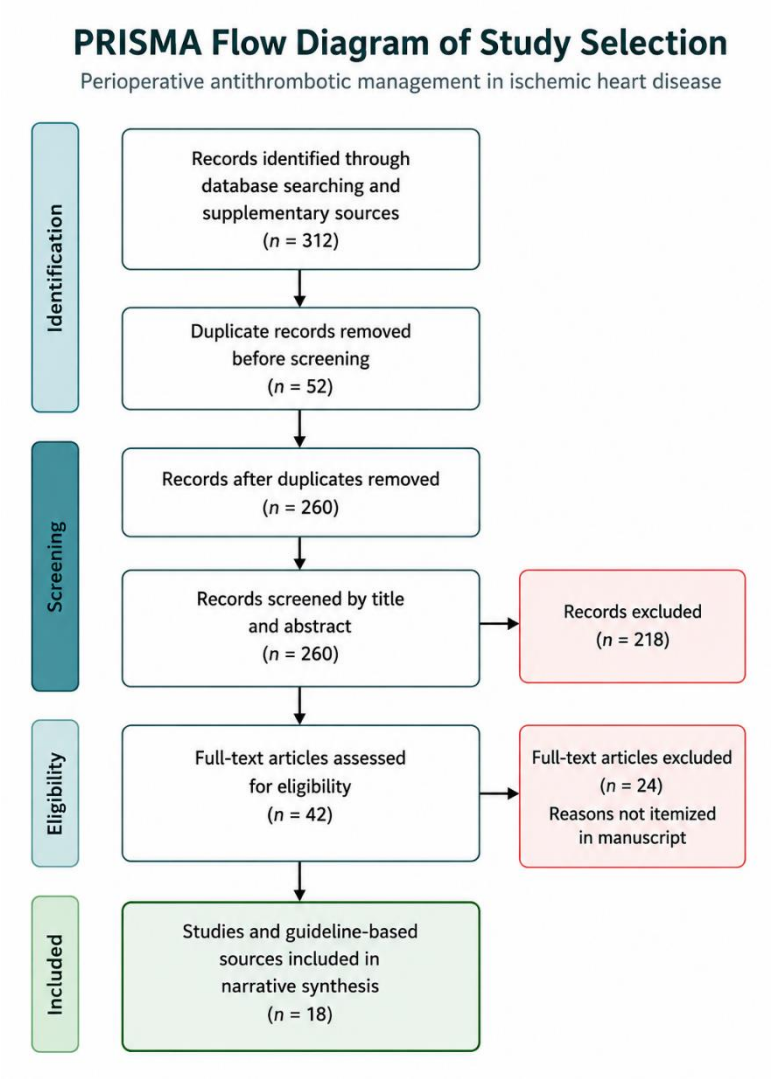

Figure 1 PRISMA Flowchart

Data extraction focused on bibliographic details, study design, population characteristics, cardiovascular indication, type of antithrombotic therapy, perioperative strategy, timing of preoperative discontinuation, timing of postoperative resumption, surgical context, bleeding risk category, thrombotic risk category, reported thromboembolic outcomes, bleeding outcomes, and main clinical recommendations. For guideline and consensus documents, extracted information included agent-specific interruption timelines, restart recommendations, bridging indications, and patient-risk categories. For clinical studies and meta-analyses, extracted information included event rates, comparative findings, and direction of effect for thromboembolic and bleeding outcomes where available.

Because the included evidence comprised heterogeneous study designs and guideline documents, findings were synthesized narratively rather than pooled statistically. The synthesis was organized around three clinically relevant perioperative strategies: continuation of antithrombotic therapy, interruption without bridging, and bridging with heparin-based regimens. Within each strategy, evidence was summarized according to thrombotic protection, bleeding risk, suitability for different risk groups, and practical timing of perioperative drug management. Particular attention was given to differences between antiplatelet agents, vitamin K antagonists, direct oral anticoagulants, and heparin-based bridging approaches. Where numerical outcome estimates were reported in the source literature, these were presented descriptively and interpreted in relation to the clinical population and surgical context from which they were derived.

