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ORIGINAL ARTICLE

Prevalence of preoperative asymptomatic deep vein thrombosis in patients undergoing elective general surgery for benign disease

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Abstract

Background: The systemic inflammatory response following surgery as well as that of malignant disease itself is associated with a hypercoagulable state, and thromboprophylaxis is thus recommended during postoperative management of cancer patients. However, limited information is available on the prevalence of preoperative deep vein thrombosis (DVT) and its risk factors in surgical candidates, especially those receiving operations for benign diseases.

Methods: This is a retrospective observational study with data of all patients scheduled for elective general surgery between January 2011 and September 2020, undergoing lower extremity venous ultrasonography as preoperative screening for DVT. The prevalence of preoperative asymptomatic DVT was estimated and its associations with clinical variables were evaluated.

Results: Among 1512 patients included in the study, 161 (10.6%) had asymptomatic DVT before surgery. DVT prevalence was 13.7% in patients with malignant disease, while it was 8.6% in those with benign disease. The site of the thrombus was distal type in 141 (87.6%) patients, most commonly in the soleal vein. Advanced age (>70 years), female sex, and decreased hemoglobin level were significantly associated with preoperative asymptomatic DVT by multivariate analysis. The odds ratio for advanced age was the highest and rose as age increased. Malignant disease was not an independent risk factor for preoperative DVT.

Conclusion: This study showed the prevalence of asymptomatic DVT to be equal in patients with and without malignant disease undergoing elective general surgery. Preoperative DVT assessment is necessary regardless of the disease indicated for surgery, especially in patients with the risk factors identified in this study.

KEYWORDS
benign disease, deep vein thrombosis, general surgery, preoperative, venous thromboembolism

1 | INTRODUCTION

Pulmonary thromboembolism (PE) secondary to deep vein thrombosis (DVT) is recognized as a potentially fatal complication. It is one of the leading causes of cardiovascular mortality and mortality rates range from <1% to 7%.[1] The systemic inflammatory response following surgery is highly associated with a hypercoagulable state and has a causal relationship with venous thromboembolism (VTE) development,[2] and has thus drawn considerable research attention in regards to postoperative management. The postoperative VTE incidence reportedly ranges from 19.4% to 24.3% with elective general surgery.[3–5] Therefore, risk models to predict postoperative VTE have been developed, and thromboprophylaxis, such as intermittent pneumatic compression (IPC) and antithrombotic drugs, are generally recommended during the postoperative period.

Cancer is widely recognized as being associated with increased risk of VTE.[6] Large epidemiological studies have also shown that the risk of developing VTE is 4.7–6.7 times higher in patients with malignant disease.[7–9] Given that surgery is the mainstay of treatment for various malignant tumors, surgery for such patients essentially raises serious concerns about possible VTE even before surgery. In fact, studies on the prevalence of preoperative asymptomatic DVT yielded a prevalence range of 4.4%–13.5% in patients with gastrointestinal cancer.[10–13] Notably, cancer stage was not associated with preoperative DVT in any of these studies, suggesting that its incidence might be unrelated to cancer stage, raising the possibility that this complication might occur in any surgical candidate irrespective of the disease. However, studies on the prevalence of preoperative asymptomatic DVT in patients undergoing surgery for benign diseases are lacking. We thus investigated the prevalence of preoperative asymptomatic DVT in patients scheduled for general surgery to clarify its exact prevalence and to elucidate risk factors.

2 | METHODS

2.1 | Patients

This is a retrospective observational study with data of all patients scheduled for elective general surgery between January 2011 and September 2020, undergoing lower extremity venous ultrasonography (LEVU) as preoperative screening for DVT within 8 weeks prior to surgery at Toride Medical Association Hospital. The following factors were exclusion criteria: current anticoagulant therapy for DVT, symptoms suggestive of DVT, prior major surgery within 30 days before elective surgery. Advanced malignancies were defined as T2 or higher, or M1 according to the UICC TNM classification 8th edition.[14] Owing to the anonymous nature of the data, the requirement for informed consent was waived. This study was approved by the institutional ethics committee of the Toride Medical Association Hospital (approval number 113).

