J Plast Surg Hand Surg, 2014; Early Online: 1–7

ISSN: 2000-656X print / 2000-6764 online
DOI: 10.3109/2000656X.2014.981267

informa
healthcare

ORIGINAL ARTICLE

Increased anaesthesia duration increases venous thromboembolism risk in plastic surgery: A 6-year analysis of over 19,000 cases using the NSQIP dataset

Alexei S. Mlodinow[1], Nima Khavanin[1], Jon P. Ver Halen[2], Aksharananda Rambachan[1], Karol A. Gutowski[3] & John Y. S. Kim[1]

[1]Division of Plastic and Reconstructive Surgery, Northwestern University, Feinberg School of Medicine, Chicago, IL, USA, [2]Division of Plastic and Reconstructive Surgery, Baptist Cancer Center – Vanderbilt Ingram Cancer Center, Memphis, TN, USA and [3]Department of Plastic Surgery, Ohio State University, Columbus, OH, USA

Abstract

Background: Venous thromboembolism (VTE) is a significant cause of morbidity and mortality, particularly in the postoperative setting. Various risk stratification schema exist in the plastic surgery literature, but do not take into account variations in procedure length. The putative risk of VTE conferred by increased length of time under anaesthesia has never been rigorously explored. ***Aim:*** The goal of this study is to assess this relationship and to benchmark VTE rates in plastic surgery. ***Methods:*** A large, multi-institutional quality-improvement database was queried for plastic and reconstructive surgery procedures performed under general anaesthesia between 2005–2011. In total, 19,276 cases were abstracted from the database. *Z*-scores were calculated based on procedure-specific mean surgical durations, to assess each case's length in comparison to the mean for that procedure. A total of 70 patients (0.36%) experienced a post-operative VTE. Patients with and without post-operative VTE were compared with respect to a variety of demographics, comorbidities, and intraoperative characteristics. Potential confounders for VTE were included in a regression model, along with the *Z*-scores. ***Results:*** VTE occurred in both cosmetic and reconstructive procedures. Longer surgery time, relative to procedural means, was associated with increased VTE rates. Further, regression analysis showed increase in *Z*-score to be an independent risk factor for post-operative VTE (Odds Ratio of 1.772 per unit, p-value < 0.001). Subgroup analyses corroborated these findings. ***Conclusions***: This study validates the long-held view that increased surgical duration confers risk of VTE, as well as benchmarks VTE rates in plastic surgery procedures. While this in itself does not suggest an intervention, surgical time under general anaesthesia would be a useful addition to existing risk models in plastic surgery.

Key Words: Complication, plastic surgery, breast, flaps

Introduction

The last decade has witnessed a sustained interest in the causes and prevention of venous thromboembolism (VTE). In the postoperative setting, venous thromboembolism is a multifactorial process that includes both deep venous thrombosis (DVT) and pulmonary embolism (PE). While it is unclear if VTE is entirely preventable, it is a significant cause of excess morbidity, mortality, and cost [1,2]. VTE incidence among plastic surgery patients has been reported at 1–2% in a hospital setting, or an estimated 33,000 patients per year [3,4]. However, this carries tremendous variability among procedure types, with incidence of VTE ranging from less than 0.5% to greater than 7% in procedure-specific cohorts [5,6]. Further, high rates of occult DVTs and PEs have been reported in both general and plastics-specific cohorts [7,8]. The often asymptomatic nature of DVT, coupled with the devastating results of progression to PE, emphasise the role of prophylaxis over therapy in VTE. Calls to reduce incidence of VTE have come from the Centers for Medicare and Medicaid Services, the American Society of Plastic Surgeons, and others [9,10].

Current approaches to stratifying patients by risk take into account varying combinations of both patient and procedural characteristics. Individualised risk assessment models (RAM), such as the Rogers Score and the Caprini Score, have been created and repeatedly validated in both general and plastic surgery cohorts [1,11,12]. While acknowledging the validity of individualised RAMs, the American College of Chest Physicians has advocated a more procedure-focused strategy [2,13]. Moreover, the Caprini score has been recreated and revalidated, in the form of the Davison-Caprini score, in order to specifically address the plastic and reconstructive surgery population [3,14].