Given the methodological diversity of the included evidence, formal quantitative meta-analysis was not performed. Heterogeneity was expected across study populations, indications for antithrombotic therapy, definitions of major bleeding, categories of surgical risk, and perioperative interruption protocols. Therefore, the synthesis emphasized consistency of direction across evidence sources rather than pooled effect estimation. The review also considered the directness of evidence for ischemic heart disease populations, recognizing that some perioperative anticoagulation data are derived from broader cardiovascular populations, including patients with atrial fibrillation, mechanical valves, or venous thromboembolism. No formal risk-of-bias or certainty-of-evidence grading was performed in the original review process; therefore, conclusions were framed cautiously and interpreted according to the strength, consistency, and clinical applicability of the available evidence.

RESULTS

The database and supplementary search identified 312 records relevant to perioperative antithrombotic management in patients with ischemic heart disease or clinically relevant cardiovascular comorbidity undergoing surgery. After removal of duplicates, 260 records were screened by title and abstract, of which 42 articles were reviewed in full text. Eighteen studies and guideline-based sources met the eligibility criteria and were included in the final narrative synthesis. The included evidence comprised clinical guidelines, systematic reviews, meta-analyses, randomized trial evidence, and perioperative review articles addressing antiplatelet continuation, oral anticoagulant interruption, direct oral anticoagulant protocols, and bridging with heparin-based regimens. Because the included sources differed substantially in design, population, surgical setting, antithrombotic indication, outcome definition, and analytic method, findings were synthesized narratively rather than pooled statistically.

Table 1. PRISMA Flow Summary of Study Selection

Selection Stage	Number of Records
Records identified	312
Records after duplicate removal	260
Records screened	260
Full-text articles assessed	42
Studies/sources included in synthesis	18

The final evidence base was heterogeneous but clinically complementary. Several sources addressed broad perioperative antithrombotic management, while others focused more specifically on antiplatelet therapy, bridging anticoagulation, direct oral anticoagulants, or cardiac-risk patients undergoing non-cardiac or cardiac surgery. The evidence was organized into three clinically relevant perioperative strategies: continuation of antithrombotic therapy, temporary interruption without bridging, and bridging with heparin-based agents. The available evidence most consistently supported structured interruption without bridging for most patients receiving direct oral anticoagulants and low-to-moderate thrombotic-risk vitamin K antagonist therapy, selective continuation of aspirin in patients with high cardiac risk, and avoidance of routine bridging except in narrowly defined very high-risk thrombotic populations.

Table 2. Evidence Profile of Included Sources

Evidence Category	Main Focus	Contribution to Synthesis	Key Limitation for This Review
Clinical guidelines and consensus documents	Perioperative timing of antiplatelet and anticoagulant interruption, restart, and bridging indications	Provided agent-specific timing recommendations and risk-stratified clinical decision frameworks	Recommendations may apply to broader cardiovascular populations, not exclusively ischemic heart disease
Systematic reviews and meta-analyses	Comparative safety of bridging, interruption, and antiplatelet management	Supported synthesis of bleeding and thromboembolic risks across strategies	Event definitions and included populations varied across reviews
Randomized trial evidence	Bridging versus no bridging and structured DOAC interruption strategies	Provided higher-quality evidence supporting no-bridge approaches in appropriate patients	Some trial populations were broader than ischemic heart disease alone
Narrative and perioperative review articles	Mechanisms, clinical interpretation, and perioperative decision-making	Helped contextualize thrombotic and bleeding risks by agent and surgical category	Lower evidentiary strength than randomized trials and systematic reviews

The most consistent finding across the included evidence was that routine bridging anticoagulation was associated with increased bleeding risk without a clear reduction in thromboembolic events for most patients. In contrast, temporary interruption without bridging, particularly for direct oral anticoagulants, showed the most favorable descriptive balance between thromboembolic and bleeding outcomes. Aspirin continuation showed potential cardioprotective benefit in high-risk ischemic heart disease patients, especially those with recent coronary stenting or recent acute coronary syndrome, but this was accompanied by increased bleeding risk. Therefore, aspirin continuation was best supported for patients in whom the thrombotic risk of discontinuation outweighed the surgical bleeding risk.

