The Heart Surgery Forum 2021-4533
25 (2), 2022 [Epub April 2022]
doi: 10.1532/hsf.4533

Online address: http://journal.hsforum.com

Perioperative Safety Evaluation of Gastrointestinal Surgery in Patients With Prosthetic Valves

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ABSTRACT

Background: In patients with prosthetic valves, the perioperative outcomes, as well as the risk factors, following gastrointestinal surgery remain to be defined.

Methods: From January 2010 to March 2018, the clinical data of 69 cases with prosthetic valves after gastrointestinal surgery retrospectively were collected. Univariate and multivariate analysis were applied to identify the risk factors associated with significant bleeding events and non-hemorrhagic complications.

Results: Among 69 cases, 9 patients (13.0%) presented major bleeding events, and 21 patients (30.4%) presented non-hemorrhagic complications. Major bleeding events were significantly higher in patients with simple aortic valve replacement (AVR) than in other types of prosthetic valves (27.6% vs. 2.5%, $P = 0.003$), and there was no significant difference in the incidence of non-hemorrhagic complications. Simple AVR was the significant risk factor for major bleeding events ($P = 0.043$). Significant risk factors for non-hemorrhagic complications were operative duration ≥ 160 minutes ($P = 0.021$), duration from heart valve replacement to gastrointestinal surgery ≥ 84 months ($P = 0.039$), and simple AVR ($P = 0.047$).

Conclusion: The patients with simple AVR had a much higher bleeding risk following gastrointestinal surgery.

INTRODUCTION

With an increasing number of patients undergoing heart valve replacement (HVR) [Sun 2009], a growing population of patients with prosthetic valves has required surgical care for GI diseases in recent years. Patients with mechanical valves, who need long-term and even life-long use of warfarin, urge surgeons to find an optimal balance between thrombosis and hemorrhagic complications [Carnicelli 2016]. Although patients with bioprosthetic valves do not require long-term use of anticoagulants, the diversity of cardiopulmonary and vascular diseases in those patients causes perioperative management to be even more challenging. A study showed that patients with mechanical prosthetic valves and native valves undergoing non-cardiac and non-vascular surgery had a similar risk of mortality and morbidity [Biteker 2012]. However, this study was aimed at a group of highly selective patients, and the risk factors for perioperative bleeding in patients with prosthetic valves were still not adequately elucidated. This study intends to evaluate the perioperative safety of HVR patients undergoing GI surgery at a large tertiary medical center to analyze their risk factors for major bleeding events (MBE) and non-hemorrhagic complications (NHC), to guide the surgeon's clinical decision-making.

MATERIALS AND METHODS

Study population and data collection: From January 1, 2010, to March 31, 2018, 80 196 consecutive surgeries took place at the Department of General Surgery, Zhongshan Hospital, Fudan University. A total of 68 patients with HVRs underwent 69 GI surgical operations, and their medical records were reviewed following institutional review board approval. Demographic data, medical history, comorbidities, clinical data, and laboratory features were collected from the clinical databases. All laboratory tests were performed 3 days before the operation. In the case of repeated tests, the results closest to the time of the operation were used. One patient underwent two different types of operation during unrelated admissions, respectively, so his data of each operation were treated as independent data in the following analysis. Standardized data collection forms were completed by investigators blinded to the outcomes.

Antithrombotic therapy: Given the high risk of thrombosis and embolism after mechanical valve replacement [Carnicelli 2016], the mainstay of treatment for patients with mechanical HVRs is indefinite anticoagulation using warfarin, while long-term use of anticoagulants is not recommended for patients having bioprosthetic heart valves. The international normalized ratio (INR) targeted range from 2.5 to 3.5 is suggested to guide the use of warfarin. Bridging anticoagulation therapy with low molecular weight heparin instead of warfarin was applied to elective surgery patients at least 5 days before the operation. According to different bleeding risks, low molecular weight heparin was administered 24 to 72 hours after surgery, and warfarin therapy was

Received December 23, 2021; accepted March 7, 2022.

