Deep Venous Thrombosis
Prevention and Management

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KEYWORDS

• Deep vein thrombosis • Patient safety • Postoperative complications
• Postoperative risk assessment • Pulmonary emboli • Venous thromboembolism

KEY POINTS

- Deep vein thrombosis and its possible sequela of pulmonary embolism are a major risk for plastic surgery patients.
- Patients undergoing an abdominoplasty are at a significant risk of death due to pulmonary emboli.
- Risk assessment is the basis for prevention of thromboembolic phenomena.
- Measures to prevent deep venous thrombosis must be taken based on risk stratification.
- Early diagnosis and treatment of deep venous thrombosis or pulmonary emboli are essential to decrease the risks of these serious sequelae.

The incidence of thromboembolic phenomena, including deep venous thrombosis (DVT) and its feared sequela of pulmonary embolism (PE), are major health care issues and known postoperative risks of lengthy surgical procedures.[1,2] *The Surgeon General's Call to Action to Prevent Deep Vein Thrombosis and Pulmonary Embolism*, 2008 estimated that 350,000 to 600,000 Americans suffer annually from DVT and PE and that at least 100,000 deaths per year may be related to these diseases.[3] In 2009, the National Quality Forum had even more impressive statistics[4]: each year more than 900,000 Americans form DVTs, of which 500,000 experience a PE, resulting in roughly 300,000 deaths. Surgeons who operate in ambulatory facilities must become aware of these health risks for their patients.

Overview

An historical review of the plastic surgery literature reveals studies that offer recommendations for both DVT prophylaxis and risk management, starting with a 1999 article by Noel McDevitt.[5] The executive committee of the American Society of Plastic Surgeons (ASPS)–approved *Venous Thromboembolism Task Force Report* identified the best practices for DVT/PE prevention and treatment.[6] The ASPS Task Force on Patient Safety has also published articles offering recommendations for DVT prophylaxis based on levels of risk in ambulatory surgery settings.[7–9] The need for awareness of DVT/PE prophylaxis in plastic surgery, and specifically in liposuction and abdominoplasty procedures, has been the basis for numerous articles.[9–18] The correlation of DVT/PE and body-contouring surgery after massive weight loss was addressed by Kenkel,[19] for abdominal contouring by Hatef and colleagues,[20,21] and is still receiving attention as documented by Egrari[21] in 2012. The risk of DVT is even greater in patients receiving orthopedic care and in certain categories of trauma and general surgery than in plastic surgery. There is extensive published literature to support this conclusion.[22–29]

Facelifts and their association with DVT/PE were documented by Rigg[30] and by Reinisch and colleagues[31] in 1998, and still remain an important

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topic, as pointed out in the article by Abboushi and colleagues[32] in 2012. The facelift procedures that were complicated by postoperative DVT were performed under both local anesthesia with sedation and general anesthesia, continuing a long discussion as to whether avoidance of general anesthesia can decrease or eliminate DVT/PE.[33–37] Hoefflin[38] countered by reporting no major complications in 23,000 cases under general anesthesia.

AMERICAN ASSOCIATION FOR THE ACCREDITATION OF SURGICAL FACILITIES

Peer Review Data: September 2012

The American Association for the Accreditation of Surgical Facilities (AAAASF), through its quality assurance and peer review process, has previously reported on significant issues in ambulatory surgery.[14,15] The latest data are shown in **Table 1** and confirm the many reports that DVT/PE is a major problem for patients having plastic surgery. Of the 3,922,202 plastic surgery cases, there were 215 DVTs and 264 PEs for a total of 479. This is an incidence by case of 0.01222% or 1 in every 8188 cases. The largest number of venous thromboembolism (VTE), 308, occurred with abdominoplasties. The abdominoplasty procedures performed alone were 98; abdominoplasties plus 1 additional procedure were 137; plus 2 additional procedures, 58; and plus 3 additional procedures, 15, which is an incidence of 0.0666% or 1 in every 1502 cases. Total abdominoplasties that were associated with a PE were 185, with an incidence of 0.04% or 1 in every 2500 cases. The distribution of PE cases associated with abdominoplasty alone or abdominoplasties with multiple procedures is similar to the data for patients having VTE/PE. There is no significant statistical difference for VTE or PE whether the abdominoplasty is performed alone or with multiple other procedures. It has been reported in the literature that performing multiple procedures at the same time increases the risk of complications, such as VTE. These peer-reviewed data do not support that conclusion.

