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ORIGINAL ARTICLE

The risk of venous thromboembolism after minor surgical procedures: A population-based case-control study

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Abstract

Background: Surgery is a well-known risk factor for venous thromboembolism (VTE). However, for several minor surgical procedures, thromboprophylaxis is not advised.

Objectives: These "low-risk" procedures include a wide variation of interventions for which we estimated the VTE risk to verify their "low-risk" status.

Patients/Methods: We used data from a large population–based case-control study (Multiple Environment and Genetic Assessment study) into causes of VTE, and linked these to the Dutch Hospital Data Registry to identify exposure to surgical procedures. Logistic regression was used to calculate odds ratios for the 90-day and 1-year relative risks of VTE following these procedures, which were adjusted for body mass index (BMI), sex, age, comorbidities, and infection/inflammation.

Results: We included 4247 patients with VTE and 5538 control subjects. Median age and BMI were 48.5 years and 25.5 m^2/kg, respectively. Nine unique procedures or groups of procedures were analyzed. One hundred twenty-three participants—90 cases and 33 controls—had undergone a minor procedure within 90 days of the index date, resulting in a 3.5-fold (OR, 3.5; 95% CI, 2.3-5.3) overall increased VTE risk. Furthermore, venous stripping (OR, 7.2; 95% CI, 2.4-21.2), open abdominal/inguinal hernia repair (OR, 3.7; 95% CI, 1.2-11.6), and laparoscopic cholecystectomy (OR, 3.2; 95% CI, 1.0-10.6) were associated with an increased risk. Other minor procedures were less strongly or not associated with an increased risk. In the 1-year period before the index date, all odds ratios were lower.

Conclusion: Of the "low-risk" procedures, we found that venous stripping, open abdominal/inguinal hernia repair, and laparoscopic cholecystectomy were associated with a clearly increased risk of VTE within 90 postoperative days.

KEYWORDS
case-control studies, epidemiology, minor surgical procedures, risk assessment, venous thromboembolism

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1 | INTRODUCTION

Venous thromboembolism (VTE) manifests in 1 to 2 persons per 1000 person-years within the general population [1]. Both deep venous thrombosis (DVT) and pulmonary embolism (PE) are associated with long-term morbidities such as post-thrombotic syndrome and chronic pulmonary hypertension, respectively [2]. PE is associated with a mortality of 15% to 20% within 3 months [3]. Surgery is an important risk factor for VTE, which could partially be explained by its associated perioperative immobilization and induced tissue damage [4–7].

Both the Dutch and German national guidelines for VTE prevention and the American "updated 3 bucket model", which is based on the American College of Chest Physicians (ACCP) guidelines from 2012, categorize surgical procedures into 3 groups according to their postoperative VTE risk: low, moderate, and major [8–11]. Examples of low-risk procedures, according to these guidelines/models (including the ACCP guidelines), are minor surgeries such as open or laparoscopic abdominal/inguinal hernia repair, endoscopic prostate resections, and nonmalignant laparoscopic surgeries under 45 minutes, such as appendectomy and cholecystectomy. All 3 guidelines state that chemical thromboprophylaxis should not be administered to patients undergoing low-risk procedures in the absence of other strong risk factors [8–10].

However, although minor interventions lead to limited tissue damage and perioperative immobilization, multiple studies have shown that some of these interventions nevertheless lead to an increased risk of VTE [12,13]. Consequently, it remains unclear whether the reduction in VTE risk with medicinal thromboprophylaxis outweighs an increased postoperative bleeding risk and costs and, hence, whether thromboprophylaxis is indicated for some of these procedures. Furthermore, as risk estimates of these minor surgeries, included in the current low-risk category, were mostly assessed in differing populations and study designs, it is difficult to compare these risks against each other [12–25]. More detailed knowledge on the risk of VTE following specific minor procedures would allow for finer ranking of the risks and could further enhance our capability to specifically target those patients who need thromboprophylaxis, particularly when other risk factors for VTE are also present.

