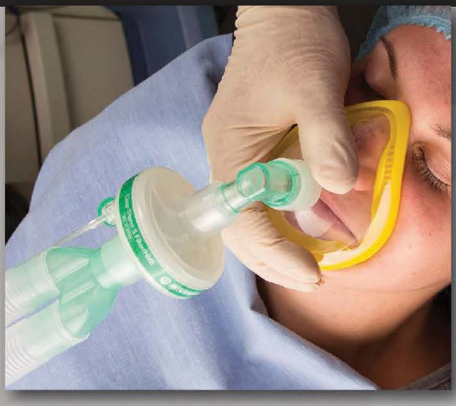
nesthesia books, visit our website **www.jaypeebrothers.com,** for detailed information on anesthesia books

Yearbook *of* Anesthesiology-7



Yearbook

Indian College of Anaesthesiologists
Whole Constituent of
Indian Society of Anaesthesiologists
(Member of the World Federation of
Societies of Anaesthesiologists)

Editors
Raminder Sehgal
Anjan Trikha

Editorial Board Members
VP Kumra
B Radhakrishnan
Jayashree Sood
Baljit Singh

Foreword
SM Basu

JAYPEE

Contents

1. **Conflict-of-Interest in Anesthesiology** 1
Amitabh Dutta, Prabhat Choudhary

2. **Understanding Hemostasis: The Knowns and the Unknowns** 16
Anil Karlekar

3. **Moving away from Null Hypothesis Significance Testing** 36
LN Yaddanapudi

4. **Remifentanil for Labor Analgesia** 43
Preet Mohinder Singh, Anuradha Borle

5. **Low Flow Anesthesia: Revisited and Reiterated** 52
Asha Tyagi, Rashmi Salhotra

6. **Local Anesthetic Systemic Toxicity** 63
Nishkarsh Gupta, Anju Gupta

7. **Videolaryngoscopy: Current Perspectives** 76
Chand Sahai, Bimla Sharma

8. **Preoxygenation: Physiological Basis, Techniques, Benefits and Potential Risks** 90
Kavita Rani Sharma

9. **Pulmonary Function Tests and their Clinical Applications** 103
Susmita Sarangi, Dipali Taneja

10. **Neuropathic Pain** 122
Pramod Kumar

11. **Management of Chronic Low Back Pain: An Overview** 129
Babita Ghai, Dipika Bansal

12. **Intracranial Pressure versus Brain Relaxation** 142
Dilip Kumar Kulkarni

13. **Sepsis and the Anesthesiologist** 152
Krishna HM, Basavaraj Herekar

14. **Congenital Tracheoesophageal Fistula: Anesthetic Considerations and Management** 159
Sharmila Ahuja, Medha Mohta

15. **Extremely Premature Infants and Anesthesia** 168
Elsa Varghese

16. **ECMO: Need of the Hour** 179
Poonam Malhotra Kapoor, Shivani Aggarwal

17. **Anesthesia for Laryngotracheal Stenosis** 190
Amit Rai, Gunjan Singh

18. **Perioperative Fibrinogen Supplementation: Safety and Efficacy** 204
Anju Grewal, Nidhi Bhatia

19. Pain, Agitation and Delirium in Adult Intensive Care Unit **210**
SP Ambesh

20. Perioperative Atrial Fibrillation: A Perioperative Physician's Outlook **226**
Priya R Menon, Akshaya Rai

21. Perioperative Medication Errors **241**
Lakshmi Kumar, Keerthi Nandakumar

22. Prognostication after Cardiac Arrest **252**
Suman D Chaudhry, Murali Pandurangan

23. Anesthesia for Liver Transplantation **267**
Vijay Vohra, Pooja Bhangui

24. Myocardial Protection during Cardiac Surgery: An Overview of Cardioplegia **285**
Deepak K Tempe, Deepti Saigal

25. Journal Scans: **306**
1. *Sanjeev Aneja* *306*
2. *Ashok Jadon* *310*
3. *Yatin Mehta* *314*
4. *Monish Nakra* *318*
5. *Ashok Kumar Saxena* *321*

Index *325*

CHAPTER 2

Understanding Hemostasis: The Knowns and the Unknowns

Anil Karlekar

JAYPEE BROTHERS

KEY POINTS

- Physiological preparedness of blood to readily form clots when required, is continually balanced by ongoing processes that prevent unnecessary coagulation, with a tilt in favor of the latter.
- No amount of clot formation by itself can prevent blood loss if the breached vessels size is bigger than 50 µm.
- Platelets play an important role in clot formation and justifiably are target of various anticoagulation strategies. They also have a role to play in immunothrombosis and netosis.
- Controversy around cardiovascular safety of NSAIDs is gradually being resolved. Naproxen appears to be a safe choice for pain relief in patients with cardiovascular disease.
- Deranged coagulation and pathological thrombosis is equally challenging for perioperative physician, the risk of VTE and PE is very real and yet prophylaxis on the ground has discernible gaps.
- Surgical patients on antithrombotics require careful planning of interval between the last dose of the antithrombotic agent and the elective surgery or the placement/removal of catheters for neuraxial anesthesia.