There were 94 deaths associated with plastic surgery, or an incidence of 0.0024% or 1 in every 41,726 cases. The incidence of death in plastic surgery procedures is 0.0017% or 1 in every 58,779 procedures. The death rate in plastic surgery by case or procedure is less than when all specialties are combined; the number of deaths related to PE in the plastic surgery cases was 40 of 94, or 43%. It is significant that, of the 40 deaths in plastic surgery procedures, an incidence of 0.0010% or 1 in every 98,055 cases, 26 occurred with abdominoplasties for an incidence of 0.0056% or 1 in every 17,791 cases. The data also reveal that PEs have occurred with a significant number of other procedures; 5 in facelift and blepharoplasty, 5 with liposuction, 2 with buttocks/thigh extremity lift, and 2 with breast surgery.

Risk Assessment

Plastic surgery continues to emphasize risk assessment and risk-stratifying models for DVT as a basis for prevention and avoidance.[2,5,7] Many patient characteristics, behaviors, and medical histories identify increased risks for postoperative DVT. Obstetric history is important and frequently overlooked.[23] Past obstetric complications including a still birth, miscarriage, or premature birth with toxemia may indicate a serious thrombophilia defect. Postmenopausal hormone therapy and selective estrogen-receptor modulators (tamoxifen and raloxifene) are associated with 2-fold to 3-fold increased risk of venous thrombosis.[39] The factors that predisposed a patient to thrombosis or embolism in 2002 formed a limited list.[7] It has not only been expanded but better defined by Caprini and others.[22–24,40]

The 2005 Caprini Risk Assessment Model (**Fig. 1**) and its subsequent, more developed, version, the 2010 Caprini Risk Assessment Model (**Fig. 2**), are thorough, noting common risk factors for DVT and PE. Each factor is weighted 1, 2, 3, or 5 points, depending on its significance for risk. An overall total risk category score is then assigned (**Table 2**). A correlation between the total risk score and proven VTE incidents in surgical patients has been reported.[24,41,42]

The assessment of postoperative VTE risk in patients having plastic surgery, using both the 2005 and 2010 Caprini Risk Assessment Models, was studied by Pannucci and colleagues.[43] Their conclusion identified the 2005 Caprini model as a more appropriate method for risk stratification of patients having plastic surgery than the 2010 model.

Although the Caprini assessment models do not include smoking as a risk factor, the presence of coagulation abnormalities associated with smoking[44] may further increase the risk for DVT/PE. Tobacco smoking has been associated with increased serum homocysteine, representing a 3-point risk factor in the model. The interrelationship between smoking, its procoagulant mechanisms, and VTE awaits further therapeutic studies. The importance of evidence-based medicine in these areas mandates further research.[45–47]

Prevention

The strategies for prevention of DVT/PE are extensive and most often based on preoperative risk

Table 1
American association for the accreditation of surgical facilities, plastic surgery data for VTE, PE, and deaths (September 2012)