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Table 1. Demographic and clinical characteristics of study patients

Variables	Total (*N* = 69)	Simple AVR (*N* = 29)	Other sites (*N* = 40)	*P*
Age, years	63.2 (±10.0)	63.8 (±11.3)	62.7 (±9.1)	0.641
Sex	-	-	-	0.001
Male	44 (63.8%)	25 (86.2%)	19 (47.5%)	
Female	25 (36.2%)	4 (13.8%)	21 (52.5%)	
Diagnosis	-	-	-	0.580#
Malignant	50 (72.5%)	20 (69.0%)	30 (75.0%)	
Benign	19 (27.5%)	9 (31.0%)	10 (25.0%)	
Medical comorbidity				
Hypertension	20 (29.0%)	8 (27.6%)	12 (30.0%)	0.827#
Atrial fibrillation	24 (34.8%)	5 (17.2%)	19 (47.5%)	0.009#
Diabetes	5 (7.2%)	1 (3.4%)	4 (10.0%)	0.389
Coronary artery bypass grafting	5 (7.2%)	3 (10.3%)	2 (5.0%)	0.643
Pacemaker implantation	2 (2.9%)	0 (0.0%)	2 (5.0%)	0.506
Use of Warfarin	61 (88.4%)	23 (79.3%)	38 (95.0%)	0.061
Type of prosthetic valve	-	-	-	0.208
Mechanical	57 (82.6%)	22 (75.9%)	35 (87.5%)	
Bioprosthetic	12 (17.4%)	7 (24.1%)	5 (12.5%)	
Duration from HVR to GI surgery, months	87.6 (±64.8)	76.9 (±59.3)	95.4 (±68.2)	0.245
Preoperative laboratory tests				
Hemoglobin, g/L	109.7 (±25.3)	108.0 (±27.9)	110.8 (±23.5)	0.654
Platelet, 10^9/L	217.2 (±83.9)	245.7 (±90.6)	196.5 (±73.0)	0.015
White blood cells, 10^9/L	6.5 (±3.5)	7.4 (±3.9)	5.8 (±3.0)	0.064
International normalized ratio	1.5 (±1.5)	1.7 (±2.2)	1.4 (±0.5)	0.421
Prothrombin time, seconds	16.6 (±11.5)	17.9 (±16.5)	15.7 (±5.8)	0.441
Activated partial thromboplastin time, seconds	34.0 (±16.3)	35.6 (±23.6)	32.8 (±8.0)	0.485
Fibrinogen, mg/dL	316.0 (±120.0)	339.2 (±133.0)	299.2 (1±08.2)	0.173
Total bilirubin, μmol/L	16.0 (±13.8)	16.5 (±13.4)	15.6 (±14.3)	0.795
Albumin, g/L	37.1 (±5.3)	36.4 (±5.1)	37.7 (±5.5)	0.336
Alanine aminotransferase, U/L	21.0 (±27.2)	25.1 (±39.9)	18.0 (±11.0)	0.285
Serum creatinine, μmol/L	83.3 (±31.7)	91.6 (±35.6)	77.3 (±27.5)	0.064

Fisher's exact test except # Chi-square test for categorical data. AVR, aortic valve replacement; HVR, heart valve replacement; GI, gastrointestinal

given with the preoperative maintenance dose right after the patient resumed oral intake. Heparin was discontinued once INR reached 2 or more.

Endpoints and definitions: The primary outcome for this analysis was MBE, and the secondary outcome was NHC. MBE was defined as that which was clinically overt and associated with any of the following [Baklanov 2013; Goodman 2014]: (1) fatal outcome; (2) involvement of a critical anatomic site (intracranial, spinal, ocular, pericardial, articular, retroperitoneal, or intramuscular with compartment syndrome); (3) intro-operative severe bleeding tendency, refers to intro-operative blood lost ≥ 300 mL; (4) decrease in hemoglobin > 30 g/L during 24 h after operation; (5) unplanned blood transfusion, refers to blood transfusion among patients with preoperative hemoglobin > 80 g/L; (6) postoperative bleeding that required a second intervention – surgical, endoscopic, or radiological. The complications within 30 days after operation were categorized from grade I to grade V, according to the Clavien-Dindo classification [Clavien 2009].