2.2 | Assessment of preoperative DVT

Whole-leg ultrasonography was performed by two certified clinical vascular technologists. Initially, the external iliac vein and the common, superficial, and deep femoral veins were examined in the supine position, followed by surveillance of the popliteal, soleal, small saphenous, anterior tibial, posterior tibial, gastrocnemius, and peroneal veins in the sitting position. Vascular flow was assessed by color Doppler analysis. The compression method was used to detect DVT.

Acute DVT was assessed according to the established guidelines; degree of occlusion, total; free-floating, free; clot retraction, retracted; clot distension, distended; clot compressibility, soft; surface character, smooth; echogenicity, faint; homogeneity, homogeneous; collaterals, absent; and recanalization, absent.[15] DVT in the popliteal or any of the more proximal veins was defined as proximal DVT, while DVT in the calf vein was defined as distal DVT. Perioperative thromboprophylaxis was performed in accordance with the Japanese guidelines for prevention of VTE.[16] When DVT was not detected preoperatively, IPC was initiated at the start of surgery and continued until the patient was able to ambulate adequately. Elastic stockings were used without IPC for patients with concurrent DVT. Inferior vena cava filters (IVCF) were placed for proximal DVT or distal DVT with possible extension into the popliteal vein. Pharmacological prophylaxis was ultimately determined based on the results of preoperative patient status and preexisting venous thrombus.

The preoperative asymptomatic DVT prevalence was estimated and its associations with clinical variables were evaluated thereafter. Variables relevant to the development of postoperative VTE were subsequently analyzed to establish risk factors for preoperative asymptomatic DVT.

2.3 | Statistical analysis

All statistical analyses were carried out using JMP 14.0.0 (SAS Institute). Continuous variables are presented as the median with range or mean with standard deviation, as appropriate. The chi-square test or Fisher's exact test was used to evaluate differences between demographic and categorical parameters, and the Wilcoxon signed-rank test to compare differences in quantitative parameters. Risk factors for preoperative DVT were analyzed by univariate and multivariate logistic regression. A multivariate forward stepwise logistic regression analysis was performed to identify independent variables that were associated with preoperative DVT. Odds ratios are presented with 95% confidence intervals (CIs). Statistical significance was defined as $p < 0.05$.

3 | RESULTS

3.1 | Patient characteristics

Of the 1555 patients who underwent general surgery during the study period, 13 receiving current anticoagulant therapy for DVT and 19 who had undergone major surgery within the prior 30 days were excluded

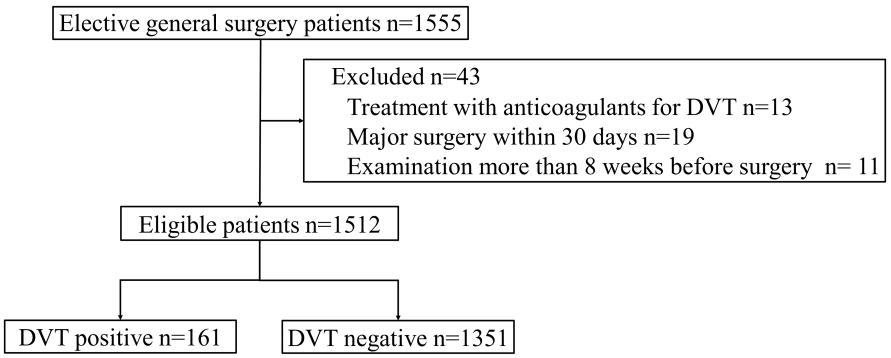

FIGURE 1 Flowchart of the patient selection process.

TABLE 1 Characteristics of 1512 patients in this study.