Time under general anaesthesia is a putative risk factor that is inadequately addressed by existing risk models. The Rogers score does not take surgical time into account at all, while the Caprini score takes it into account only insofar as a surgery longer than 45 minutes is defined as "major" [15]". While prolonged time under anaesthesia has been described as a risk factor for VTE in multiple cohorts [16,17], the details of this relationship have not been probed in the plastic and reconstructive surgery literature. Plastic surgery has led other surgical specialties in its utilisation of outpatient surgery, and is unique in that many procedures (i.e. cosmetic) are not covered by traditional health insurance, and are, thus, directly paid for by the patient. Given these unique considerations, a targeted analysis of anaesthesia duration and VTE risk is warranted. The current study uses the American College of Surgeons' National Surgical Quality Improvement Program (ACS-NSQIP) to carry out a robust statistical analysis of plastic and reconstructive

Correspondence: John Y. S. Kim, MD, Division of Plastic and Reconstructive Surgery, Northwestern University, Feinberg School of Medicine, 675 North St. Clair Street, Galter Suite 19-250, Chicago, IL 60611, USA. Tel: +1 312 695 6022. Fax: +1 312 695 5672. E-mail: jokim@nmh.org

(Received 9 August 2014; accepted 22 October 2014)

surgery patients, with the goals of both benchmarking the incidence of VTE and elucidating the role of surgical time in this potentially devastating outcome.

Methods

Data acquisition and patient selection

The ACS-NSQIP registry is a nationally validated, risk-adjusted surgical outcomes database, aimed at measuring and improving the quality of care delivered to surgical patients throughout the US. Data collection methods for the NSQIP registry are fully described in the user guide [18]. These data are independently abstracted by trained surgical nurses and are subject to random audits, providing a high quality, standardised database that has a demonstrated disagreement rate of less than 1.8% [3].

The NSQIP database was retrospectively reviewed to obtain data on all patients undergoing plastic surgery procedures under general anaesthesia from 2005–2011. From the 1,777,035 patients included in the ACS-NSQIP registry between 2005–2011, a total of 344,180 patients with a non-general anaesthesia type or an unlisted anaesthesia time were eliminated. Of the remaining 1,432,855 patients, those undergoing a plastic surgery procedure were identified by the "Surgical Specialty" variable.

Outcomes and risk adjustment variables

The primary outcome of interest was 30-day venous thromboembolism (VTE). VTE was defined as the occurrence of DVT and/or PE. In NSQIP, a DVT is confirmed by duplex ultrasound, venogram or CT scan. A diagnosis of pulmonary embolism requires a V-Q scan interpreted as high probability of pulmonary embolism, a positive CT scan (spiral or angiogram), transoesophageal echocardiography, or pulmonary arteriogram.

Other variables collected by NSQIP include demographic data, clinical characteristics, medical comorbidities, and anaesthesia time. Demographic data included age, BMI, and gender. Clinical characteristics included outpatient status, active smoking, prior operation within 30 days, pre-operative exposure to chemotherapy or radiation, steroid use, ASA level 3, 4, or 5, and emergent procedures. Medical comorbidities include: diabetes, hypertension, chronic obstructive pulmonary disorder (COPD), congestive heart failure (CHF), dyspnea, previous stroke or transient ischaemic attack (TIA), previous percutaneous coronary intervention (PCI) or cardiac surgery, and bleeding disorders. The *Z*-score for anaesthesia time was calculated for each patient relative to the mean for his/her respective US Current Procedural Terminology (CPT) code. CPT codes are used in the US to identify specific procedures, for reimbursement and tracking purposes. *Z*-scores are an established statistical technique of calculating a give value's difference from a mean, in terms of standard deviations from the mean. In this study, the *Z*-score represents the number of standard deviations from the mean duration of the index procedure, regardless of the absolute value of that duration. In other words, a higher *Z*-score means more time spent under anaesthesia compared to other patients undergoing the same operation. This methodology allows for comparison of patients undergoing procedures with intrinsic differences in duration to be compared on the basis of their relative time under anaesthesia.

Statistical analysis

Descriptive statistics were calculated for the study population using Pearson's chi-square or Fisher's exact tests for categorical variables and student *t*-tests for quantitative variables. Incidences of VTE across intervals defined by both time and *Z*-score were assessed. Additionally, a Mann-Whitney U-test was performed on procedures that were listed as "outpatient" to determine the difference in mean anaesthesia *Z*-score between outpatients with and without VTE. The entire study population was analysed with multivariate logistic regression to control for potential confounding variables and to identify the impact of the *Z*-score for anaesthesia time as an independent risk factor for a VTE. Patient demographics, clinical characteristics, and comorbidities underwent bivariate screening using Pearson's chi-square and independent *t*-tests for categorical and continuous variables, respectively. Variables from Table I with a significance value of $p < 0.2$ were included in the regression models. To improve model precision, variables with fewer than 10 events were excluded [19]. Additionally, the sum of the relative value units (RVUs) for additional procedures were also used to adjust for added complexity and concurrent procedures, as has been described previously [20,21]. RVUs are set by the US Center for Medicare and Medicaid Services, and are intended to represent the relative complexity and difficulty of a given procedure. Hosmer-Lemmeshow (HL) and C-statistics were computed to assess model calibration and discrimination [22].