Statistical analysis: Data were analyzed using IBM SPSS Statistics 20.0 (Chicago, Illinois, U.S.), a significance level of 0.05, and a 95% confidence interval (CI). Categorical variables were summarized by percentage, and numerical variables were summarized by mean and standard deviation. Associations

Table 2. Operative characteristics and postoperative complications

Variables	Total (*N* = 69)	Simple AVR (*N* = 29)	Other sites (*N* = 40)	*P*
Laparoscopic surgery	21 (30.4%)	9 (31.0%)	12 (30.0%)	0.927#
Emergent surgery	13 (18.8%)	8 (27.6%)	5 (12.5%)	0.114#
Anatomic site of operation	-	-	-	0.328
Stomach & duodenum	23 (33.3%)	9 (31.0%)	14 (35.0%)	
Jejunum & ileum	5 (7.2%)	4 (13.8%)	1 (2.5%)	
Appendix	11 (15.9%)	5 (17.2%)	6 (15.0%)	
Colon & rectum	30 (43.5%)	11 (37.9%)	19 (47.5%)	
Estimated blood loss, mL	73.6 (±84.3)	105.7 (±112.9)	50.3 (±43.6)	0.017
Operative duration, minutes	135.2 (±58.8)	132.5 (±50.9)	137.2 (±64.5)	0.748
Post-operation hospital stay, days	9.2 (±5.1)	10.6 (±6.4)	8.1 (±3.6)	0.068
Major bleeding events	9 (13.0%)	8 (27.6%)	1 (2.5%)	0.003
Blood transfusion unplanned	6 (8.7%)	6 (20.7%)	0 (0.0%)	0.004
Postoperative bleeding	5 (7.2%)	4 (13.8%)	1 (2.5%)	0.154
Intraoperative severe bleeding tendency	2 (2.9%)	2 (6.9%)	0 (0.0%)	0.173
Decrease of hemoglobin ≥ 30g/L	2 (2.9%)	2 (6.9%)	0 (0.0%)	0.173
Postoperative complications	24 (34.8%)	15 (51.7%)	9 (22.5%)	0.012
Non-hemorrhagic complications	21 (30.4%)	12 (41.4%)	9 (22.5%)	0.093#
Pleural effusion	7 (10.1%)	3 (10.3%)	4 (10.0%)	1.000
Surgical site infection	5 (7.2%)	4 (13.8%)	1 (2.5%)	0.154
Ascites	5 (7.2%)	2 (6.9%)	3 (7.5%)	1.000
Thromboembolic complications	1 (1.4%)	0 (0.0%)	1 (2.5%)	1.000
Other surgical complications	8 (11.6%)	6 (20.7%)	2 (5.0%)	0.061
Clavien-Dindo Classification of Surgical Complications	-	-	-	0.073
Grade I	7 (10.1%)	3 (10.3%)	4 (10.0%)	
Grade II	8 (11.6%)	6 (20.7%)	2 (5.0%)	
Grade III	6 (8.7%)	3 (10.3%)	3 (7.5%)	
Grade IV	2 (2.9%)	2 (6.9%)	0 (0.0%)	
Grade V	1 (1.4%)	1 (3.4%)	0 (0.0%)	

Fisher's exact test except # Chi-square test for categorical data. AVR, aortic valve replacement

were explored using Fisher's exact test or Chi-square test if all expected values in the contingency table were no less than 5. A T-test was performed for group comparison. Binary logistic regression was used in multivariate analysis. The final model is determined by the entering method. Only variables with P-value < 0.1 in univariate analysis were selected for the multivariate analyses related to MBE and NHC.

RESULTS

Preoperative characteristics: Twenty-nine (42.0%) patients underwent aortic valve replacement (AVR), while 26 (37.7%) underwent mitral valve replacement (MVR). Fourteen (20.3%) patients underwent double valves replacement, including 12 (17.4%) patients with AVR and MVR and 2 (2.9%) with MVR and TVR. Comparing AVR patients with other valves (MVR and double valves replacement), the proportion of males is higher (86.2% vs. 47.5%, $P = 0.001$), proportion of patients with a history of atrial fibrillation is lower (17.2% vs. 47.5%, $P = 0.009$), and preoperative platelets is higher (245.7±90.6 vs. 196.5±73.0, $P = 0.015$) in AVR patients. Demographic and clinical characteristics of the two groups, including age, sex, diagnosis, medical comorbidity, duration from HVR to GI surgery, and preoperative laboratory tests, are summarized in Table 1.

