Efficacy and Safety of Venous Thromboembolism Prophylaxis in Highest Risk Plastic Surgery Patients

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Background: The purpose of this study was to stratify plastic surgery patients into venous thromboembolism risk categories; identify patients at highest risk for venous thromboembolism; and quantify rates of postoperative all-cause mortality, venous thromboembolism, and hematoma/bleeding on different forms of thromboprophylaxis. Furthermore, this study aimed to determine the compliance and average duration of outpatient chemoprophylaxis.
Methods: A retrospective cohort study was carried out on a single plastic surgeon's experience. Venous thromboembolism risk stratification identified patients at highest risk. Records were reviewed for regimen of thromboprophylaxis and for occurrences of all-cause mortality, venous thromboembolism, and hematoma/bleeding. Outpatient compliance and duration of low-molecular-weight heparin chemoprophylaxis was also documented.
Results: During the study time period, 173 operations involved 120 patients at highest risk for venous thromboembolism. Among highest risk patients, one (0.8 percent) suffered a pulmonary embolism, eight (6.7 percent) experienced a deep vein thrombosis, and 15 (12.5 percent) endured a hematoma/bleed. Thirteen of 14 outpatients (92.9 percent) were compliant with low-molecular-weight heparin and remained on chemoprophylaxis for an average of 7.4 days.
Conclusions: Mechanical prophylaxis plus subcutaneous heparin (unfractionated or low-molecular-weight heparin) conferred a statistically significant reduction in the rate of venous thromboembolism without a significant increase in bleeding versus mechanical prophylaxis alone. Subgroup analysis of patients placed on mechanical prophylaxis plus low-molecular-weight heparin revealed similar statistically significant findings. Outpatients placed on low-molecular-weight heparin chemoprophylaxis demonstrated excellent compliance and comfort with self-administration. Therefore, the use of mechanical prophylaxis supplemented with low-molecular-weight heparin is strongly recommended as the first-line regimen for thromboprophylaxis in plastic surgery patients at highest risk for venous thromboembolism. (*Plast. Reconstr. Surg.* 122: 1701, 2008.)

Venous thromboembolism represents a spectrum of disease that ranges from deep vein thrombosis to pulmonary embolism. It has been the subject of increasing attention in the plastic surgery literature.[1–11] Recent studies have cited rates of venous thromboembolism from 1 to 2 percent, affecting an estimated 33,000 plastic surgery patients per year.[2,12–15] Of particular concern are patients undergoing abdominoplasty combined with a gynecologic procedure and patients undergoing belt lipectomy. These patients have the highest potential rates of venous thromboembolism, with frequencies of pulmonary embolism as high as 6.6 and 9.4 percent, respectively.[16,17] Together, studies have shown that the plastic surgery specialty is not immune to the dangers of venous thromboembolism.

Up to two-thirds of patients with venous thromboembolism are clinically silent,[18] leading to a substantial delay in diagnosis and treatment,

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which results in significant mortality, morbidity, and cost.[19,20] In one survey of board-certified plastic surgeons, pulmonary embolism was found to be the leading cause of death following liposuction, accounting for 23 percent of all deaths.[21] In a prospective series of office-based surgical procedures, 63.6 percent of postoperative deaths in those that survived surgery were secondary to thromboembolism.[22] Management of venous thromboembolism also translates into a significant economic burden, impacting both the cost of health care and the payouts of lawsuit settlements. In a recent prospective study, the average total annual health care reimbursement for deep vein thrombosis and pulmonary embolism was $10,804 and $16,644, respectively.[23] In the Washington, D.C., Metropolitan Area, verdicts, and settlements for morbidity and mortality secondary to a venous thromboembolism have ranged between $100,000 and $1 million or more.[24]

Given the incidence of venous thromboembolism in plastic surgery, costs, and potential morbidity and mortality associated with unprevented thrombi, the need for thromboprophylaxis is paramount, especially because the majority of plastic surgery is elective, to allow for appropriate planning and risk-reduction strategies. Surprisingly, however, a recent survey of current members of the American Society of Plastic Surgeons found that only 48.7 percent of surgeons performing face lifts, 43.7 percent of surgeons performing liposuction, and 60.8 percent performing a combined procedure use thromboprophylaxis all the time.[11] This hesitancy in instituting thromboprophylaxis may be attributable to the belief that there is a low incidence of venous thromboembolism or the concern over bleeding complications secondary to chemoprophylaxis.