For this purpose, we used data from a large population–based case-control study on risk factors for VTE, linked to the Dutch Hospital Data Registry, to assess the relative risks of symptomatic VTE following minor surgical procedures, all within a single population.

Essentials

- Several minor surgeries are classified as having a low risk of venous thromboembolism (VTE).
- We verified the risk of VTE following multiple minor surgeries in a single population.
- Absolute risks of VTE at 90 days and 1 year following minor surgery seem indeed low.
- The observed risk differences could refine personalized thromboprophylaxis.

2 | METHODS

2.1 | Study population

Data from the Multiple Environment and Genetic Assessment (MEGA) study were used, the details of which have been published previously [26,27]. In short, the MEGA study is a large population–based case-control study into the etiology of VTE and includes 4956 individuals with a first VTE and 6297 control participants. Cases were unselected patients, aged 18 to 70 years, with a confirmed PE or deep vein thrombosis, who were recruited from 6 anticoagulation clinics in the Netherlands between March 1999 and August 2004. Because patients were included upon admission to one of the anticoagulation clinics, patients who suffered a directly fatal PE were not included in the study. As controls, partners of the patients were invited to participate. Additionally, between January 2002 and August 2004, the control group was expanded by the identification of controls through random digit dialing (RDD) [28]. Partners were matched individually with patients, whereas RDD controls were frequency-matched for sex and age. To minimize the effect of an underlying cancer on the VTE risk, participants with a history of cancer in the 5 years preceding the index date were excluded.

2.2 | Data collection

Upon inclusion, patients and controls completed a questionnaire on risk factors for VTE, including age, sex, weight, and height, and comorbidities. The date of VTE diagnosis was used as the index date for both patients and their partner controls. For RDD controls, the date upon the completion of the questionnaire was used as the index date. Both patients and controls were asked to report on any surgical intervention they might have had in the year preceding the index date. However, as these data were prone to recall bias and may possibly be incomplete or incorrect, particularly with respect to exact dates, participants of the MEGA study were linked to the Dutch Hospital Data (DHD) registry. Details of this linkage have been described previously [27]. This registry provides nationwide electronic coverage of data on all hospital admissions (including day care admissions) since 1995. For each admission, information on the dates of admission and discharge, diagnoses, and surgical procedures is available (coded according to the International Classification of Diseases, Ninth Revision, Clinical Modification) [29]. A previous study comparing a random sample of hospital admissions in the Dutch Hospital Data Registry with information from hospital records showed that 99% of the personal, admission, and discharge data and 84% of the principal diagnosis data were correctly encoded [30]. Individuals with information leading to more than 1 person (eg, twins) or to no one at all (eg, immigrants or visitors) were excluded. Of the MEGA participants with VTE, 4721 patients (95.3%) could be uniquely linked to the registry [27,31].

2.3 | Determination of minor interventions

Classification of procedures as being minor or major surgeries is a debated topic without clear definitions [32]. Therefore, to determine which surgical interventions would classify as minor, we combined the current low-risk classifications from the Dutch, German, and the 9th edition of the ACCP preoperative thromboprophylaxis guidelines [9–11]. In cases where these guidelines seemed contradictive, as for laparoscopic cholecystectomy and inguinal hernia repair, the broadest definition was chosen. In the Dutch guideline for example, it is stated that surgeries up to 45 minutes should be considered as low-risk, while in the ACCP guideline, laparoscopic cholecystectomy and inguinal hernia repair are explicitly named as low-risk procedures. Hence, although the procedure time for laparoscopic cholecystectomy and inguinal hernia repair may be longer than 45 minutes, we did include them based on the definition by the ACCP guideline.

2.4 | Statistical analysis

Interventions that occurred within 90 days preceding the index date were considered as the exposure of interest. In case of more than one surgical procedure, the one closest to the index date was included (for each analysis). The types of interventions were analyzed either separately or grouped together by surgical discipline (in case of small numbers). Logistic regression was used to obtain odds ratios (ORs) with their 95% CIs as an estimate of relative risks (RRs). ORs were adjusted for body mass index (BMI), sex, age, comorbidities, and infection/inflammation in the year preceding the index date, as specified in the questionnaires. Comorbidities included chronic obstructive pulmonary disease, liver disease, kidney disease, rheumatoid arthritis, multiple sclerosis (MS), heart failure, hemorrhagic stroke, and arterial thrombosis.