Surgical outcomes: Among the studied patients, as shown in Table 2, MBE, including blood transfusion unplanned

Table 3. Postoperative complications according to the Clavien–Dindo classification

	Number of cases	Details of complications
Minor complications	25 (in 18 patients)	
Grade I	16 (in 13 patients)	Pleural effusion (*N* = 6)
		Ascites (*N* = 5)
		Wound infection (*N* = 3)
		Vocal chord paralysis (*N* = 1)
		Uroschesis (*N* = 1)
Grade II	9 (in 9 patients)	Abdominal infection (*N* = 2)
		Gastroparesis (*N* = 2)
		Functional ileus (*N* = 2)
		Anastomotic bleeding (*N* = 1)
		Wound bleeding (*N* = 1)
		Pneumonitis (*N* = 1)
Major complications	10 (in 8 patients)	
Grade IIIa	4 (in 3 patients)	Intra-abdominal abscess (*N* = 2)
		Anastomotic bleeding (*N* = 1)
		Pleural effusion requiring drainage (*N* = 1)
Grade IIIb	3 (in 3 patients)	Wound bleeding (*N* = 1)
		Rectovaginal fistula (*N* = 1)
		Lower extremity arterial thrombosis (*N* = 1)
Grade IVa	2 (in 2 patients)	Heart failure (*N* = 2)
Grade IVb	0	
Grade V	1	Death from intra-abdominal bleeding
Total	35 (in 24 patients)	

(N = 6, 8.7%), postoperative bleeding (N = 5, 7.2%), intraoperative severe bleeding tendency (N = 2, 2.9%), and decrease of hemoglobin ≥ 30 g/L (N = 2, 2.9%) presented in 9 patients (13.0%). Postoperative complications, including postoperative bleeding and non-hemorrhagic complications, presented in 24 patients (34.8%). The most common postoperative complications were pleural effusion (N = 7, 10.1%), surgical site infection (N = 5, 7.2%), and ascites (N = 5, 7.2%). Thromboembolic complications presented in one patient (1.4%).

Two patients who experienced postoperative bleeding, including one with incision one with anastomosis, required surgical or endoscopic intervention. Two patients received interventional treatment for postoperative abdominal infection and pleural effusion. One patient, who presented lower extremity arterial thrombosis postoperatively, underwent embolectomy. One patient underwent unplanned reoperation for a rectovaginal fistula. Two patients suffered heart failure requiring ICU management. According to the Clavien-Dindo classification system (Table 3), 8 patients mentioned above were classified as Grade III and IV. (Table 3) Unfortunately, one patient died of postoperative intra-abdominal bleeding (Grade V).

Univariate and multivariate analysis for risk factors for MBE and NHC

Univariate analysis showed that preoperative hemoglobin < 90 g/L, WBC ≥ 7×10^9/L, total bilirubin ≥ 34 μmol/L, and simple AVR were associated with the risk of MBE significantly ($P < 0.05$). Likewise, univariate analysis showed that duration from HVR to GI surgery > 84 m and operative duration ≥ 160 min were associated with the risk of postoperative NHC significantly ($P < 0.05$). (Table 4) Furthermore, multivariate analyses of the risk factors for MBE and NHC were performed. As summarized in Table 5, simple AVR was the single significant risk factor for MBE (OR = 10.486, 95% CI 1.080~101.800, P = 0.043). (Table 5) Significant risk factors for NHC were operative duration≥160 min (OR = 5.412, 95% CI 1.292~22.678, P = 0.021), duration from HVR to GI surgery ≥ 84 m (OR = 4.043, 95% CI 1.072~15.253, P = 0.039), and simple AVR (OR = 3.632, 95% CI 1.020~12.933, P = 0.047).

DISCUSSION

Our study demonstrates that patients with HVR can safely undergo GI surgery with a relatively low risk of major bleeding

Table 4. Univariable analysis of factors associated with major bleeding events and non-hemorrhagic complications

