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

日本大学医学部外科学系消化器外科学分野

萩原　謙

申請年　2023 年

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Received: 4 April 2023 | Revised: 7 June 2023 | Accepted: 10 June 2023

DOI: 10.1002/ags3.12709

AGSurg Annals of Gastroenterological Surgery Open Access WILEY

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

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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

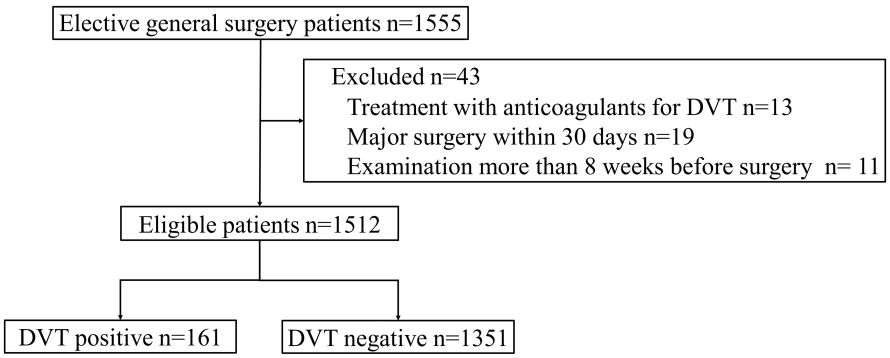

FIGURE 1 Flowchart of the patient selection process.

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,

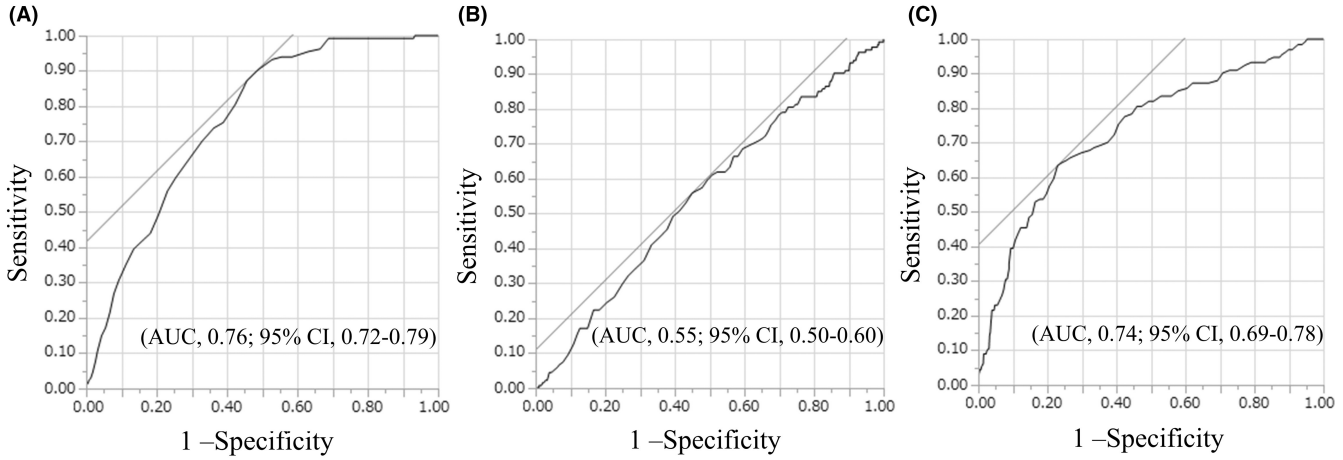

FIGURE 2 Receiver-operating characteristic curves for age (A), white blood cell count (B), and hemoglobin level (C).

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.