Table 3. Clinical Outcomes of Perioperative Antithrombotic Strategies

Strategy	Thromboembolic Events	Major Bleeding	Reported Comparative Effect	Interpretation
Aspirin continuation	4.2%	7.8%	Approximately 28% reduction in perioperative myocardial infarction risk compared with discontinuation	Potentially cardioprotective in high-risk ischemic heart disease, but increases bleeding risk
Aspirin discontinuation	6.5%	5.1%	Approximately 32% increase in myocardial infarction risk compared with continuation	Lower bleeding risk but higher thrombotic concern in high-risk cardiac patients
Interruption without bridging, especially DOAC-based protocols	2.8%	6.2%	Lowest combined descriptive risk across reported strategies	Preferred approach for most DOAC-treated and moderate-risk patients when timing is individualized
Bridging anticoagulation	3.9%	12.4%	Approximately 50–70% increase in major bleeding without clear thromboembolic reduction	Net clinical harm in most patients; reserved for selected very high-risk thrombotic indications

The outcome data in Table 3 should be interpreted as descriptive aggregated estimates reported in the included evidence rather than pooled estimates generated by a de novo meta-analysis. The direction of evidence was nevertheless consistent: bridging produced the highest bleeding burden, while structured interruption without bridging produced the most favorable overall balance. Aspirin continuation reduced ischemic risk in selected high-cardiac-risk patients but increased bleeding complications, indicating that aspirin decisions should be guided by cardiac risk, surgical site, and bleeding consequences rather than applied uniformly.

Table 4. Direct Comparison of the Three Main Perioperative Strategies

Comparison Factor	Continuation of Antithrombotic Therapy	Interruption Without Bridging	Bridging With Heparin-Based Regimens
Best suited patient group	High thrombotic risk, especially recent coronary stent, recent acute coronary syndrome, or very high cardiac risk	Most DOAC-treated patients and low-to-moderate thrombotic-risk VKA-treated patients	Very high thrombotic risk only, such as selected mechanical valve patients or very recent venous thromboembolism
Main pharmacological rationale	Maintains antithrombotic protection during surgical stress	Allows drug clearance before surgery while avoiding overlapping anticoagulant exposure	Substitutes oral anticoagulation with short-acting parenteral anticoagulation
Thromboembolic event rate	4.2%	2.8%	3.9%
Major bleeding rate	7.8%	6.2%	12.4%
Management complexity	Low to moderate	Moderate; requires correct timing by agent, renal function, and bleeding risk	High; requires dosing, monitoring, interruption, and restart coordination
Evidence direction	Beneficial in selected high cardiac-risk patients, especially aspirin continuation	Most favorable overall risk–benefit profile for many patients	Generally unfavorable due to excess bleeding
Guideline-aligned role	Selective use after individualized bleeding-risk assessment	Preferred for most DOAC-treated patients and many moderate-risk patients	Discouraged routinely; limited to narrowly defined high-risk indications

Continuation of antithrombotic therapy was most relevant for patients in whom interruption would expose the patient to clinically serious ischemic complications. Low-dose aspirin was the principal agent considered for perioperative continuation. The evidence suggested that aspirin continuation may reduce perioperative myocardial infarction risk among high-risk ischemic heart disease patients, particularly those with recent coronary stents or recent acute coronary syndrome. However, this benefit was offset by a higher rate of major bleeding compared with aspirin discontinuation. Continuation was therefore most appropriate for low-to-moderate bleeding-risk procedures or for cases in which the cardiac consequences of withdrawal were judged to be more serious than the expected bleeding risk. For high-anatomical-risk procedures, such as intracranial, spinal, posterior eye, or other closed-space operations, interruption may still be appropriate after shared surgical, anesthesia, and cardiology assessment.