Variables	Total (*N* = 69)	Major bleeding events (*N* = 9)	*P*	Non-hemorrhagic complications (*N* = 21)	*P*
Age	-	-	0.306	-	0.481#
≥ 65 years	35 (50.7%)	3 (33.3%)	-	12 (57.1%)	
< 65 years	34 (49.3%)	6 (66.7%)	-	9 (42.9%)	
Sex	-	-	0.471	-	0.831#
Male	44 (63.8%)	7 (77.8%)	-	13 (61.9%)	
Female	25 (36.2%)	2 (22.2%)	-	8 (38.1%)	
Diagnosis	-	-	0.699	-	0.899#
Malignant	50 (72.5%)	6 (66.7%)	-	15 (71.4%)	
Benign	19 (27.5%)	3 (33.3%)	-	6 (28.6%)	
Hypertension	-	-	1.000	-	0.960#
Yes	20 (29.0%)	2 (22.2%)	-	6 (28.6%)	
No	49 (71.0%)	7 (77.8%)	-	15 (71.4%)	
Diabetes	-	-	1.000	-	1.000
Yes	5 (7.2%)	0 (0.0%)	-	1 (4.8%)	
No	64 (92.8%)	9 (100.0%)		20 (95.2%)	
Atrial fibrillation	-	-	0.480	-	0.702#
Yes	24 (34.8%)	2 (22.2%)	-	8 (38.1%)	
No	45 (65.2%)	7 (77.8%)	-	13 (61.9%)	
Pacemaker implantation	-	-	1.000	-	1.000
Yes	2 (2.9%)	0 (0.0%)	-	0 (0.0%)	
No	67 (97.1%)	9 (100.0%)	-	21 (100.0%)	
Coronary artery bypass grafting	-	-	0.124	-	0.313
Yes	5 (7.2%)	2 (22.2%)	-	0 (0.0%)	
No	64 (92.8%)	7 (77.8%)	-	21 (100.0%)	
Use of warfarin	-	-	0.278	-	0.692
Yes	61 (88.4%)	7 (77.8%)	-	18 (85.7%)	
No	8 (11.6%)	2 (22.2%)	-	3 (14.3%)	
Hemoglobin	-	-	0.045	-	0.140
≥ 90 g/L	51 (73.9%)	4 (44.4%)	-	18 (85.7%)	
< 90 g/L	18 (26.1%)	5 (55.6%)	-	3 (14.3%)	
Platelet	-	-	1.000	-	0.636
≥ 125 × 10^9/L	64 (92.8%)	9 (100.0%)	-	19 (90.5%)	
< 125 × 10^9/L	5 (7.2%)	0 (0.0%)	-	2 (9.5%)	
White blood cells	-	-	0.045	-	0.378
≥ 7 × 10^9/L	18 (26.1%)	5 (55.6%)	-	4 (19.0%)	
< 7 × 10^9/L	51 (73.9%)	4 (44.4%)	-	17 (81.0%)	
International normalized ratio	-	-	0.423	-	0.760
≥ 1.5	16 (23.2%)	3 (33.3%)	-	4 (19.0%)	
< 1.5	53 (76.8%)	6 (66.7%)	-	17 (81.0%)	
Prothrombin time	-	-	0.282	-	0.963#

≥ 15 seconds	26 (37.7%)	5 (55.6%)	-	8 (38.1%)	
< 15 seconds	43 (62.3%)	4 (44.4%)	-	13 (61.9%)	
Activated partial thromboplastin time	-	-	0.723	-	0.236#
≥ 30 seconds	32 (46.4%)	5 (55.6%)		12 (57.1%)	
< 30 seconds	37 (53.6%)	4 (44.4%)	-	9 (42.9%)	
Fibrinogen	-	-	1.000	-	0.476#
≥ 350 mg/dL	19 (27.5%)	2 (22.2%)	-	7 (33.3%)	
< 350 mg/dL	50 (72.5%)	7 (77.8%)	-	14 (66.7%)	
Total bilirubin	-	-	0.042	-	0.667
≥ 34 μmol/L	7 (10.1%)	3 (33.3%)	-	3 (14.3%)	
< 34 μmol/L	62 (89.9%)	6 (66.7%)	-	18 (85.7%)	
Albumin	-	-	0.687	-	0.365#
≥ 35 g/L	51 (73.9%)	6 (66.7%)	-	14 (66.7%)	
< 35 g/L	18 (26.1%)	3 (33.3%)	-	7 (33.3%)	
Alanine aminotransferase	-	-	0.674	-	0.089#
≥ 30 U/L	13 (18.8%)	2 (22.2%)	-	7 (33.3%)	
< 30 U/L	56 (81.2%)	7 (77.8%)	-	14 (66.7%)	
Serum creatinine	-	-	0.224	-	1.000
≥ 115 μmol/L	7 (10.1%)	2 (22.2%)	-	2 (9.5%)	
< 115 μmol/L	62 (89.9%)	7 (77.8%)	-	19 (90.5%)	
Emergency surgery	-	-	0.355	-	0.740
Yes	13 (18.8%)	3 (33.3%)	-	3 (14.3%)	
No	56 (81.2%)	6 (66.7%)	-	18 (85.7%)	
Laparoscopic surgery	-	-	1.000	-	0.429#
Yes	21 (30.4%)	3 (33.3%)	-	5 (23.8%)	
No	48 (69.6%)	6 (66.7%)	-	16 (76.2%)	
Operative site	-	-	0.707	-	0.096#
Upper digestive tract	23 (33.3%)	2 (22.2%)	-	10 (47.6%)	
Lower digestive tract	46 (66.7%)	7 (77.8%)	-	11 (52.4%)	
Simple AVR	-	-	0.003	-	0.093#
Yes	29 (42.0%)	8 (88.9%)	-	12 (57.1%)	
No	40 (58.0%)	1 (11.1%)	-	9 (42.9%)	
Simple MVR	-	-	0.138	-	0.622#
Yes	26 (37.7%)	1 (11.1%)	-	7 (33.3%)	
No	43 (62.3%)	8 (88.9%)	-	14 (66.7%)	
Multiple HVR	-	-	0.187	-	0.199
Yes	14 (20.3%)	0 (0.0%)	-	2 (9.5%)	
No	55 (79.7%)	9 (100.0%)	-	19 (90.5%)	
Mechanical valve	-	-	0.183	-	0.744
Yes	57 (82.6%)	6 (66.7%)	-	18 (85.7%)	
No	12 (17.4%)	3 (33.3%)	-	3 (14.3%)	
Duration from HVR to GI surgery	-	-	0.729	-	0.043#
≥ 84 months	27 (39.1%)	4 (44.4%)	-	12 (57.1%)	
< 84 months	42 (60.9%)	5 (55.6%)	-	9 (42.9%)	

