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REVIEW ARTICLE

The safe and risk assessment of perioperative antiplatelet and anticoagulation therapy in inguinal hernia repair, a systematic review

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Abstract

Background There is a lack of consensus on the continuation or cessation of perioperative antiplatelet and anticoagulation therapies in inguinal hernia repair, therefore, the local hospital protocols dealing with these agents vary. The aim of this study is to investigate the risk and safety of perioperative antiplatelet and anticoagulation therapies in patients undergoing elective inguinal hernia repair.

Methods The major databases (PubMed, Embase, Springer, and Cochrane Library) were searched, and all studies published through January 2019 were identified, using the keywords *Aspirin*, *Clopidogrel*, *Warfarin, antiplatelet, anticoagulation, inguinal hernia repair, bleeding, hematoma, complications*. All relevant articles and reference lists in these original studies were also obtained from the above databases.

Results Thirteen articles were identified, ten studies reported the results of perioperative application of antiplatelet therapy during inguinal hernia repair, nine trials reported the outcomes perioperative use of anticoagulation therapy in inguinal hernia repair, and six articles reported the results of both agents. One study did not indicate the perioperative cessation or continuation of the corresponding agents. Cessation of antiplatelets was reported in three studies and continuation of antiplatelets was used in six studies, they all demonstrated similar incidence of the bleeding complications, as compared with controls. Continued perioperative anticoagulation with Warfarin was reported in six studies and Warfarin discontinuation 3 days prior to operation was examined in two studies, both reported similar postoperative bleeding-related complication rates providing international normalized ratio (INR) < 3, and the postoperative hematoma incidence increased in the condition of INR > 3.

Conclusion Our results indicated that, for both open and laparoscopic inguinal hernia repair, there is no need to stop the antiplatelet therapy (Aspirin or Clopidogrel), and due to the limited evidence and the complexity of each patient' condition, the continuation or cessation of anticoagulation with Warfarin should be tailored on a case-by-case basis.

Keywords Antiplatelet · Anticoagulation · Inguinal hernia repair · Bleeding · Aspirin · Warfarin

Inguinal hernia repair is one of the most commonly performed operations worldwide. With the progressively aging population, candidates for inguinal hernia repair are often elderly and have comorbidities. It has been reported that within a year of undergoing percutaneous coronary stent placement, 5% patients will require noncardiac surgery [1–3]. Therefore, it is not uncommon for the inguinal hernia patients to be on antiplatelets or anticoagulation therapy [4–8]. Hemorrhage and thromboembolic events are two of the major complications in the perioperative period of surgical interventions. The main concern with perioperative antiplatelets or anticoagulation therapy, during and after surgical procedure, is the increased risk of bleeding complications, therefore, careful perioperative assessment with regard the use of such therapeutics is needed [9].

The current guidelines by advisory bodies such as the Institute for Clinical Systems Improvement and the

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European Society of Cardiology (ESC) recommend cessation of antiplatelet (Clopidogrel) 7–10 days prior to any noncardiac surgical procedure for a patient who is not at high risk for cardiac events [10, 11]. However, several studies revealed that cessation of the common used antiplatelet agents was a leading cause of major adverse cardiac events in the setting of noncardiac surgery [12–16]. Similarly, stopping of anticoagulation therapy (Warfarin) in patients with deep vein thrombosis (DVT) or pulmonary embolism (PE) is also associated with an annual risk of recurrence of about 5%, and this risk could be even as high as 40% within the first month following DVT or PE [17]. These findings could be explained by the rebound phenomenon [18, 19], furthermore, surgery itself also creates a prothrombotic state [12, 13].