Age (years)		Hepatobiliary and pancreatic	51
Median (range)	70 (12–96)	Others	2
Sex		Early cancer	113
Male	935	Advanced cancer	493
Female	577	Prior chemotherapy	39
Body mass index (kg/m^2)		Semi-elective surgery	232
Median (range)	22.7 (11.2–45.7)	Central venous catheter placement	99
Performance status		Previous history of DVT	8
0–1	1428	Previous history of cancer	178
≥2	84	Hypertension	632
Benign disease	906	Hyperlipidemia	268
Cholelithiasis	315	Diabetes mellitus	222
Inguinal hernia	289	Current medication usage	
Appendicitis	141	Steroid	16
Ileus	50	Estrogen receptor antagonist	10
Peritonitis	28	Immunosuppressive drug	8
Anal disease	26	Smoking	241
Colon polyp	7	Leg paralysis	21
Others	50	Laboratory data, median (range)	
Malignant disease	606	WBC count (×10^3/μL)	6.4 (1.0–31.3)
Upper gastrointestinal	199	Hemoglobin level (g/dl)	13.2 (4.4–19.0)
Colon and rectum	354	Platelet count (×10^4/μL)	22.7 (5.1–81.0)

Abbreviation: WBC, white blood cell.

from this study. In addition, 11 patients whose preoperative LEVU was more than 8 weeks before their surgery were also excluded. The remaining 1512 patients (935 men and 577 women) were included in this study (Figure 1). The median age was 70 years (range, 12–96 years) and the median body mass index was 22.7 kg/m^2 (range, 12.5–45.7 kg/m^2). In total, 606 patients (4%) had malignant diseases, including 493 (81%) with advanced disease. The median time between the date of ultrasonography and surgery was 5 days (range, 0–56 days; Table 1).

3.2 | Prevalence and clinical features of DVT

The overall prevalence of DVT in our study cohort was 10.6% (161 of 1512 patients), and all of these patients were asymptomatic. DVT prevalence was 13.7% (83 of 606) in patients with malignant disease, while it was 8.6% (78 of 906) in those with benign disease (Table 2). It was 11.6% (27 of 232) in patients with acute disease requiring semi-elective surgery. Distal type DVT was detected in 141 (87.6%) patients, most commonly in the soleal vein. DVT was present in the proximal deep vein in 20 patients (12.4%). The site was the popliteal vein in nine patients, superficial femoral vein in nine, common femoral vein in one, and external iliac vein in one patient. In 137 patients (85.1% of 161), DVT was diagnosed as an acute phase thrombus, and two or more DVTs were found in 70 patients. IVCF placement was performed preoperatively in 15 (9.3%) patients (Table 2).

3.3 | Risk factors for preoperative DVT

Univariate analysis demonstrated that preoperative DVT was significantly associated with age, female sex, body mass index <25 kg/m^2, low white blood cell (WBC) count, low hemoglobin level, malignancy, prior chemotherapy, presence of a central venous (CV) catheter, previous history of cancer, and hypertension (Table 3). The cutoff values

TABLE 2 Characteristics of deep vein thrombosis.

	Benign disease	Malignant disease	
Number of patients	**906**	**606**	
with DVT	**78 (8.6%)**	**83 (13.7%)**	***p*-Value**
Distribution			
Right/Left/Bilateral	29/29/20	32/26/25	0.70
Distal type/Proximal type	72/6	69/14	0.08
Distal type[a]			
Soleal vein	68	67	
Posterior tibial vein	3	3	
Peroneal vein	6	4	
Gastrocnemius vein	2	3	
Small saphenous vein	1	3	
Proximal type			
Popliteal vein	4	5	
Superficial femoral vein	1	8	
Common femoral vein	1	0	
External iliac vein	0	1	
Acute phase	64	73	0.29
Multiple lesions	34	36	0.97
Placement of IVCF	4	11	0.10

Abbreviations: DVT, deep vein thrombosis; IVCF, inferior vena cava filter.
[a]Overlapping distribution.

TABLE 3 Univariate analysis of risk factors for preoperative DVT.