INTRODUCTION

Hemostasis is the physiological process of maintaining blood circulation in the event of a breach in integrity of vessel wall (like in trauma) by initially forming a localized clot to contain blood loss, restricting the clot to the site of breach only and later actively dissolving the clot as a part of repair to restore normal circulation through the affected vessels. Hemostasis, thus, is one of the most finely balanced physiological process involving coagulation when required followed by appropriately timed lysis of the clot formed. The steps of coagulation and clot dissolution are interlinked and regulated in such a precise manner that forward steps in many instances, would simultaneously set in motion their own inhibition to contain an overwhelming wave that could engulf the whole being.

Anesthesiologists, as perioperative physicians, are increasingly involved in crucial decision making related to hemostasis. The common situations related to altered physiology routinely confronted are given further

Glossary of Terms often used in the Context of Hemostasis

- **Platelet adhesion:** Platelets adhering with exposed tissues like collagen
- **Platelet aggregation:** Clumping of platelets with other platelets
- **Cell adhesion molecules (CAM)** are proteins located on the cell surfaces involved in binding with other cells or with other extracellular matrix. *Integrins and Selectins* are Glycoprotein (GP) CAMS located on platelets. *Integrins* are calcium independent and involved with cell to extracellular matrix interactions. Integrins GPs form diverse platelet receptors from a combination of 20 α and 8 β subunits. *Selectins* are calcium dependent, platelet-selectin is released from alpha granules of platelets, promote adhesion with leucocytes and expression of tissue factor on monocytes that further amplifies coagulation.
- **Zymogens** are inactive circulating coagulation factors, and are termed serine proteases once activated.
- **Serine** is a nonessential amino acid and serine protease are enzymes that cleave proteins.
- **Serpins** are the inhibitor serine proteases; antithrombin is the most important serpin.
- **Ligand** is a molecule like hormone or transmitter that binds to a receptor.
- **UFH:** Unfractionated Heparin
- **Heparan sulfate** (and heparin) are complex, acidic polysaccharides belonging to the glycosaminoglycan (GAG) family, found in higher organisms on the cell surface or in the extracellular matrix and responsible for inhibiting thrombin by activating/enhancing antithrombin.
- **LMWH:** Low Molecular Weight Heparin
- **PCC:** Prothrombin Complex Concentrates, prepared from pooled plasma and has vitamin K dependent coagulation factors II, VII, IX and X and inhibitors protein C, S, antithrombin and heparin.

- Surgical patients receiving anticoagulants preoperatively may not only be confronted with excessive intraoperative blood loss, they may have limited options to choose from the anesthetic techniques available to them.
- Surgery itself involves *intentional* breach of vascular integrity of varying scale resulting in blood loss on one hand and triggering a state of inflammation in response to what body perceives as *an assault*. Surgery thus triggers the process of coagulation to arrest the *iatrogenic* blood loss, resulting in a *hypercoagulable* state perioperatively.
- Intravenous fluids, blood/blood products and anticoagulants/procoagulants are ordered perioperatively, each affecting hemostasis, directly or indirectly. In addition to managing surgery related blood loss on one hand, anesthesiologists are expected to prescribe appropriately timed anticoagulants postoperatively either for prophylaxis of dreaded venous thromboembolism (VTE) or for therapeutic use in conditions like implanted devices.

Therefore, anesthesiologists ought to have a comprehensive understanding of hemostasis to help them manage perioperative disturbances of coagulation, whether due to disease states or as a result of pharmacological interventions.

JAYPEE BROTHERS

PHYSIOLOGY OF HEMOSTATSIS

Hemostasis comprises of two distinct opposing yet interrelated processes, '*coagulation*' and *'prevention of undesirable coagulation and clot lysis'* and can be described as a 4-component process:[1]

- Initiation (trigger),
- Acceleration (akin to explosion of biologic activity),
- Control (limiting coagulation locally) and
- Lysis (recanalization)

Elements of Coagulation

Coagulation involves three biologic elements: *the vascular (endothelium), platelets* and *plasma factors* to form an effective clot at the site of injury (*see* Fig. 1A for basic coagulation schema and Table 1 for plasma factors). It is noteworthy that all the required 'ingredients' to form a clot are either circulating in blood itself or are available in subendothelial layers across body, albeit in inactive forms. Counter-regulatory set of events too are initiated simultaneously to ensure clot is restricted to site of injury and help restore normalcy once bleeding is controlled.