Recently, the senior authors (S.P.D. and M.L.V.) devised a venous thromboembolism risk assessment model and thromboprophylaxis regimen for patients undergoing plastic surgery at Georgetown University Hospital.[4] This algorithm is based on the risk assessment model by Caprini et al. and the recommendations on prophylaxis from the American College of Chest Physicians.[19,25] Since 2003, this venous thromboembolism risk stratification and prophylaxis protocol has been implemented in the senior author's daily plastic surgery practice.

The purpose of this study was to stratify plastic surgery patients into different venous thromboembolism risk categories; identify plastic surgery patients at highest risk for venous thromboembolism; and quantify the rates of postoperative all-cause mortality, venous thromboembolism, and hematoma/bleeding in highest risk patients on different forms of thromboprophylaxis. Furthermore, this study aimed to determine the compliance and average duration of outpatient chemoprophylaxis. We hypothesize that the risk of venous thromboembolism in a mixed plastic surgery practice approaches that of general surgery, that our venous thromboembolism risk assessment and prophylaxis algorithm is effective at identification of at-risk patients and prevention of venous thromboembolism, and that outpatients placed on low-molecular-weight heparin would be compliant and comfortable with self-administration of chemoprophylaxis.

PATIENTS AND METHODS

A retrospective cohort study was carried out on a single plastic surgeon's performance of 1156 operations between July of 2005 and September of 2007. Venous thromboembolism risk stratification was performed on the basis of the patients' sum of exposing and predisposing risk factors (Fig. 1), and patients at highest risk were identified. Hospital charts of highest risk patients were analyzed for associated demographics; regimen of thromboprophylaxis; and postoperative occurrences of all-cause mortality, pulmonary embolism, deep venous thrombosis, and hematoma/bleeding. Given that a large number of patients underwent multiple operations during the study period, rates of postoperative venous thromboembolism and hematoma/bleeding were calculated per operation as opposed to per patient. This involved calculating a patient's individualized risk factor score for each operation according to Caprini et al. and classifying the patient as "low," "moderate," "high," or "highest" risk. Only those operations involving a patient with a venous thromboembolism risk factor score greater than 4, categorized as "operations on highest risk patients," were included in this study.

Associated demographics were analyzed, including patient age, body mass index, American Society of Anesthesiologists class, history of tobacco use, and prevalence of diabetes mellitus. Smoking history was classified similar to Spear et al.,[26] dividing patients into nonsmokers (with no history of tobacco use), former smokers (quit smoking at least 4 weeks before surgery), and active smokers.

Types of thromboprophylaxis included mechanical prophylaxis (elastic stockings with intermittent pneumatic compression stockings), mechanical prophylaxis supplemented with single chemoprophylaxis (unfractionated heparin, low-

Step I.

Exposing Risk Factors			
1 Factor	**2 Factors**	**3 Factors**	**5 Factors**
Minor surgery	*Major surgery	Previous myocardial infarction	Hip, pelvis, or leg fracture
	Immobilizing plaster cast	Congestive heart failure	Stroke
	Patients confined to bed for >72hrs or air travel	Severe sepsis	Multiple trauma
	Central venous access	Free flap	Acute spinal cord injury

*Major surgery is defined by the use of general anesthesia or any procedure lasting longer than 1 hour.

Step II.

Predisposing Risk Factors		
Clinical Setting	**Inherited**	**Acquired**
Age 40 to 60 (1 Factor)	Any genetic hypercoagulable disorder (3 Factors)	Lupus anticoagulant (3 Factors)
Age > 60 (2 Factors)		Antiphospholipid antibodies (3 Factors)
History of DVT/PE (3 Factors)		Myeloproliferative disorders (3 Factors)
Pregnancy or < 1 month postpartum (1 Factor)		Heparin-induced thrombocytopenia (3 Factors)
Malignancy (2 Factors)		Hyperviscosity (3 Factors)
Obesity > 20% IBW (1 Factor)		Homocystinemia (3 Factors)
Oral contraceptive / hormone replacement therapy (1 Factor)		

Step III. Total Step I and Step II = _____ Factors

Step IV. Orders

1 Factor	Low risk	Ambulate patient TID
2 Factors	Moderate risk	Intermittent pneumatic compression stockings with elastic compression stockings on at all times when not ambulating
3-4 Factors	High risk	Intermittent pneumatic compression stockings with elastic compression stockings on at all times when not ambulating
> 4 Factors	Highest risk	Intermittent pneumatic compression stockings with elastic compression stockings on at all times when not ambulating + 1. Enoxaparin (Lovenox) 40 mg SQ once daily post op ***Give first dose 12 hours post-op**

*Lovenox 30 mg SQ once daily is recommended for patients with renal failure.

