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Review Article

Dushta Vrana and Chronic Wound Biofilm: Integrating Ayurvedic Wound-Cleansing Principles with Modern Biofilm-Based Wound Care

Dr.Abhishek Suresh Shedage,
Assistant Professor- Department of Shalyatantra, S.C.Mutha
Aryangla Vaidyak Mahavidyala, Satara.
Abhishekshedage@Gmail.com

Dr.Ramdhave Sarang Sureshrao,
Associate Professor,
Department of Shalyatantra,Government Ayurved College,Dharashiv.
drsarang100@gmail.com

Dr.Omkar Subhash Jyotik,
Assistant Professor- Department of Shalyatantra,
Government Ayurveda College, Baramati
omkarjyotik29@gmail.com

Abstract

Chronic wounds are difficult to heal because local tissue damage, impaired perfusion, systemic disease, inflammation, and microbial persistence reinforce one another. Biofilms are now recognized as an important part of this cycle. Their extracellular matrix and altered microbial behaviour reduce susceptibility to host defences and antimicrobial treatment, allowing inflammation to continue even when overt infection is not obvious. Classical Ayurvedic surgery describes *Dushta Vrana* as an unhealthy, non-healing wound marked by discharge, odour, discoloration, pain, swelling, devitalized tissue, and delayed repair. Management begins with *Vrana Shodhana*—repeated cleansing, irrigation, drainage, and removal of unhealthy tissue—before *Vrana Ropana* is undertaken. This review compares that staged approach with contemporary wound-bed preparation and biofilm-based wound care. The strongest parallel is practical: both approaches recognize that a persistent wound must be reassessed and its wound bed repeatedly optimized rather than treated with a single antimicrobial intervention. *Dushta Vrana* is not synonymous with biofilm, and traditional preparations cannot be assumed to disrupt clinical biofilms without direct evidence. Integrative care should therefore preserve standard vascular assessment, pressure relief, glycaemic management, debridement, infection treatment, and appropriate dressings while investigating standardized Ayurvedic measures as possible adjuncts. Priorities include product quality, biofilm-relevant laboratory methods, controlled clinical trials, safety monitoring, and objective healing outcomes.

Keywords

Dushta Vrana; chronic wound; biofilm; Vrana Shodhana; debridement; wound-bed preparation; Ayurveda

1. Introduction

A chronic wound is not simply an acute wound that has taken longer to close. It is a biologically unstable environment in which inflammation, ischemia, repeated mechanical stress, systemic illness, and microbial communities can prevent orderly repair. The visible ulcer is therefore only one part of a wider clinical problem.

Classical Ayurvedic surgery approaches a comparable problem through the concept of *Dushta Vrana*. Sushruta's discussion of wound examination provides the foundational description of an unhealthy wound and its observable features [1]. The therapeutic account then places cleansing and correction of the wound environment before efforts to promote closure [2]. A related discussion of *Vrana* and swelling further connects local appearance with the condition of the surrounding tissue [3].

The comparison with modern biofilm science is useful because both traditions give repeated wound-bed care a central role. It must nevertheless be handled carefully.

Dushta Vrana is a clinical category within *Ayurveda*; a biofilm is a structured microbial community demonstrated through microbiological methods. They overlap in some chronic wounds, but they are not interchangeable diagnoses.

2. Aim and Review Approach

This narrative review examines the clinical and therapeutic relationship between *Dushta Vrana* and chronic wound biofilm. It summarizes classical wound-cleansing principles, outlines current understanding of biofilm persistence, compares *Vrana Shodhana* with wound-bed preparation, and identifies safe directions for integrative research.

The classical context was broadened with the *Charaka Samhita* [4] and the *Ashtanga Hridaya* [5]. Dravyaguna literature informed the discussion of medicinal substances [6], while a contemporary *Shalya Tantra* text provided the surgical context [7]. Modern material included foundational biofilm studies, systematic reviews, consensus statements, wound-bed frameworks, and clinical literature on debridement and hard-to-heal wounds. This was not a registered systematic review, and the cited sources were not graded with a formal risk-of-bias instrument.

3. *Dushta Vrana* as a Clinical Description

Vrana refers broadly to a break or defect in tissue. A wound that progresses through healthy granulation and epithelialization differs from a *Dushta Vrana*, which remains inflamed, contaminated, devitalized, excessively wet or otherwise unsuitable for healing. Commonly described features include *Ati Srava*, *Durgandha*, *Vivarnata*, *Vedana*, *Shotha*, unhealthy granulation tissue, and delayed closure.

These observations are clinically recognizable, but none is specific to biofilm. Excessive exudate may reflect venous hypertension, inflammation, infection, or dressing failure. Odour may arise from microbial metabolism or necrotic tissue. Discoloration may indicate slough, ischemia, bruising, or pigment change. The classical description is therefore best understood as a prompt for comprehensive wound assessment rather than a microbiological conclusion.

Ayurveda also considers *Dosha*, *Dhatu*, *Mala*, tissue vitality, nutrition, contamination, retained material, and inadequate drainage. Modern practice uses different concepts, yet it reaches a similar practical conclusion: local treatment will fail if perfusion, pressure, oedema, glucose control, nutrition, or repeated trauma is not addressed.

4. From Planktonic Bacteria to Biofilm

Direct examination of chronic wound material helped establish that organisms may live in organized biofilm communities rather than only as free-floating cells [8]. Subsequent reviews described how the extracellular matrix, microbial diversity, and altered metabolic states contribute to persistence [9]. A systematic review and meta-analysis found biofilms in a substantial proportion of chronic wounds, although prevalence estimates depend strongly on sampling and detection methods [10].