Vascular Endothelium

Vascular response to injury, in order to minimize blood loss, is not restricted to vasoconstriction only. While non-thrombogenic surfaces of endothelium and other mediators ensure uninterrupted circulation in health, it goes through changes to arrest bleeding when challenged. Undisturbed vascular endothelium in health keeps the coagulation under control by:

a. Maintaining its inherent antifibrinolytic and antiplatelet character (prevents adhesion, activation, secretion and aggregation of platelets) by producing and releasing nitric oxide, prostacyclin and CD39.
b. Inhibiting thrombin through Tissue Factor Pathway Inhibitor (TFPI), Antithrombin (AT), Protein S, Heparin factor II, Heparan Sulfate, Thrombomodulin (TM) and Dermatan Sulfate.

When challenged, vascular endothelium supports coagulation by:

- Suspending a and b above (Fig. 1A).
- Promoting platelet adhesion (with tissue) and aggregation (amongst themselves).
- Accelerating thrombin formation by providing the essential phospholipid surface, exposing tissue vWF and P-selectin for platelet attachment.
- Secreting Tissue Factor and Factor V and modulating fibrinolytic response by releasing PAI-1(inhibits tPA/urokinase) (Fig. 1A).

While the finely calibrated response is initiated in the event of a disrupted vessel, vasoconstriction and eventual stable clot can arrest bleeding only in vessels smaller than 50 μm, a fact worth remembering during surgery to emphasize the importance of meticulous surgical hemostasis.[1] In the event of pathological atherosclerotic plaque formation and thrombotic diseases, deranged vascular endothelial goes through similar processes.

JAYPEE BROTHERS

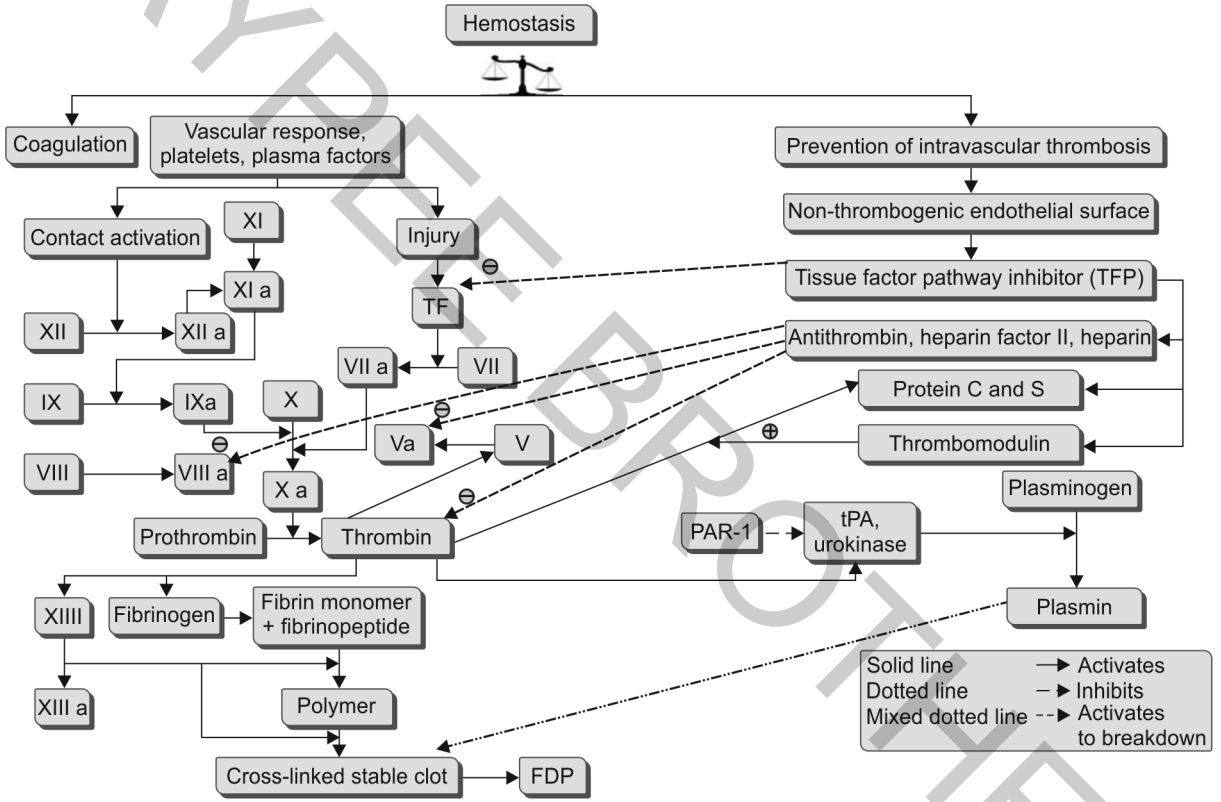


Fig. 1A: Basic hemostasis schema depicting coagulation and its counter-regulation that ensures fluidity of blood and its circulation. Thrombin is central to coagulation like plasmin is central to clot lysis.