Due to the small number of participants having undergone certain interventions in the 90 days preceding the index date, the analysis was repeated with inclusion of interventions, which preceded the index date by up to 1 year. To approximate the absolute risk of VTE at 90 days and 1 year following each of the minor procedures, we first estimated the expected 90-day and 1-year cumulative incidence of VTE in the general Dutch population (reference population), weighted for age and sex distribution of the control population [33]. These expected cumulative incidences were subsequently multiplied by each of the ORs separately to obtain the cumulative incidence that would be observed had the reference population undergone the concerning minor intervention.

All results were based on calculations using nonpublic microdata from Statistics Netherlands (where the DHD is located) and their privacy regulations prohibit reporting of numbers <3. Therefore, these numbers and corresponding ORs and estimated incidences had to be masked. For all statistical analyses, Stata version 15 (Statacorp) was used.

3 | RESULTS

3.1 | Study population

After exclusion of participants with a history of cancer, 9785 participants, 4247 cases, and 5538 controls were assessed. The median age and BMI were 48.5 years and 25.5 m^2/kg, respectively (Table 1). We considered 9 types of surgical procedures or grouped procedures (venous stripping, laparoscopic cholecystectomy, open abdominal/inguinal hernia repair, ophthalmologic interventions, peripheral nerve interventions, minor perianal interventions, open appendectomy, otolaryngology head and neck surgery [OHNS], and urologic interventions). One hundred twenty-three participants had undergone at least one of these minor surgical procedures within 90 days preceding the index date. One thousand one hundred ninety-three participants (684 cases and 509 controls) were excluded during the adjusted logistic regression analyses because of missing data (Table 1).

3.2 | Risk of venous thromboembolism after minor surgery

Minor surgery (all interventions combined) was associated with a 3.5-fold increased risk of postoperative VTE within the first 90 days postoperatively, ie, an adjusted OR of 3.5 (95% CI, 2.3 to 5.3; Table 2 and Figure 1).

At 90 days, increased VTE risks were found following venous stripping (OR, 7.2; 95% CI, 2.4 to 21.2), open abdominal/inguinal hernia repair (OR, 3.7; 95% CI, 1.2 to 11.6), and laparoscopic cholecystectomy (OR, 3.2; 95% CI, 1.0 to 10.6).

For the remaining procedures, only ophthalmologic interventions were weakly associated with an increased VTE risk. Other surgeries either were not associated or could not be reported on due to too small numbers.

Inclusion of procedures that preceded the index date by 1 year resulted in lower ORs for all procedures. Venous stripping, open abdominal/inguinal hernia repair, and laparoscopic cholecystectomy remained associated with an increased risk of VTE. Point estimates for peripheral nerve interventions and perianal minor interventions also showed an elevated risk of VTE, albeit inconclusive. None of the other procedures were associated with an increased risk of VTE at 1 year.

The approximated cumulative incidences for the reference population were 0.03% and 0.09% at 90 days and 1 year, respectively. Multiplying these incidences with the observed RRs following each of the minor surgeries led to estimated absolute risks that were all below 0.5% at both time-points (Table 3).

4 | DISCUSSION

4.1 | Main findings

The aim of this study was to determine the risks of VTE following multiple low-risk surgeries within a single population. Our data clearly

TABLE 1 General characteristics of the study population.