Fig. 1. Venous thromboembolism risk assessment model and order form.

molecular-weight heparin, or aspirin), and mechanical prophylaxis supplemented with combination chemoprophylaxis (more than one pharmacologic agent). Highest risk plastic surgery patients were placed on mechanical prophylaxis supplemented with once-daily low-molecular-weight heparin, enoxaparin administered at 40 mg subcutaneously and started 12 hours postoperatively according to our protocol (Fig. 1). Outpatients at highest risk for venous thromboembolism were placed on a once-daily regimen of low-molecular-weight heparin until they were fully ambulatory or a screening Doppler ultrasound of the bilateral lower extremities at approximately postoperative day 7 was negative. Patients on other surgical services were placed on mechanical prophylaxis supplemented with unfractionated heparin, usually administered at 5000 units subcutaneously twice daily. In other situations, patients' comorbidities or surgeons' preferences necessitated the use of antiplatelet therapy or restricted the use of chemoprophylaxis. A subset of patients was placed on therapeutic anticoagulation secondary to a history of venous thromboembolism or medical comorbidities, such as atrial fibrillation.

All-cause mortality was defined as deaths secondary to all causes, with hospital and quality as-

surance records aiding in identification of the mechanism responsible for patient death. Venous thromboembolic complications, either deep vein thrombosis or pulmonary embolism, were diagnosed by lower extremity Doppler ultrasound and spiral chest computed tomography, respectively. Hematoma/bleeding complications were subdivided into minor or major subtypes, with major defined as the need for surgical intervention. Hematomas prompted the immediate discontinuation of chemoprophylaxis. Compliance and duration of outpatient chemoprophylaxis were documented and based on office charts and telephone survey.

Fisher's exact two-tailed test was used to determine statistical significance for all comparison groups. A value of $p < 0.05$ was considered statistically significant.

RESULTS

During the 26-month study period, 1156 operations were performed by the senior author at a single academic hospital. Venous thromboembolism risk stratification identified 173 operations (15.0 percent) involving 120 patients at highest risk for venous thromboembolism. The distribution of operations is detailed in Table 1, with 44.5 percent of the procedures involving free tissue transfer. All patients underwent general anesthesia. Patient demographics for the highest risk cohort are summarized in Table 2. The mean patient age was 59 years, with a range of 22 to 87 years, and the average body mass index was 27.8. American Society of Anesthesiologists classification categorized 44.2 percent of patients as class II, 49.2 percent as class III, 6.7 percent as class IV, and 0 percent as class I or V. Smoking history demonstrated that 65.8 percent of patients were nonsmokers, 21.7 percent were former smokers, and 12.5 percent were active smokers. A history of diabetes mellitus was present in 19.2 percent of patients.

After operations on highest risk patients, 27.7 percent were managed with mechanical prophylaxis alone, 34.7 percent with mechanical prophylaxis plus subcutaneous heparin (unfractionated heparin or low-molecular-weight heparin), 13.9 percent with mechanical prophylaxis plus acetylsalicylic acid, 15.0 percent with mechanical prophylaxis plus combination chemoprophylaxis, and 8.7 percent with therapeutic anticoagulation (i.e., heparin drip for a history of atrial fibrillation) (Table 3).

Postoperative complications were assessed (Table 4). Among highest risk patients, there was a 4.2 percent all-cause mortality rate. As seen in Table 4, none of the deaths were attributable to a venous thromboembolic event. Nine patients (7.5 percent) suffered a venous thromboembolism,

Table 1. Distribution of Operations for Patients at Highest Risk for Venous Thromboembolism

Type of Procedure	No.	% of Operations (n = 173)
Abdominoplasty	1	0.6
Body contouring	1	0.6
Face lift	1	0.6
Head and neck reconstruction		
Free tissue transfer	63	36.4
Local flaps	40	23.1
Breast reconstruction		
Free tissue transfer	14	8.1
Flaps/expanders	16	9.2
Abdominal wall repair/reconstruction	21	12.1
Skin cancer excision/reconstruction	3	1.7
Miscellaneous	13	7.5