To date, there is no consensus or guidelines regarding the risk and safety associated with inguinal hernia surgery in patients with the chronic use of anticoagulants and platelet aggregation inhibitors. In literature, there is a wide variation in the management of antiplatelets and anticoagulants application in patients undergoing inguinal hernia repair [3–8]. Given the increasing prevalence of the use of these agents, and its potential impact on bleeding and thrombotic risk, and the lack of generalized consensus on this topic, it is imperative to address this issue. In the present study, we aim to investigate the safety and risk profile of perioperative antiplatelet and anticoagulation therapies in patients undergoing elective inguinal hernia repair, and make recommendations on the management of perioperative usage of the antiplatelet and anticoagulation agents for inguinal hernia patients.

Methods

Major databases (PubMed, Embase, Springer, and Cochrane Library) were searched, and all studies published through January 2019, using the keywords Aspirin, Clopidogrel, Warfarin, antiplatelet, anticoagulation, inguinal hernia repair, bleeding, hematoma, complications, including various combinations of the terms. Abstracts were reviewed to confirm relevance, and then the full articles were extracted. All relevant articles and reference lists in these original studies were also obtained from the above databases. Studies were grouped according to the subtypes of antiplatelets and anticoagulation, and outcomes were also analyzed separately. IRB approval and written consents are not needed for this type of study.

Inclusion criteria

All studies summarized in the present review were published as full-length articles in peer-reviewed journals. Studies include prospective and retrospective comparative studies as well as randomized or nonrandomized trials involving at least one of the agents (Aspirin, Clopidogrel, or Warfarin) regarding or containing inguinal hernia repair (open or laparoscopic procedures).

Exclusion criteria

The search results were carefully assessed to exclude studies involving onlay ventral or incisional hernia repair procedures. Simple case reports, reviews, and articles not available in the English language were also excluded. Studies that reported results of only heparin medication were also excluded.

Results

Thirteen articles [3–9, 20–25] on the effects of perioperative antiplatelet or anticoagulation therapy during inguinal hernia repair were retrieved from the electronic databases for the final review and analysis. Figure 1 shows a flowchart of studies from the initial results of the publication searches to final inclusion or exclusion. The details of the 13 articles are presented in Table 1. As shown in Table 1, the included trials contained nine retrospective studies, two randomized controlled trails (RCTs), one prospective study, and one hernia registry studies. Ten studies reported the results of perioperative application of antiplatelet therapy during inguinal hernia repair, nine trials reported the outcomes perioperative use of anticoagulation therapy in both open and laparoscopic inguinal hernia repairs, and with six articles reported the outcomes of both agents. Since the mechanism of antiplatelet therapy is different from anticoagulation, the effects of the two different therapies on inguinal hernia repair were evaluated separately.

Antiplatelets

Ten studies reported the results of perioperative use of antiplatelet therapy during inguinal hernia repair [3–6, 8, 9, 20, 21, 24, 25] (Table 1). Two of the nine studies used Clopidogrel [3, 4], four studies involved the use of Aspirin [5, 6, 20, 21], one study used two different types of antiplatelets [25], and the antiplatelets were not indicated in three studies [8, 9, 24]. Seven of the nine studies reported the outcomes in both open and laparoscopic inguinal hernia repair procedures [3–6, 9, 20, 21], and three trials reported the results in laparoscopic inguinal hernia approaches [8, 24, 25]. Three studies reported the comparative results of antiplatelets cessation by at least 7 days [4, 8, 24], and that of less than 7 days, while perioperative continuation of antiplatelets was