Results

Cohort characteristics

Of the 19,276 patients identified as having undergone a plastic surgery procedure under general anaesthesia between 2005–2011, 70 (0.36%) experienced a VTE within 30 days of the operation. Table I shows a comparison of patients with vs without a post-operative VTE. The two cohorts were significantly different with respect to demographic information, comorbidities, and clinical characteristics. Patients who experienced a VTE were on average older (48 years vs 54 years, $p = 0.002$), had a higher BMI (28.4 vs 31.0, $p = 0.003$), and had a greater number of comorbid conditions (Table I). Hypertension, steroid use, prior operation within the past 30 days, inpatient status, and ASA class of 3, 4, or 5 were all more common in the VTE cohort. The two cohorts did not differ with respect to gender, active smoking, preoperative chemotherapy or radiation exposure, positive history of bleeding disorders, previous PCI or cardiac surgery, or previous stroke or TIA. On average, patients with post-operative VTE had longer anaesthesia times (316 min vs 194 min, $p < 0.001$).

Venous thromboembolism

The incidence of VTE across hour-long intervals is represented in Figure 1. Incidence was highest in the longest interval, representing procedure durations greater than 5 hours (34 cases, or 1.30%). The incidence of VTE within each of the remaining intervals was lower than the population mean (0.36%).

Controlling for differences in the mean anaesthesia time among surgical procedures, 43 (61.4%) of the patients with a VTE experienced anaesthesia times longer than the mean for their respective CPT code (i.e. $Z > 0$). Distribution of VTE occurrences across *Z*-score intervals is shown in Table II. Each successive *Z*-score interval, representing high surgical duration

Table I. Patient demographics and clinical characteristics.

	No VTE (n = 19,206) (99.64%)	VTE (n = 70) (0.36%)	p-value
Age (years)*	48.1 (38, 58)	53.7 (44.5, 64)	0.002
BMI (kg/m^2)*	28.4 (23.5, 31.8)	31.0 (24.3, 37.2)	0.003
Gender (% male)	19.50%	27.14%	0.107
Active smoker	17.20	12.86%	0.336
Diabetes	7.73%	11.43%	0.247
Hypertension*	26.11%	48.57%	< 0.001
COPD*	1.57%	5.71%	0.025
CHF*	0.24%	4.29%	0.001
Dyspnea*	3.42%	10.00%	0.003
Previous stroke or TIA	4.94%	1.43%	0.264
Previous PCI or cardiac surgery	5.86%	7.14%	0.606
Bleeding disorder	1.71%	2.86%	0.338
Steroid use*	1.55%	10.00%	< 0.001
Chemotherapy within 30 days	1.98%	4.29%	0.162
Radiotherapy within 90 days	0.44%	1.43%	0.270
Prior operation within 30 days*	4.66%	20.00%	< 0.001
ASA class*			< 0.001
1 or 2	77.16%	44.29%	
3, 4, or 5	22.84%	55.71%	
Emergency procedure	2.60%	0.00%	0.267
Outpatient procedure*	70.38%	24.29%	< 0.001
Anaesthesia time (minutes)*	194 (112, 239)	316 (175, 358)	< 0.001

*Represents statistical significance at the 0.05 level.
Continuous variables given as: mean (25th percentile, 75th percentile).COPD = chronic obstructive pulmonary disorder; CHF = congestive heart failure; TIA = transient ischaemic attack; PCI = percutaneous cardiac intervention.

relative to procedural mean, had a higher rate of VTE than the last. This trend is depicted in Figure 2.

Venous thromboembolism occurred in cases with 20 different primary CPT codes. The majority of these procedures had only one or two occurrences. However, procedures 15830, 19318, 15734, 19367, and 15847 each represented greater than two occurrences. Procedural descriptions and incidence rates for each of these codes is presented in Table III.