FUNDING INFORMATION

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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How to cite this article: Hagiwara K, Watanabe Y, Suzuki T, Okamura Y, Yamashita H. Prevalence of preoperative asymptomatic deep vein thrombosis in patients undergoing elective general surgery for benign disease. Ann Gastroenterol Surg. 2023;00:1–7. https://doi.org/10.1002/ags3.12709

要約

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論文題名：Prevalence of preoperative asymptomatic deep vein thrombosis in patients undergoing elective general surgery for benign disease
（一般外科手術を受ける良性疾患患者における術前の無症候性深部静脈血栓症の有病率）

【背景】
深部静脈血栓症（DVT）に続発する肺血栓塞栓症（PE）は、一般外科手術における致命的な合併症であり、死亡率は 1%未満から 7%と報告されている。悪性疾患に対する手術は、手術による全身的な炎症反応だけでなく、悪性疾患による凝固亢進状態のため、術後の血栓予防が推奨されてきた。さらに悪性疾患は静脈血栓塞栓症（VTE） リスクの上昇と強く関連することから、既に術前から VTE が存在している可能性も示唆され検討されてきた。その結果、術前の無症候性 DVT の有病率は 4.4～13.5%と報告されている。ただし注目すべきは、どの研究も悪性疾患の病期と術前 DVT の発症に有意な関連がないことである。術前 DVT の発症は悪性疾患の有無に関係なくすべての一般外科手術患者に起こりうる可能性が示唆されるが、一般外科手術患者、特に良性疾患患者の術前の無症候性 DVT の情報は非常に限られている。本研究は、一般外科手術患者の術前の無症候性 DVT の有病率とそのリスク因子を明らかにすることを目的として計画された。
【対象と方法】
本研究は 2011 年 1 月～2020 年 9 月に取手北相馬保健医療センター医師会病院において一般外科手術を予定し、DVT の術前スクリーニングとして下肢静脈超音波検査を、手術 8 週間以内に施行された患者を解析対象として後ろ向きに検討した。DVT に対する抗凝固療法を施行中の患者、症候性 DVT の患者、下肢静脈超音波検査施行前に別の手術を既に受けていた患者（検査 30 日前）は本研究の対象から除外された。本コホートではガイドラインに沿った予防のほかに、術前 DVT を保有した患者に間歇的空気圧迫法（IPC）は使用せず、症例毎に抗凝固療法の介入が検討された。術前の無症候性 DVT の有病率と特徴、リスク因子、臨床経過が評価された。本研究は取手北相馬保健医療センター医師会病院倫理委員会の承認をうけた。（承認番号 113）
【結果】
解析対象となった 1512 例のうち、161 例（10.6%）（悪性疾患患者 83 例（13.7%）、良性疾患患者 78 例（8.6%））が、術前に無症候性 DVT を有していた。141 例（87.6%）が末梢型であり、ヒラメ筋静脈が 135 例（84%）と最多であった。70 例（43%）で多発病変を認め、血栓の長軸方向の大きさ（多発病変は最大血栓径）の中央値は 27mm（四分位点 18.0－42.5）であった。 20 例（12%）で中枢型 DVT を認め、15 例（9.3%）に下大静脈フィルターが挿入された。良性疾患においても中枢型 DVT が 6 例（7.7%）に認められた。130 例（8.6%）（DVT 無し群 64 例（4.7%）、DVT 有り群 66 例（41%）、$p<0.001$）に術後に抗凝固療法が行われた。術後の症候性 VTE は 2 例（0.013%）に認められた。術前 DVT を有した症例で、術後に症候性 VTE を認めた症例はなかった。
単変量解析では高齢（70 歳以上）、女性、BMI（<25 kg/m^2）、白血球数（<5.8×10^3/μL）、貧血（Hb<11.8 g/dl）、悪性疾患、化学療法、中心静脈カテーテル、癌の既往、高血圧、喫煙が有意なリスク因子として挙がったが、多変量解析では、高齢（70 歳以上）[オッズ比 6.40（95%CI 3.77-10.87）、$p<0.001$]、女性[オッズ比 2.39（95%CI 1.63-3.49）、$p<0.001$]、貧血（Hb<11.8 g/dL）[オッズ比 3.03（95%CI 2.04-4.50）、$p<0.001$]が術前の無症候性 DVT と有意に関連していた。高齢のオッズ比が最も高く、年齢が上昇するとともにオッズ比も上昇した。一方、悪性疾患は独立したリスク因子ではなかった [オッズ比 0.77（95%CI 0.52-1.16）、$p=0.21$]。
【考察】
本研究は、一般外科手術患者の術前の無症候性 DVT の有病率は高く、良性疾患においても既知の悪性疾患の術前の無症候性 DVT の有病率（4.4～13.5%）と同程度の、高い有病率であることを示した。また高齢、女性、貧血が独立したリスク因子であり、悪性疾患は有意なリスク因子とならなかった。
リスク因子の候補となった説明変数間の φ 係数は小さく、交絡の影響は低いと考えられた。また 70 歳以上、女性、Hb11.8g/dl 未満のそれぞれの限定した群で悪性疾患のオッズ比を検討しても、