Total Cases all AAAASF Specialties	5,416,071				
Total Procedures all AAAASF Specialties	7,629,686	1.41	Procedures per Case		
Plastic Surgery Cases	3,922,202				
Plastic Surgery Procedures	5,525,255	1.41	Procedures per Case		
		Incidence % by Case	1 in # Case	Incidence % by Procedure	1 in # Procedure
All Deaths all Specialties	184	0.0034%	29,435	0.0024%	41,466
		Incidence % by Plastic Surgery Case	1 in # Plastic Surgery Case	Incidence % by Plastic Surgery Procedure	1 in # Plastic Surgery Procedure
All Plastic Surgery Deaths	94	0.0024%	41,726	0.0017%	58,779
Total Abdominoplasties Performed	462,564				
Abdominoplasty Alone	176,092				
Abdominoplasty + 1 other procedure	187,847				
Abdominoplasty + 2 other procedures	73,869				
Abdominoplasty + 3 other procedures	24,756				
		Incidence % by Case	1 in # Case	Incidence % by Procedure	1 in # Procedure
Total Plastic Surgery VTE	479	0.0122%	8188	0.0087%	11,535
Plastic Surgery DVT	215	0.0055%	18,243	0.0039%	25,699
Plastic Surgery PE	264	0.0048%	20,929	0.0048%	20,929
		Incidence % by Case	1 in # Case		
Abdominoplasty + VTE	308	0.0666%	1502		
VTE Abdominoplasty Alone	98	0.0557%	1797		
VTE Abdominoplasty + 1 other procedure	137	0.0729%	1371		
VTE Abdominoplasty + 2 other procedures	58	0.0785%	1274		
VTE Abdominoplasty + 3 other procedures	15	0.0606%	1650		
		Incidence % by Case	1 in # Case		
Abdominoplasty + PE	185	0.0400%	2500		
PE Abdominoplasty Alone	60	0.0341%	2935		
PE Abdominoplasty + 1 other procedure	81	0.0431%	2319		
PE Abdominoplasty + 2 other procedures	37	0.0501%	1996		

(*continued on next page*)

Table 1
(*continued*)

PE Abdominoplasty + 3 other procedures	7	0.0283%	3537		
		Incidence % by Case	1 in # Case	Incidence % by Procedure	1 in # Procedure
Deaths PE All Plastic Surgery Procedures	40	0.0010%	98,055	0.0007%	138,131
Deaths PE Abdominoplasty Alone	6	0.0034%	29,349		
Deaths PE Abdominoplasty + 1 other procedure	10	0.0053%	18,785		
Deaths PE Abdominoplasty + 2 other procedure	9	0.0122%	8208		
Deaths PE Abdominoplasty + 3 other procedure	1	0.0040%	24,756		
Total Deaths PE Abdominoplasty	26	0.0056%	17,791		
Deaths Facelift and Blepharoplasty	5				
Deaths PE Liposuction	5				
Death PE Buttocks Thigh Extremity Lift	2				
Deaths PE Breast Augmentation or Lift	2				

Data from American Association for Ambulatory Surgical Facilities, Inc. Internet Based Quality Assurance and Peer Review Program. Available at: http://www.aaaasf.org.

