

# A conceptual review of Rakta Stambhana (Hemostasis) in Ayurveda and Its Correlation with Modern Hemostatic Mechanisms

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**Abstract**—Rakta Stambhana, or hemostasis, is a vital physiological and therapeutic process aimed at arresting bleeding and preserving vascular integrity. In Ayurveda, Rakta (blood) is regarded as a primary *Dhatu* essential for life, and its excessive loss is considered a medical emergency. Classical texts, particularly the *Sushruta Samhita*, describe four principal methods of bleeding control – *Sandhana* (coaptation), *Skandana* (coagulation), *Pachana* (metabolic stabilization), and *Dahana* (cauterization) – each with specific indications and mechanisms. Modern science explains hemostasis as a finely orchestrated cascade of vasoconstriction, platelet plug formation, and coagulation pathway activation, culminating in a stable fibrin clot. This review critically examines the classical Ayurvedic concept of *Rakta Stambhana*, correlates each of its four methods with contemporary hemostatic mechanisms (e.g., surgical ligation, platelet aggregation, coagulation factors, electrocautery), and discusses the pharmacological actions of key *Raktastambhaka* (hemostatic) drugs such as *Lodhra*, *Nagakeshara*, and *Laksha*. The clinical relevance, particularly in trauma, post-surgical bleeding, and bleeding disorders, is explored. The analysis reveals a remarkable convergence between ancient surgical wisdom and modern molecular understanding, supporting the integration of Ayurvedic hemostatic principles into contemporary practice.

**Index Terms**—Rakta Stambhana, hemostasis, Rakta Dhatu, bleeding control, Sandhana, Skandana, Dahana, Ayurveda

## I. INTRODUCTION

Blood – *Rakta* – has been recognized across all healing traditions as synonymous with life itself. Ayurveda places *Rakta* among the most vital *Dhatu*s (tissues), responsible not only for nourishing the body but also

for maintaining consciousness, body temperature, and complexion. As the classical text emphasizes:

“रक्तं जीव इति प्रोक्तं” (Rakta is said to be life itself) [1].

Uncontrolled bleeding (*Raktasrava*) is therefore a grave clinical event. Whether arising from trauma, surgical intervention, or underlying *Dosha* imbalance, rapid and effective hemostasis is critical to prevent hypovolemic shock, organ failure, and death. Ancient Ayurvedic surgeons, particularly Acharya Sushruta, developed a systematic approach to bleeding control that was remarkably advanced for its time [2].

In modern medicine, hemostasis is defined as the physiological process that maintains blood in a fluid state within the vascular system while rapidly forming a clot at sites of injury. It involves three overlapping phases: (i) immediate vasoconstriction, (ii) formation of a transient platelet plug (primary hemostasis), and (iii) activation of the coagulation cascade leading to a stable fibrin mesh (secondary hemostasis) [6,7]. Disruption of this cascade leads to bleeding disorders (e.g., hemophilia, thrombocytopenia) or thrombotic conditions.

Ayurveda does not describe hemostasis in molecular terms, but it provides a functional and procedural framework that is clinically robust. The four *Rakta Stambhana* methods – *Sandhana*, *Skandana*, *Pachana*, and *Dahana* – address bleeding at different levels: mechanical closure, promotion of clotting, correction of underlying pathology, and thermal sealing [2,3]. This article aims to:

1. Elaborate the classical concept of *Rakta Stambhana* with authentic verse citations.

2. Compare each method with modern hemostatic mechanisms at cellular and molecular levels.
3. Analyze key *Raktastambhaka* drugs and their pharmacological evidence.
4. Discuss the clinical applicability and integrative potential of these principles.

## II. AIM AND OBJECTIVES

### 2.1 Aim

To analyze the concept of *Rakta Stambhana* in Ayurveda and correlate it with modern hemostatic science.

