Application of the Caprini Risk Assessment Model in Evaluation of Non-Venous Thromboembolism Complications in Plastic and Reconstructive Surgery Patients

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ABSTRACT

Goals/Purpose: The Caprini Risk Assessment Model (RAM) is an ordinal scoring tool used to quantify and categorize a patient's risk for venous thromboembolism in the post-surgery setting. However, there has been no similar exploration into predictive associations of this score with the other potential complications of surgical procedures (infection, seroma, hematoma, delayed wound healing, etc.). This is surprising because the full list of variables that comprise an individual Caprini score involve a host of inherited and acquired clinical characteristics, systemic factors that involve multiple organ systems. This study investigates whether Caprini scores can be applied to non-VTE complications.

Methods/Technique: Authors undertook a retrospective chart review of 1598 encounters for a series of complex reconstructive and body-contouring operations at an academic medical institution. Input variables included Caprini score components, patient co-morbidities, and prophylactic use. Output variables were postoperative complications. Tests for proportions were performed on percentile data. Non-percentile data was treated with comparison of means (t-test). Odds ratios for complications were calculated for stratified risk groups and compared.

Results/Complications: The overall complication rate was 28.03%. Deep vein thrombosis (DVT) incidence was 1.50%. Differences in age, body mass index (BMI), operation time, hypertension, diabetes, renal disease, and cancer were statistically significant between patients who experienced complications and those who did not. For DVT versus DVT-free patients, differences in sex, BMI, operation time, smoking status, diabetes, hypertension, and prior DVT were significant. Caprini scores identified 628 encounters as low risk (0-4) and 970 as high risk (>5). Dehiscence, infection, necrosis, seroma, hematoma, and overall complication rate had significantly increased the incidence for the high-risk group.

Conclusions: Caprini scores can be applied preoperatively to categorize a patient's risk of developing multiple non-VTE complications. Patients in higher risk categories will be at an increased risk of suffering from wound dehiscence, infection, seroma, hematoma, and necrosis. Considering all of these potential complications as a single group, a high-risk patient has a 69% increased odds of suffering at least one problem compared with low-risk individuals. These results can help physicians better understand which complications to keep watch for most rigorously during postoperative monitoring. In addition, the data can guide conservations with patients during initial preoperative consultations.

INTRODUCTION

The Caprini Risk Assessment Model (RAM) is a scoring tool used to quantify a patient's risk for venous thromboembolism. It was developed because older indices required extensive laboratory testing or failed to account for individual differences relevant to disease incidence. Use of the Caprini RAM now encompasses the non-surgical practice of medicine, as well as numerous surgical sub-specialties.

In plastic surgery, Davison et al first proposed an adaptation of the Caprini RAM [1]. Subsequent studies have largely corroborated the original study. However, despite strong support for its utility in VTE risk assessment, the Caprini RAM has not been thoroughly analyzed for correlation with other potential complications of surgical procedures.

This sort of investigation is necessary because up to 98,000 Americans die yearly due to preventable medical errors, among them the failure to administer appropriate thromboembolism prophylaxis. Wound and medical complication still affect up to 4.6 and 4.9% of patients, and the overall incidence of post-operative complication is 10.9%.

The authors conducted a retrospective chart review of patients who underwent a series of complex reconstructive and body contouring procedures. The study attempted to analyze the appropriateness of utilizing the Caprini RAM for evaluating a patient's risk for non-VTE complications following operation.

MATERIALS AND METHODS

Retrospective chart review was undertaken subsequent to IRB approval. The study population consisted of a subset of 1801 unique plastic surgery encounters encompassing a series of complex reconstructive and body-contouring procedures as determined by CPT codes. Members of the UT Southwestern Plastic Surgery Department saw these patients from January 2008 to January 2012 and performed operations at facilities associated with UT Southwestern Medical Center.

Variables: The independent variables included all information points necessary to calculate a Caprini score under the guidelines of the 2005 Caprini Risk Assessment Model [2]. Patient co-morbidity information was also noted during data collection. Also, if thromboembolism prophylaxis was given, type (heparin, warfarin, or low molecular weight heparin), frequency, and number of days administered was noted.

In addition to newly diagnosed venous thromboembolism events within the 30-day follow up period, outcome variables included other potential post-operative complications. For data analysis, wound complications were defined by one or more of the following: infection, dehiscence, erythema, necrosis, seroma, hematoma, or delayed wound healing. Incidences of the complications of interest (infection, dehiscence, etc.) were included whether they were localized to the donor site, recipient site, or the flap used for the operation.