JAYPEE BROTHERS

Table 1: Plasma coagulation factors

Factor	Name	Type	Source	Dependent on	Available in
I	Fibrinogen	Zymogen	Liver		Cryo, FFP
II	Prothrombin	Zymogen	Liver	Vit K	FFP, PCC
III	Tissue factor (Thromboplastin)	Cofactor	Platelets, endothelium		
IV	Calcium	Cofactor	Bone and from GI		IV preparations
V	Proaccelarin (Labile factor)	Cofactor	Liver and platelets		FFP
VII	Proconvertin (Stabilizing factor)	Zymogen	Liver	Vit K	Factor VII, PCC
VIII	Antihemophilic factor A, Antihemophilic globulin	Cofactor	Endothelium (blood vessels), platelets		Cryo, FFP
IX	Antihemophilic factor B, Plasma thromboplastin component, Christmas factor	Zymogen	Liver	Vit K	FFP, PCC
X	Stuart-Prower factor	Zymogen	Liver	Vit K	FFP, PCC
XI	Plasma thromboplastin antecedent	Zymogen	Liver		FFP
XII	Hageman factor	Zymogen	Liver		----
XIII	Fibrin stabilizing factor	Zymogen	Liver		FFP, Cryo
vWF	von Willebrand Factor	Cofactor	Injured tissue, Endothelium		Cryo,FFP
Serpins	Protein C and S		Liver	Vit K	
	Antithrombin	Traditionally FFP was administered to substitute deficient antithrombin. Now, concentrates from human plasma and goat milk are also available			

Platelets

Platelets the anucleated smallest blood particles (diameter 2–3 mm, normal blood count 150–400 × 10^3 per mL, average lifespan 5–9 days) play a key role in coagulation and are vital to hemostasis. The role of platelets in hemostasis could be summed up as under:

- As the first responders earning them the title of 'circulating band-aids', platelet reach the damaged intima, adhere to the tissues and try to plug the gap physically, though such a platelet-only clot is inherently unstable.

JAYPEE BROTHERS

- As the coagulation process continues, the platelets get *activated* through several mechanisms and undergo conformational changes that expose platelet receptors and binding sites including essential phospholipid surfaces. They release several chemicals which are stored in granules and lysosomes as follows:
  - Dense granules — ADP, ATP, serotonin (further platelet activation)
  - Alpha granules — Fibrinogen, fibronectin, vitronectin, vWF (promote adhesion)
  - Lysosomal granules — Glycosidases and proteases (so far unclear function).

The activation of platelets along with sequential activation of plasma coagulation factors lead to a chain of events resulting in tissue, platelets and fibrin coming together to convert the unstable soft clot into insoluble clot.

Platelets, though mainly known for their important role in hemostasis, have also been implicated in diabetes, renal diseases, tumor genesis, cardiovascular and Alzheimer's disease. The change in the face of innocent looking inactive platelets can be credited to the plethora of receptors that open up in response to diverse stimuli. Platelet receptors[2-5] play a crucial role in platelet functioning, and in the context of hemostasis, receptor specific agonists and antagonists make the basis of many therapeutic interventions (Tables 2A and 2B).

Platelet and endothelium interact in multiple ways, platelets are said to *adhere* to tissues and *aggregate* amongst themselves. Endothelial cells convert arachidonic acid to prostacyclin with the help of cyclooxygenase and prostacyclin synthase. Prostacyclin inhibits platelet aggregation and dilates vessels. Platelet through their own cyclooxygenase forms thromboxane A2 which promotes aggregation and is a vasoconstrictor. Low dose aspirin inhibits platelet COX but not endothelial COX, thus while thromboxane synthesis ceases, endothelial production of prostacyclin continues. The selective platelet inhibition with low dose aspirin produces desired reduced platelet activation and aggregation without affecting prostacyclin induced vasodilation. High dose aspirin blocks both platelets as well as endothelial COX, negating the intended effect of platelet inhibition as accompanying vasoconstriction favors stasis and possible thrombosis.[6]

Platelet microvesicles[7] were discovered when clotting of blood was found prolonged following centrifugation, further confirmed by electron microscopy. Microvesicles are released by cell membranes of various cells including platelets during activation or apoptosis. Platelet microvesicles are most abundant in plasma and are procoagulant. They are produced by multiple pathways as a part of platelet activation and are accompanied by movement of phosphatidylserine that acts on Factor X and prothrombin, propagating coagulation.

Circulating platelet microvesicles are higher in females until menopause. Other conditions that are associated with higher levels are systemic lupus erythematosus, acute coronary syndrome, venous thromboembolism, myeloproliferative diseases, diabetes and chronic renal failure. Though not yet available for routine testing, their estimation could possibly predict bleeding in surgical patients particularly cardiac surgery. Future developments may place platelet microvesicles count as part of platelet function assessment and their transfusion to control bleeding.