Table 5. Antiplatelet Agents: Perioperative Dosing and Timing

Drug	Class	Preoperative Management	Intraoperative Use	Postoperative Management	Practical Notes
Aspirin	Antiplatelet, COX-1 inhibitor	Continue 75–100 mg/day in high cardiac-risk patients; stop 7–10 days before surgery when bleeding risk is high	Not routinely administered intraoperatively	Continue or restart within 24–48 hours once hemostasis is secure	Most suitable for continuation in high cardiac-risk and low-to-moderate bleeding-risk procedures
Clopidogrel	P2Y12 inhibitor	Stop 5–7 days before surgery	Not used intraoperatively	Restart 24–48 hours postoperatively when hemostasis is secure	Longer interruption may be required for high bleeding-risk procedures
Ticagrelor	P2Y12 inhibitor	Stop 3–5 days before surgery	Not used intraoperatively	Restart approximately 24–48 hours postoperatively when bleeding risk is controlled	Faster offset than clopidogrel
Prasugrel	P2Y12 inhibitor	Stop 7–10 days before surgery	Not used intraoperatively	Restart when surgical hemostasis is secure	Highest bleeding concern among commonly used P2Y12 inhibitors

Interruption without bridging was the most consistently favored strategy for patients receiving direct oral anticoagulants and for many patients receiving vitamin K antagonists who were not in the highest thrombotic-risk categories. The rationale for this strategy is pharmacological as well as clinical: anticoagulant effect is allowed to decline before surgery, while the bleeding risk associated with overlapping heparin exposure is avoided. This approach was particularly suitable for DOACs because their predictable offset permits planned discontinuation according to renal function, drug half-life, and surgical bleeding risk. In the descriptive outcome data, interruption without bridging had the lowest thromboembolic event rate and a lower major bleeding rate than bridging, supporting its role as the preferred strategy for many perioperative patients.

Table 6. Vitamin K Antagonists: Perioperative Management

Drug	Class	Preoperative Management	Intraoperative Consideration	Postoperative Restart	Target INR / Monitoring
Warfarin	Vitamin K antagonist	Stop approximately 5 days before surgery; confirm INR is acceptable before procedure	Reversal may be required for urgent surgery	Restart evening of surgery or next day when hemostasis is secure	Standard INR 2.0–3.0; higher targets may apply for selected mechanical valves
Acenocoumarol	Vitamin K antagonist	Stop approximately 3–4 days before surgery due to shorter half-life	Manage similarly to warfarin protocols	Restart 12–24 hours postoperatively when hemostasis is secure	INR monitoring required
Phenprocoumon	Vitamin K antagonist	Stop approximately 5–7 days before surgery due to longer half-life	Vitamin K may be required for urgent reversal	Restart 24–48 hours postoperatively with close INR monitoring	INR monitoring mandatory

Table 7. Direct Oral Anticoagulants: Perioperative Interruption and Restart

Drug	Class	Preoperative Stop: Lower Bleeding Risk	Preoperative Stop: Higher Bleeding Risk	Postoperative Restart	Renal / Clinical Considerations
Apixaban	Factor Xa inhibitor	Approximately 48 hours	Approximately 72 hours	24–48 hours postoperatively when hemostasis is secure	Longer interruption may be needed with impaired renal function or high bleeding risk
Rivaroxaban	Factor Xa inhibitor	24–48 hours	Approximately 48 hours	Approximately 24–48 hours postoperatively	Avoid or adjust according to renal function and indication
Dabigatran	Direct thrombin inhibitor	24–48 hours with normal renal function	72–96 hours when renal function is reduced or bleeding risk is high	24–72 hours postoperatively depending on bleeding risk	Most renal-dependent DOAC; timing should be adjusted by creatinine clearance
Edoxaban	Factor Xa inhibitor	24–48 hours	Approximately 48 hours	Approximately 24–48 hours postoperatively	Dose and restart timing should consider renal function and body weight