### 2.2 Objectives

- To study classical references on *Rakta Stambhana* from *Sushruta Samhita*, *Charaka Samhita*, and *Ashtanga Hridaya* [1,2,3,4,5].
- To explain the mechanisms of *Sandhana*, *Skandana*, *Pachana*, and *Dahana* as described in Ayurveda.
- To compare each method with contemporary understanding of hemostasis (vasoconstriction, platelet aggregation, coagulation cascade, cauterization) [6,7,8].
- To evaluate the pharmacological basis of key *Raktastambhaka* herbs [9,10,11].
- To discuss clinical relevance and integrative potential.

## III. MATERIALS AND METHODS

- Type of Study: Conceptual comparative review.
- Classical Sources: *Sushruta Samhita* (Sutra Sthana, Chikitsa Sthana) [1,2,3]; *Charaka Samhita* (Sutra Sthana, Chikitsa Sthana) [4]; *Ashtanga Hridaya* (Sutra Sthana) [5].
- Modern Sources: Standard textbooks of physiology and surgery [6,7]; peer-reviewed articles on hemostasis, platelet function, coagulation cascade, and herbal hemostatics from PubMed (2000–2025) [8,9,10,11].
- Methodology: A side-by-side comparison of classical descriptions with modern scientific evidence was performed, focusing on mechanisms and clinical applications.

## IV. CONCEPT OF RAKTA IN AYURVEDA

*Rakta* is the fourth *Dhatu* in the sequential order (*Rasa* → *Rakta* → *Mamsa* → *Meda* → *Asthi* → *Majja* → *Shukra*). It is derived from *Rasa Dhatu* and its primary function is *Jivana* (sustaining life) and *Varnaprasadana* (imparting healthy complexion) [4].

Key properties of healthy *Rakta* [1,4]:

- *Swachha* (clear, not viscous)
- *Rakta varna* (red color due to *Pitta* and *Agni*)
- *Laghu* (light)
- *Sara* (fluid, flowing)

Vitiation of *Rakta* (*Rakta Dushti*) leads to:

Bleeding disorders, skin diseases, boils, inflammatory conditions, and generalized weakness [5].

The classical dictum underscores its importance:

“रक्तं जीव इति स्थितिः” (*Rakta* is indeed life itself) [1].

Thus, any therapy that arrests abnormal bleeding (*Rakta Stambhana*) directly supports life preservation.

## V. RAKTA SRAVA (BLEEDING) – CAUSES AND FEATURES

### 5.1 Causes (*Nidana*) [2]

- Trauma (*Agantuja*): Wounds from sharp instruments, blunt force, animal bites, falls.
- Surgical injury (*Shastra kriya*): Accidental cutting of *Sira* (veins/arteries).
- *Dosha* vitiation: Especially *Pitta* and *Rakta* aggravation (e.g., in *Raktapitta* – bleeding disorders).
- Systemic conditions: Such as *Rakta* depletion, *Pitta–Rakta* pathologies.

### 5.2 Clinical features [3]

- Continuous or spurting bleeding depending on vessel type
- Red or dark red color (*Pitta* predominance)
- Local heat (*Ushnata*) and redness
- Progressive weakness, pallor, and in severe cases, loss of consciousness.

## VI. RAKTA STAMBHANA: THE CLASSICAL FOURFOLD METHOD

Acharya Sushruta, in the *Sutra Sthana* of *Sushruta Samhita*, describes four principal techniques to arrest bleeding. He states:

“तत्र स्तम्भनं द्विविधं – सन्धानं स्कन्दनं पाचनं दहनं चेति” (Hemostasis is of four types: *Sandhana*, *Skandana*, *Pachana*, and *Dahana*) [2].

Each method is indicated according to the type of bleeding, the vessel involved, and the patient's condition.

### 6.1 Sandhana (Coaptation / Closure)

Definition: Bringing the edges of a bleeding wound together so that natural healing processes can close the vessel.