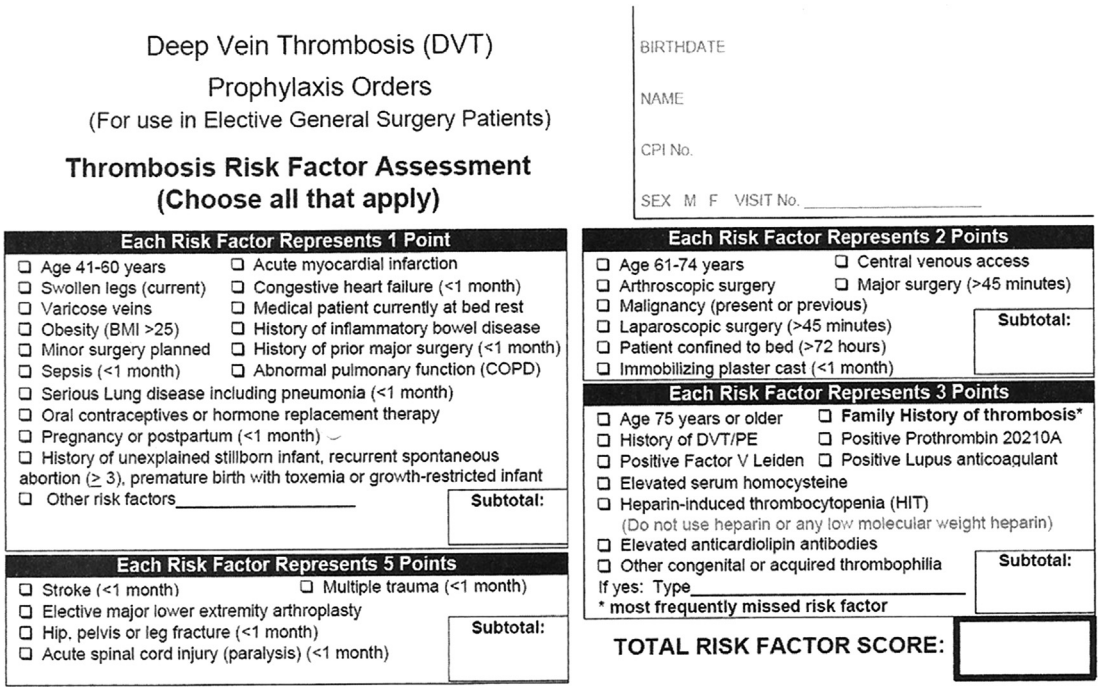
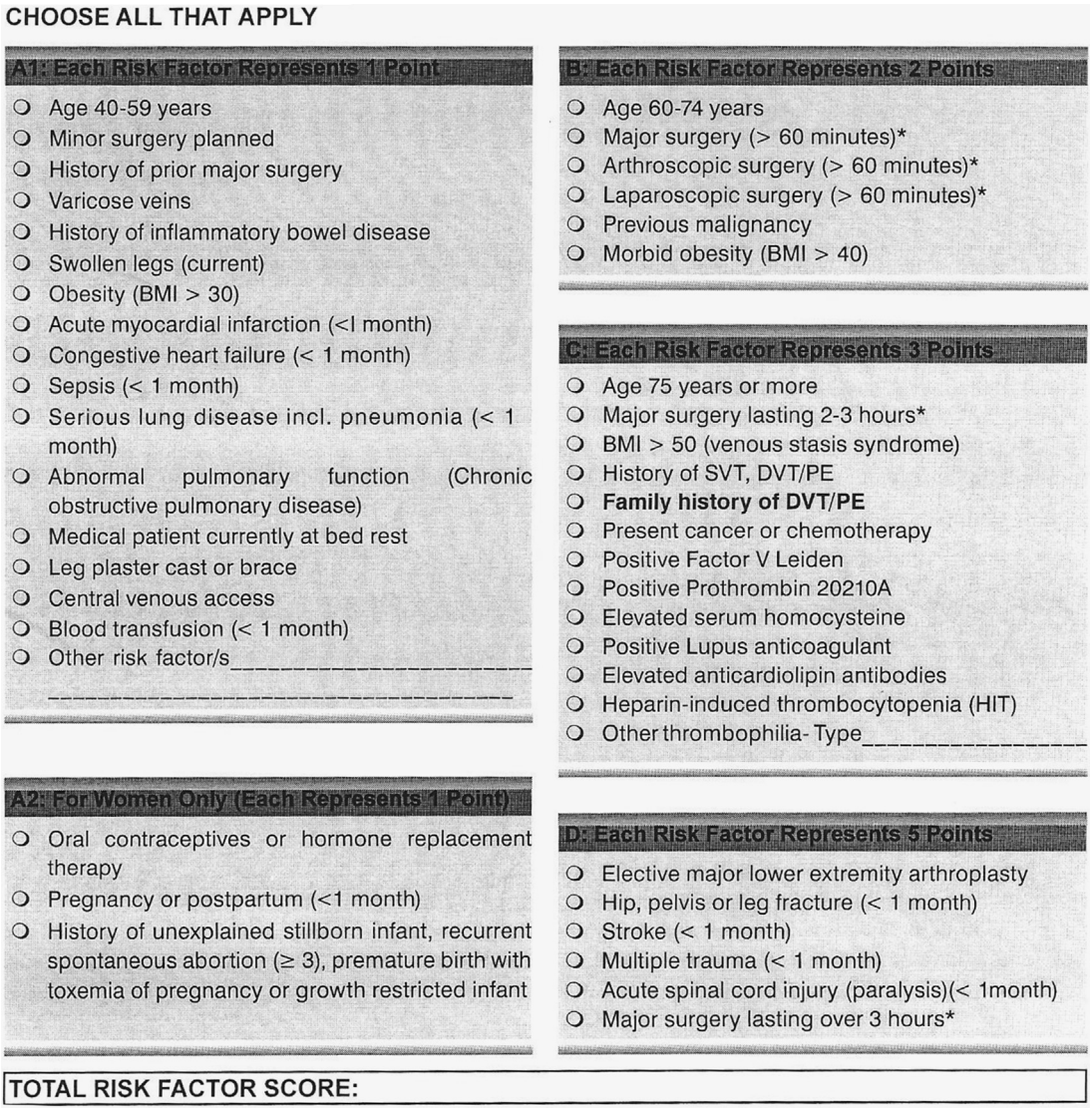