Bridging with heparin-based regimens produced the least favorable safety profile in the reviewed evidence. Although bridging was historically used to reduce thromboembolic risk during interruption of oral anticoagulation, the included evidence indicated that it did not clearly reduce thromboembolic outcomes compared with no bridging, while it substantially increased major bleeding. The descriptive major bleeding rate was highest with bridging, reaching 12.4%, compared with 6.2% for interruption without bridging. As a result, bridging should not be used routinely in ischemic heart disease patients and should be restricted to narrowly defined very high-risk thrombotic indications, such as selected mechanical valve patients or patients with very recent venous thromboembolism, when the thrombotic risk of interruption clearly exceeds the bleeding risk.

Table 8. Heparin-Based Bridging Agents: Perioperative Dosing and Monitoring

Drug	Class	Preoperative Use	Intraoperative Use	Postoperative Use	Monitoring Considerations
Unfractionated heparin	Indirect thrombin inhibitor	Intravenous infusion may be used in selected very high-risk patients; stop 4–6 hours preoperatively	Used in selected cardiac surgery settings	Restart 6–24 hours postoperatively only after hemostasis is secure	aPTT monitoring and platelet count surveillance for heparin-induced thrombocytopenia
Enoxaparin	Low-molecular-weight heparin	Therapeutic bridging may use 1 mg/kg every 12 hours or 1.5 mg/kg once daily; last dose usually 24 hours before surgery	Not routinely used intraoperatively	Restart 24–72 hours postoperatively depending on bleeding risk	Consider anti-Xa monitoring in renal impairment, obesity, or high-risk cases
Dalteparin	Low-molecular-weight heparin	Therapeutic regimens may include 200 IU/kg once daily or 100 IU/kg every 12 hours; last dose usually 24 hours preoperatively	Not routinely used intraoperatively	Prophylactic or therapeutic restart after hemostasis is secure	Anti-Xa monitoring may be needed in renal impairment or extremes of body weight
Fondaparinux	Factor Xa inhibitor	Stop approximately 36–48 hours before surgery	Not used intraoperatively	Restart 48–72 hours postoperatively when bleeding risk is controlled	Avoid in severe renal impairment; anti-Xa monitoring may be considered in selected cases

Surgical bleeding risk modified the interpretation of all antithrombotic strategies. Minor procedures and many low-to-moderate bleeding-risk operations were more compatible with aspirin continuation when cardiac risk was high. In contrast, operations involving high bleeding consequences required more conservative interruption strategies. Cardiac, orthopedic, and abdominal operations differed in expected bleeding rates and thrombotic consequences, reinforcing that perioperative antithrombotic management should be individualized rather than standardized across all procedures.

Table 9. Surgical Risk Stratification and Strategy Selection

Surgery Type	Approximate Bleeding Risk	Thrombotic Risk if Therapy Is Stopped	Preferred Strategy
Cardiac surgery	10–15%	Up to 12% myocardial infarction or stent thrombosis in high-risk groups	Individualized continuation or interruption based on procedure and indication
Orthopedic surgery	5–8%	4–7%	Selective interruption with restart after hemostasis
Abdominal surgery	6–10%	5–9%	Structured interruption, especially for DOAC-treated patients
Minor surgery	Less than 3%	Low in most patients, but higher in recent stent or ACS patients	Continue aspirin in high cardiac-risk patients

Overall, the synthesis indicates a shift from uniform perioperative discontinuation or empiric bridging toward individualized, agent-specific, and risk-stratified management. For patients at high risk of coronary events, particularly those with recent stent placement or recent acute coronary syndrome, continuation of low-dose aspirin may provide meaningful protection against perioperative myocardial infarction, provided the surgical bleeding risk is acceptable. For most patients receiving direct oral anticoagulants, temporary interruption without bridging provides the most favorable balance between bleeding avoidance and thrombotic safety because the pharmacokinetic properties of these agents allow predictable preoperative offset and postoperative resumption. For warfarin-treated patients, interruption without bridging is appropriate for many low-to-moderate thrombotic-risk cases, while bridging should be reserved for the small subset of patients in whom thrombotic risk is exceptionally high.