Variables	DVT (+) $n = 161$	DVT (−) $n = 1351$	*p* Value
Age	77 [39–95]	69 [12–96]	<0.001
Age (≥70 years)	140 (87%)	642 (48%)	<0.001
Sex (Female)	94 (58%)	483 (36%)	<0.001
BMI (≥25 kg/m^2)	28 (17%)	344 (25%)	<0.025
Malignancy	83 (52%)	523 (39%)	0.002
Semi-elective operation	27 (17%)	205 (15%)	0.60
White blood cells (×10^3/μL)	5.9 [2.9–31.3]	6.4 [1.0–26.9]	0.047
White blood cells (<5.8 × 10^3/μL)	73 (49%)	496 (39%)	0.02
Hemoglobin level (g/dL)	11.2 [4.4–16.1]	13.4 [6.0–19.0]	<0.001
Hemoglobin level (<11.8 g/dL)	90 (56%)	299 (22%)	<0.001
Platelets (×10^4/μL)	22.2 [7.7–68.3]	22.8 [5.1–81.0]	0.76
Chemotherapy	10 (6.2%)	29 (2.2%)	0.002
Central venous catheter	21 (13%)	78 (5.8%)	<0.001
Previous history of DVT	2 (1.2%)	6 (0.4%)	0.21
Previous history of cancer	30 (18%)	148 (11%)	0.004
Hypertension	81 (50%)	551 (41%)	0.02
Hyperlipidemia	34 (21%)	234 (17%)	0.23
Diabetes mellitus	26 (16%)	196 (15%)	0.58
Smoking	18 (11%)	223 (17%)	0.08
Leg paralysis	2 (1.2%)	19 (1.4%)	1.00

Abbreviations: BMI, body mass index; DVT, deep vein thrombosis.

for age, WBC count, and hemoglobin level were 70 years, 5800/μL, and 11.8 g/dL, respectively, based on the receiver-operating characteristic curve for each parameter [area under the curve: age, 0.76 (95% CI, 0.72–0.79; Figure 2A); WBC, 0.55 (95% CI, 0.50–0.60; Figure 2B); and hemoglobin, 0.74 (95% CI, 0.69–0.78; Figure 2C)]. Multivariate logistic regression analysis demonstrated age ≥70 years,

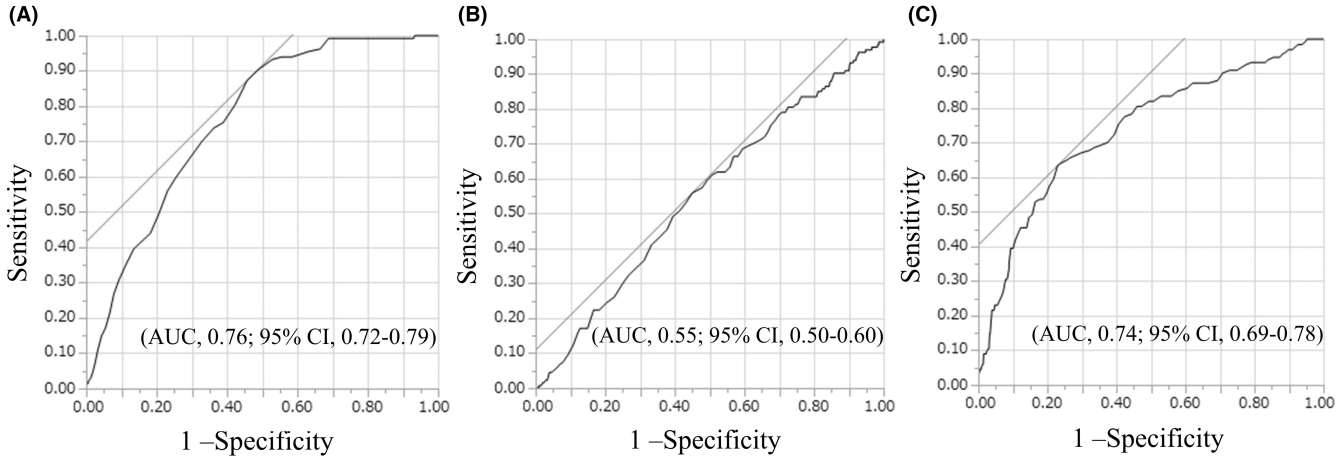

FIGURE 2 Receiver-operating characteristic curves for age (A), white blood cell count (B), and hemoglobin level (C).