Characteristics	Total	Cases	Missing in cases n (%)	Controls	Missing in controls n (%)
Total, n (%)	9785	4247 (43.4)	684 (16.1)	5538 (56.6)	509 (9.2)
Female, n (%)	5316 (54.3)	2334 (55.0)	0	2982 (53.9)	0
Age, median (p25, p75)	48.5 (38.1, 57.8)	48.9 (38.3, 58.5)	0	48.2 (38.0, 57.4)	0
BMI, median (p25, p75)	25.5 (23.0, 28.4)	26.3 (23.7, 29.3)	368 (8.7)	25.0 (22.6, 27.8)	376 (6.8)
Lung disease, n (%)[a]	409 (4.2)	243 (5.7)	541 (12.7)	166 (3.0)	470 (8.5)
Liver disease, n (%)	40 (0.4)	20 (0.5)	555 (13.1)	20 (0.4)	471 (8.5)
Kidney disease, n (%)	63 (0.6)	43 (1.0)	554 (13)	20 (0.4)	468 (8.5)
Rheumatoid arthritis, n (%)	251 (2.6)	133 (3.1)	546 (12.9)	118 (2.1)	468 (8.5)
Multiple sclerosis (MS), n (%)	41 (0.4)	25 (0.6)	555 (13.1)	16 (0.3)	472 (8.5)
Heart failure, n (%)	116 (1.2)	62 (1.5)	552 (13)	54 (1.0)	470 (8.5)
Hemorrhagic stroke, n (%)	40 (0.4)	31 (0.7)	553 (13)	9 (0.2)	472 (8.5)
Arterial thrombosis, n (%)[b]	353 (3.6)	178 (4.2)	543 (12.8)	175 (3.2)	466 (8.4)
Infection/inflammation, n (%)[c]	2620 (26.8)	1255 (29.6)	384 (9.0)	1365 (24.6)	349 (6.3)
Admission duration, median days (p25, p75)[d]	1 (0, 2)	3.25 (0, 3.25)	0	2 (0, 2)	0

TIA, transient ischemic attack.

[a] Consisting of chronic bronchitis and emphysema.

[b] Consisting of myocardial infarction, ischemic stroke and TIA.

[c] Consisting of lung infection, urinary tract infection, arthritis, bursitis, sinusitis, orthodontitis, hepatitis and other.

[d] Admission duration for patients in the 90-day analysis.

TABLE 2 Ninety-day and 1-year odds ratios of venous thromboembolism after minor surgical procedures.

	90 days			1 year		
Procedures	Cases N = 4247	Controls N = 5538	Adjusted ORs[a] (95% CI)	Cases N = 4247	Controls N = 5538	Adjusted ORs[a] (95% CI)
All procedures[c]	90	33	3.5 (2.3-5.3)	132	104	1.7 (1.3-2.3)
Venous stripping	23	4	7.2 (2.4-21.2)	25	10	3.9 (1.9-8.1)
Open abdominal/inguinal hernia repair	13	4	3.7 (1.2-11.6)	19	9	2.9 (1.3-6.6)
Laparoscopic cholecystectomy	10	5	3.2 (1.0-10.6)	15	9	2.2 (1.0-5.2)
Ophthalmologic interventions[d]	9	7	2.3 (0.8-6.5)	20	25	1.1 (0.6-1.9)
Peripheral nerve interventions[e]	6	<3[b]	-	8	3	3.2 (0.8-12.4)
Perianal minor interventions[f]	<3[b]	<3[b]	-	7	5	2.1 (0.7-6.5)
Open appendectomy	5	<3[b]	-	7	7	1.3 (0.5-3.8)
OHNS[g]	16	11	1.5 (0.7-3.6)	27	28	1.2 (0.7-2.1)
Urologic interventions[h]	<3[b]	<3[b]	-	4	7	0.5 (0.1-2.1)

Results based on calculations using nonpublic microdata from Statistics Netherlands.

BMI, body mass index; OHNS, otolaryngology head and neck surgery; OR, odds ratio.

[a] Adjusted for BMI, sex, age, comorbidities (as one variable) and infections or inflammations (as one variable).

[b] Numbers smaller than 3 had to be masked due to privacy regulations by the Dutch Bureau for Statistics. Therefore, odds ratios could also not be reported for these procedures.