In total, 13,535 outpatient cases were isolated for independent analysis. Overall VTE incidence in this cohort was 17 (1.3%). Cases with postoperative VTE had a mean Z-score of 0.31, while those without had a mean Z-score of 0.00, in keeping with the trend in the population as a whole. However, this difference failed to reach statistical significance ($p = 0.166$)

Multivariable analysis

Potential confounding variables screened for risk adjustment included patient demographics, comorbidities, and clinical characteristics. After adjusting for potential confounders, each standard deviation (Z-score unit) above the mean anaesthesia time for a given CPT code was found to increase the odds of a VTE by 77.2% ($p < 0.001$). Table IV compares the odds ratio for the Z-score of anaesthesia time before and after adjustment with the relevant confounding variables. The adjusted odds ratio represents the ultimate verification of the relationship seen in Figures 1 and 2, showing an increase in VTE risk with increased duration relative to procedural mean, independent of procedure type and patient characteristics.

Discussion

Venous thromboembolic disease continues to be a major cause of post-operative morbidity and mortality across all surgical fields. Post-thrombotic syndrome, a constellation of symptoms that develops in 20–30% of patients within 5 years of a DVT [23,24], was found by Khan et al. [25] to be a major predictor of low quality-of-life. Progression to PE portends even worse outcomes, with a 10% death rate within the hour if symptomatic, and 50% incidence of right ventricular dysfunction among survivors [26]. Additionally, VTE is being used as a quality indicator, which will impact future hospital reimbursement [27,28]. Plastic surgery, although among the safest of

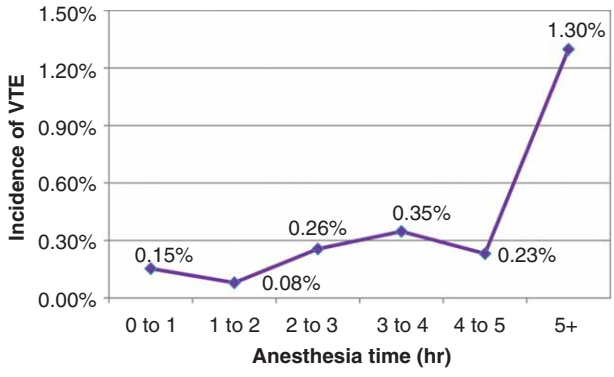

Figure 1. Incidence of VTE Across 1 hour Intervals. As general anesthesia time increases, the incidence of venous thromboembolism tends to increase as well.

Table II. VTE incidence by Z-score category.

	Z-score					
Interval	$Z < -1.0$	$-1 \le Z < -0.50$	$-0.50 \le Z < 0$	$0 \le Z < 0.50$	$0.50 \le Z < 1.0$	$Z \ge 1.0$
Total *n*	2027	4506	4625	3149	2098	2636
VTE occurrences	4	11	13	9	11	21
VTE frequency	0.20%	0.24%	0.28%	0.29%	0.52%	0.80%

specialties, is not left untouched. In fact, the unique volume of outpatient and elective procedures in this field makes this issue more complex, and demands ever-more rigorous risk-stratification. A recent survey found that 4–7% of plastic surgeons have experienced a patient death due to post-operative pulmonary embolism [29].

VTE incidence in plastic surgery

A causative link between surgical duration and medical complications has been well-established in the plastic and reconstructive surgery literature [30]. Further, increased duration has been specifically linked to VTE and other thrombotic complications, both in plastic surgery and other fields [31,32]. However, a thorough quantitative analyses of this link has not been performed. Specifically identifying those patients who are at an increased risk for VTE using the *Z*-score will allow surgeons to more appropriately institute preventative measures for VTE than simply looking at absolute surgical duration. A better understanding of the VTE risk associated with varying surgical duration will aid in the perioperative management and risk stratification of patients. The robust NSQIP cohort allows for the largest and most detailed analysis of this relationship in plastic and reconstructive surgery patients.

Previous studies have displayed widely divergent rates of VTE among plastic surgery procedures. Reinisch et al. [5], in a year-long series of nearly 10,000 face lifts, reported a DVT incidence of 0.35%, and a PE incidence of 0.14%. At the other end of the spectrum, post-bariatric patients undergoing body-contouring procedures are at significantly increased risk, with incidence of VTE reported as high as 5.7–9.6% [9,33]. A recently published study also used the 2005–2011 NSQIP dataset, and extracted all mastectomies and immediate breast reconstruction patients [8]. It identified a total of 48,634 patients undergoing mastectomy, with 37% undergoing breast reconstruction (~18,000 patients), and found that immediate breast reconstruction and obesity were risk factors for VTE. However, their study only examined mastectomy and breast reconstruction patients (vs all types of plastic surgical patients), and did not evaluate the risks of surgical duration on VTE. The current study finds the incidence of VTE across plastic surgery procedures to be 0.36%, at the low end of the literature range. Stratification of patients by length of procedure, as shown in Figure 1, yields an upward trend in VTE incidence with surgical duration. This association is logical, as operative time has been called a surrogate for surgical complexity [31], and a hallmark of VTE risk is significant interprocedural variability [34]. We further applied statistical analysis to validate and quantify this association.