TABLE 4 Multivariate analysis of risk factors for DVT.

Variable	Odds ratio	95% CI	*p* Value
Age ≥ 70 years	6.40	3.77–10.87	<0.001
Female	2.39	1.63–3.49	<0.001
BMI <25 kg/m^2	1.20	0.74–1.95	0.47
WBC <5.8 × 10^3/μL	1.42	0.98–2.05	0.06
Hemoglobin <11.8 g/dL	3.03	2.04–4.50	<0.001
Malignancy	0.77	0.52–1.16	0.21
Chemotherapy	1.51	0.56–4.09	0.41
Central venous catheter	1.53	0.83–2.82	0.17
Previous history of cancer	1.29	0.76–2.18	0.35
Hypertension	0.98	0.68–1.43	0.93
Smoking	1.60	0.89–2.90	0.12

Abbreviations: BMI, body mass index; CI, confidence interval; DVT, deep vein thrombosis; WBC, white blood cell.

female sex, and hemoglobin level <11.8 g/dL to be associated with the presence of preoperative DVT (Table 4). Having malignant disease was not a risk factor [odds ratio 0.77 (95% CI 0.52–1.16), $p = 0.21$]. There was no significant difference in DVT characteristics regarding the acute phase or the distribution of thrombosis between benign and malignant diseases. Considering that the highest odds ratio was for advanced age, the odds ratio per 10 years of age is additionally presented in Table 5. The odds ratio for having preoperative DVT rose as age increased. As compared with a reference age of ≦59 years, the odds ratios in the age strata of 60–69, 70–79, and ≧80 years were 18.5, 62.6, and 95.7, respectively.

3.4 | Perioperative thromboprophylaxis and clinical courses of patients

Pharmacological prophylaxis was ultimately required for 130 (8.6%) patients (66 of the 161 patients with DVT and 64 of the 1351 without DVT). None of the patients with preoperative DVT developed postoperative symptomatic VTE. Furthermore, no patient receiving IVCF placement developed postoperative symptomatic PE. Postoperative symptomatic VTE occurred only in two patients without preoperative DVT (0.013%), both of whom underwent total gastrectomy for advanced gastric cancer. PE developed on postoperative days 11 and 12, but recovery was achieved with anticoagulant therapy in both cases.

4 | DISCUSSION

Our study showed advanced age, female sex, and decreased hemoglobin level to be significantly associated with preoperative DVT. The former two variables are consistent with the results of previous cancer cohort studies.[11–13,17,18] Since advanced stage was not independently associated with preoperative DVT in these studies, the risk for asymptomatic DVT development might not be dependent on the extent of tumor burden. In fact, the prevalence of asymptomatic DVT is consistently high in patients with benign diseases as well, and the presence of malignant disease was not independently associated with having DVT in this study. Furthermore, rates of acute phase disease, proximal thrombus distribution, and multiple lesions were equivalent in patients with benign and malignant diseases.

Increased frequency of thrombosis, first reported by Trousseau in 1865, is widely known to be associated with malignant disease.[19] Patients with distant metastases have a much higher risk of DVT than those with localized cancer.[8,9] The cancer-associated hypercoagulable state is presumably due to aberrant overexpression of tissue factor (TF), an initiator of blood coagulation cascades, in the cancer cells. Given that TF expression is more likely in advanced stages,[20] patients with advanced cancer especially are regarded as being in a subclinical hypercoagulable state even in the absence of any abnormalities in blood coagulation data. Our clinical results appear to challenge the notion that DVT is a risk only in patients undergoing surgery for malignant diseases. Even patients with non-malignant disease should be evaluated preoperatively for DVT.

TABLE 5 Preoperative prevalence of DVT by age.