Fig. 1. The 2005 Caprini Risk Assessment Model. COPD, chronic obstructive pulmonary disease. (*Adapted from* Caprini JA. Thrombosis risk assessment as a guide to quality patient care. Dis Mon 2005;51:70–8; with permission.)


CHOOSE ALL THAT APPLY

A1: Each Risk Factor Represents 1 Point
- ❍ Age 40-59 years
- ❍ Minor surgery planned
- ❍ History of prior major surgery
- ❍ Varicose veins
- ❍ History of inflammatory bowel disease
- ❍ Swollen legs (current)
- ❍ Obesity (BMI > 30)
- ❍ Acute myocardial infarction (<I month)
- ❍ Congestive heart failure (< 1 month)
- ❍ Sepsis (< 1 month)
- ❍ Serious lung disease incl. pneumonia (< 1 month)
- ❍ Abnormal pulmonary function (Chronic obstructive pulmonary disease)
- ❍ Medical patient currently at bed rest
- ❍ Leg plaster cast or brace
- ❍ Central venous access
- ❍ Blood transfusion (< 1 month)
- ❍ Other risk factor/s_____

A2: For Women Only (Each Represents 1 Point)
- ❍ Oral contraceptives or hormone replacement therapy
- ❍ Pregnancy or postpartum (<1 month)
- ❍ History of unexplained stillborn infant, recurrent spontaneous abortion (≥ 3), premature birth with toxemia of pregnancy or growth restricted infant

B: Each Risk Factor Represents 2 Points
- ❍ Age 60-74 years
- ❍ Major surgery (> 60 minutes)*
- ❍ Arthroscopic surgery (> 60 minutes)*
- ❍ Laparoscopic surgery (> 60 minutes)*
- ❍ Previous malignancy
- ❍ Morbid obesity (BMI > 40)

C: Each Risk Factor Represents 3 Points
- ❍ Age 75 years or more
- ❍ Major surgery lasting 2-3 hours*
- ❍ BMI > 50 (venous stasis syndrome)
- ❍ History of SVT, DVT/PE
- ❍ **Family history of DVT/PE**
- ❍ Present cancer or chemotherapy
- ❍ Positive Factor V Leiden
- ❍ Positive Prothrombin 20210A
- ❍ Elevated serum homocysteine
- ❍ Positive Lupus anticoagulant
- ❍ Elevated anticardiolipin antibodies
- ❍ Heparin-induced thrombocytopenia (HIT)
- ❍ Other thrombophilia- Type_____

D: Each Risk Factor Represents 5 Points
- ❍ Elective major lower extremity arthroplasty
- ❍ Hip, pelvis or leg fracture (< 1 month)
- ❍ Stroke (< 1 month)
- ❍ Multiple trauma (< 1 month)
- ❍ Acute spinal cord injury (paralysis)(< 1month)
- ❍ Major surgery lasting over 3 hours*

TOTAL RISK FACTOR SCORE:

Fig. 2. The 2010 Caprini Risk Assessment Model. BMI, body mass index; DVT/PE, deep venous thrombosis/pulmonary embolus; SVT, superficial venous thrombophlebitis. (*Adapted from* Caprini JA. Risk assessment as a guide to thrombosis prophylaxis. Curr Opin Pulm Med 2010;16:448–52; with permission.)