Table 2. Patient Demographics and History (n = 120)

	No.	% of Patients
Total operations	1156	
Highest risk patients	120	
Operation on highest risk patients	173	
Average age (yr)	59.0 (range, 22–87)	
Mean BMI (kg/m^2)	27.8	
ASA class		
I	0	0
II	53	44.2
III	59	49.2
IV	8	6.7
V	0	0
Smoking history		
Nonsmokers	79	65.8
Former smokers	26	21.7
Active smokers	15	12.5
Diabetes	23	19.2

BMI, body mass index; ASA, American Society of Anesthesiologists.

Table 3. Patients at Highest Risk for Venous Thromboembolism and Thromboprophylaxis Regimen

	No.	% of Patients
Total operations	173	
IPC/ES	48	27.7
IPC/ES + single chemoprophylaxis	84	48.6
LMWH	45	26.0
UFH	15	8.7
ASA	24	13.9
IPC/ES + combination chemoprophylaxis	26	15.0
LMWH and ASA	12	6.9
UFH and ASA	14	8.1
Therapeutic anticoagulation	15	8.7

IPC/ES, intermittent pneumatic compression/elastic stockings; LMWH, low-molecular-weight heparin; UFH, unfractionated heparin; ASA, acetylsalicylic acid.

Table 4. Individual Complications in All Patients

	No.	% of Patients (n = 120)
All-cause mortality	5*	4.2
VTE		
PE	1	0.8
DVT	8	6.7
Total	9	7.5
Hematoma		
Major†	11	9.2
Minor	4	3.3
Total	15	12.5

VTE, venous thromboembolism; DVT, deep venous thrombosis; PE, pulmonary embolism.
*Respiratory failure during comfort care (n = 3); upper airway obstruction from cancer (n = 1); multisystem failure (n = 1). No mortalities were secondary to a venous thromboembolic event.
†Major was defined as a hematoma necessitating operative management.

with none of the venous thromboembolism episodes related to trauma or placement of temporary vena cava filters. One patient (0.8 percent) developed a pulmonary embolism and eight patients (6.7 percent) experienced a deep vein thrombosis. Doppler studies were used to screen 29 patients clinically suspected of having a deep vein thrombosis and resulted in the identification of eight deep vein thrombosis events. Overall, 15 patients (12.5 percent) had a hematoma/bleed, with 11 patients (9.2 percent) experiencing a major event and four patients (3.3 percent) experiencing a minor event. Notably, four of 15 hematoma/bleed events (26.7 percent) were observed in patients placed on therapeutic anticoagulation.

Of 17 outpatients at highest risk for venous thromboembolism, data on compliance and duration of chemoprophylaxis were available for 14 patients. Thirteen of 14 outpatients (92.9 percent) were compliant with low-molecular-weight heparin chemoprophylaxis, with the remaining patient noncompliant secondary to a language barrier. Outpatients remained on chemoprophylaxis for an average of 7.4 days. All six outpatients screened with a bilateral lower extremity Doppler ultrasound were negative for a deep vein thrombosis. Home nursing assistance in administration of subcutaneous low-molecular-weight heparin was needed in one patient (7.1 percent).

When different regimens of thromboprophylaxis were calculated and compared (Table 5), highest risk patients on mechanical prophylaxis plus subcutaneous heparin (unfractionated heparin or low-molecular-weight heparin) had a significantly lower rate of venous thromboembolism than patients on mechanical prophylaxis alone (1.7 percent versus 14.6 percent, $p = 0.021$). Rates of hematoma/bleeding were comparable between patients placed on mechanical prophylaxis plus subcutaneous heparin versus mechanical prophylaxis alone (6.7 percent versus 6.3 percent, $p = 1.000$). Among patients on mechanical prophylaxis plus subcutaneous heparin, the subgroup of patients placed on low-molecular-weight heparin was further analyzed (Table 6). Mechanical prophylaxis plus low-molecular-weight heparin had a significantly lower rate of venous thromboembolism (0 percent versus 14.6 percent, $p = 0.013$), whereas rates of hematoma/bleeding were comparable (8.9 percent versus 6.3 percent, $p = 0.709$) in relation to patients on mechanical prophylaxis alone.