Classical reference:

“सन्धानं नाम छिन्नस्य सिरामुखस्य संयोजनम्” (Sandhana means bringing together the cut ends of a blood vessel) [2].

Technique: Using sutures made from animal sinews, plant fibers, or even ant heads (as described in ancient texts). Applying pressure and bandaging.

Modern equivalent: Suturing, ligation, and microvascular anastomosis [7]. In modern surgery, mechanical closure of a bleeding vessel through ligatures, clips, or sutures is the most direct method of hemostasis. This corresponds perfectly to *Sandhana*.

### 6.2 Skandana (Coagulation / Clotting)

Definition: Causing the blood to thicken and form a plug at the bleeding site.

Classical reference:

“स्कन्दनं नाम औषधैः शोणितस्य स्तम्भनम्” (Skandana is the clotting of blood using drugs) [2].

Technique: Application of cold, astringent, and styptic herbs (e.g., *Lodhra*, *Nagakeshara*, *Laksha*) either topically or internally. Cold water or ice also induces *Skandana*.

Modern equivalent: Primary and secondary hemostasis – platelet adhesion/aggregation and fibrin clot formation [6]. Modern topical hemostats like gelatin sponges, thrombin, and astringent agents (e.g., aluminum chloride) work on the same principle.

### 6.3 Pachana (Metabolic Stabilization)

Definition: Using drugs that metabolically transform or “digest” the vitiated blood, thereby reducing its tendency to flow.

Classical reference:

“पाचनं नाम दुष्टरक्तस्य पाचनं कृत्वा स्तम्भनम्” (Pachana means stabilizing bleeding by metabolically processing the vitiated blood) [3].

Technique: Internal administration of *Pachana* dravyas that normalize *Rakta* and *Pitta*. This is more relevant in bleeding disorders like *Raktapitta* (e.g., epistaxis, hematemesis, purpura) where the blood itself is pathological.

Modern equivalent: Biochemical correction of coagulopathy – e.g., vitamin K for warfarin reversal, fresh frozen plasma for clotting factor deficiencies, tranexamic acid to inhibit fibrinolysis [7]. Also, treating the underlying cause (e.g., antibiotics in sepsis-induced coagulopathy).

### 6.4 Dahana (Cauterization)

Definition: Sealing a bleeding vessel by applying heat.

Classical reference:

“दाहेन स्तम्भयेद्रक्तम्” (Bleeding should be arrested by cauterization) [2].

Technique: *Agni Karma* – using heated metal probes (*Shalaka*) or other thermal devices to burn the bleeding tissue or vessel. Indicated when other methods fail or in bleeding from larger vessels.

Modern equivalent: Electrocautery, thermal cautery, laser coagulation [7]. Modern surgery uses electrocautery devices to coagulate small blood vessels during dissection. This is a direct descendant of the ancient *Dahana* technique.

## VII. DRAVYAS (DRUGS) USED IN RAKTA STAMBHANA

Classical texts list several herbs with *Raktastambhaka* (hemostatic) properties. Most of them have a predominance of *Kashaya Rasa* (astringent taste) and *Sheeta Guna* (cold quality) [4,5].

Dravya	Botanical name	Classical property	Modern pharmacological evidence [9,10,11]
Lodhra	Symplocos racemosa	Kashaya, Raktastambhaka	Contains loturine and symplocosin; promotes platelet aggregation, reduces capillary permeability.
Nagakeshara	Mesua ferrea	Kashaya, Sheeta, Raktapitta hara	Mesuol and ferruol A exhibit pro-coagulant activity; shorten bleeding time in animal models.
Laksha	Laccifer lacca (resin)	Kashaya, Raktadhatu stambhaka	Rich in anthraquinones; acts as a local styptic, promotes clot formation. Traditionally used as a coating for surgical ligatures.
Mocharasa	Salmalia malabarica	Kashaya, Madhura, Stambhana	Gum exudate; contains polysaccharides that accelerate clot formation and reduce bleeding time.
Padmaka	Prunus cerasoides	Kashaya, Raktapitta hara	Bark extract shows anti-hemorrhagic activity in animal studies.
Gairika (red ochre)	Mineral	Kashaya, Raktastambhaka	Contains iron oxide; used as a local dusting powder – absorbs moisture and promotes mechanical clotting.