JAYPEE BROTHERS

Table 2A: Know your drugs: antiplatelet agents

Receptors	Agonist	Antagonist	Route	Rveresibility	Caution	Comments	Recommended interval before intervention
P2Y1 and $P2Y_{12}$	ADP	Ticlopidine	Oral	Irreversible	Low blood counts	Has generally been replaced by newer drugs	
		Clopidogrel	Oral	Irreversible	Incidence of resistance is high, almost 30% are non-responders. Risk of bleeding+	Delayed prodrug activation in liver, needs loading dose	D/C 5 to 7 days prior to elective surgery or catheter placement
		Prasugrel	Oral	Irreversible	Higher risk of bleeding: avoid in >75 years, wt <60kg, in h/o stroke, TIA	More predictable platelet blockage.	D/C 7–10 days prior to catheter placement
		Ticagrelor	Oral	Reversible	May cause dyspnea, ventricular pauses. Increases uric acid and creatinine. Dose of aspirin should be kept < 100 mg	Potent blocker. Better outcomes in ACS, MI without increasing risk of bleeding.	D/C 5 days prior to catheter placement.
		Cangrelor	IV	Reversible	May cause dyspnea	Has been suggested for 'platelet anesthesia' during CPB to protect platelets from activation and consumption, to eventually reduce bleeding. May have a role in HIT.	Has rapid onset and offset, complete recovery of platelet function within 1–2 hours. Delay intervention 1–6 hours.
		Elenogrel	IV as well as oral	Reversible	Dyspnea	Rapid and profound platelet blockade without increased bleeding risk.	Needs further evaluation
Thrombo-xane A2 receptor	Thrombo-xane	Aspirin	Oral/IV	Irreversible	GI bleed	Part of Dual Antiplatelet therapy and between the two, aspirin is mostly continued perioperatively. May be discontinued for 0–5 days	

(ACS: Acute coronary syndrome; CPB: Cardiopulmonary bypass; HIT: Heparin induced thrombocytopenia)

JAYPEE BROTHERS

Table 2B: Know your drugs: antiplatelet agents used during percutaneous coronary intervention (PCI)

Receptors	Agonists	Antagonists	Route	Reversibility	Comments	Recommended interval before intervention
GPIIb/IIIa	Act at the final common pathway of platelet aggregation involving fibrinogen, forming interplatelet bridges.	Abciximab	IV	Reversible	Has onset of action, long biological activity	Advisable to delay catheter placement for at least 24–48 hours
		Tirofiban	IV	Reversible	Effect on platelets disappears soon after discontinuation of infusion	Advisable to delay catheter placement for at least 4–8 hours
		Eptifitide	IV	Reversible		

Platelets also play a role in infections.[8] Coordinated intravascular coagulation in response to pathogens in blood has been termed *Immunothrombosis.*[9] In order to confine the pathogens, platelets along with other immune cells tend to form a physical barrier around them in the form of a thrombus, thus leading to a prothrombotic state.

Plasma Factors

Circulating inactive precursors (zymogens) and cofactors together make the plasma components for hemostasis. Following an initial activation trigger, like an injury, the zymogens and cofactors get activated sequentially, the product of one reaction, a serine protease, causing activation of the next. Many of these reactions require Ca^{++} and a phospholipid surface that is provided by activated platelets and endothelium and occasionally even white cell.

It may be worthwhile recalling that plasma factors and cofactors (like Tissue Factor and Factor V), mostly synthesized in liver, have been identified as Roman numerals and/or names (Table 1) as they were discovered and not in the sequence that they participate in the process of coagulation. Traditionally coagulation has been taught as comprising of intrinsic and extrinsic pathways, both merging finally into a common pathway. However, it is now known that the in-vivo coagulation does not happen compartmentalized into intrinsic or extrinsic pathways. These pathways crisscross, are highly interactive, work on feedback loops and the two probably complement each other. Thus, *initiation* of coagulation happens through contact activation while *amplification* and *propagation* involves intrinsic and extrinsic pathways leading to a common pathway of activated factor X and thrombin. Thrombin converts fibrinogen to fibrin which enmeshes activated platelets and finally forms a stable clot (Figs. 1A and 1B).