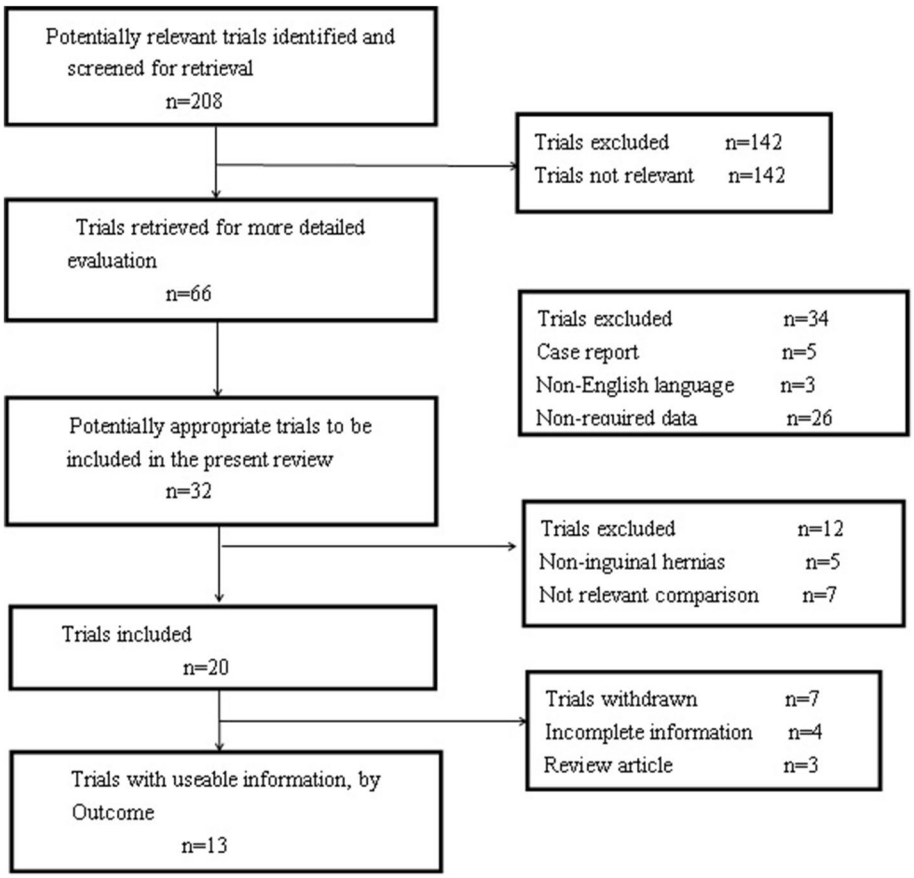

Fig. 1 A flow diagram of trials selection

maintained through the surgeries in the other six studies [3, 5, 6, 20, 21, 25] (Tables 1, 2).

Although one study reported fourfold higher risk for onset of postoperative secondary bleeding in patients with coagulopathy or antithrombotic therapy; however, the analysis of the results was not specific to antiplatelets [9]. The other eight of the nine studies clearly showed that the intraoperative and postoperative bleeding-related complications were not significant different in the antiplatelet therapy group and control group. These results clearly indicated that the perioperative continuation of antiplatelet therapy (Aspirin or Clopidogrel) was safe for both open and laparoscopic inguinal hernia repair. The summarized results and recommendation are presented in Table 2.

Anticoagulant (Warfarin)

Nine studies reported the results perioperative use of Warfarin in both open and laparoscopic inguinal hernia repairs [7–9, 20–25].

Warfarin continuation versus discontinuation

Warfarin was not stopped perioperatively in six studies [7, 20–23, 25], among the six studies, one study compared postoperative incidence of hematoma based on international normalized ratio (INR) levels: INR < 2, INR $= 2$–3, INR > 3, and they found that there were no statistically different postoperative complication rates, partially for hematoma when comparing patients by INR [23]. The INR was not reported in three studies, two of the three studies indicated that continuation of Warfarin was the independent risk factor for the development of groin hematoma after inguinal hernia repair [20, 21], the third one reported on difference in postoperative complications [25]. Another two studies with no cessation of Warfarin revealed that patients can safely undergo inguinal hernia repair while on Warfarin as long as the INR is < 3, of note, an INR of > 3 significantly increased the risk of postoperative hematoma [7, 22].