Operative duration	-	-	1.000	-	0.014#
≥ 160 minutes	19 (27.5%)	2 (22.2%)	-	10 (47.6%)	
< 160 minutes	50 (72.5%)	7 (77.8%)	-	11 (52.4%)	
Non-hemorrhagic complications	-	-	0.712	-	-
Yes	21 (30.4%)	2 (22.2%)	-	-	
No	48 (69.6%)	7 (77.8%)	-	-	
Major bleeding events	-	-	-	-	0.712
Yes	9 (13.0%)		-	2 (9.5%)	
No	60 (87.0%)		-	19 (90.5%)	

Fisher's exact test except # Chi-square test for categorical data. AVR, aortic valve replacement; MVR, mitral valve replacement; HVR, heart valve replacement

Table 5. Multivariable analysis of factors associated with major bleeding events and non-hemorrhagic complications

Variables	Odds ratio	95% Confidence interval	*P*
Major bleeding events			
Simple AVR, Yes	10.486	1.080~101.800	0.043
Total bilirubin, ≥ 34 μmol/L	10.670	0.978~116.368	0.052
Hemoglobin, < 90 g/L	6.338	0.960~41.845	0.055
White blood cells, ≥ 7×10^9/L	2.094	0.353~12.431	0.416
Non-hemorrhagic complications			
Operative duration ≥ 160 minutes	5.412	1.292~22.678	0.021
Duration from HVR to GI surgery ≥ 84 months	4.043	1.072~15.253	0.039
Simple AVR, Yes	3.632	1.020~12.933	0.047
Alanine aminotransferase, ≥ 30 U/L	3.826	0.867~16.887	0.077
Operative site, Lower digestive tract	1.871	0.477~7.344	0.369

AVR, aortic valve replacement

events and non-hemorrhagic complications. In the present study, major bleeding events in the perioperative period were 13.0%, including 7.2% of postoperative bleeding. Meanwhile, the incidence of postoperative non-hemorrhagic complications was 30.4%, among which the incidence of major complications was 13.0% and of thromboembolic complications, it was 1.4%. This is valuable information for GI surgeons faced with difficult decisions in managing patients with HVR but requiring surgery. Previously, similar studies had focused on the risk of bleeding and thrombotic complications in patients with mechanical valves or antithrombotic treatment and concluded consistent with our present study. For example, a retrospective study, which evaluated the risk of complications in patients with mechanical valves undergoing non-cardiac and non-emergency surgery, showed that the risk of severe bleeding events was 3.6%, and the incidence of thromboembolic complications was 3.6% [Biteker 2012]. Another retrospective investigation on patients with gastric cancer undergoing radical gastrectomy revealed that perioperative antithrombotic treatment increased the risk of postoperative bleeding complications (8.1%). However, other complications, including thromboembolic events (1.6%), were similar in thromboprophylaxis and control groups [Mita 2012]. A recent retrospective study in Canada also showed a 1.9% incidence of venous thrombosis in abdominal and pelvic surgery [McAlpine 2019].