The complexity of nomenclature of plasma coagulation factors will remain incomplete without mentioning *von Willebrand Factor* (*vWF*).[10] It circulates in plasma but is not a coagulation factor. vWF in its normal inactive coiled form

JAYPEE BROTHERS

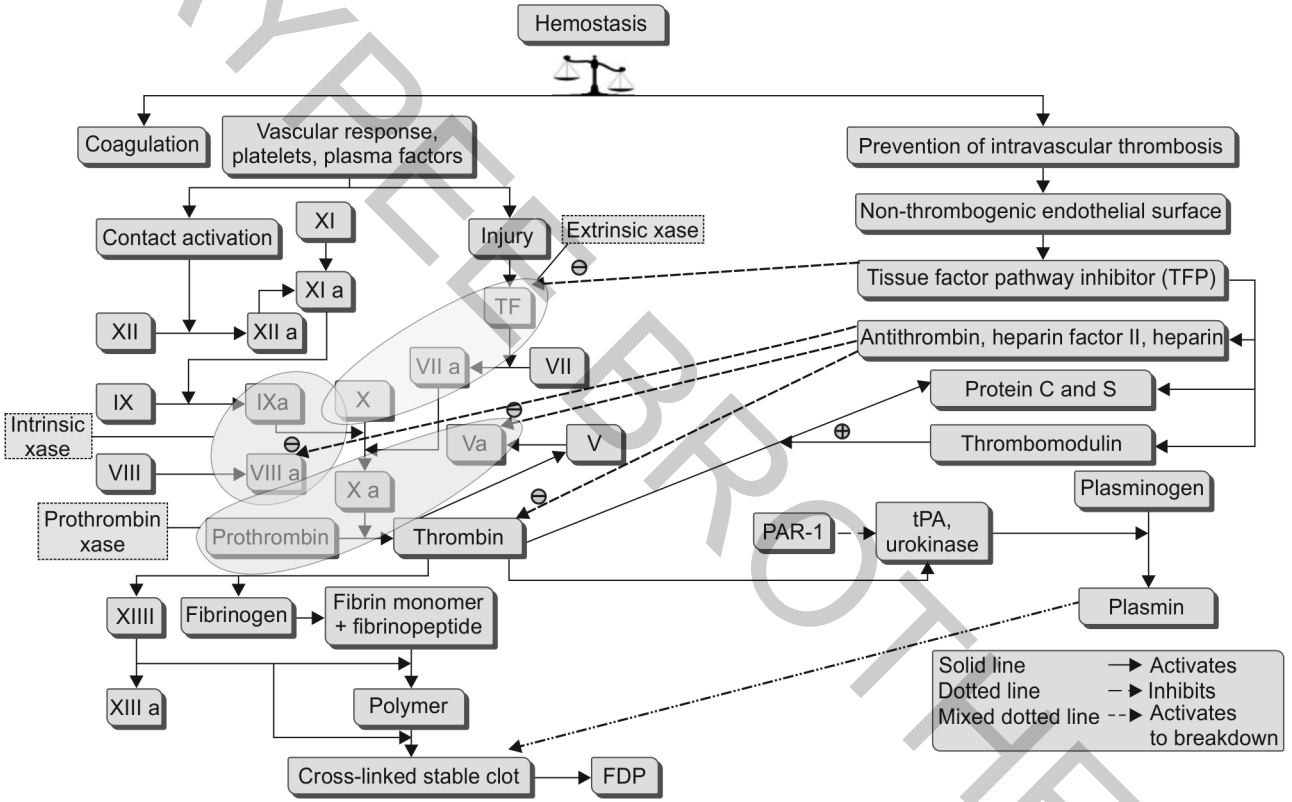


Fig. 1B: Basic hemostasis schema with superimposed three procoagulant complexes, Prothrombin Xase, Extrinsic Xase and Intrinsic Xases, composition of each depicted within the respective shaded area. Each complex comprises of one serine protease (VIIa, IXa and Xa), cofactor (VIIIa, Va, TF) and a negatively charged cell surface that is provided by cells (platelets, monocytes). These membrane-bound complexes localize enzymatic activity.

JAYPEE BROTHERS

functions as a protector carrier of Factor VIII, saving it from proteolytic enzymes. It can also be expressed from injured tissue and endothelium. Injury induced endothelial disruption binds vWF, it uncoils as part of activation, facilitating platelet trapping beginning the hemostasis with the soft clot. vWF released by endothelium, facilitates factor IX to reach activated platelet (GP1b, IX), a crucial step in keeping platelets and fibrinogen together to form clot, thus earning it term of 'glue'.

Hemophilia, a bleeding disorder, is distinct from vWF-deficiency induced bleeding disorder, von Willebrand Disease (vWD). Deficiency of F VIII causes Hemophilia A and that of F IX is called Hemophilia B. Hemophilia leads to bleeding due to lack of fibrin as F VIII or F IX are deficient; vWD causes bleeding as platelets fail to stick together to form the plug in absence of vWF. vWD is underdiagnosed, and a deficient vWF would lead to lower levels of unprotected F VIII too, and is often misdiagnosed as hemophilia.

Desmopressin (DDAVP), a synthetic analogue of vasopressin (ADH) promotes release of vWF and F VIII from endothelial cells as well as platelets and has been used to control bleeding in Hemophilia A.[11] Novel approaches to manage bleeding in hemophiliacs like emicizumab (a recombinant antibody that binds F IX and F X together obviating the need of F VIII in the coagulation cascade), concizumab (an antibody against TFPI), antithrombin gene silencing and gene therapy are under various stages of development, and may become available in near future.