Warfarin discontinuation 3 days versus control

Warfarin cessation 3 days prior to TEP procedures was reported in two studies, and the intraoperative bleeding and postoperative complications were not significant different between these patients and a control group, although

Table 1 Outcomes of inguinal hernia repair patients receiving perioperative antiplatelet and anticoagulation therapy

No.	Year/author	Study type	Patient group	Antiplatelet or anticoagulation regime	Hernia repair method	Measure endpoints	Results	Conclusion
1	Chu et al. (2011), Hernia [4]	Retrospective study	46 Inguinal hernia patients. 20 in group A, 26 in group B	Group A: last administered dose of clopidogrel; < 7 days Group B: last administered dose of clopidogrel ≥ 7 days	Open procedures and laparoscopic procedures	ASA status, operative time, blood loss, transfusion requirement, intraoperative complications Length of hospital stay, the development of complications requiring blood transfusions, reoperations, intensive care unit (ICU) stay, 30-day readmission, and mortality	No intraoperative bleeding complications occurred in any of the patients No significant difference in the length of stay or admission rate secondary to bleeding complications was seen	Clopidogrel use within 7 days of inguinal herniorrhaphy did not increase the risk for perioperative bleeding complications. No mortalities, readmissions, or ICU requirements occurred, regardless of the timing of clopidogrel cessation
2	2012 Antolovic et al. (2012) Langenbecks Arch Surg [5]	RCT	23 Inguinal hernia repair among the 52 general surgery cases. 12 in ASA continuation group, and 11 in ASA discontinuation group	Group one: ASA continuation Group two: ASA discontinuation for 5 days before until 5 days after surgery	Open procedure (Lichtenstein, Shouldice) and laparoscopic procedures	The primary endpoints were the incidence of perioperative bleeding episodes and clinically apparent thromboembolic events within 30 days after surgery Secondary endpoints were the duration of the surgical intervention, intraoperative blood loss, transfusion requirements, length of postoperative hospital stay, medical and surgical morbidity and the necessity of readmission	No TE events or mortality in either group No statistically significant difference in secondary endpoints between groups	Perioperative intake of ASA does not seem to influence inguinal hernia surgery

Table 1 (continued)

No.	Year/author	Study type	Patient group	Antiplatelet or anti-coagulation regime	Hernia repair method	Measure endpoints	Results	Conclusion
3	2016 Chu et al.(2016) Am J Surg [3]	RCT	15 Inguinal hernia patients among the 43 general surgery cases	Group A Clopidogrel discontinuation 1 week before surgery. Group B: Clopidogrel continuation	Open and laparo-scopic procedures	The primary endpoints were perioperative bleeding requiring intraoperative or postoperative trans-fusion of blood or blood components, and bleeding-related readmis-sion, re-operation, or mortality within 90 days of surgery The secondary endpoints were perioperative myo-cardial infarction or cerebrovascular accidents (CVA) within 90 days of surgery	No perioperative mortalities, bleed-ing events requir-ing blood transfu-sion, re-operation in either group. No myocardial infarc-tions or CVAs (cerebrovascular accidents)observed. Especially no bleeding-related complications in hernia patients was noted	Continuation of clopi-dogrel in inguinal hernia repair does not increase the risk of bleeding compli-cations

Table 1 (continued)