0.69（95%CI 0.44-1.08、p=0.11）、0.62（95%CI 0.35-1.10、p=0.10）、0.99（95%CI 0.57-1.79、p=0.98）と独立した相関を認めず、炎症性疾患を除外した検討でも悪性疾患は独立したリスク因子にならなかった。

高齢は術前DVTのリスク因子として知られており、そのオッズ比は加齢により急激に上昇した。運動能力の低下は病院関連 VTE の発生率の上昇と関連し、サルコペニアの有病率は加齢とともに上昇することから、加齢による運動能力の低下が結果に影響を与えた可能性がある．貧血は、栄養失調、慢性炎症、悪性疾患などと関連するため術前DVTのリスクになりうる。

女性もまた術前DVTのリスク因子として知られており、本研究の結果はそれらの報告と一致する。経口避妊薬やホルモン補充療法は血液凝固能を亢進し、妊娠は血液凝固能の亢進に加えて血流停滞も引き起こすことが知られている。しかしながら、本研究の女性577例のうち444例（77%）が60歳以上であるためそれらの理由は考えにくい。本邦でのDVTの有病率は女性で高く（1.33-1.95倍）性差が認められるという事実から、本研究における DVT の有病率はそれを反映している可能性がある。ただし、欧米では DVT の有病率は男性が高い（1.18 倍）にかかわらず、Stender らの大腸癌の術前 DVT に対する前向き検討では、女性が独立したリスク因子として挙がっている。DVT と性差については今後の検討が必要である。

本研究は、一般外科手術患者の術前の無症候性DVTの有病率を後方視的に検討した研究であり、治療介入の有効性についてデザインされたものではないため、治療の是非、治療対象については、本研究結果を元にした明確な結論は出せない。しかしながら、本研究で用いたコホートに対しては、日常診療としてガイドラインに沿った予防のほかに、術前DVTを保有した患者にIPCは使用せず、症例毎に抗凝固療法の介入が検討された。20例(12%)で中枢型DVTを認め、15例(9.3%)に下大静脈フィルターが挿入された。本研究全体での症候性 VTE 発症は 2 例（0.013%）のみで、一般外科患者の症候性VTEの発症率（0.85%~4.1%）に比べて低率であった。さらに術前にDVTを認めた患者で術後に症候性VTEを発症した患者はいなかったことから、術前の無症候性DVTの検索とそれに対する治療介入が一定の効果を示した可能性がある。ただし、本研究では術前DVTに対してプロトコールに則った一律の治療介入を行ってはおらず、術前の無症候性DVTの治療介入の是非はさらなる前向きな検討が必要である。

【結論】

本研究では、一般外科手術を予定された患者で術前の無症候性DVTの有病率は高く、良性疾患患者においても、悪性疾患患者と同様にその有病率が高いことが示された。良悪性にかかわらず、特にリスク因子を持つ一般外科患者では、術前に無症候性DVTを有する可能性を念頭に置いた対応が必要である。