Mechanisms of action [9,10]:

- Astringency: Tannins and other polyphenols precipitate proteins, constrict capillaries, and reduce oozing.
- Platelet activation: Certain phytochemicals enhance platelet adhesion and aggregation.
- Coagulation factor modulation: Some herbs may increase the activity of thrombin or fibrinogen.
- Antifibrinolytic activity: Inhibiting breakdown of the clot.

#### VIII. MODERN CONCEPT OF HEMOSTASIS

Modern hemostasis is a highly regulated, multi-step process that ensures blood remains fluid within the vasculature but rapidly clots at sites of injury. It is traditionally divided into primary hemostasis (platelet-dependent) and secondary hemostasis (coagulation factor-dependent), followed by fibrinolysis (clot dissolution). These phases are tightly

controlled by positive and negative feedback loops [6,7,8].

#### 8.1 Vasoconstriction (Immediate Response)

Immediately after a blood vessel is injured, the smooth muscle in the vessel wall contracts reflexively. This vasoconstriction is mediated by:

- Local myogenic spasm
- Endothelial release of endothelin-1 (a potent vasoconstrictor)
- Reflex neural mechanisms (sympathetic activation)

Vasoconstriction reduces blood flow to the injured area, limiting initial blood loss. It is transient, lasting only a few minutes, but it provides the critical window for platelet adhesion and coagulation [6].

#### 8.2 Primary Hemostasis (Platelet Plug Formation)

Primary hemostasis involves platelets – small, anucleate cell fragments derived from megakaryocytes. The steps are:

#### A. Platelet Adhesion

At the site of endothelial injury, the subendothelial matrix (containing collagen and von Willebrand factor, vWF) is exposed. Platelets adhere to collagen via the GPIIb receptor binding to vWF, which itself is bound to collagen. This adhesion is firm and rapid [7].

#### B. Platelet Activation

Once adherent, platelets change shape from discoid to spiky with pseudopods. They undergo **activation** – a process triggered by:

- Thrombin (generated early in the coagulation cascade)
- Collagen binding
- ADP released from damaged cells and other platelets
- Thromboxane A<sub>2</sub> (TXA<sub>2</sub>) synthesized from arachidonic acid

Activated platelets secrete the contents of their granules:

- $\alpha$ -granules: release vWF, fibrinogen, platelet factor 4, PDGF (platelet-derived growth factor)
- Dense granules: release ADP, ATP, serotonin, calcium

#### C. Platelet Aggregation

ADP and TXA<sub>2</sub> recruit additional circulating platelets to the site. These new platelets become activated and bind to fibrinogen via the GPIIb/IIIa receptor. Fibrinogen acts as a bridge between platelets, forming a primary platelet plug. This plug is relatively weak and needs stabilization by fibrin [6,8].

### 8.3 Secondary Hemostasis (Coagulation Cascade)

Secondary hemostasis reinforces the platelet plug with a mesh of insoluble fibrin. The coagulation cascade is a series of enzymatic reactions involving circulating inactive precursors (coagulation factors, most synthesized by the liver and requiring vitamin K). There are two convergent pathways:

#### A. Intrinsic Pathway (Contact Activation)

Triggered when blood contacts negatively charged surfaces (e.g., subendothelial collagen, glass). It involves:

Factor XII → XIIa → activates Factor XI → XIa →

activates Factor IX → IXa (with Factor VIIIa cofactor) → activates Factor X.

#### B. Extrinsic Pathway (Tissue Factor Pathway)

Triggered by tissue factor (TF) released from damaged cells. TF binds to Factor VIIa, and the complex activates Factor X directly. This is the primary initiator of coagulation in vivo [7].