Patients on acetylsalicylic chemoprophylaxis did not demonstrate significant differences in venous thromboembolic or bleeding complications as compared with mechanical prophylaxis alone. The rate of venous thromboembolism was lower for mechanical prophylaxis plus acetylsalicylic acid versus mechanical prophylaxis alone, yet this difference did not reach statistical significance (0 percent versus 14.6 percent, $p = 0.087$). Patients on mechanical prophylaxis plus acetylsalicylic acid had a comparable rate of bleeding/hematoma versus patients on mechanical prophylaxis alone (4.2 percent versus 6.3 percent, $p = 1.000$).

Mechanical prophylaxis plus combination chemoprophylaxis had a reduced rate of venous thromboembolism as compared with mechanical prophylaxis alone, yet this difference was not statistically significant (3.8 percent versus 14.6 percent, $p = 0.245$). Patients on mechanical prophylaxis plus combination chemoprophylaxis experienced a higher rate of bleeding/hematoma than patients on mechanical prophylaxis alone but this too was not statistically significant (11.1 percent versus 6.3 percent, $p = 0.659$).

DISCUSSION

In this study, the frequency of patients at highest risk for venous thromboembolism is large and comprises 15 percent of the plastic surgery patient population. Based on our risk stratification model, it requires surprisingly little to raise an individual's risk ratio. Among plastic surgery patients at highest risk for venous thromboembolism, 7.5 percent experienced a venous thromboembolic event on at least one modality of thromboprophylaxis. Of the nine venous thromboembolism episodes, two occurred in patients receiving some form of chemoprophylaxis and seven were in patients not covered by chemoprophylaxis. With rates of venous thromboembolism reported to be approximately 14 to 30 percent in highest risk surgical patients on no form of prophylaxis,[27] our study suggests that

Table 5. Complication Rates of Patients at Highest Risk for Venous Thromboembolism with Different Regimens of Thromboprophylaxis*

	IPC/ES (n = 48)		IPC/ES + LMWH or UFH (n = 60)			IPC/ES + ASA (n = 24)			IPC/ES + ASA + LMWH or UFH (n = 26)		
	No.	%	No.	%	p Value	No.	%	p Value	No.	%	p Value
VTE	7	14.6	1	1.7	0.021	0	0	0.087	1	3.8	0.245
Hematoma	3	6.3	4	6.7	1.000	1	4.2	1.000	3	11.1	0.659

IPC/ES, intermittent pneumatic compression/elastic stockings; LMWH, low-molecular-weight heparin; UFH, unfractionated heparin; ASA, acetylsalicylic acid; VTE, venous thromboembolism.
*The p values reflect comparison between the variable listed for the respective subgroup and the variable for the IPC/ES group.

Table 6. Complication Rates of Patients at Highest Risk for Venous Thromboembolism on Mechanical Prophylaxis versus Mechanical Prophylaxis plus Low-Molecular-Weight Heparin

	IPC/ES (n = 48)		IPC/ES + LMWH (n = 45)		
	No.	%	No.	%	p Value*
VTE	7	14.6	0	0	0.013
Hematoma	3	6.3	4	8.9	0.709

IPC/ES, intermittent pneumatic compression/elastic stockings; LMWH, low-molecular-weight heparin; VTE, venous thromboembolism.
*The p values reflect comparison between the variable listed for the IPC/ES plus LMWH subgroup and the variable for the IPC/ES group.

thromboprophylaxis is more effective in this group than mechanical prophylaxis alone.

The results of this study are consistent with the current recommendations of the American College of Chest Physicians[27]—specifically, that mechanical prophylaxis alone is not adequate prophylaxis in the highest risk patient group. The American College of Chest Physicians recommends intermittent pneumatic compression stockings in combination with chemoprophylaxis for this group in both the overall recommendations and the general surgery recommendations. The overall recommendations allow for intermittent pneumatic compression stockings as a standalone therapy in both the moderate- and high-risk groups but not the highest risk group.

The recommendations specific for general surgery do not support the use of intermittent pneumatic compression in either the moderate- or high-risk group at all. The reason for this lack of support stems from the disproportionate number of studies in the general surgery literature that use chemoprophylaxis rather than mechanical prophylaxis. Therefore, mechanical prophylaxis was dropped in the 2004 American College of Chest Physicians recommendations for general surgery patients in the moderate- or high-risk category but remained as an overall recommendation for these same groups.