Statistical analysis and results

While our group has previously done analyses of the relationship between complication rates and increased surgical duration, one of the main criticisms of this methodology is the fact that longer procedures are likely more complex, more invasive, and, thus, intrinsically more dangerous [32]. The initial step of the current analysis provides a novel way to compare inherently different operations. *Z*-scoring allows VTE incidence to be compared over time, independent of normal variation intrinsic to procedural differences. The results of this grouping provide a more convincing and statistically rigorous trend, as depicted in Figure 2. The regression analysis validates this relationship, by controlling for patient-specific confounders. Specifically, each one-point increase in *Z*-score relative to the mean duration translates to a 77.2% increase in odds of VTE, independent of other factors in the regression analysis such as total RVU, comorbidities, etc.

Clinical implications

Caprini risk scoring has been *validated* in plastic surgery, but there have not been many investigations into *de novo* associations between risk factors and incidence of VTE in plastic and reconstructive surgical procedures [8,35,36]. The content of the Caprini risk scoring system, with specific application to plastic surgery, is available free of charge online [37]. Specific cohorts which have been evaluated include body contouring, burn, and facelift patients. However, data from these reviews is limited, and lacks the comprehensive, prospective nature of the NSQIP database. Our group recently found an increased risk of VTE with increasing surgical duration in a study of over 1.4 million patients between 2005–2011 (data not shown). The current study verifies this finding, in a large cohort specific to plastic surgeons.

The results of the current study verify the intuitive view that increased time under general anaesthesia increases the risk of VTE in plastic surgery procedures done in a hospital setting. More importantly, they *assign a number* to that increased risk.

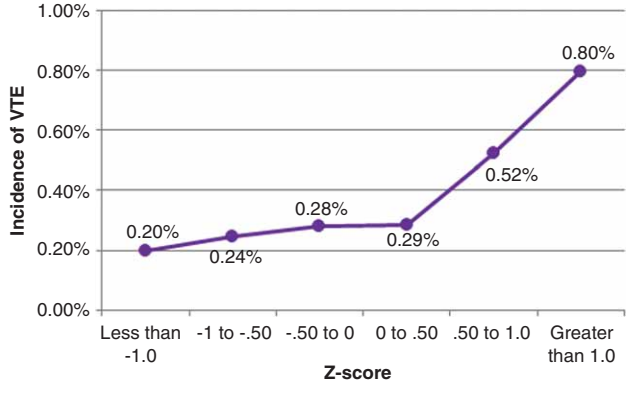

Figure 2. Incidence of VTE across Z-Score Intervals. As general anesthesia increases relative to the mean for a given procedure, the incidence of venous thromboembolism increases.

Table III. VTE incidence by procedure.

CPT code	Procedure description	VTE occurrences*	VTE frequency	Duration□ (minutes)
15830	Excision, excessive skin and subcutaneous tissue (includes lipectomy); abdomen, infraumbilical panniculectomy	9	0.78%	243 (98)
19318	Reduction mammaplasty	8	0.23%	225 (76)
15734	Muscle, myocutaneous, or fasciocutaneous flap; trunk	6	1.61%	242 (134)
19367	Breast reconstruction with transverse rectus abdominis myocutaneous flap (TRAM), single pedicle, including closure of donor site	6	2.62%	368 (139)
15847	Excision, excessive skin and subcutaneous tissue (includes lipectomy), abdomen (e.g. abdominoplasty) (includes umbilical transposition and fascial plication)	4	1.08%	244 (97)

* The remaining 29 VTEs in the study population were distributed among several other procedures.
□ Reported as mean (standard deviation).