[c] Does not sum up as some individuals underwent multiple procedures within 90 days or 1 year.

[d] Mainly consisting of cataract surgery and blepharoptosis repair interventions.

[e] Mainly consisting of nerve damage repair, nerve decompression, and transposition procedures.

[f] Including hemorrhoid surgery and perianal incision and excisions.

[g] OHNS includes mainly tonsillectomies, nose septum and sinus surgery, and tracheostomy procedures.

[h] Mainly consisting of vasectomy and circumcision procedures.

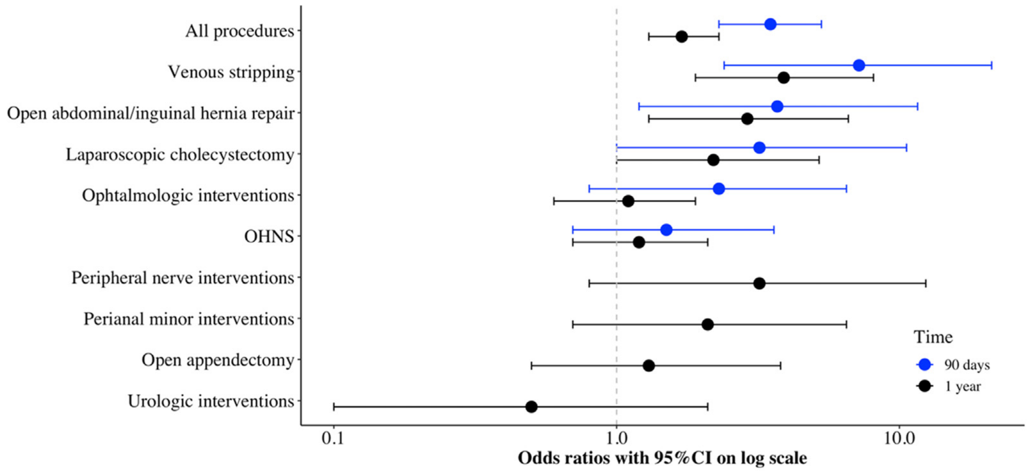

FIGURE 1 Adjusted odds ratios for the 90-day and 1-year risk of VTE following minor surgical procedures. Odds ratios are adjusted for BMI, sex, age, comorbidities, and infection/inflammation in the year preceding the index date. Ninety-day odds ratios could not be reported for peripheral nerve interventions, minor perianal interventions, and open appendectomy procedures due to small numbers, which would violate the privacy regulations by Statistics Netherlands. BMI, body mass index; OHNS, otolaryngology head and neck surgery; VTE, venous thromboembolism. Results based on calculations using nonpublic microdata from Statistics Netherlands.

showed an elevated risk of VTE after venous stripping, open hernia repair, and laparoscopic cholecystectomy with 7-, 4- and 3-fold increased risks, respectively. Furthermore, several procedures, ie, ophthalmologic interventions, peripheral nerve interventions, and minor perianal interventions, showed a weakly increased risk. The remaining interventions were not associated with postoperative VTE. The variation in risks between surgeries is likely due to the differences in tissue damage and immobilization, as these 2 factors are thought to be the greatest in the surgeries for which we found the highest ORs.

TABLE 3 Approximations of 90-day and 1-year cumulative incidences of VTE following minor procedures.

