

## Refining Anesthesia Practice Part-2 Thromboprophylaxis: Combating the Clot

### ABSTRACT

Perioperatively, the development of thromboembolism is a known entity. There are options available to prevent this occurrence which involve general measures, mechanical measures having fewer risks, pharmacological measures that include a wide range of anticoagulants, and interventional measures requiring advanced setup and personnel. In this article, we aim to provide a brief overview of available modalities.

**Key words:** Anticoagulation, Heparin, Platelet aggregation inhibitors, Thrombosis

### PREVENTION OF PERIOPERATIVE THROMBOEMBOLISM

As doctors, we understand the fine line between choosing to intervene and recognizing situations where it is best not to disturb a natural healing process. Thromboprophylaxis is one such conundrum that has evoked much discussion. Surgery and its aftermath are known to cause a disturbance to coagulation homeostasis by creating a hypofibrinolytic and hypercoagulable state.<sup>[1]</sup>

In our country, the incidence of venous thromboembolism (VTE) is approximately 17.46/10,000 admissions.<sup>[2]</sup> However, it is believed to be underreported.

VTE is a well-known complication occurring in the perioperative setting because undergoing surgery involves a combination of risk factors [Figure 1] that predispose to the development of a thrombus. As is famous in Virchow's triad, there are three factors attributed to the development of a thrombus namely: endothelial injury, hypercoagulability, and venous stasis.

At present, we have various options including mechanical, pharmacological measures, and venous filters available to us to tackle this growing burden of VTE.

### GENERAL MEASURES

It is important to recognize signs and symptoms pointing toward VTE such as calf tenderness, discoloration, swelling, breathlessness, and chest pain. There are several risk assessment models, one of which is the Caprini score [Figure 3] which guides identification of risk factors and stratification of risk.

Primordial and primary prevention are essential aspects of prophylaxis.

- a. Advice to maintain a healthy lifestyle: cutting out smoking, excessive alcohol intake, routine fast food consumption, and maintaining an ideal BMI

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- b. Identify risk factors for thrombosis or bleeding and order required tests to assess coagulation.<sup>[3]</sup>
- c. Detailed drug history to identify drugs that may interfere in coagulation homeostasis, for example, Hormone-containing pills, blood thinners, etc.
- d. Surgical, anesthesia, and post-operative critical care teams must work together to share information and decide on a suitable plan of management. This includes site and size of incision and resection, probable risk of bleeding, surgical time, and patient positioning, the scale of pain the patient is predicted to experience which may affect his mobility, estimated recovery time, etc.<sup>[3]</sup>
- e. Avoid perioperative dehydration, and ensure adequate oral or intravenous fluid intake.<sup>[4]</sup>
- f. Early mobilization following surgery by maintaining patient motivation and involving physiotherapists as and when required.<sup>[1,4]</sup>

### MECHANICAL PROPHYLAXIS

- a. Elastic graduated compression stockings
- b. Pneumatic compression stockings
- c. Electrical calf stimulation
- d. Foot impulse pumps.