While this finding by no means obviates the need for accurate risk assessment models and prophylaxis guidelines, it provides a benchmark with everyday clinical implications. For example, the "highest-risk" group in a paper by Seruya et al. [3], utilising a modified Caprini model, demonstrated a VTE incidence of 7.5%. Using this value as a baseline risk, the results suggest that a patient whose procedure takes 1 SD longer than the mean would have a post-operative risk of 12.6%. For example, while the baseline risk for VTE after a pedicled TRAM for breast reconstruction is 2.62%, for a patient whose procedure lasts longer than 1 SD than the mean (i.e. 507 minutes; Table III), her risk is 5.24%. This information is more specific, and more useful that simply treating all patients who have had surgery longer than 5 hours with increased suspicion for VTE (Figure 1). Furthermore, this increase in odds holds across procedures and patients. In other words, the increase in VTE risk is true whether performing a simple tissue expander placement or a bilateral free TRAM flap reconstruction; and whether the patient is a young healthy patient or an elderly patient with multiple comorbidities.

The findings are particularly important in the context of cosmetic procedures, in which each additional thromboprophylactic measure represents more out-of-pocket costs to the patient. Cosmetic procedures have their own inherent risks, as indicated in Table III, where three of the top five procedures by VTE incidence are cosmetic. Ultimately, the current study does not suggest that lengthy procedures be avoided, but that procedure length be taken into account in conjunction with existing risk models and patient-specific factors when considering thromboprophylaxis and post-operative clinical suspicion of VTE. In addition, such patients may be considered candidates for more aggressive DVT prophylaxis, such as TID heparin, lovenox, or other agents. This is true whether considering the difference between a short procedure and a longer one, or the time difference between a resident and a more experienced surgeon performing the same procedure. Time under anaesthesia is a useful and easily measurable addition to the robust risk models already in use in the plastic surgery community, and could yield further targeting of intervention.

Study limitations

There are a number of limitations to the current study. NSQIP tracks complications for only 30 days after the operation. While VTE risk peaks at 19 days after surgery [37], it has been shown to remain elevated for up to 12 weeks [12,38,39]. Additionally, although hospitals enrolled in a national quality improvement programme would be expected to have high rates of adherence to standard prophylaxis regimens, these are not explicitly tracked within the NSQIP database and thus cannot be included for analysis in our models.

While it provides a robust dataset for a variety of specialties, NSQIP is not designed to capture the large number of plastic surgery procedures performed at outpatient surgery centres. Over 13,000 outpatient procedures were included in the initial sample abstracted from the NSQIP database. However, subgroup analysis of these showed that there were only 17 incidents of VTE among them. Thus, despite mean *Z*-scores suggestive of the same trend seen in the total population, meaningful statistical analysis could not be performed. Similarly, the low incidence of VTE in any given procedure precluded subgroup analysis of those patients. In addition, particular procedures may be under-represented, while others are over-represented. The Tracking Operations and Outcomes for Plastic Surgeons (TOPS) database is a large clinical database maintained by members of the American Society of Plastic Surgeons [40]. Another study of the relationship between surgical time and VTE incidence using the TOPS database would provide a critical validation of our findings in plastic surgery performed outside of a hospital setting.

Finally, no statistical analysis can control for unmeasured variables. While the authors attempted to control for surgical complexity by including RVU's and patient characteristics in the regression, unquantifiable variables such as anatomic or pathologic differences from one case to the next could not be controlled. It is the view of the authors that surgical duration, even if simply a surrogate for immeasurable intraoperative

Table IV. Odds ratios for *Z*-score on the incidence of venous thromboembolism.

	Odds ratio	95% CI	*p*-value	H-L statistic	c-statistic
Unadjusted	1.388	1.167–1.649	< 0.001	0.005	0.620
Adjusted*	1.772	1.290–2.435	< 0.001	0.126	0.903

* Variables for adjustment were selected through a bivariate screen. Variables with a p-value ≤ 0.20 and $n \geq 10$ were included in the model.

variables, is a useful and easily measurable risk factor that should be taken into account.

Conclusions

Analysis of over 19,000 plastic surgery patients from the prospectively-maintained ACS-NSQIP database yielded a significant upward trend in VTE incidence relative to surgical duration. Multivariable logistic regression substantiated this finding, showing increased general anaesthesia duration relative to their respective procedural means to be a statistically significant, independent risk factor for post-operative VTE. This study confirms and quantifies the widely held belief that increased periods of general anaesthesia are associated with an increased risk of venous thromboembolism. While this is not the basis for specific treatment guidelines, it provides a useful benchmark for future VTE risk reduction initiatives. Further, it suggests that surgical duration should be taken into account when assessing a patient's risk for VTE following plastic surgery procedures.