	90 days		1 year	
Procedures	Adjusted ORs[a] (95% CI)	Approximated cumulative incidence (%)	Adjusted ORs[a] (95% CI)	Approximated cumulative incidence (%)
Weighted baseline risk		0.03		0.09
All procedures	3.5 (2.3-5.3)	0.11 (0.07-0.16)	1.7 (1.3-2.3)	0.16 (0.12-0.21)
Venous stripping	7.2 (2.4-21.2)	0.22 (0.07-0.64)	3.9 (1.9-8.1)	0.36 (0.17-0.73)
Open abdominal/inguinal hernia repair	3.7 (1.2-11.6)	0.11 (0.04-0.35)	2.9 (1.3-6.6)	0.27 (0.12-0.59)
Laparoscopic cholecystectomy	3.2 (1.0-10.6)	0.10 (0.03-0.32)	2.2 (1.0-5.2)	0.20 (0.09-0.47)
Ophthalmologic interventions[c]	2.3 (0.8-6.5)	0.07 (0.024-0.20)	1.1 (0.6-1.9)	0.10 (0.05-0.17)
Peripheral nerve interventions[d]	[b]	-	3.2 (0.8-12.4)	0.30 (0.07-1.12)
Perianal minor interventions[e]	[b]	-	2.1 (0.7-6.5)	0.20 (0.06-0.59)
Open appendectomy	[b]	-	1.3 (0.5-3.8)	0.12 (0.05-0.34)
OHNS[f]	1.5 (0.7-3.6)	0.05 (0.02-0.11)	1.2 (0.7-2.1)	0.11 (0.06-0.19)
Urologic interventions[g]	[b]	-	0.5 (0.1-2.1)	0.05 (0.01-0.19)

Results based on calculations using nonpublic microdata from Statistics Netherlands.

BMI, body mass index; OHNS, otolaryngology head and neck surgery; VTE, venous thromboembolism.

[a] Adjusted for BMI, sex, age, comorbidities (as one variable) and for infections or inflammations (as one variable).

[b] Numbers smaller than 3 had to be masked due to privacy regulations by the Dutch Bureau for Statistics. Therefore, odds ratios and cumulative incidences also could not be reported for these procedures.

[c] Mainly consisting of cataract surgery and blepharoptosis repair interventions.

[d] Mainly consisting of nerve damage repair, nerve decompression, and transposition procedures.

[e] Including hemorrhoid surgery and perianal incision and excisions.

[f] OHNS includes mainly tonsillectomies, nose septum and sinus surgery, and tracheostomy procedures.

[g] Mainly consisting of vasectomy and circumcision procedures.

The 1-year risk estimates were lower for all surgeries. This is because the elevation of the risk of VTE is restricted to the first 90 days and, hence, the 1 year ORs are a "dilution" of the 90-day risk.

4.2 | Literature overview

Previous studies have found the risk of VTE after venous stripping to be high in the absence of thromboprophylaxis [14,15]. In a randomized controlled trial, the incidence of DVT (symptomatic and asymptomatic combined) and PE was reported to be 5% and 1.5% within the first month following venous stripping without thromboprophylaxis, respectively [14]. Any form of thromboprophylaxis used in the other arms of the trial lowered the incidence of DVT (between 0.35% and 0.56%) and PE (0%) drastically [14]. Additionally, White et al. assessed the risk of multiple surgeries simultaneously and found the incidence of VTE after venous ligation and stripping to be 1.6% in the first 91 postoperative days [15]. Information on thromboprophylaxis was lacking in this study.

The same study by White et al. also assessed the risks of inguinal hernia repair and laparoscopic cholecystectomy, and reported these to be 0.4% and 0.2%, respectively [15]. A more recent study by Alizadeh et al. found a risk of 0.24% for developing VTE within the first 30 postoperative days for inguinal hernia repair and 0.20% for cholecystectomy [16]. The OR, at 90-days postoperatively, following a hernia repair procedure was estimated to be 2.7 by one study, while another study found hazard ratios of 2.3 and 3.5 within the first postoperative month for the same-day and planned in-patient procedures, respectively [12,17]. For laparoscopic cholecystectomy, a study by Bouras et al. reported a 90-day OR of 3.41, while that by Henry et al. [13] reported hazard ratios varying between 4.5 for in-patient procedures and 2.4 for day cases, depending on the time since the procedure [17].

For ophthalmologic interventions, literature regarding the postoperative VTE risk is limited to 2 case reports [34,35]. One of these case reports focused on a 38-year-old woman who was bed-rested for more than 2 weeks postoperatively and developed a PE [35]. On VTE following peripheral nerve interventions, 2 previous studies reported a cumulative incidence of 0.1% DVT and 0% PE within the first 30 days following surgery [18,19]. To our knowledge, there is no existing literature on the risk of VTE following minor perianal interventions.