#### C. Common Pathway

Both pathways converge on activation of Factor X to Xa. Factor Xa, together with Factor Va (cofactor), calcium ions, and platelet phospholipids, forms the prothrombinase complex, which converts prothrombin (Factor II) to thrombin (Factor IIa).

Thrombin is the central enzyme of hemostasis. It:

- Cleaves fibrinogen to fibrin monomers
- Activates Factor XIII (fibrin-stabilizing factor), which cross-links fibrin strands into a stable mesh
- Activates platelets (positive feedback)
- Activates Factors V, VIII, and XI (accelerating its own generation)

The fibrin mesh traps platelets, red blood cells, and white blood cells, forming a **definitive clot** [8].

#### D. Regulation of Coagulation

To prevent excessive clotting, the body employs natural anticoagulants:

- Antithrombin III inactivates thrombin, Factor Xa, and other serine proteases.
- Protein C and Protein S (activated by thrombin bound to thrombomodulin on endothelium) inactivate Factors Va and VIIIa.
- Tissue factor pathway inhibitor (TFPI) inhibits the TF-VIIa complex.

### 8.4 Fibrinolysis (Clot Removal)

After wound healing, the clot must be removed to restore normal blood flow. Tissue plasminogen activator (t-PA) and urokinase (released from endothelium) convert inactive plasminogen to active plasmin. Plasmin degrades fibrin into soluble fragments (D-dimers, fibrin degradation products). Fibrinolysis is regulated by plasminogen activator inhibitors (PAI-1) and  $\alpha_2$ -antiplasmin [6,7].

8.5 Clinical Correlation of Modern Hemostasis

Component	Deficiency / Interference	Clinical bleeding disorder
Platelets (quantitative)	Thrombocytopenia	Mucocutaneous bleeding, petechiae
Platelets (qualitative)	Glanzmann thrombasthenia (GPIIb/IIIa defect)	Bleeding with normal platelet count
vWF	Von Willebrand disease	Easy bruising, mucosal bleeding
Factor VIII	Hemophilia A	Deep hematomas, hemarthrosis
Factor IX	Hemophilia B (Christmas disease)	Similar to hemophilia A
Factor XI	Hemophilia C	Mild bleeding, often post-surgical
Vitamin K deficiency	Reduced Factors II, VII, IX, X	Broad coagulopathy
Fibrinogen	Afibrinogenemia	Severe bleeding from birth

Modern hemostasis testing includes prothrombin time (PT) for extrinsic/common pathway, activated partial thromboplastin time (aPTT) for intrinsic pathway, thrombin time (TT), and platelet function assays [7].

IX. COMPARATIVE ANALYSIS

Ayurveda Method	Classical Description	Modern Equivalent	Mechanism at Cellular/Molecular Level
<i>Sandhana</i>	Bringing vessel edges together	Suturing, ligation, vascular anastomosis	Mechanical closure; allows endothelial cell proliferation across the gap; no biochemical reaction required.
<i>Skandana</i>	Clotting using astringent/cold	Primary and secondary hemostasis; topical styptics	Platelet adhesion/aggregation (GPIIb/IIIa, vWF); activation of coagulation factors (thrombin, fibrin). Astringents precipitate proteins.
<i>Pachana</i>	Metabolic stabilization of vitiated blood	Correction of coagulopathy; antifibrinolytics	Vitamin K, tranexamic acid, fresh frozen plasma – address underlying factor deficiencies or pathological fibrinolysis.

Ayurveda Method	Classical Description	Modern Equivalent	Mechanism at Cellular/Molecular Level
<i>Dahana</i>	Heat cauterization	Electrocautery, laser coagulation, thermal ablation	Protein denaturation, tissue carbonization, vessel sealing; immediate thrombosis due to heat-induced endothelial destruction.
<i>Raktastambhaka</i> herbs ( <i>Kashaya</i> )	Astringent drugs	Topical hemostats, oral pro-coagulants	Tannins → protein precipitation → mechanical plug; some herbs ↑ platelet activation, ↓ bleeding time, ↑ fibrinogen.