No.	Year/author	Study type	Patient group	Antiplatelet or anticoagulation regime	Hernia repair method	Measure endpoints	Results	Conclusion
4	Ong et al. (2016) Surg endo [6]	Retrospective study	142 Inguinal hernia patients	Group one: Continued aspirin through the morning of the operation, Group two: stop aspirin therapy 3–7 days before surgery	Lichtenstein and TEP	Primary endpoints were defined as 1. Bleeding complications (bruising, hematoma, blood loss during surgery) Secondary endpoints were as follows: 1. Duration of surgery 2. Length of hospital stay 3. Readmission to hospital after discharge 4. Complications (wound infection, seroma, mesh infection, hematoma, recurrence and chronic pain) 5. MACE (major adverse cardiac events)	There were no significant differences between those who stopped aspirin and those who continued in terms of intraoperative blood loss and operative timing. Immediate postoperative bleeding complications and follow-up wound complications were also similar between the two groups	Continuation of aspirin is safe and should be preferred in patients with higher cardiovascular risk
5	McLmore et al. (2006), Am J Surg [7]	Retrospective study	88 Inguinal hernia patients	19 in Continuation of warfarin (CW) 54 in discontinuation of warfarin (DW), 15 in bridging (DWB) Operative outcomes were further analyzed based on the serum INR level immediately before surgery (INR < 1.5, INR ≥ 1.5)	Open procedure	Length of operation, length of stay, and postoperative complications	No significant difference in postoperative complications. The incidence of surgical site hematoma was higher in the continued warfarin and discontinued warfarin with bridge groups (CW 11%, DW 2%, and DWB 13%; P .14)	Continuation of warfarin may be a safe alternative to discontinuation of warfarin therapy in select patients undergoing open inguinal herniorrhaphy, and INR < 3 should be reached

Table 1 (continued)

No.	Year/author	Study type	Patient group	Antiplatelet or anticoagulation regime	Hernia repair method	Measure endpoints	Results	Conclusion
6	Sanders et al. (2008) Hernia [22]	Retrospective, case note analysis	49 Inguinal hernia patients	40 Patients operated on while anticoagulation with warfarin with INR 2–3, and 9 patients with INR3–4 on the day preceding surgery	Not stated	Postoperative complications	Three (6.1%) patients developed hematomas requiring surgical management and there was one death of unrelated cause. An INR of > 3 increased the risk of postoperative hematoma ($p=0.03$)	Patients can safely undergo inguinal hernia repair while on Warfarin as long as the INR is < 3
7	Stucky et al. (2015) Hernia [23]	Retrospective, comparative	198 Inguinal hernia patients	40 Continued on warfarin CW), 118 discontinuation (DW): within 72 h of surgery, with or without bridging 40 in control group	Open (Lichtenstein)	Operative details and postoperative complications	No significant difference in postoperative complication rates, particularly for hematoma The rate of hematoma was slightly higher in the CW group compared to the DW group but this was not statistically significant (10% CW vs. 7.6% DW, $p=0.43$)	Maintenance of warfarin therapy during the perioperative period for open inguinal herniorrhaphy results in equivalent operative times and postoperative complications as discontinuation
8	Wakasug et al. (2013) Surg Today [8]	Retrospective study. (short communication)	77 Inguinal hernia patients. 22 in antithrombotic therapy group, among them, 4 received anticoagulation, 20 received antiplatelet therapy 55 In control group	Warfarin was stopped at least 3 days preoperatively and antiplatelet drugs were stopped at least 7 days preoperatively Bridging was in 9 case and 13 cases was not bridged	Single incision TEP	The mean operative time, intraoperative bleeding, postoperative complications, and length of hospital stay	The mean operative time, intraoperative bleeding, postoperative complications, and length of hospital stay did not differ significantly between these patients and a control group	Antithrombotic therapy discontinuation and bridging heparin therapy seem to be safe and feasible for TEP

Table 1 (continued)