The great unknown in thromboembolism prophylaxis is how the bleeding rate is affected by chemoprophylaxis. In this study of highest risk patients, the bleeding rate is 6.3 percent with mechanical prophylaxis alone, 4.2 to 6.7 percent in mechanical prophylaxis plus single chemoprophylaxis, and 11.1 percent in mechanical prophylaxis plus combination chemoprophylaxis. These differences were not found to be statistically significant, although there is a trend for increased bleeding in mechanical plus combination chemoprophylaxis. This is not surprising, as subcutaneous heparin and acetylsalicylic acid work at different points in the clotting cascade.

The results of this study demonstrate two important points. First, that some form of chemoprophylaxis in combination with mechanical prophylaxis is required for plastic surgery in the highest risk group. Second, that there is no significant increase in the hematoma rate for patients on appropriate chemoprophylaxis. These two points stress the need for plastic surgeons to follow the overall recommendations of the American College of Chest Physicians for highest risk patients.

Our article complements the study reported by Ashjian et al. on the effect of postoperative anticoagulation on microvascular thrombosis.[28] Results of their study found that aspirin was as effective as low-molecular-weight heparin in rates of total and partial flap loss. Within our current study, patients on mechanical prophylaxis combined with low-molecular-weight heparin demonstrated a significant reduction in the rate of venous thromboembolism, with a comparable rate of bleeding versus mechanical prophylaxis alone. Therefore, we suggest that mechanical prophylaxis plus low-molecular-weight heparin is the ideal regimen for thromboprophylaxis in free tissue transfer, securing the benefits of venous thromboembolism risk reduction and microvascular patency without incurring an increased rate

of bleeding. Our current regimen has eliminated acetylsalicylic acid, intravenous heparin, or dextran and consists of low-molecular-weight heparin alone.

This study does have several limitations. Despite a well-thought-out and well-defined plan, a substantial number of patients identified as highest risk did not receive chemoprophylaxis. There are a number of reasons for this, which include physician oversight, patients at too high a risk for chemoprophylaxis, and patients on a primary service where the team deferred prophylaxis secondary to an unacceptable risk of bleeding, such as into the brain or neck. Furthermore, primary physician bias was a major factor in cases where the plastic surgeon was in a supporting role.

This study could also be criticized for not using Doppler ultrasound on all patients, leaving open the possibility of not identifying all deep vein thrombosis episodes. Instead, Doppler analysis was directed at inpatients clinically suspected of having a deep vein thrombosis and at outpatients on low-molecular-weight heparin chemoprophylaxis with insurance approval for screening ultrasounds. A multicenter venous thromboembolism prophylaxis study that analyzes patients prospectively is necessary, with Doppler analysis on all patients between postoperative days 5 and 7 to document the true incidence of venous thromboembolism and more accurately quantify risk reduction with thromboprophylaxis.

Finally, the results and conclusions drawn from this study regarding low-molecular-weight heparin cannot be generalized. Other low-molecular-weight heparin agents, such as dalteparin, may have different anticoagulant and bleeding profiles than enoxaparin, the low-molecular-weight heparin drug investigated in this study. Further studies are needed to determine the efficacy and safety of other low-molecular-weight heparin agents in thromboprophylaxis of plastic surgery patients at highest risk for venous thromboembolism.

CONCLUSIONS

In this retrospective cohort study of plastic surgery patients, 15 percent of operations involved patients at highest risk for venous thromboembolism. Within these highest risk patients, 7.5 percent experienced a venous thromboembolic event despite at least one modality of thromboprophylaxis. Mechanical prophylaxis plus subcutaneous heparin (unfractionated or low-molecular-weight heparin) conferred a statistically significant reduction in the rate of venous thromboembolism without a significant increase in bleeding versus mechanical prophylaxis alone. Subgroup analysis of patients placed on mechanical prophylaxis plus low-molecular-weight heparin revealed similar statistically significant findings. Outpatients placed on low-molecular-weight heparin chemoprophylaxis demonstrated excellent compliance and comfort with self-administration. Therefore, the use of mechanical prophylaxis supplemented with low-molecular-weight heparin is strongly recommended as the first-line regimen for thromboprophylaxis in plastic surgery patients at highest risk for venous thromboembolism.

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