Age	*n*	DVT prevalence (%)	Odds ratio	95% CI	*p* Value
≤59	342	0.3	1.00		
60–69	388	5.2	18.5	2.5–138.8	0.005
70–79	490	15.5	62.6	8.7–452.5	<0.001
≥80	292	21.9	95.7	13.2–694.9	<0.001

The age-related increase in postoperative DVT is widely known and was demonstrated in previous studies.[21,22] Preoperative DVT was also associated with advanced age in our study. Odds ratios of having preoperative DVT rose sharply as age increased. Early postoperative mobilization is recommended to prevent VTE in elderly surgical patients.[23] Indeed, reduced mobility is associated with increased odds of hospital-associated VTE,[24] and major orthopaedic surgery requiring postoperative immobilization is recognized as conferring a higher risk of thromboembolism, such that pharmacological thromboprophylaxis is recommended.[25] Although physical activity was not assessed in this study, reduced mobility due to low muscle quality and quantity might have impacted our results since the prevalence of sarcopenia rises dramatically with increasing age.[26]

Anemia is reportedly an independent risk factor for developing postoperative symptomatic VTE.[27] However, its possible association with preoperative DVT was not fully evaluated in previous studies.[11-13] Anemia is associated with underlying conditions associated with VTE, such as malnutrition,[28] chronic inflammation,[29] and malignant disease.[30] Therefore, a decreased hemoglobin level might well prompt further comorbidity assessment including DVT screening when deciding on surgical interventions, regardless of the primary disease being treated.

Preoperative asymptomatic DVT is present in 3.1%–13.5% of patients undergoing general surgery.[11,13,17,18] Consistently, the prevalence of preoperative asymptomatic DVT was 10.6% in patients undergoing elective general surgery in this study. The incidences of postoperative symptomatic VTE and PE are as low as 1.4%–2.4%[31,32] and 0.2%–0.3%,[33,34] respectively, but asymptomatic DVT does not necessarily progress to symptomatic VTE during the postoperative period based simply on incidence. In fact, postoperative symptomatic VTE occurred only in patients without preoperative DVT, i.e., none of the patients with preoperative asymptomatic DVT in this study cohort developed symptomatic VTE.

This study has several limitations. First, this was a single-center observational study and was not designed to demonstrate whether preoperative DVT is a causal factor for postoperative symptomatic VTE. Second, pharmacological intervention was employed only for selected patients, not administered routinely. Thus, we can draw no conclusions as to whether symptomatic VTE incidence differs between asymptomatic DVT patients with versus without pharmacological thromboprophylaxis. A randomized controlled study showed that thromboprophylaxis with postoperative enoxaparin injection did not reduce the incidence of postoperative VTE in patients without preoperative DVT after laparoscopic colorectal cancer surgery.[35] Perioperative pharmacological intervention confined to the population with asymptomatic DVT merits prospective study.

In conclusion, this study showed the prevalence of asymptomatic DVT to be equivalent in patients with malignant and benign diseases undergoing elective general surgery. Preoperative DVT assessment is thus considered to be necessary regardless of the disease for which surgery is indicated, especially in patients with the risk factors identified in this study.

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We have no outside financial support.

CONFLICT OF INTEREST STATEMENT

HY is an editorial board member of the *Annals of Gastroenterological Surgery*. The other authors have no conflicts of interest to declare for this article.

ETHICS STATEMENT

Approval of the research protocol: This study was approved by the institutional ethics committee of the Toride Medical Association Hospital (approval number 113).

Informed consent: The requirement for informed consent was waived owing to the anonymous nature of the data.

Registry and the registration No. of the study: N/A.

