

A New Approach for Venous Thromboembolism Prevention in Plastic Surgery

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Individual risk stratification and chemoprophylaxis for venous thromboembolism (VTE) prevention have been promoted in the plastic surgery literature for over a decade. Today, with more information available, it is appropriate to review the evidence. How have these methods performed? Is a safer and more effective alternative available?

A 2021 review of this topic endorses individual risk assessment for VTE prevention.¹ The authors write, “the Caprini score was validated in patients who had general endotracheal anesthesia,” erroneously referencing two studies that in fact refute the validity of Caprini scores.^{2,3} The authors state that the odds ratio for VTE risk when undergoing general anesthesia in comparison with monitored anesthesia care needs to be studied, again referencing publications that made no such recommendation.^{2,4} The existing literature already makes clear the increased VTE risk of surgery under general anesthesia with paralysis.²⁻⁹

Risk mitigation is recommended,¹ but supportive evidence is lacking.⁴ Hormonal supplementation does not correlate with VTE risk.⁴ Abdominoplasty with rectus plication does not significantly increase intra-abdominal pressure,¹⁰ and does not independently correlate with VTE risk.⁴ A level 1 randomized study reveals no increased fibrinolytic activity in plastic surgery outpatients treated with sequential compression devices.¹¹

Not surprisingly, preoperative anticoagulation significantly increases the risk of bleeding.¹ As any surgeon will attest, anticoagulation is not needed to identify bleeders!¹ Impractical antifactor Xa assays provide no direct information regarding the development of a deep venous thrombosis.^{3,12} Enoxaparin doses greater than 40 mg daily exceed dosing guidelines, are not FDA-approved,^{3,12} and cause overdoses in 27% of patients and an unacceptable bleeding risk of 6.8%.¹³

Agrawal et al¹ acknowledge an alternative approach using total intravenous anesthesia without paralysis to preserve the calf muscle pump and ultrasound surveillance to identify patients for anticoagulation therapy.⁴ The authors caution, however, that a 2020 study finding that sequential compression devices were of no benefit “was likely underpowered,”¹ referencing this study,⁴ which included no such statement. This 5-year prospective study in 1000 patients included an a priori power analysis and sample size calculation—measures that improve reliability.¹⁴ Nevertheless, the authors advise against adopting this treatment alternative until it has been corroborated by other surgeons and the findings reproduced.¹ There is considerable irony in this recommendation.

Despite its title, the “VTE Prevention study” did not find a significant VTE risk reduction from anticoagulation in patients with higher Caprini scores ($P = 0.230$ and $P = 0.182$).¹⁵ The VTEPS authors recognize that their study was underpowered.¹⁵ Moreover, the VTEP study findings, demonstrating a marginal ($P = 0.042$) overall benefit for chemoprophylaxis despite equal VTE rates in treated and untreated patients (1.2%),^{5,6} have not been reproduced. On the contrary, a large study ($n = 1598$) by Jeong et al¹⁶ reported *more* VTEs among anticoagulated patients ($P < 0.00001$). A meta-analysis found no significant VTE risk reduction, either overall ($P = 0.17$) or in any Caprini subgroup, including inpatients with scores greater than 8.⁷

Support for individual risk stratification in predicting affected patients is lacking.^{5,6} Caprini scores are not scientifically based and, not surprisingly, do not correlate with published relative risk values.⁵ The false positive rate using a Caprini score of 7 or more to screen patients is 97%; almost half of the affected patients are missed.⁶ Shaikh et al¹⁷ reported no VTEs in 36 patients with “super-high” Caprini scores exceeding 10. Keyes et al¹⁸ concluded that Caprini scores were unhelpful because 67% of abdominoplasty patients who developed VTEs had Caprini scores less than 6. Lemaine et al¹⁹ found that 96.6% of “high risk” microsurgical breast reconstruction patients had no ultrasonic evidence of deep venous thromboses.

Proponents claim that Caprini scores are validated¹ because patients with higher scores are, on average, more at risk for VTEs. This is a low bar for validity; age scores alone would qualify.⁴ It would be surprising

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indeed if these scores were of any useful predictive value, and many investigators believe they are not, including the lead author of the 2004 and 2008 American College of Chest Physicians antithrombotic guidelines (W.H. Geerts, M.D., personal communication, December 21, 2021) and the authors of the 2012 orthopedic section of these guidelines.²⁰

When investigators consistently cite *P* values of just under 0.05 that favor their hypothesis,^{15,21,22} one must be alert to the possibility of *P* hacking—the risky practice of adjusting eligibility criteria or controlling for other study factors to produce a *P* value under 0.05.²³ For example, Caprini scores are underestimated in retrospective chart reviews.³ The length of hospitalization is not a VTE risk factor.^{4,6} Therefore, controlling for median Caprini scores and hospital stays to force a *P* value under 0.05 is not justified.^{4,6} Other examples are widening the eligibility criteria to include upper extremity thromboses,²¹ which have a different etiology (central line trauma), or finding a safety advantage for weight-based enoxaparin dosing²² when controlling for age and central lines—factors not known to affect antifactor Xa levels.