Coagulation Cascade (Fig. 1A)

Contact activation, the initial step, triggered by *contact*, involves factor XII, high molecular weight kininogen (HMWK), prekallikrein (PK) and factor IX. HMWK anchors PK and F XI to exposed tissue or activated platelets. F XII is said to be activated by exposed sub-endothelial collagen, activated platelets or autoactivation. Activated F XII cleaves F XI and PK, triggering production of bradykinin, thought to be responsible for complement activation and fibrinolysis, hitherto associated with consumption coagulopathy and bleeding following cardiopulmonary bypass. Deficiency of F XII though has not been found to cause coagulation disorders in humans.

Intrinsic and Extrinsic Coagulation Pathways

Intrinsic pathway can be said to start with contact activation forming F IXa from F IX. F IXa then acts on F X to form F Xa in the presence of cofactor-VIII and Ca^{++} on the phospholipid surface of platelet that gets exposed subsequent to activation.

Extrinsic pathway, as the name suggests was thought to be triggered by extravascular substances (tissue factor) independent of F XII of the contact activation. The line of distinction between intrinsic and extrinsic pathways gets blurred as one realizes that tissue factor can actually be produced by endothelial cells under varied pathological conditions like sepsis, ischemia and reperfusion. Tissue factor converts F VII to F VIIa which converts F X to F Xa as a part of common pathway and also acts as a cofactor for F VIIa mediated F X activation. Interestingly, F VII and F X then activate each other facilitated by platelet phospholipid surface and Ca^{+}.

JAYPEE BROTHERS

Common Pathway

The common pathway depends on Vit K dependent complexes for hemostatic balance, each one has a factor, a cofactor, a negatively charged cell surface along with either F X/Xa or prothrombin/thrombin[12] (Fig. 1B). These vitamin K dependent complexes are:

- Extrinsic X'ase' (VIIa, IX, TF, X)
- Intrinsic X'ase' (VIIIa, IXa, X)
- Prothrombin'ase' (Xa,Va, Prothrombin) and
- Protein C'ase' (Thrombin, Thrombomodulin, Protein C)

These complexes are bound to membranes and serve to localize the enzymatic activity to specific sites. Prothrombinase complex converts prothrombin to active thrombin. Functionally, thrombin, the active form of inactive plasma factor prothrombin, is central to coagulation process. It is the key regulator for final step of fibrin generation from fibrinogen, as well as for initiating downregulation of hemostasis to limit its spread. Thrombin is unique in its role of sustaining the cascade by a feedback mechanism wherein it promotes its own production. Understandably, being two common final steps of the cascade, thrombin and Factor X are the target of many therapeutic anticoagulation strategies (Fig. 1C).

Thrombin initiates several processes (Fig. 1A). It breaks fibrinogen to soluble fibrin monomer + polypeptide fragments called fibrinopeptides A and B. Monomers come together to form polymer. It activates factor VIII and factor XI as well as activates F XIII to F XIIIa which strenghthens bonds between adjacent fibrin polymers and forms the insoluble clot enmeshing critical mass of active and aggregated platelets and other cells. Thrombin also activates more platelets and other mediators that results in more thrombin generation thus resulting in 'thrombin burst', a multiplier of action. It modulates coagulation by simultaneous release of tPA, prostacyclin and nitric oxide. With thrombomodulin, thrombin activates protein C, that inactivates FVa and FVIIIa, helped by protein S. It also has a role to play in inflammation and mitogenesis involving leucocytes and macrophages.

PLASMA FACTORS REGULATING COAGULATION

Coagulation is counterbalanced by serine protease inhibitors, the serpines. Antithrombin (previously known as antithrombin III) is the most potent inhibitor. It mainly inhibits thrombin by binding to its active site and to some extent inhibits XIIa, XIa, IXa, Xa, kallikrein and fibrinolytic molecule plasmin as well. Antithrombin can not reach thrombin bound to fibrin, protected by platelets. Antithrombin is inactive while circulating, it is the heparan of endothelial layer that unfolds its activity. Heparin has the same pentasaccharide sequence as that of heparan, and its acts by accelerating antithrombin action. Cardiopulmonary bypass (CPB) causes low levels of antithrombin by dilution as well as by consumption. Patients with low levels of antithrombin also have higher risk of deep vein thrombosis, its addition may help reduce the risk of thrombosis.[13] The so called 'resistance' to heparin is likely due to deficiency of antithrombin and has been mostly managed by transfusion of fresh frozen plasma, providing antithrombin from an extraneous source. Concentrates of antithrombin from human plasma and the one produced from goat milk are also available now and are preferred over fresh frozen plasma.[9]