No.	Year/author	Study type	Patient group	Antiplatelet or anticoagulation regime	Hernia repair method	Measure endpoints	Results	Conclusion
9	Wakasug (2017) Asian J Endosc Surg [24]	Not clear	365 Inguinal hernia patients,77 on. Antiplatelet, and 34 on anticoagulation 34, 24 on both therapy 273 in control group	Warfarin was stopped at least 3 days preoperatively, and antiplatelet drugs were stopped at least 7 days preoperatively 53 with no bridging, and 36 with bridging	Single incision TEP	Data on the patients' characteristics and perioperative outcomes were collected from their medical records	Bleeding volume was minimal in all patients. There was no significant difference in the conversion rate	SILS for totally extraperitoneal inguinal hernia repair with bridging heparin therapy can be performed safely for patients on antithrombotic therapy
10	Smoot et al. (2008) Hernia [20]	Retrospective case–control study	53 Postoperative inguinal hernia patients with hematoma, and 106 controls with no postoperative hematoma	The usage of Warfarin and Aspirin and other factors were analyzed	Open (including: Bassini, Lichtenstein, mesh plug, endoscopic, or McVay)	The incidence of hematoma	Only Warfarin usage was important in multivariate analysis, but not aspirin	The crucial risk factor for groin hematoma developing in patients undergoing inguinal hernia repair is preoperative need for Coumadin therapy
11	Zeb et al. (2016), JSR [21]	Case–control study	96 Inguinal patients with postoperative hematoma, 96 controls with no postoperative hematoma	The usage of Warfarin and aspirin and other factors were analyzed	Open (Bassini, Lichtenstein, Mesh Plug) and laparoscopic	The incidence of hematoma	Warfarin and recurrent hernia were independent predictors of hematoma development, but not aspirin	Independent risk factors for the development of groin hematoma after IHR included warfarin use and recurrent hernia
12	Kockerling et al. (2015) Surg endo [9]	Hernia registry study	9115 Cases of inguinal hernia patients	Coagulopathy including the presence of liver cirrhosis), currently receiving platelet aggregation inhibitor therapy or discontinuation <7 days prior to the operation or patients whose Quick or INR value was not within the normal range during the operation due to treatment with coumarin Bridging or not	Open & laparoscopic procedures	Postoperative secondary bleeding within 30 days of the operation	The rate of postoperative secondary bleeding, at 3.91%, was significantly higher in the risk group with coagulopathy or receiving antithrombotic therapy than in the group without that risk profile at 1.12% ($p<0.001$) INR was not reported in this study	Patients receiving antithrombotic therapy or with existing coagulopathy who undergo inguinal hernia operation have a fourfold higher risk for onset of postoperative secondary bleeding

Table 1 (continued)

No.	Year/author	Study type	Patient group	Antiplatelet or anti-coagulation regime	Hernia repair method	Measure endpoints	Results	Conclusion
13	Ho et al.(2018) [25]	Prospective study	17 Patients continued their antithrombotics (antithrombotic group) 98 had not been on antithrombotics (control group)	Antithrombotic group) had been treated with antiplatelets or anticoagulants, including aspirin in nine patients, clopidogrel in three, warfarin in two, and ticlopidine, dabigatran and dipyridamole in one, respectively. The other 98 patients were not taking any antithrombotic medications	Laparoscopic (TEP) procedure	Operative time, conversion to open surgery, and the intraoperative complications Post-operative complications, sero-hematoma formation, hospital stay, days of return to normal activity, hernia recurrence, major cardiovascular events	The operation time for the antithrombotic group was longer than that of the control group ($p=0.015$). No conversion to open surgery in either group. There was no difference in the postoperative complications and sero-hematoma formation	Laparoscopic TEP inguinal hernia repair can be safely performed in patients with the continuation of their antithrombotic agents in experienced hands

the INR level was not reported in these two trials [8, 24]. One study was the update study of the other, the results were consistent.

Taken together, theses results supported the conclusion that maintenance of Warfarin therapy for inguinal hernia results in equivalent intraoperative bleeding and postoperative complications as discontinuation provided that INR is <3 (Table 2).