Importantly, chemoprophylaxis is not approved by the U.S. Food and Drug Administration (FDA) for VTE prophylaxis in plastic surgery patients.^{3,12} By contrast, ultrasound is FDA-approved, and anticoagulation (including oral anticoagulants) is FDA approved for patients with ultrasound evidence of thromboses. Oral medications are better tolerated by patients than enoxaparin injections, improving compliance.⁴

Surprisingly, advocates of individual risk stratification, who consider this method to represent the standard of care, do not actually use a preoperative Caprini score when deciding whether or not to anticoagulate

patients.^{13,21,22,24–26} They use nonrisk-stratified chemoprophylaxis instead, against published guidelines.⁷

Its proponents are persuaded that risk stratification predicts affected patients,^{1,7} that enoxaparin prevents VTEs in patients with higher Caprini scores,¹⁵ that enoxaparin does not increase the bleeding risk,²⁷ that hematomas are an acceptable trade anyway,^{1,7} and that risk stratification and chemoprophylaxis represent the standard of care.²⁸ Some plastic surgeons suggest that ultrasound surveillance (the only practical means of accurately detecting deep venous thromboses)⁴ falls below the standard of care.²⁴ Recent recommendations include withholding estrogens, tranexamic acid, and tamoxifen.¹ Fortunately, these recommendations do not include extra enoxaparin doses and weight-based dosing.^{13,21,22} Some authors still believe that optimizing risk assessment models will eventually reduce the VTE risk close to zero,¹ despite evidence to the contrary (Table 1).^{6,7,12,15–19,29}

Improved diagnostic methods (ultrasound) can only improve our knowledge base. Methods of detection and VTE prevention are likely to evolve. Accordingly, plastic surgeons do well to avoid offering opinions regarding the standard of care.²⁹ VTEs cannot be predicted by risk assessment methods,^{4,6} and clinical detection is unreliable.⁴ The alternative approach is quite simple. Avoid paralysis,^{4,6,8} adopt ultrasound surveillance,^{2,4} and prescribe anticoagulation only when a deep venous thrombosis is detected.⁴ Sequential compression devices are unhelpful in plastic surgery outpatients treated with total intravenous anesthesia.^{4,11} Ultrasound is highly accurate^{2,4} and allows for early detection of deep venous thromboses and treatment using FDA-approved oral anticoagulants,⁴ reducing the risk of thrombus propagation.³⁰ Only by embracing new

Table 1. Venous Thromboembolism Risk Reduction Methods in Plastic Surgery Patients

Intervention	Supportive Evidence	Nonsupportive Evidence
Individual risk stratification using Caprini scores	0	Pannucci et al ¹⁵ Shaikh et al ¹⁷ Keyes et al ¹⁸ Lemaine et al ¹⁹
Chemoprophylaxis	Pannucci et al ^{15*}	Pannucci et al ⁷ Jeong et al ¹⁶
Sequential compression devices	Reinisch et al ^{9†}	Swanson ⁴ Swanson ¹¹
Ultrasound surveillance for deep venous thromboses	Swanson ⁴ Lemaine et al ¹⁹	0
Total intravenous anesthesia, no paralysis	Swanson ⁶ Pannucci et al ⁷ Swanson and Gordon ⁸	0
Oral anticoagulants in patients with documented thromboses	Swanson ⁴	0
Withholding estrogens	0	Swanson ⁴
Avoiding tranexamic acid and tamoxifen	0	0
Avoiding long flights after surgery	0	0
Not repairing diastasis in abdominoplasty and avoiding flexion	0	Swanson ⁴ Huang et al ¹⁰
Limiting operating room time	0	Swanson ⁴ Pannucci et al ¹⁵
Not combining procedures	0	Swanson ⁴

**P* = 0.042 after controlling for Caprini score and length of hospitalization.

†Authors did not account for type of anesthesia as a confounding variable.

technology are we likely to make progress in understanding and preventing this serious complication.

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