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REFERENCES

1. Laporte S, Mismetti P, Decousus H, Uresandi F, Otero R, Lobo JL, et al. Clinical predictors for fatal pulmonary embolism in 15 520 patients with venous thromboembolism: findings from the Registro Informatizado de la Enfermedad TromboEmbolica venosa (RIETE) registry. Circulation. 2008;117:1711–6.
2. Albayati MA, Grover SP, Saha P, Lwaleed BA, Modarai B, Smith A. Postsurgical inflammation as a causative mechanism of venous thromboembolism. Semin Thromb Hemost. 2015;41:615–20.
3. Sakon M, Maehara Y, Yoshikawa H, Akaza H. Incidence of venous thromboembolism following major abdominal surgery: a multicenter, prospective epidemiological study in Japan. J Thromb Haemost. 2006;4:581–6.
4. Sakon M, Kobayashi T, Shimazui T. Efficacy and safety of enoxaparin in Japanese patients undergoing curative abdominal or pelvic cancer surgery: results from a multicenter, randomized, open-label study. Thromb Res. 2010;125:e65–70.
5. Iversen LH, Thorlacius-Ussing O. Relationship of coagulation test abnormalities to tumour burden and postoperative DVT in resected colorectal cancer. Thromb Haemost. 2002;87:402–8.