Methods: Caprini scores were recorded as both ordinal values (0-17) and as stratified groups. Two-tailed tests for proportions were performed on percentile data to look for differences in rates of complication in female gender, proportion of patients with BMI > 25 and 40, history of major surgery 1 month prior, smoking, diabetes, COPD or other pulmonary disease, HTN, CAD, history of myocardial infarction or other cardiovascular disease, renal disorders, cancer, HIV/AIDS, and a history of DVT. Non-percentile data (age, BMI, and OR time) were treated with a comparison of means using the Student T-test.

For correlation of complications with Caprini score, patient encounters were separated into "low risk" and "high risk" categories based on Caprini score, with a value of 0-4 constituting low risk and a value equal to or greater than 5 constituting high risk. These low and high-risk groups were compared for complication rates using simple odds ratios. Odds ratios were calculated for the event of any overall complication and the individual complications of DVT, dehiscence, infection, erythema, seroma, hematoma, necrosis, and delayed wound healing. Sensitivity and specificity were also calculated utilizing the risk stratification as a 2x2 contingency table for each of the noted complications.

MATERIALS AND METHODS

Choose All That Apply

2005 Caprini Risk Assessment Model Scoring Card

RESULTS

Table 1: DVT and Wound Complication Rate by Procedure Type

Procedure Type	Patients (N)	Patients with Any Complication	Patients with VTE
Flap-Based Procedure	491	170	16
Removal of Facial Wrinkles	31	5	0
Excision (Excessive Skin Tissue)	271	70	0
Suction-Assisted Lipectomy	226	28	2
Delayed Breast Prosthesis	177	17	0
Breast Reconstruction	402	158	6
Total	1598	448	24

203 patients of the original cohort of 1801 patient encounters were excluded because inconsistencies and deficiencies in medical records prevented calculation of a reliable Caprini score. These patients were subsequently excluded from further analysis, giving a final cohort of 1598 encounters. Patients in this cohort ranged in age from 14 to 86, with an average age of 49.79. There were 1289 female and 309 male patients. The majority of patients underwent breast reconstruction (n=402) or flap-based (n=491) procedures, with excision lipectomy (n=271), suction assisted lipectomy (n=226), delayed breast prosthesis (n=177), and facial wrinkle removal (n=31) comprising the remainder. Overall complication incidences for these procedures were: 158, 170, 70, 28, 17, and 5 cases respectively, resulting in an overall complication rate of 28.03% (Table 1). The overall rate of DVT was 1.50%.

When comparing individual risk factors between complication versus complication-free patients, age, BMI, operation time, hypertension, renal disease and cancer were identified to be statistically significant. Interestingly, for female patients, oral contraceptive pill (OCP) use was associated with lower complication rate. For DVT versus DVT-free patients, sex, BMI, operation time, smoking status, diabetes, hypertension, and prior history of DVT were identified as significant (Table 2). For the low and high-risk stratifications, 628 encounters were identified as low risk, and 970 were identified as high risk. Dehiscence, infection, necrosis, seroma, hematoma, and overall complication rate had significantly increased incidence for the high-risk group (Table 3).

RESULTS

Table 2: Univariate Analysis of Patient Cohort

Risk Factor	Patients without Complications	Patients with Any Complication	p Value (Any Complication)	Patients without VTE	Patients with VTE	p Value (VTE)
Patients (N)	1150	448		1574	24	
Age (Mean)	49.28	51.09	0.016	49.76	51.83	0.454
Female (%)	81.76%	77.90%	0.094	81.07%	54.17%	0.002
BMI (Mean)	27.59	29.71	<0.001	28.11	32.91	0.001
BMI > 25 (%)	59.57%	70.54%	<0.001	62.33%	83.33%	0.057
BMI > 40 (%)	4.96%	8.71%	0.007	5.84%	16.67%	0.0745
OR Time (Mean)	4.07	5.85	<0.001	4.55	5.95	0.033
Major surgery one month prior (%)	8.61%	11.83%	0.061	9.53%	8.33%	0.88
Smoking (%)	9.57%	10.04%	0.849	9.47%	25.00%	0.028
Diabetes (%)	11.39%	17.41%	0.002	12.71%	37.50%	0.001
COPD / Pulmonary (%)	18.35%	20.54%	0.351	18.87%	25.00%	0.619
HTN (%)	29.48%	37.95%	0.001	31.45%	58.33%	0.01
CAD, History of MI, or other cardiovascular (%)	21.83%	24.33%	0.314	22.30%	37.50%	0.128
Renal Disease (%)	6.78%	10.49%	0.017	7.69%	16.67%	0.214
Cancer (%)	30.70%	35.94%	0.050	32.15%	33.33%	0.923
HIV/AIDS (%)	0.78%	0.89%	0.928	0.76%	4.17%	0.483
History of DVT/PE (%)	2.09%	3.13%	0.297	2.22%	12.50%	0.009
Women (N)	940	349		1276	13	
Oral contraceptive use (%)	14.15%	9.74%	0.045	12.93%	15.38%	0.878