The findings also show that perioperative decision-making cannot rely on drug class alone. Appropriate management requires simultaneous assessment of cardiovascular indication, time since coronary intervention, renal function, planned surgical bleeding risk, feasibility of local hemostasis, anesthesia approach, and postoperative ability to resume therapy. The clearest safety signal across the included evidence was excess bleeding with routine heparin bridging, while the clearest practical advance was the adoption of structured interruption protocols for direct oral anticoagulants. These findings support a perioperative framework in which aspirin is selectively continued for high-cardiac-risk patients, DOACs are interrupted according to renal function and surgical bleeding risk, VKAs are interrupted with INR confirmation when appropriate, and bridging is avoided except in narrowly defined very high-risk thrombotic scenarios.

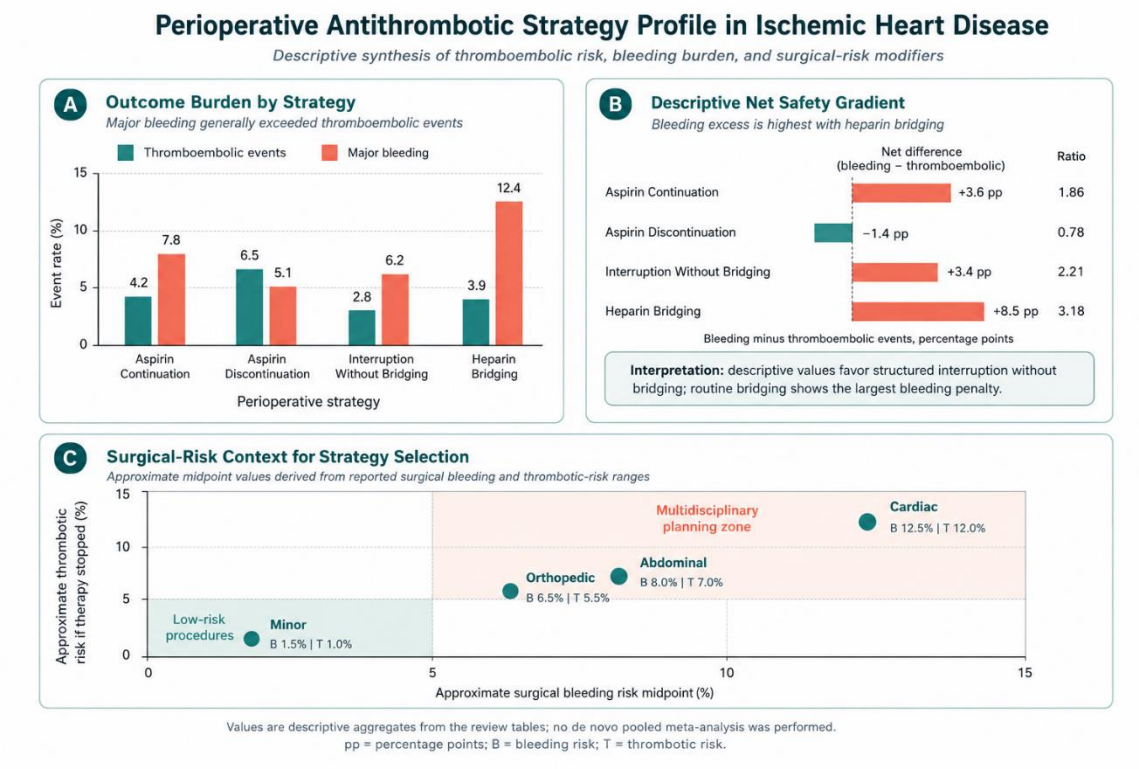

Figure 1. Perioperative Antithrombotic Strategy Profile in Ischemic Heart Disease. Panel A compares descriptive thromboembolic and major bleeding event rates across aspirin continuation, aspirin discontinuation, interruption without bridging, and heparin bridging. Panel B presents the descriptive net safety gradient as the difference between major bleeding and thromboembolic events, showing the largest bleeding excess with heparin bridging. Panel C maps surgical bleeding-risk and thrombotic-risk midpoints derived from the review's reported surgical-risk ranges, emphasizing that cardiac surgery occupies the highest combined-risk zone and requires multidisciplinary perioperative planning. Values are descriptive aggregates from the review tables and should not be interpreted as pooled meta-analytic estimates.

DISCUSSION

This systematic review synthesized evidence on perioperative antithrombotic management in patients with ischemic heart disease or clinically relevant cardiovascular comorbidity undergoing surgery, with specific emphasis on three practical strategies: continuation of antithrombotic therapy, temporary interruption without bridging, and bridging with heparin-based regimens. The principal finding is that perioperative management should not follow a uniform stop-or-bridge approach. Instead, available evidence supports individualized decision-making based on thrombotic risk, surgical bleeding risk, antithrombotic agent, renal function, time since coronary intervention, and feasibility of postoperative hemostasis. Across the included evidence, structured interruption without bridging showed the most favorable descriptive balance between thromboembolic and bleeding outcomes, particularly for direct oral anticoagulants, whereas routine heparin bridging was associated with the highest bleeding burden without clear evidence of proportional thromboembolic benefit (2,7,8).