It is worth noting that in this study, patients with simple AVR were at high risk for MBE during the perioperative period. The incidence of MBE in this patient population was 27.6% (8/29), while the incidence in simple MVR was 3.8% (1/26). Previous reports based on population-based cohort studies showed that bleeding events in patients with mechanical AVR and MVR were 2.6%~4.4% and 3.9%~4.6%, respectively [Labaf 2014; Labaf 2016]. In this study, the incidence of MBE in patients with simple MVR was similar to that reported in the literature mentioned before. In contrast, in uncomplicated AVR patients, it was significantly increased. The study also found that simple AVR was a significant risk factor for postoperative complications in HVR patients after GI surgery. This suggests that patients with simple AVR may have a severe bleeding tendency and be more prone to complications on the conditions of surgery, anesthesia, and other "hits." However, the exact mechanism remains to be further studied.

In this study, the duration of surgical operation showed a stronger predictive value for NHC than other variables, such as the duration from HVR to GI surgery and simple AVR. Other studies also have shown that the risk of venous thrombotic complications increases gradually with the length of surgery [McAlpine 2019]. Therefore, for patients whose operation time exceeds 160 minutes, the surgeon should be highly alert to postoperative complications and thrombotic complications, especially. They should be gently manipulated and have strict hemostasis during operation. The vital signs and drainage tubes should be closely observed after the procedure. Traits and surgical incisions, and timely follow-up of laboratory indicators, such as blood routine and coagulation function, standardized anticoagulation, and antithrombotic treatment.

This study also showed that HVR to GI surgery duration is also an important risk factor for postoperative complications. Patients who have undergone valve replacement surgery for more than 84 months have a significantly higher postoperative complication rate. A meta-analysis revealed that mechanical valves in adult patients were associated with substantial excess mortality over time and considerable lifetime risk of anticoagulation-related complications [Korteland 2017]. Studies have suggested that optimizations of the required anticoagulation therapy such as self-management and lower dosing might be promising methods of reducing complication rates after mechanical AVR [Korteland 2017].

In emergencies, systemic stress and inflammatory reactions can cause abnormal liver and coagulation function and lack sufficient preoperative preparation to correct abnormal coagulation function, which becomes a risk factor for severe surgical complications, such as bleeding [de Siqueira Corradi 2020]. However, this study shows that neither emergency surgery nor abnormal liver and coagulation functions have been the risk factor for MBE in HVR patients undergoing GI surgery. The reason may be that surgeons are more cautious in choosing surgery for valve patients who have been taking warfarin for a long time and seldom choose complex surgery or emergency surgery for them, which has avoided MBE. Today, many inflammation markers (such as C-reactive protein and calcitonin) have been proven to predict the prognosis of emergency or surgical patients [Goulart 2018; Tanaka 2019], and their predictive value for bleeding complications in HVR patients needs further study.

In recent years, percutaneous valve interventions increasingly have been used as an alternative treatment option for patients deemed at high surgical risk and inoperable [El Hajj 2019; Gryaznov 2018; Tabata 2020]. Compared with patients undergoing surgical valve replacement, percutaneous valve interventions had different procedural complications [Conte 2017]. Its antithrombotic treatment plan also needed to be further identified [Carnicelli 2016; Cigarroa 2018]. Since the patients involved in this cohort all were patients who underwent surgical valve replacement, the profile of complications following gastrointestinal surgery in patients with percutaneous valve replacement remains to be seen in future case accumulation.

This study revealed the risk profiles of perioperative complications in HVR patients undergoing GI surgery and elucidated the risk factors to help the clinical decision for surgeons. But this study also has certain limitations. First, this was a single-center retrospective study with limited sample size. The cases included in the study lacked a control group in patients with native heart valves and the possibility of selection bias cannot be excluded. Second, this study only investigated the short-term complications of patients and failed to follow up on long-term clinical outcomes. Therefore, based on this study, the authors look forward to conducting a multicenter prospective control study to clarify further the risk factors affecting the development of GI surgery for HVR patients, to provide strong evidence support for the formulation of more scientific and reasonable anticoagulant and antithrombotic management.

ACKNOWLEDGEMENTS

This work was supported by grant from the National Natural Science Foundation of China 82172803 (to Dr Fenglin Liu).

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