Table 2
Risk assessment categories. The 2005 Caprini Risk Assessment Model

Risk Factor Score	Risk Level
0–1	Low risk
2	Moderate risk
3–4	High risk
5 or more	Highest risk

Adapted from Caprini JA. Thrombosis risk assessment as a guide to quality patient care. Dis Mon 2005;51:70–8; with permission.

assessment for DVT.[11,23–25,40] For instance, the patient's risk factors for increased bleeding are critical to evaluate because the presence of these factors may rule out the use of chemoprophylaxis. Risk factors for increased bleeding are listed in **Box 1**.

It is also important to identify and appraise any relevant findings before intermittent pneumatic compression (IPC) devices are automatically used. Peripheral arterial disease, congestive heart failure, acute superficial venous thrombophlebitis, or DVT are known diseases and conditions that are contraindicated for IPC therapy.

Box 1
Risk factors for increased bleeding

- Current medications such as aspirin or Coumadin
- Family history of bleeding disorder
- History of heparin-induced thrombocytopenia
- Known acquired bleeding disorder
- Patient bruises or swells easily
- Platelet count less than 100,000/mm^3
- Previous bleeding issues during surgery or dental procedures

The prophylaxis regime,[1,23–25] based on the Caprini Risk Assessment Model, is shown in **Table 3**. The basic recommendations in this table should be augmented with a comprehensive perioperative and intraoperative approach.[1,10,20,48,49] The use of chemoprophylaxis as part of the approach to prevention is explained in the article by Alan Gold, MD, elsewhere in this issue.

Somogyi and colleagues[49] thought that their preventative approach lowered the risk of VTE in abdominoplasties to a level that made chemoprophylaxis unnecessary. They made numerous recommendations, but the most significant seem to be (1) celecoxib (Celebrex) 200 mg, taken 1 hour before surgery, (2) use of graded compression stockings beginning 24 hours before surgery, (3) IPC devices in place before surgery and maintained until discharge from the postanesthesia care unit, (4) maintenance of normothermia, and (5) encouraging ambulation as early as possible. Surgical time was minimized by their technique and staff training. These suggestions are reasonable and should be proactively considered to improve patient safety.

The authors use and recommend the strategies listed in **Box 2** for postoperative management of surgical patients.

The current standard for IPC devices from the AAAASF, Version 13 200.017.030, states that sequential compression devices are used for surgical procedures of 1 hour or longer, except for procedures performed under local anesthesia.[50] This reasonable recommendation should be adhered to no matter what level of risk is identified for the patient, unless the contraindications previously discussed are present.

Seruya and colleagues[1] found that the incidence of treated patients who present with high-risk factors for DVT are sizable and comprise 15% of the population of patients having plastic surgery. His studies suggest that thromboprophylaxis is more effective in this highest risk factor group than mechanical prophylaxis alone. All these risk factors and risk levels must be discussed with individual patients before the determination of their candidacy for surgery; this discussion is an essential part of an adequate informed consent. The patient's decision to have surgery and the surgeon's decision to perform surgery hinge on those factors and levels of risks. Patients who are in the highest risk category, especially if that risk is double digit, may need to forego elective quality-of-life procedures given that their total risk factor score indicates an extremely high risk of DVT/PE.