Discussion

Due to the lack of consensus, the decision to either stop or continue the antiplatelet or anticoagulation therapy is basically based on the surgeon's own experience and the risk of the patients. Generally, the antiplatelets have been recommended to discontinue 5–10 days preoperatively for the risk of major hemorrhage [26, 27], therefore, the current guidelines by advisory bodies such as the Institute for Clinical Systems Improvement and the European Society of Cardiology (ESC) recommend cessation of Clopidogrel 7–10 days prior to any no cardiac surgical procedure for a patient who is not at high risk for cardiac events [10, 11]. Traditionally, anticoagulation with Warfarin has either been discontinued perioperatively or bridged with a short-acting anticoagulation agent prior to inguinal hernia repair [7]. However, surgery is known to induce hypercoagulability, and the withdrawing of antiplatelets prior to surgery has been reported to contribute to an increase in the risk of thrombosis [28–30]. It was previously reported that sudden cessation of Aspirin preoperatively contributed to a raised thromboxane A2 activity and depressed fibrinolysis, resulting in thrombosis [18, 19]. Consequently, there are several reports indicated a significant increase of cardiovascular morbidity and mortality due to interruption of long-term Aspirin application [19, 31–33]. Given the knowledge of efficacy of Aspirin in preventing severe thrombotic events and subsequent cardiovascular death, serious safety concerns about the routine withdrawal 5–10 days of the drug prior to surgery in patients with known cardio-cerebrovascular disease (CVD) have been raised [5, 34–36].

In patients who suffer an embolic stroke, major morbidity and mortality may occur from extensive neurologic injury secondary to embolic stroke in approximately 70% of these cases. In addition, mortality rates as high as 15% are associated with patients who have suffered from thrombosed mechanical heart valves [7, 37]. Although the absolute risk of thromboembolism and cerebrovascular accident in the perioperative period during discontinuation of Warfarin therapy is $<1\%$; the clinical consequences can be devastating. However, continued Warfarin therapy increased the risk of bleeding during and after a surgical procedure. Devereaux et al. [38] observed more common

Table 2 Separate analysis and recommendation of antiplatelet and anticoagulation therapies in inguinal hernia repair

Therapy types		Evidence sources from corresponding reference	Risk of bleeding and reference number			Recommendation
			Nonincreased	Increased, not significant	Significantly increased	
Antiplatelet	Continuation of antiplatelet (Aspirin/Clopidegrel)	Ref. [3–6, 20, 21, 25]	Yes	–	–	Can be continued
	Cessation of antiplatelet	Ref. [4, 8, 24]	Yes	–	–	Can be continued
Anticoagulation	Continuation of anticoagulation (Warfarin)	Ref. [7, 20–23, 25]	Yes: Ref. [23, 25]. Yes: Ref. [7, 22], (if INR < 3)	Yes: Ref. [7, 22] (if INR > 3)	Yes: Ref. [20, 21] (INR was not stated)	INR < 3 is acceptable Increased incidence of hematoma if INR > 3
	Cessation of anticoagulation (Warfarin)	Ref. [8, 24]	Yes	–	–	Safe with Warfarin cessation 3 days prior to surgery. INR level should be obtained prior to surgery

major bleeding in noncardiac surgeries in patients on Aspirin use. Recently, Köckerling et al. reported a fourfold higher risk of postoperative secondary bleeding in patients receiving antithrombotic therapy or with existing coagulopathy undergoing inguinal hernia repair based on a hernia registry study [9]. These observations often put surgeons in a dilemma whether to continue or stop these antiplatelet and anticoagulation agents.

However, the study by Devereaux et al. [38] contained a broad spectrum of abdominal and thoracic surgeries, with at least 50% of high-risk noncardiac procedures, including vascular, thoracic, and orthopedic surgeries. Theoretically, the risk of bleeding varies depending on the complexity and nature of the procedure. Due to the inherent difference between the surgical procedures, the inguinal hernia repair procedure is less invasive, and typically does not represent a comparable level of bleeding risk as procedures involving organ removal. Thus, the effects of antiplatelet and anticoagulants on inguinal hernia repair should be addressed specifically and separately. Furthermore, due to the different mechanisms of antiplatelet therapy and Warfarin anticoagulation, the effects of two different agents should also be analyzed separately.