Contrary to previous studies, we found no increased risk for open appendectomy procedures [17,20,21]. However, due to a small number of procedures at 90 days, we were only able to report the 1-year OR, while the 90-day OR would have allowed for better comparison with existing literature.

The absence of an increased VTE risk has previously been published for OHNS and urologic procedures [22–25].

4.3 | Clinical implications

Currently, the procedures assessed in this study are classified as low-risk interventions for postoperative VTE, and hence, it is not advised to provide routine thromboprophylaxis following surgery [8–11]. Our results on one hand confirm that the absolute risk of developing VTE after these surgeries is low, and therefore, there is no indication that the current policy of thromboprophylaxis should be altered. On the other hand, we also found clear variability in the risk between surgeries, which might not be directly useful for clinicians per se, but could be used to refine new or current risk prediction scores for postoperative VTE. This could be exemplified in a scenario in which a patient, with known risk factors for VTE, has to undergo a minor surgical procedure. With the knowledge from this study, a physician might decide to start thromboprophylaxis if the procedure entails an inguinal hernia repair, while the same physician might withhold prophylaxis when the procedure would be a minor urologic one, such as a vasectomy.

4.4 | Strengths and limitations

A strength of our study is that we had access to data of a large, general population, which allowed us to assess and thus compare multiple interventions within a single population, while other previous studies were mostly restricted to single interventions. Furthermore, recall bias was minimized as we used additional data from the Dutch Hospital Data register, which has been validated as described previously.

The most important limitation of our study is the absence of data on patients with long-term anticoagulants and applied thromboprophylaxis at the time of surgery. However, we expect the percentage of participants on long-term anticoagulants to be below 15% as the main indication for it would have to be atrial fibrillation, since we only included cases with a first VTE, and prevalence of atrial fibrillation would likely have been around 15% as the median age was ∼48 and nobody was above 70 [36]. Furthermore, the Dutch guideline at the time of inclusion for the MEGA study did not recommend routine thromboprophylaxis for the studied procedures [37]. If, however, thromboprophylaxis had been applied, it means that for those procedures, the true effect on the VTE risk is underestimated in our study, ie, the true effect is expected to be higher than that reported.

Another limitation is the amount of missing data (maximum 16%) in the adjusted analyses. The effect of missing data is hard to estimate as the reasons for this are unknown. Furthermore, inclusion of the MEGA study was restricted to patients aged 70 years and younger, which has likely resulted in a lower incidence of VTE, and therefore, the risk estimates might not be fully translatable to the general population, which undergoes these surgeries. Additionally, the DHD registry did not specify whether procedures were elective or emergency procedures. Therefore, risk estimates for surgeries such as laparoscopic cholecystectomy represent a combination of elective and emergency procedures. Finally, the data are between 15 and 20 years old. Meanwhile, several logistical and procedural changes have been made, such as shorter length of stay and earlier mobilization after surgery. Hence the present risk for VTE after minor surgical procedures might be lower than at the time of inclusion.

4.5 | Conclusion

Although the absolute risk of VTE, following each of the studied surgical procedures currently labeled as having a low-risk, seems indeed low, the RRs among these surgeries clearly differ, allowing a ranking in the risk. Venous stripping, open hernia repair, and laparoscopic cholecystectomy are associated with an increased VTE risk, whereas OHNS and urologic interventions are not. These results may be useful to further refine risk estimates of postoperative VTE and hence thromboprophylaxis management of individual patients.

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AUTHOR CONTRIBUTIONS

M.J.R.S. analyzed the data and wrote the manuscript. F.R.R. provided data form the MEGA-study and revised the manuscript. C.E.T., B.N., and S.C.C. contributed to the analysis, interpretation of the results, and revision of the manuscript. All authors read and approved the final version of the manuscript.

DECLARATION OF COMPETING INTERESTS

There are no competing interests to disclose.

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