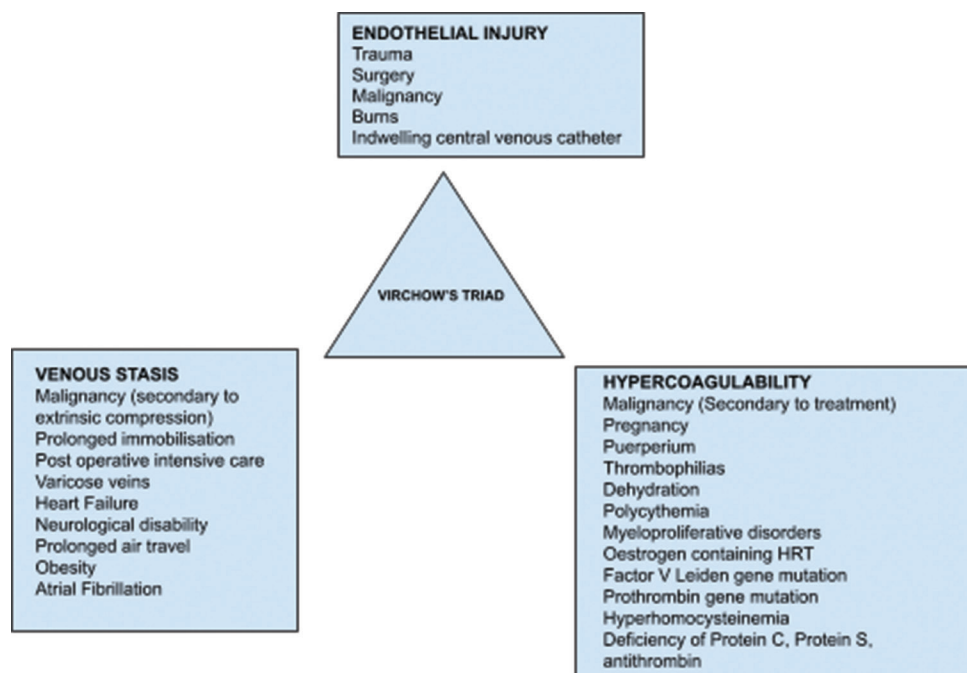


Figure 1: Virchow's triad and various risk factors for VTE

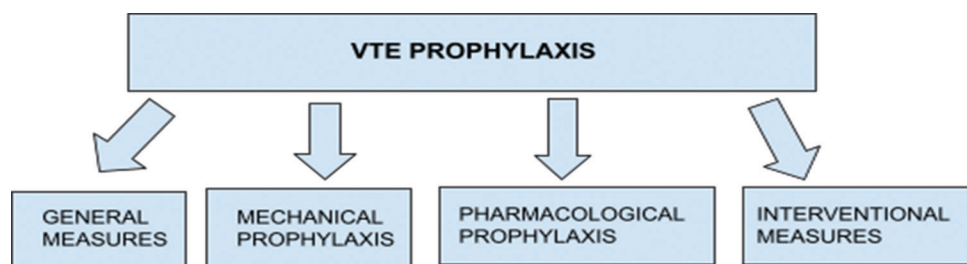


Figure 2: Four-pronged approach to thromboprophylaxis

Each risk factor=1 point	Each risk factor=2 points	Each risk factor=3 points
<ul style="list-style-type: none"> <li>Age 40–59 years</li> <li>Minor surgery planned</li> <li>BMI <math>\geq 30</math> kg/m<sup>2</sup></li> <li>History of prior major surgery (&lt;1 month)</li> <li>Swollen legs (current)</li> <li>Varicose veins</li> <li>Sepsis (&lt;1 month)</li> <li>Abnormal pulmonary function (COPD)</li> <li>Acute myocardial infarction (&lt;1 month)</li> <li>Congestive heart failure (&lt;1 month)</li> <li>History of IBD</li> <li>Medical patient currently at bed rest</li> </ul>	<ul style="list-style-type: none"> <li>Age 60–74 years</li> <li>Arthroscopic surgery</li> <li>Major open surgery (&gt;45 minutes)</li> <li>Laparoscopic surgery (&gt;45 minutes)</li> <li>Prior cancer (except non-melanoma skin cancer)</li> <li>Present cancer (except breast and thyroid)</li> <li>Confined to bed (&gt;72 hours)</li> <li>Immobilizing plaster cast</li> <li>Central venous access</li> </ul>	<ul style="list-style-type: none"> <li>Age <math>\geq 75</math> years</li> <li>History of VTE</li> <li>Family history of VTE</li> <li>Present chemotherapy</li> <li>Positive Factor V Leiden</li> <li>Positive Prothrombin 20210A</li> <li>Positive Lupus anticoagulant</li> <li>Elevated anticardiolipin antibodies</li> <li>Elevated serum homocysteine</li> <li>HIT</li> <li>Other congenital or acquired thrombophilias</li> </ul>
For women only (1 point each)	Caprini risk category based on total risk score	
<ul style="list-style-type: none"> <li>Pregnant or post-partum</li> <li>History of unexplained or recurrent spontaneous abortion</li> <li>Oral contraceptives or hormone replacement therapy</li> </ul>	Total score	Category
	0–4	Low
	5–8	Moderate
	$\geq 9$	High
	Each risk factor=5 points	
	<ul style="list-style-type: none"> <li>Major surgery lasting &gt;6 hours</li> <li>Stroke (&lt;1 month)</li> <li>Elective major lower extremity arthroplasty</li> <li>Hip, pelvis, leg fracture (&lt;1 month)</li> <li>Acute spinal cord fracture or paralysis (&lt;1 month)</li> <li>Multiple traumas (&lt;1 month)</li> </ul>	

Figure 3: Caprini's risk score

Courtesy: Makay Ö, Sun H, Pontin A, Caruso E, Pino A, Mandolino T, Dionigi G. Venous Thromboembolism Following Thyroid Surgery. *Journal of Endocrine Surgery*. 2019 Dec 1;19(4):151-3

All of these work by improving the flow of blood through the lower limbs, thereby preventing stasis and venous distention-induced endothelial damage. The use of mechanical measures as the only modality of thromboprophylaxis seems to be ineffective when compared to a combination regimen with pharmacoprophylaxis. In addition, compliance is a common concern in all the available modes of mechanical prophylaxis.<sup>[4,5]</sup> However, in cases where the risk-benefit ratio of pharmacological methods is very high such as neurological, ophthalmic, and spine surgeries, it is better to use at least mechanical modes.<sup>[6-8]</sup>

Contraindications are peripheral vascular disease, existing DVT, recent skin grafting, infection at the application site, burns, ulcers, etc.<sup>[1,4]</sup>

Graduated compression stockings are applied circumferentially such that the pressure is greatest at the ankle, optimally 18–23 mmHg, and gradually decreases in the upward direction to a pressure of 8 mm Hg at the thigh.<sup>[4]</sup>