Acknowledgements

De-identified patient information is freely available to all institutional members who comply with the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) Data Use Agreement. The Data Use Agreement implements the protections afforded by the Health Insurance Portability and Accountability Act of 1996. The NSQIP and the hospitals participating in the NSQIP are the source of the data used herein; they have not been verified and are not responsible for the statistical validity of the data analysis, or the conclusions derived by the authors of this study.

***Declaration of interest*:** The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

References

[1] Caprini JA Arcelus JI, Reyna JJ. Effective risk stratification of surgical and nonsurgical patients for venous thromboembolic disease. Semin Hematol 2001;38:12–19.

[2] Geerts WH, Bergqvist D, Pineo GF, et al. Prevention of venous thromboembolism: American College of Chest Physicians evidence-based clinical practice guidelines. 8th ed. Chest 2008;133:381S–453S.

[3] Seruya M, Venturi ML, Iorio ML, Davison SP. Efficacy and safety of venous thromboembolism prophylaxis in highest risk plastic surgery patients. Plast Reconstr Surg 2008;122:1701–8.

[4] Trussler AP, Tabbal GN. Patient safety in plastic surgery. Plast Reconstr Surg 2012;130:470e–8e; Erratum in: Plast Reconstr Surg 2012;130:1165.

[5] Reinisch JF, Bresnick SD, Walker JWT, Rosso RF. Deep venous thrombosis and pulmonary embolus after face lift: a study of incidence and prophylaxis. Plast Reconstr Surg 2001;107:1570.

[6] Chen CM, Disa JJ, Cordeiro PG, et al. The incidence of venous thromboembolism after oncologic head and neck reconstruction. Ann Plast Surg 2008;60:476–9.

[7] Dismuke SE, Wagner EH. Pulmonary embolism as a cause of death. The changing mortality in hospitalized patients. JAMA 1986;255:2039–42.

[8] Fischer JP, Wes AM, Tuggle CT, Wu LC. Venous thromboembolism risk in mastectomy and immediate breast reconstruction: analysis of the 2005 to 2011 American College of Surgeons National Surgical Quality Improvement Program data sets. Plast Reconstr Surg 2014;133:263e–73e.

[9] Centers for Medicare and Medicaid Services; Baltimore, MD USA. Press release, April 14, 2008. Available online at http://www.cms.hhs.gov.accessed 5 August 2014.

[10] American Society of Plastic Surgeons. Venous Thromboembolism Awareness Campaign online]. Available online at http://www.plasticsurgery.org/for–medical–professionals/legislation–and–advocacy/key–issues–in–plastic–surgery/venous–thromboembolism.html.accessed 29 July 2014.

[11] Motykie GD, Zebala LP, Caprini JA, et al. A guide to venous thromboembolism risk factor assessment. J Thromb Thrombolysis 2000;9:253–62.

[12] Pannucci CJ, Bailey SH, Dreszer G, et al. Validation of the Caprini risk assessment model in plastic and reconstructive surgery patients. J Am Coll Surg 2011;105–12.

[13] Gould MK, Garcia DA, Wren SM, et al. American College of Chest Physicians. Prevention of VTE in nonorthopedic surgical patients: antithrombotic therapy and prevention of thrombosis. 9th ed. American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. Chest 2012;141:e227S–77S; Erratum in: Chest 2012;141:1369.

[14] Davison SP, Venturi ML, Attinger CE, et al. Prevention of venous thromboembolism in the plastic surgery patient. Plast Reconstr Surg 2004;114:43E–51E; Review. Erratum in: Plast Reconstr Surg 2004;114:1366.

[15] Pannucci CJ, Barta RJ, Portschy PR, et al. Assessment of postoperative venous thromboembolism risk in plastic surgery patients using the 2005 and 2010 Caprini Risk score. Plast Reconstr Surg 2012;130:343–53.

[16] Zurawska U, Parasuraman S, Goldhaber SZ. Prevention of pulmonary embolism in general surgery patients. Circulation 2007;115:e302–7.

[17] Geerts WH, Pineo GF, Heit JA, et al. Prevention of venous thromboembolism: the Seventh ACCP Conference on Antithrombotic and Thrombolytic Therapy. Chest 2004;126:338S–400S; Review.

[18] American College of Surgeons. NSQIP data user guide for 2011. Available online at http://site.acsnsqip.org/wp-content/uploads/2012/03/2011-User-Guide_Final.pdf.accessed 5 August 2014.

[19] Peduzzi P, Concato J, Kemper E, et al. A simulation study of the number of events per variable in logistic regression analysis. J Clin Epidemiol 1996;49:1373–9.