JAYPEE BROTHERS

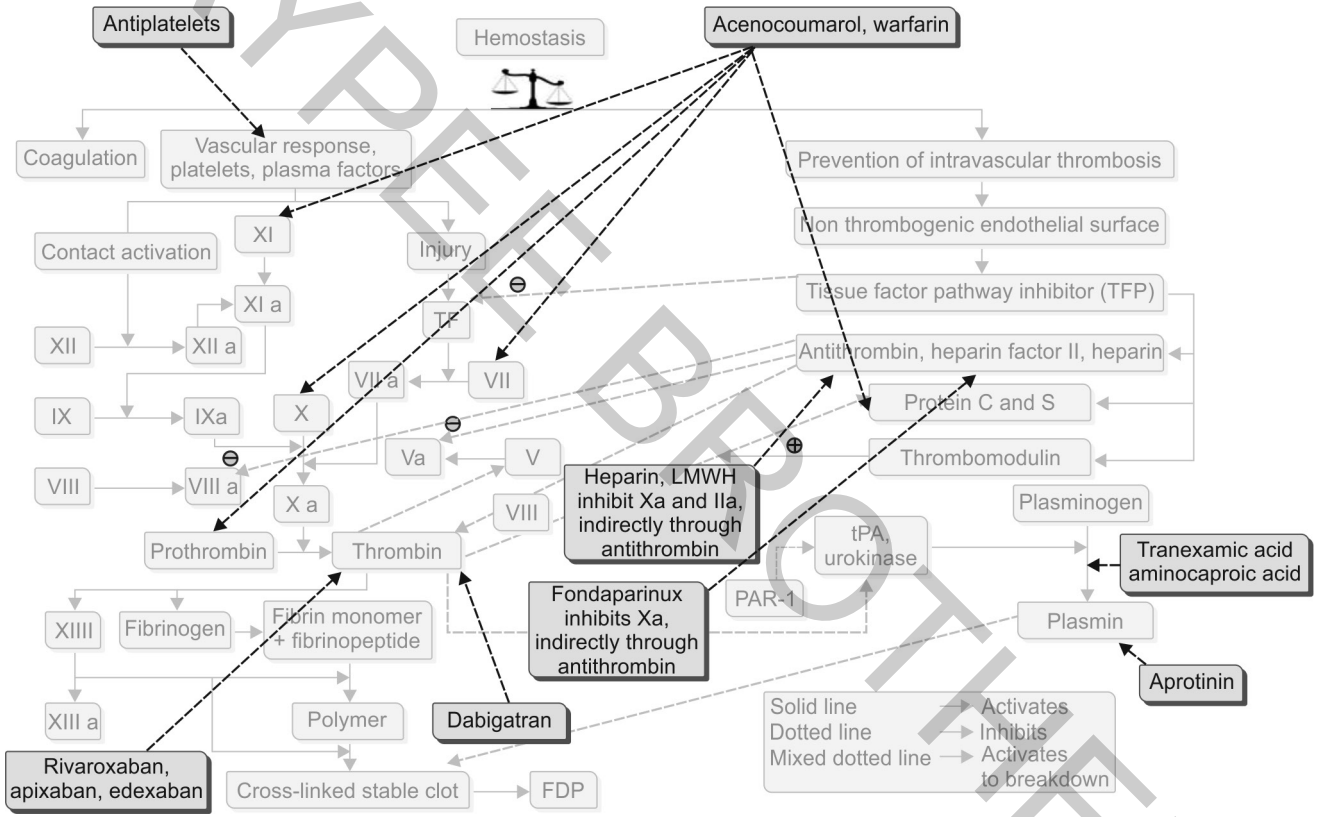


Fig. 1C: Hemostasis schema depicting site of action of antithrombotics (single line box) and procoagulants (double line box).

JAYPEE BROTHERS

for detailed information on anesthesia books, visit our website **www.jaypeebrothers.com,** for detailed info

Yearbook *of* Anesthesiology-7

This is the seventh *Yearbook of Anesthesiology* that is being published by the Indian College of Anaesthesiologists. Like all previous volumes, this one also has topics of current interest to both students and practicing anesthesiologists. These topics have been revisited and reviewed by experts in various sub-specialties of anesthesiology—general and regional anesthesia, critical care and chronic pain. Over the past years, the readership for the *Yearbook of Anesthesiology* has increased and has spread beyond India to many other countries. The editors feel that the contents of this volume will help the trainees as well practicing anesthesiologists keep abreast with the latest developments in our specialty.

Available at all medical bookstores
or buy online at www.jaypeebrothers.com

JAYPEE BROTHERS
Medical Publishers (P) Ltd.
www.jaypeebrothers.com

Join us on facebook.com/JaypeeMedicalPublishers

Shelving Recommendation
ANESTHESIA

ISBN 978-93-5270-297-8