Pneumatic compression stockings are applied at the calf or thigh usually at a pressure of 35–40 mmHg, they are intermittently inflated and deflated at this preselected pressure. The inflation lasts 10–35 s and deflation for about 1 min. These are said to promote physiological inhibitors of coagulation and increase fibrinolysis in addition to their mechanical advantage.<sup>[5,9]</sup>

Foot impulse pumps function by compressing the plantar venous plexus and producing pulsatile flow in veins thereby mimicking walking.<sup>[9]</sup>

## PHARMACOLOGICAL PROPHYLAXIS

Anticoagulants are considered the best mode of thromboprophylaxis provided that the benefits outweigh the risks. There are a large variety of options available:

- Unfractionated heparin: It is administered subcutaneously and acts by inhibiting Factor Xa and IIa. It is the preferred anticoagulant in those with renal failure and although it carries a small risk of heparin-induced thrombocytopenia, regular monitoring is not required.<sup>[4,7,9]</sup>
- Low-molecular-weight heparins (LMWH): Among these are dalteparin, enoxaparin, and tinzaparin, they too are administered subcutaneously and act by inhibiting Factor Xa and IIa. They are said to have a lower risk of HIT and osteoporosis but should be used cautiously in those with renal failure.<sup>[4,7,9]</sup>

Effects of both unfractionated and LMWH can be reversed using protamine sulfate, although the percentages of reversal are variable and should be backed up by coagulation testing.<sup>[1]</sup>

- Warfarin: This is a vitamin K antagonist which acts by inhibiting vitamin

K-dependent coagulation factors, that is, II, IV, IX, and X. It is administered orally and does not begin to act immediately. It has a narrow therapeutic index, which interacts with many drugs and regular monitoring of INR is the norm.<sup>[4,9]</sup>

- Low-dose aspirin: It is an orally administered, irreversible

inhibitor of COX-1 enzyme which prevents the action of thromboxane A2 thus discouraging platelet aggregation.<sup>[9]</sup>

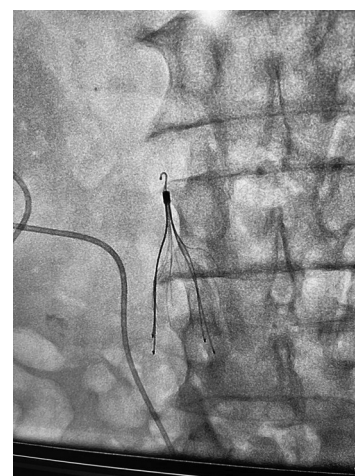
- Direct acting factor Xa inhibitors: among these are rivaroxaban and dabigatran. These may be administered subcutaneously or orally.
- Danaparoid: This is a subcutaneously administered heparinoid which directly inhibits factor Xa. It has been found to be useful in those with HIT.
- Fondaparinux: Subcutaneously administered indirect inhibitor of factor Xa does not usually require coagulation monitoring.<sup>[7,9]</sup>
- Lepirudin: Direct thrombin inhibitor derived from yeast cells, administered as a continuous infusion, and especially useful in those with HIT.<sup>[9]</sup>
- Dextran: Administered intravenously in volumes >1.5 L, act by forming a coating over RBCs and reducing their property of adhering together and promoting the action of antithrombin. They are resistant to excretion by the kidney and, therefore, have a long duration of action and often interfere with blood grouping and cross-matching.<sup>[9]</sup>

## INTERVENTIONAL MEASURES

The insertion of a filter in the inferior vena cava is a radiological interventional procedure indicated when there is a history of recurrent thromboembolism, and when pharmacological measures are contraindicated or have failed.<sup>[1]</sup> These filters are retrievable and have a hook at the top which facilitates withdrawal through the central line.

Apart from being expensive, they have the disadvantage of requiring an advanced setup and highly skilled personnel, both of which are not easily accessible to many among our population.

Shown below is an image of such a procedure carried out at our hospital.



Guidelines for the use of thromboprophylaxis are varied and protocols change across continents, institutes, and practitioners' preferences. However, shown below is a helpful recommendation:

Risk Group	Procedures	Thromboprophylaxis
Low	Major surgery in age <40 yr, Minor surgery in age <60yr	Early ambulation
Moderate	Major surgery in age >40 yr or with risk factor, Non-major surgery in age >60yr or with risk factor	GCS, IPC, LMWH, LDUH, Or Fondaparinux
High	Major cancer surgery with additional risk factor, Major surgery in patients with previous VTE or thrombophilia	LMWH, Warfarin, or Fondaparinux; IPC*

\*Recommended in patients with a risk of bleeding; consider switching to anticoagulants when the bleeding risk abates. VTE: Venous thromboembolism; GCS: Graduated compression stockings; IPC: Intermittent pneumatic compression; LMWH, Low-molecular-weight heparin; LDUH: Low dose unfractionated heparin; VTE: Venous thromboembolism.

Courtesy: Bang SM, Jang MJ, Oh D, Kim YK, Kim IH, Yoon SS, Yoon HJ, Kim CS, Park S. Korean guidelines for the prevention of venous thromboembolism. *Journal of Korean Medical Science*. 2010 Nov 1;25(11):1553-9.

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