6. Heit JA. Cancer and venous thromboembolism: scope of the problem. Cancer Control. 2005;12(Suppl 1):5–10.
7. Walker AJ, Card TR, West J, Crooks C, Grainge MJ. Incidence of venous thromboembolism in patients with cancer – a cohort study using linked United Kingdom databases. Eur J Cancer. 2013;49:1404–13.
8. Cronin-Fenton DP, Sondergaard F, Pedersen LA, Fryzek JP, Cetin K, Acquavella J, et al. Hospitalisation for venous thromboembolism in cancer patients and the general population: a population-based cohort study in Denmark, 1997–2006. Br J Cancer. 2010;103:947–53.
9. Blom JW, Doggen CJ, Osanto S, Rosendaal FR. Malignancies, prothrombotic mutations, and the risk of venous thrombosis. Jama. 2005;293:715–22.
10. Osaki T, Saito H, Fukumoto Y, Kono Y, Murakami Y, Shishido Y, et al. Risk and incidence of perioperative deep vein thrombosis in patients undergoing gastric cancer surgery. Surg Today. 2018;48:525–33.
11. Tanizawa Y, Bando E, Kawamura T, Tokunaga M, Makuuchi R, Iida K, et al. Prevalence of deep venous thrombosis detected by ultrasonography before surgery in patients with gastric cancer: a retrospective study of 1140 consecutive patients. Gastric Cancer. 2017;20:878–86.
12. Suzuki K, Shibasaki S, Nakauchi M, Nakamura K, Akimoto S, Tanaka T, et al. Impact of routine preoperative sonographic screening with early intervention for deep venous thrombosis in lower extremities on preventing postoperative venous thromboembolism in patients with gastric cancer scheduled for minimally invasive surgery. Langenbecks Arch Surg. 2022;407:597–608.
13. Nakagawa K, Watanabe J, Suwa Y, Suzuki S, Ishibe A, Ota M, et al. Clinical analysis of preoperative deep vein thrombosis risk factors in patients with colorectal cancer: retrospective observational study. Ann Gastroenterol Surg. 2019;3:451–8.
14. Brierley JD, Gospodarowicz MK, Wittekind C. TNM classification of malignant tumours. 8th ed. West Sussex: John Wiley & Sons, Ltd; 2017.
15. Meissner MH, Moneta G, Burnand K, Gloviczki P, Lohr JM, Lurie F, et al. The hemodynamics and diagnosis of venous disease. J Vasc Surg. 2007;46:S4–S24.
16. Group JCSJW. Guidelines for the diagnosis, treatment and prevention of pulmonary thromboembolism and deep vein thrombosis (JCS 2009). Circ J. 2011;75:1258–81.
17. Gainsbury ML, Erdrich J, Taubman D, Mirocha J, Manguso N, Amersi F, et al. Prevalence and predictors of preoperative venous thromboembolism in asymptomatic patients undergoing major oncologic surgery. Ann Surg Oncol. 2018;25:1640–5.
18. Stender MT, Nielsen TS, Frokjaer JB, Larsen TB, Lundbye-Christensen S, Thorlacius-Ussing O. High preoperative prevalence of deep venous thrombosis in patients with colorectal cancer. Br J Surg. 2007;94:1100–3.
19. Trousseau A. Phlegmasia alba dolens. Clinique Medicale de L'Hotel Dieu de Paris. 2nd ed. Paris: J.B. Balliere; 1865. p. 654–6.
20. Lo L, Valentine H, Harrison J, Hayes S, Welch I, Pritchard S, et al. Tissue factor expression in the metaplasia-adenoma-carcinoma sequence of gastric cancer in a European population. Br J Cancer. 2012;107:1125–30.
21. Gould MK, Garcia DA, Wren SM, Karanicolas PJ, Arcelus JI, Heit JA, et al. Prevention of VTE in nonorthopedic surgical patients: antithrombotic therapy and prevention of thrombosis: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. Chest. 2012;141:e227S–e77S.
22. Bahl V, Hu HM, Henke PK, Wakefield TW, Campbell DA Jr, Caprini JA. A validation study of a retrospective venous thromboembolism risk scoring method. Ann Surg. 2010;251:344–50.
23. Kozek-Langenecker S, Fenger-Eriksen C, Thienpont E, Barauskas G, Force EVGT. European guidelines on perioperative venous thromboembolism prophylaxis: surgery in the elderly. Eur J Anaesthesiol. 2018;35:116–22.
24. Neeman E, Liu V, Mishra P, Thai KK, Xu J, Clancy HA, et al. Trends and risk factors for venous thromboembolism among hospitalized medical patients. JAMA Netw Open. 2022;5:e2240373.
25. Geerts WH, Bergqvist D, Pineo GF, Heit JA, Samama CM, Lassen MR, et al. Prevention of venous thromboembolism: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. Chest. 2008;133:381S–453S.
26. Akune T, Muraki S, Oka H, Tanaka S, Kawaguchi H, Nakamura K, et al. Exercise habits during middle age are associated with lower prevalence of sarcopenia: the ROAD study. Osteoporos Int. 2014;25:1081–8.
27. Chi G, Gibson CM, Hernandez AF, Hull RD, Kazmi SHA, Younes A, et al. Association of anemia with venous thromboembolism in acutely ill hospitalized patients: an APEX trial substudy. Am J Med. 2018;131(972):e1–7.
28. Hung SH, Lin HC, Chung SD. Association between venous thromboembolism and iron-deficiency anemia: a population-based study. Blood Coagul Fibrinolysis. 2015;26:368–72.
29. Kulnigg-Dabsch S, Evstatiev R, Dejaco C, Gasche C. Effect of iron therapy on platelet counts in patients with inflammatory bowel disease-associated anemia. PLoS One. 2012;7:e34520.
30. Khorana AA, Kuderer NM, Culakova E, Lyman GH, Francis CW. Development and validation of a predictive model for chemotherapy-associated thrombosis. Blood. 2008;111:4902–7.
31. Buchberg B, Masoomi H, Lusby K, Choi J, Barleben A, Magno C, et al. Incidence and risk factors of venous thromboembolism in colorectal surgery: does laparoscopy impart an advantage? Arch Surg. 2011;146:739–43.
32. Shapiro R, Vogel JD, Kiran RP. Risk of postoperative venous thromboembolism after laparoscopic and open colorectal surgery: an additional benefit of the minimally invasive approach? Dis Colon Rectum. 2011;54:1496–502.
33. Saka M, Morita S, Fukagawa T, Nijjar R, Katai H. Incidence of pulmonary thromboembolism in gastric cancer surgery using routine thromboprophylaxis. Gastric Cancer. 2010;13:117–22.
34. Sakon M, Kakkar AK, Ikeda M, Sekimoto M, Nakamori S, Yano M, et al. Current status of pulmonary embolism in general surgery in Japan. Surg Today. 2004;34:805–10.
35. Nakagawa K, Watanabe J, Ota M, Suwa Y, Suzuki S, Suwa H, et al. Efficacy and safety of enoxaparin for preventing venous thromboembolic events after laparoscopic colorectal cancer surgery: a randomized-controlled trial (YCOG 1404). Surg Today. 2020;50:68–75.

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