Table 3
Prophylaxis regime. The 2010 Caprini Risk Assessment Model

Total Risk Factor Scores	Risk Level	Prophylaxis Regime
0–1	Low	Early ambulation
2	Moderate	ES or IPC or LDUH or LMWH
3–4	High	IPC or LDUH or LMWH alone or in combination with ES or IPC
5 or more	Highest	Pharmacologic: LDUH, LMWH, warfarin or FAC Xa alone or in combination with ES or IPC

Abbreviations: ES, elastic stocking; FAC Xa, factor, X inhibitor; IPC, pneumatic impression device; LDUH, low-dose unfractionated heparin; LMWH, low-molecular-weight heparin.

Adapted from Caprini JA. Risk assessment as a guide to thrombosis prophylaxis. Curr Opin Pulm Med 2010;16:448–52; with permission.

Box 2
Prevention through postoperative patient management

- Ambulation every hour
- Avoid popliteal pressure while sitting
- Foot elevation and flexion exercises at rest
- Graded compression elastic stockings for 7 days
- Hydration
- Smoking cessation

Diagnosis

DVT, in itself, is not likely to be fatal. One-half of affected patients have an asymptomatic presentation so that its diagnosis requires confirmatory laboratory tests such as duplex ultrasound (US) imaging or contrast phlebography.[24] However, the frequently associated sequela of a PE has a high mortality. DVT is historically associated with the Virchow triad of venous stasis, vascular injury, and hypercoagulability. DVT can present with the vague symptoms of feeling dizzy and faint or present dramatically with a severely swollen leg, sometimes discolored white or blue.

The early diagnosis of DVT is vital to prevent untoward sequelae from the thrombosis in the leg and to prevent a possible resulting PE. DVT most commonly develops in the veins of the calf muscle and has a low incidence of clinically significant emboli if it remains within the calf area. However, without appropriate treatment, 20% of venous thrombi in the calf propagate and pose a serious threat. At least 50% of proximal deep venous thrombi are associated with PE or recurrent DVT.[10]

Awareness and knowledge of the symptoms of DVT and associated VTE are critical for all individuals involved in postoperative communications and care with the ambulatory surgical patient. Every office staff member, from the secretary answering the patient's calls to the nursing staff providing postoperative advice and care, must be trained to recognize the sometimes vague complaints that may indicate the presence of the disease. These complaints are listed in **Box 3**.

When in doubt, and in the absence of the surgeon, staff members should instruct any postoperative patient, even those who present with symptoms 3 to 6 months after the procedure, to seek medical care immediately. Any patient contacting the office with complaints of cardiac or respiratory distress should be directed to contact emergency medical services for transport to the emergency room for a physician's evaluation. These symptoms are listed in **Box 4**.

The ninth edition of *The American College of Chest Physicians Evidence-based Clinical Practice Guidelines* on thrombotic therapy and prevention of thrombosis provides multiple levels of evaluation for patients at risk for DVT.[51] In the patient with low pretest probability of first lower extremity DVT, the following tests are recommended: (1) a moderately sensitive D-dimer, (2) a highly sensitive D-dimer, or (3) compression US (CUS) of the proximal veins. If the D-dimer is positive, further testing with CUS of the proximal veins rather than whole-leg US or venography is advised. If the CUS of the proximal veins is positive, it is recommended that confirmatory venography is performed instead of instituting treatment of DVT.

For the patient with high pretest probability of first lower extremity DVT, proximal CUS or whole-leg US is recommended. If the proximal CUS or whole-leg US is positive for DVT, treatment is recommended rather than confirmatory venography. In patients with high pretest probability, the moderately or highly sensitive D-dimer should not be used as a stand-alone test to rule out DVT. The whole-leg US may be preferred to proximal CUS in patients unable to return for serial testing and in those with severe symptoms consistent with calf DVT or risk factors for extensive distal DVT.