[20] Henderson WG, Daley J. Design and statistical methodology of the National Surgical Quality Improvement Program: why is it what it is? Am J Surg 2009;198:S19–27.

[21] Dillon P, Hammermeister K, Morrato E, et al. Developing a NSQIP module to measure outcomes in children's surgical care: opportunity and challenge. Semin Pediatr Surg 2008;17:131–40.

[22] Harrell FE Jr, Lee KL, Mark DB. Multivariable prognostic models: issues in developing models, evaluating assumptions and adequacy, and measuring and reducing errors. Stat Med 1996;15:361–87.

[23] Yamaki T, Hamahata A, Soejima K, et al. Factors predicting development of post-thrombotic syndrome in patients with a first episode of deep vein thrombosis: preliminary report. Eur J Vasc Endovasc Surg 2011;41:126–33.

[24] Prandoni P, Lensing AWA, Cogo A, et al. The long-term clinical course of acute deep venous thrombosis. Ann Intern Med 1996;125:1–7.

[25] Khan SR, Shbaklo H, Lamping DL, et al. Determinants of health-related quality of life during the 2 years following deep vein thrombosis. J Thromb Haemost 2008;6:1105–12.

[26] Kearon C. Natural history of venous thromboembolism. Circulation 2003;107(23 suppl 1):122–30.

[27] Haut ER, Noll K, Efron DT, et al. Can increased incidence of deep vein thrombosis (DVT) be used as a marker of quality of care in the absence of standardized screening? The potential effect of surveillance bias on reported DVT rates after trauma. J Trauma 2007;63:1132–5; discussion 1135–7.

[28] Pronovost PJ, Goeschel CA, Wachter RM. The wisdom and justice of not paying for "Preventable Complications". JAMA 2008;299:2197–9.
[29] Clavijo-Alvarez JA, Pannucci CJ, Oppenheimer AJ, et al. Prevention of venous thromboembolism in body contouring surgery: a national survey of 596 ASPS surgeons. Ann Plast Surg 2011;66:228–32.
[30] Mlodinow AS, Ver Halen JP, Lim S, et al. Predictors of readmission following breast reconstruction - A multi-institutional analysis of 5,012 patients. Ann Plast Surg 2013; 71:335–41.
[31] Procter LD, Davenport DL, Bernard AC, Zwischenberger JB. General surgical operative duration is associated with increased risk-adjusted infectious complication rates and length of hospital stay. J Am Coll Surg 2010;210:60–5.
[32] Rambachan A, Mioton L, Saha S, et al. The impact of surgical duration on plastic surgery outcomes. Eur J Plast Surg ; In Press.
[33] Aly AS, Cram AE, Chao M, et al. Belt lipectomy for cirumferential truncal excess: the University of Iowa experience. Plast Reconstr Surg 2013;36(11):707–14.
[34] White RH, Zhou H, Romano PS. Incidence of symptomatic venous thromboembolism after different elective or urgent surgical procedures. Thromb Haemost 2003;90:446–55.
[35] Pannucci CJ, Osborne NH, Jaber RM, et al. Early fasciotomy in electrically injured patients as a marker for injury severity and deep venous thrombosis risk: an analysis of the National Burn Repository. J Burn Care Res 2010;31:882–7.
[36] Patronella CK, Ruiz-Razura A, Newall G, et al. Thromboembolism in high-risk aesthetic surgery: experience with 17 patients in a review of 3871 consecutive cases. Aesthet Surg J 2008;28:648–55.
[37] Amin AN, Lenhart G, Princic N, et al. Retrospective administration database study of the time period of VTE risk during and following hospitalization for major orthopedic or abdominal surgery in real-world US patients. Hosp Prac 2011;39:7–17.
[38] American Society of Plastic Surgeons, VTE Risk Assessment and Prophylaxis Recommendations. Available at http://www.plasticsurgery.org/Documents/medical-professionals/health-policy/key-issues/VTE_Risk_Assessment_and_TF_Recommendations.pdf. Accessed 8 August 2014.
[39] Sweetland S, Green J, Liu B, et al. Duration and magniude of postoperative risk of venous thromboembolism in middle aged women: Prospective cohort study. BMJ 2009;339:b4583.
[40] American Society of Plastic Surgeons, Tracking Outcomes in Plastic Surgery data entry tool. Available at http://www.plasticsurgery.org/for-medical-professionals/surgeon-community/tops.html. Accessed 5 August 2014.