Table 3: Odds Ratios for Individual Complications According to Caprini Score Stratification

Dehiscence	Yes	No	Infection	Yes	No	Erythema	Yes	No
Low risk	23	605	Low risk	37	591	Low risk	44	584
High risk	60	910	High risk	110	860	High risk	63	907
Odds Ratio (P value)	1.73 (0.028)		Odds Ratio (P value)	2.04 (0.0003)		Odds Ratio (P value)	0.92 (0.690)	
Sensitivity	0.72		Sensitivity	0.75		Sensitivity	0.59	
Specificity	0.40		Specificity	0.41		Specificity	0.39	
Seroma	Yes	No	Hematoma	Yes	No	Delayed Healing	Yes	No
Low risk	35	593	Low risk	9	619	Low risk	19	609
High risk	80	890	High risk	29	941	High risk	32	938
Odds Ratio (P value)	1.52 (0.045)		Odds Ratio (P value)	2.12 (0.050)		Odds Ratio (P value)	1.09 (0.761)	
Sensitivity	0.70		Sensitivity	0.76		Sensitivity	0.63	
Specificity	0.40		Specificity	0.40		Specificity	0.39	
Necrosis	Yes	No	DVT	Yes	No	Any Complication	Yes	No
Low risk	15	613	Low risk	7	621	Low risk	137	491
High risk	63	907	High risk	17	953	High risk	311	659
Odds Ratio (P value)	2.84 (0.0004)		Odds Ratio (P value)	1.58 (0.310)		Odds Ratio (P value)	1.69 (<0.0001)	
Sensitivity	0.81		Sensitivity	0.71		Sensitivity	0.69	
Specificity	0.40		Specificity	0.39		Specificity	0.43	

Although the Caprini RAM has been extensively investigated with respect to preoperative evaluation of VTE risks, to the best of our knowledge there has been no similar exploration into predictive associations of this score with the other potential complications of surgical procedures (infection, seroma, hematoma, and delayed wound healing to highlight a few). This is surprising because the full list of variables that comprise an individual Caprini score involve a host of inherited and acquired clinical characteristics in addition to biochemical profiles. Many of the clinical factors that are taken into consideration are systemic dysfunctions that involve multiple organ systems.

The data presented here show that increasing Caprini scores are associated with increasing odds ratios (OR) for dehiscence (1.73, p = 0.028), infection (2.04, p = 0.0003), seroma (1.52, p = .045), hematoma (2.12, p = 0.050), and necrosis (2.83, p = 0.0004) with a corresponding overall OR increase of 1.69 (p < 0.0001). These odds ratios parallel similar, but not identical, increases in the baseline occurrence rates for the noted complications: dehiscence (3.66% to 6.19%), infection (5.89% to 11.34%), seroma (5.57% to 8.25%), hematoma (1.43% to 2.99%), necrosis (2.39% to 6.49%), and general complication (21.82% to 32.06%). Based on this, we support the use of Caprini scores for preoperative calculation of the risk for non-VTE complications, a recommendation that is borne out by independent studies across disciplines.

CONCLUSION

The data demonstrates that the Caprini Risk Assessment Model can be applied preoperatively to categorize patient risk of developing non-VTE complications. Patients in higher risk categories are at an increased risk of suffering wound dehiscence, infection, seroma, hematoma, and necrosis. Considering these potential complications as a single group, a high-risk patient has a 69% increased odds of suffering at least one problem compared with low-risk individuals. This information can help physicians educate patients about the risks of their operations and helps prioritize the complications to keep an especially vigilant watch for.

Furthermore, the study validates the assignment of risk in providing a gradation for the purposes of preoperative decision-By subdividing a diverse patient population into more homogenous and manageable sections, it is possible to devise standardized treatment regimens for individual risk categories. However, the study presented here is a single institution retrospective review. The patient population exhibited a normal distribution, resulting in small cohorts at either extreme of the stratified risk groups. Additional research should expand the study population and validate the results of this study. Randomized controlled trials focusing on non-VTE complications will also provide higher-quality data to help design protocols and make treatment recommendations.

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