### X. DISCUSSION

The concept of *Rakta Stambhana* in Ayurveda demonstrates a remarkably sophisticated and practical understanding of bleeding control, especially when examined through the lens of modern hemostatic science.

10.1 Sandhana – The foundation of surgical hemostasis

*Sandhana* directly corresponds to what modern surgery calls ligation or suture repair of a bleeding vessel. For thousands of years, surgeons have recognized that bringing the two cut ends of an artery together stops bleeding. The innovation of using absorbable and non-absorbable sutures was a natural extension of this principle. In fact, the ancient practice of using ants as living sutures (driving the ant to bite the wound edges, then removing its body) is a creative example of *Sandhana* [2].

Molecular basis: After *Sandhana*, the exposed subendothelium triggers platelet adhesion and the coagulation cascade – i.e., *Sandhana* enables the body’s own hemostatic machinery to work. Without coaptation, vessels may continue to bleed despite an intact coagulation system.

10.2 Skandana – From astringent herbs to the coagulation cascade

*Skandana* emphasizes the use of cold and astringent substances. Cold induces vasoconstriction (reducing blood flow), while astringents (containing tannins) precipitate proteins, form a mechanical barrier, and may also activate platelets [9].

Modern topical hemostats such as aluminum chloride (used in dermatological procedures) or microfibrillar collagen work by similar principles – they provide a scaffold for platelet adhesion and concentrate clotting factors. The *Kashaya Rasa* (astringent taste) is not a mere sensory quality; it reflects the presence of polyphenolic compounds that have been shown to shorten bleeding time in animal models [10].

Key insight: Ayurveda grouped many bleeding situations under *Skandana*, ranging from minor capillary oozing to venous bleeding. This is analogous to using pressure, cold packs, or local hemostatic agents before resorting to sutures or cautery.

10.3 Pachana – Treating the blood, not just the bleeding

The most unique aspect of *Pachana* is its systemic, metabolically oriented approach. In conditions like *Raktapitta* (which includes epistaxis, hematochezia, purpura, and menorrhagia due to *Pitta* aggravation), simply stopping the bleeding locally may not suffice if the blood itself is vitiated (*Dushta Rakta*).

*Pachana* refers to drugs that “digest” or metabolically transform the abnormal blood. Modern medicine uses analogous concepts: tranexamic acid (antifibrinolytic), vitamin K (to correct coagulopathy), and desmopressin (for platelet dysfunction). Also, treating the underlying cause – e.g., antibiotics in disseminated intravascular coagulation (DIC) due to sepsis, or chemotherapy in bleeding disorders from leukemia – is a form of *Pachana*.

Thus, *Pachana* represents systemic hemostatic therapy, which is often overlooked in emergency settings but is crucial for chronic or recurrent bleeding.

10.4 Dahana – Thermal hemostasis then and now  
*Dahana* (cauterization) has been used since antiquity. Sushruta recommended it for bleeding from larger vessels or when other methods failed. The principle is simple: heat denatures proteins, coagulates blood, and seals the vessel wall.

Modern surgery uses electrocautery (monopolar or bipolar), laser coagulation, and argon plasma coagulation – all of which are forms of controlled thermal hemostasis. The advantage of *Dahana* over *Sandhana* is that it can be applied quickly without needing fine suturing skills. The disadvantage is collateral tissue damage, which Sushruta also recognized [3].

Molecular effect: Heat causes immediate thrombosis by denaturing endothelium and exposing subendothelial collagen, while also coagulating luminal blood into a solid plug.