The findings are consistent with contemporary guideline recommendations that have moved away from routine bridging in most anticoagulated patients. Earlier perioperative practice often assumed that temporary substitution of warfarin or other oral anticoagulants with low-molecular-weight heparin or unfractionated heparin would protect patients during the interruption window. However, randomized and guideline-based evidence has increasingly shown that this approach may expose many patients to avoidable bleeding harm. In the present synthesis, bridging was associated with the highest descriptive major bleeding rate, while thromboembolic event rates were not meaningfully lower than with interruption without bridging. This supports the current interpretation that bridging should be reserved for narrowly defined very high-risk indications, such as selected mechanical valve patients or recent

venous thromboembolism, rather than applied broadly to patients with ischemic heart disease alone (2,7).

Direct oral anticoagulants have changed the perioperative management landscape because their relatively predictable onset and offset allow planned interruption according to renal function and procedural bleeding risk. In the included evidence, interruption without bridging showed the lowest descriptive thromboembolic event rate and a lower major bleeding rate than heparin bridging. This does not mean that interruption without bridging is universally risk-free, but it indicates that pharmacology-driven interruption is generally safer than adding overlapping parenteral anticoagulation in most non–very-high-risk settings. Dabigatran requires particular attention because renal clearance strongly influences interruption timing, whereas factor Xa inhibitors such as apixaban, rivaroxaban, and edoxaban are typically managed according to bleeding risk, renal function, and timing of postoperative hemostasis (8,14,15).

The role of aspirin remains more nuanced. The synthesis suggests that continuation of low-dose aspirin may reduce perioperative myocardial infarction risk in selected high-cardiac-risk patients, especially those with recent coronary stenting or recent acute coronary syndrome. However, this benefit is accompanied by an increased risk of surgical bleeding. Therefore, aspirin continuation should not be framed as universally beneficial or universally harmful. Rather, it is most defensible when the expected consequence of coronary thrombosis is greater than the expected consequence of bleeding, particularly in low-to-moderate bleeding-risk surgery. In high-anatomical-risk procedures, including intracranial, spinal, posterior eye, or other closed-space operations, the threshold for discontinuation may be lower because even modest bleeding can produce serious clinical harm (5,6,13).