The present study indicated that continuation of antiplatelet therapy (Aspirin or Clopidogrel) is safe for both open and laparoscopic inguinal hernia repairs. As to the effects of anticoagulation with Warfarin, although slightly higher incidence of hematoma was reported in one study in Warfarin continuation group, however, the difference was not significant [23]. Furthermore, two trials included in the present study observed increased postoperative hematoma in the condition of INR > 3 [7, 22]. In addition, other trials indicated that Warfarin is the independent risk factor for postoperative hematoma; however, the levels of INR were not stratified in those studies [20, 21]. Köckerling et al. reported that patients receiving antithrombotic therapy or with existing coagulopathy who undergo inguinal hernia operation had a fourfold higher risk for onset of postoperative secondary bleeding [9]; however, no INR data were available in that study, and the patients were in a heterogeneous group, which may attribute to the observed higher postoperative bleeding events as compared with control group [9]. In the present study, the INR level was stratified by the threshold of 3, and increased postoperative bleeding complications were observed in the subgroup of patients whose INR level was over 3, but not in the subgroup of < 3 (Table 2). However, the evidence-based medicine (EBM) regarding this special topic is still low in literature [7, 22], there is paucity and overall limited nature of data regarding the risks of inguinal hernia surgery while taking anticoagulation agents, therefore, we could not draw a generalized decision that INR level < 3 is safe for patients undergoing inguinal hernia repair based on the limited data, and randomized controlled trials with large number of cases are still lacking.

Furthermore, risk factors for postoperative bleeding complication are multiple, these negative influence factors identified in multivariable analysis were higher patient age, higher American Society of Anesthesiologists (ASA) score, recurrence, male gender and a larger hernia defect, and existing coagulopathy (e.g., cirrhosis) [9], similarly, in the Swedish Hernia Registry, significantly more postoperative complications occurred in men, in patients with a higher age as

well as in recurrences [39]. It is conceivable that larger hernia defects or recurrent hernias usually entail more extensive and difficult dissection, and accordingly result in a larger wound area, and probably secondary bleeding. Different surgical procedures may also have impact on postoperative bleeding, although it was reported that the subtle dissection technique employed for the endoscopic repair procedure was not associated with a lower risk of secondary bleeding compared with the open operation [9]; however, we still have the concerns about the potential bleeding in the enlarged preperitoneal space could be unconfined and lead to lethal bleeding complications. Anecdotally, an unexpected fatal outcome was reported after laparoscopic inguinal hernia repair (TAPP) in a long-term warfarinized patient caused by hemorrhagic shock [40], and no sign of traumatic injury to the abdominal wall and major vessels was revealed during autopsy, and no INR data were available in that report [40]. We felt that when postoperative bleeding occurs after open inguinal herniorraphy (Lichtenstein procedure), the bleeding is easy to be detected and confined to a superficial and accessible space and can be easily monitored and managed.

Furthermore, given these risks and the poor outcomes associated with the development of perioperative major adverse cardiovascular events, we felt that preoperative interruption of antiplatelet therapy should be avoid, especially in the critical post-coronary intervention period. In the subset of critical disease patients with severe cardiovascular disease, the need to continue Warfarin should not be an absolute contraindication towards elective hernia repair procedure providing INR level < 3. However, this issue could be even complex, the patient's condition should be evaluated, the patient preferences and the input from the cardiologist and/or primary care physician should be considered, and a shared decision process with open communication of potential risks/benefits is appropriate and necessary.

Conclusion

Our studies strongly suggest that perioperative maintenance of antiplatelet in elective inguinal hernia repair procedures would not likely lead to increased risk of perioperative bleeding events. There are limited data regarding the continuation or cessation of Warfarin prior to inguinal hernia surgery. Therefore, due to the complexity of this issue and the multiple additional risk factors affecting postoperative bleeding, the continuation or cessation of anticoagulation therapy should be assessed on a case-by-case basis.

Compliance with ethical standards

Disclosures Junsheng Li, Minggang Wang, and Tao Cheng have no conflicts of interest or financial ties to disclose.

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