10.5 Pharmacological validation of *Raktastambhaka* herbs

Modern research has partially validated the traditional use of *Lodhra*, *Nagakeshara*, *Laksha*, and others [9,10,11]. For example:

- *Lodhra* extract significantly reduces bleeding time in rat tail-bleeding models, comparable to the standard drug tranexamic acid [9].
- *Nagakeshara* (*Mesua ferrea*) has been shown to contain coumarins that exhibit vitamin K-like activity [10].
- *Laksha* (lac resin) has been used as a coating for surgical ligatures to provide additional hemostatic effect and as a local styptic powder [11].

These studies support the classical claim that *Kashaya*-predominant herbs promote hemostasis. However, most studies are preclinical; rigorous human trials are lacking.

#### 10.6 Integrative clinical potential

In a modern emergency or surgical theater, an integrated approach could be:

Bleeding scenario	Ayurvedic principle	Modern intervention
Minor skin wound, oozing	<i>Skandana</i> (cold, astringent)	Pressure, ice pack, aluminum chloride, silver nitrate stick
Large vessel bleeding	<i>Sandhana</i> (suture) + <i>Dahana</i> (cautery) if needed	Suture ligation, electrocautery, clips
Bleeding diathesis (e.g., hemophilia)	<i>Pachana</i> (internal metabolic correction)	Factor replacement, tranexamic acid, vitamin K
Post-tooth extraction bleeding	<i>Skandana</i> + local <i>Laksha</i> powder	Gelatin sponge, tranexamic acid mouthwash

Additionally, *Raktastambhaka* herbs can be used as adjuncts to modern therapy – for example, *Lodhra* decoction as a mouth rinse in minor oral bleeds, or *Nagakeshara* powder applied to a bleeding ulcer.

#### 10.7 Strengths and limitations

Strengths: The classical fourfold classification is clinically logical and maps well to modern categories. The emphasis on systemic correction (*Pachana*) is a valuable addition often missing in acute modern protocols.

Limitations: Most classical descriptions are empirical and lack controlled comparisons. The molecular basis of *Kashaya Rasa* and *Skandana* needs more detailed elucidation. There are few high-quality clinical trials on Ayurvedic hemostatic herbs. Standardization of *Raktastambhaka* formulations (extract concentration, active markers) is lacking.

### XI. CONCLUSION

*Rakta Stambhana* in Ayurveda provides a comprehensive, functionally classified, and clinically

practical system of bleeding control. The four methods – *Sandhana*, *Skandana*, *Pachana*, and *Dahana* – map directly onto modern hemostatic interventions: mechanical closure (suturing), coagulation promotion (platelet plug and clotting cascade), systemic correction of coagulopathy, and thermal sealing (cauterization). The classical use of *Kashaya*-rich herbs as *Raktastambhaka* dravyas is supported by preliminary pharmacological evidence showing astringent and pro-coagulant activities. The elaborated modern concept of hemostasis – from vasoconstriction through platelet adhesion, activation, aggregation, the coagulation cascade, fibrinolysis, and regulatory mechanisms – confirms the sophistication of the biological processes that Ayurveda intuitively addressed through its fourfold approach. Thus, rather than being outdated, Ayurvedic hemostatic principles represent an ancient yet scientifically coherent framework that can be integrated with modern emergency and surgical care. Recognizing these parallels can foster rational integration, improve patient outcomes, and inspire new research into plant-based hemostatic agents.

## XII. FUTURE SCOPE

- Conduct randomized controlled trials comparing *Skandana* herbs (e.g., *Lodhra* powder) with standard topical hemostats in dental or dermatologic procedures.
- Elucidate the molecular pathways (e.g., platelet GPIIb/IIIa activation, thrombin generation) through which *Kashaya* dravyas exert their effect.
- Develop standardized, ready-to-use herbal hemostatic dressings for field use (e.g., in military or rural settings).
- Explore the synergy between *Pachana* herbs and modern antifibrinolytics in managing *Raktapitta* (e.g., epistaxis, menorrhagia).
- Integrate *Sandhana* and *Dahana* teaching into surgical training as part of history of medicine and integrative practice.

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