A clinically important implication of this review is that ischemic heart disease should not be treated as a single homogeneous perioperative risk category. Patients with stable coronary artery disease, remote myocardial infarction, recent acute coronary syndrome, recent percutaneous coronary intervention, or ongoing dual antiplatelet therapy have different thrombotic profiles. Similarly, the bleeding consequences of a minor dermatological procedure differ substantially from those of cardiac, orthopedic, abdominal, spinal, or neurosurgical operations. The panelled figure generated from the review's aggregated data demonstrates this clinically relevant gradient: minor procedures cluster in the low-risk zone, while cardiac surgery occupies the highest combined bleeding and thrombotic-risk space. This visual pattern reinforces the need for multidisciplinary planning in high-risk surgical contexts and supports a tailored approach involving surgeons, anesthesiologists, cardiologists, and perioperative physicians.

The present synthesis also advances interpretation by separating antithrombotic strategy from drug class. Continuation is most relevant to aspirin and occasionally selected antiplatelet therapy in patients with high coronary risk. Interruption without bridging is most relevant to DOACs and many VKA-treated patients with low-to-moderate thrombotic risk. Bridging is not a routine alternative to interruption but a selective strategy for a much smaller subgroup with very high thrombotic risk. This distinction is important because perioperative decisions are often simplified into whether treatment should be "stopped" or "continued," whereas the safer clinical question is whether the patient's thrombotic indication justifies ongoing antithrombotic exposure despite the surgical bleeding risk.

The findings should be interpreted in light of several limitations specific to this review. First, although the review followed a structured systematic approach, the available manuscript does not report a prospectively registered protocol, which limits transparency regarding prespecified eligibility criteria and synthesis decisions. Second, a formal risk-of-bias or certainty-of-evidence assessment was not performed in the original review process, limiting the ability to grade the strength of recommendations across strategies. Third, the included evidence was methodologically heterogeneous and included randomized trials, systematic reviews, meta-analyses, guidelines, and narrative perioperative sources. Fourth, some evidence informing perioperative anticoagulation strategies comes from broader

cardiovascular populations, such as atrial fibrillation, venous thromboembolism, or mechanical valve cohorts, and may not be directly generalizable to all ischemic heart disease patients. Fifth, the event rates reported in this review are descriptive aggregate values from included evidence rather than pooled estimates generated through de novo meta-analysis; they should therefore be interpreted as clinically informative summaries rather than definitive comparative effect estimates.

Future research should focus on prospective, procedure-specific studies that directly evaluate ischemic heart disease patients according to coronary risk profile, antithrombotic indication, renal function, and surgical bleeding category. Standardized definitions of major bleeding, clinically relevant non-major bleeding, perioperative myocardial infarction, stent thrombosis, and thromboembolism are needed to improve comparability across studies. Future systematic reviews should prospectively register protocols, use formal risk-of-bias tools such as RoB 2 for randomized trials and AMSTAR-2 for included reviews, and apply GRADE or an equivalent framework to rate certainty of evidence. Where sufficient homogeneous data exist, meta-analysis should be performed using prespecified effect measures, heterogeneity statistics, and sensitivity analyses. Until such evidence is available, perioperative antithrombotic management in ischemic heart disease should remain individualized, multidisciplinary, and grounded in the balance between preventable coronary events and avoidable bleeding harm.

CONCLUSION

Perioperative antithrombotic management in patients with ischemic heart disease undergoing surgery requires individualized, risk-stratified decision-making rather than routine discontinuation or routine bridging. The available evidence supports structured interruption without bridging for most patients receiving direct oral anticoagulants and for many low-to-moderate-risk patients receiving vitamin K antagonists, while selective continuation of low-dose aspirin may be appropriate in patients with high cardiac risk when surgical bleeding risk is acceptable. Routine heparin bridging appears unfavorable for most ischemic heart disease patients because it increases bleeding burden without clear thromboembolic benefit, and should be reserved only for narrowly defined very high-risk thrombotic indications. Future research should develop standardized perioperative risk models that integrate cardiovascular indication, surgical bleeding risk, renal function, antithrombotic agent, and postoperative restart timing to support safer and more consistent perioperative decision-making.

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