In patients with suspected lower extremity DVT in whom US is impractical, for example in a case in which there is excessive fluid or subcutaneous tissue to prevent adequate assessment of compressibility or diagnosis, computed tomography venography is suggested. Magnetic resonance (MR) venography or MR direct thrombus imaging

Box 3
Manifestations of DVT or PE that may elicit calls to the office

- Chest pain
- Fainting
- Feeling dizzy, or faint leg color change
- Leg pain
- Leg swelling
- Leg tenderness
- Shortness of breath or tachypnea

Box 4
Manifestations of DVT or PE requiring a physician's evaluation

- Hemoptysis
- Transient or orthostatic hypotension
- Transient hypoxemia
- Unexplained decrease in level of consciousness
- Suspected postoperative myocardial infarction
- Postoperative nonhemorrhagic stroke
- Postoperative pneumonia
- Unexplained sudden death
- Venous engorgement of the leg

can be used as an alternative to venography. Patients suspected of DVT may choose treatment rather than venography.

Treatment

Once the diagnosis of DVT is made, the surgeon must immediately consider a consultation with the appropriate medical physician specialist and possibly a vascular surgeon. Without appropriate treatment, 20% of calf vein thrombi propagate proximately to where they pose a serious threat. At least 50% of proximal DVTs are associated with a PE or recurrent DVT, 10% were immediately fatal with PE, and 5% caused death later as a result of right ventricular dysfunction and/or pulmonary hypertension.[10] The other major problem following a DVT is postthrombotic syndrome (PTS).[25,26] PTS is clinically associated with leg pain, swelling of the leg, and varicose veins.

The protocol for antithrombotic therapy is covered in the 2012 *The American College of Chest Physicians Evidence-based Clinical Practice Guidelines*,[51] summarizing bodies of evidence to offer 600 recommendations for diagnosing, preventing, and treating DVT. The guidelines suggest that the initial anticoagulation for acute DVT be a parenteral anticoagulation low-molecular-weight heparin (Enoxaparin), fondaparinux (Arixtra), intravenous unfractionated heparin, or subcutaneous heparin. This protocol is also indicated for patients with a high suspicion of acute VTE. Any patient who has been identified as high risk for bleeding dyscrasias requires special evaluation before instituting initial anticoagulation.

Catheter-directed thrombolysis must be considered because of the benefit for the prevention of the PTS. Catheter-assisted thrombus removal is also a consideration as a method of decreasing the risk of PTS and the consequences of a PE. Vena cava filters are a consideration for patients with acute proximal DVT. The inferior vena cava filter is recommended for a patient in whom anticoagulation is contraindicated.

A vitamin K antagonist is often used for the long-term treatment of DVT. Treatment considerations, like medication usage, length of treatment, and follow-up strategies, are complex issues and should be managed by an internal medicine specialist.

Discussion

Quality care measures in the health care system are at the forefront of medicine.[41] There is a national movement to make DVT/PE a so-called never event and evidence-based medicine must be applied to the evaluation of this complex problem. It seems from all current information that DVT/PE problems will never be eliminated.

The level of awareness of DVT/PE as a major cause of mortality in ambulatory surgery has dramatically increased over the past 10 years. There are many strategies for the prevention and treatment of DVT/PE. It is only through both patients and surgeons being informed about the dangers and realities of DVT that the incidence of the problem can be decreased. It is imperative that plastic surgeons continue their efforts for increased public awareness and patient education related to the risk factors and symptoms of DVT. Plastic surgeons must routinely incorporate preoperative DVT risk assessment models for all patients who are to undergo surgery as well as apply a renewed vigilance on patient selection. The prevention protocol should be based on risk assessment and all appropriate recommended perioperative and postoperative modalities for prevention must be used. Surgeon and their staff must be trained to identify and diagnose a DVT for when prevention fails. If a DVT is suspected, appropriate treatment using a specialist medical consultation is a necessity and should be instituted immediately.

When these approaches are used by all plastics surgeons, a significant improvement in patient safety and surgical outcomes should be seen. The overall safety of performing surgery in an ambulatory setting is well documented. Continued vigilance is essential for all safety issues in the surgery suite, but those precautions for DVT/PE prevention should be foremost because those diseases are frequently associated with a patient's disability and even death.

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