A biofilm is commonly described as a community of microorganisms attached to a surface and embedded in a self-produced matrix of polysaccharides, proteins, extracellular DNA, and water. The matrix provides structure, but tolerance also arises from slow-growing cells, local gradients of oxygen and nutrients, stress responses, and interactions among species.

Biofilm development is often discussed in stages: initial attachment, more stable adhesion, maturation into a structured community, and dispersal of cells or fragments. This model is useful, but a clinical wound is more dynamic than a laboratory surface. Debris, exudate, host proteins, immune cells, dressings, debridement, and repeated contamination continually reshape the community.

5. Why Biofilm Can Delay Healing

A review of experimental and clinical evidence describes several routes through which biofilm may delay repair [11]. Consensus guidance similarly frames biofilm as one component of a hard-to-heal wound that requires repeated assessment and combined management [12].

Persistent immune stimulation can maintain neutrophil and macrophage activity without clearing the organisms. The resulting proteases and reactive products may damage extracellular matrix, growth factors, and viable tissue. Research on biofilm-associated inflammation has helped explain this self-sustaining cycle [13]. Fibroblast function, angiogenesis, keratinocyte migration, and collagen organization may all be impaired when the wound remains inflamed.

Clinical recognition is difficult. Algorithms based on wound behaviour can raise suspicion, but visible signs alone do not prove that a biofilm is present [14]. The broader literature on chronic infection shows why ordinary culture and antibiotic susceptibility do not always predict behaviour within a mature biofilm [15]. Clinical experience with biofilm-based wound care therefore favours a multifaceted strategy rather than reliance on a single test or product [16].

Biofilm tolerance must also be distinguished from heritable antimicrobial resistance. Both can coexist, but they are not the same process. Work on healthcare-associated biofilms illustrates how attachment, protected growth, and repeated exposure can complicate treatment across many clinical settings [17].

6. Wound-Bed Preparation and Repeated Debridement

Removal of devitalized tissue remains one of the most direct ways to reduce physical barriers and disrupt surface-associated biofilm. Regular debridement has therefore been described as a central tool for maintaining a healthier wound bed [18]. Clinical work in critical limb ischemia also illustrates the potential value—and the limitations—

of biofilm-based management in patients whose vascular disease remains decisive [19].

Biofilm control strategies include physical disruption, moisture and exudate management, appropriate topical antisepsis, systemic antibiotics when clinically indicated, and correction of the underlying cause [20]. Practical guidance emphasizes that these measures must be coordinated and repeated [21]. Wound microbiology is complex, and culture results must be interpreted with the clinical picture rather than treated as an automatic instruction to prescribe antibiotics [22].

Host factors matter just as much. Age, perfusion, diabetes, nutrition, smoking, medicines, and local oxygenation can alter repair [23]. Reviews of chronic wound treatment accordingly describe the challenge as systemic and local, not purely microbial [24]. The TIME framework organized care around tissue, infection or inflammation, moisture, and the wound edge [25]. TIMERS later added repair or regeneration and social factors, highlighting the patient and care environment around the wound [26].

Modern wound-bed preparation brings these elements together [27]. Debridement can be surgical, sharp, autolytic, enzymatic, mechanical, or biological; selection depends on perfusion, anatomy, bleeding risk, pain, infection, clinician skill, and treatment goals [28]. Newer strategies target matrix integrity, quorum signalling, microbial metabolism, or delivery of antimicrobial agents, but many remain investigational [29]. A multifaceted approach is more plausible than a universal antibiofilm product [30]. Experimental work further supports an association between bacterial biofilm and delayed healing while underscoring the difference between models and heterogeneous human wounds [31].

7. A Cautious Comparison with *Dushta Vrana*

Recent Ayurvedic literature has revisited the features of *Dushta Vrana* in relation to chronic and complex wounds [32]. The comparison is strongest at the level of clinical behaviour: persistent discharge, odour, devitalized tissue, recurrent inflammation, pain, and failure to progress. The accompanying table presents these parallels without claiming identity.

The key difference is scope. *Dushta Vrana* may include wounds in which biofilm is present, but it may also include ischemic, inflammatory, malignant, neuropathic, or mechanically stressed wounds whose main barrier lies elsewhere. Conversely, a biofilm can exist without every classical feature. Using one term as a replacement for the other would narrow both concepts.

Classical observation	Possible modern reading	Important boundary
Dushta Vrana	Hard-to-heal or chronic wound	Does not establish biofilm
Ati Srava	Persistent exudate	Also occurs with oedema or inflammation
Durgandha	Microbial activity or necrotic tissue	Not a species-specific sign
Vivarnata	Slough, ischemia, necrosis, or inflammation	Requires vascular and tissue assessment
Vedana and *Shotha*	Pain and inflammatory oedema	May signal urgent pathology
Mamsa Dushti	Devitalized tissue or unhealthy granulation	Histology and depth vary
Repeated *Vrana Shodhana*	Repeated wound-bed maintenance	Methods and evidence are not equivalent
Vrana Ropana	Granulation, epithelialization, and repair	Depends on cause control

Table 1. Clinical parallels and interpretive limits between *Dushta Vrana* and chronic wound terminology.

8. *Vrana Shodhana*: Preparing the Wound to Heal

Vrana Shodhana is a staged effort to convert an unhealthy wound into one capable of repair. Its objectives include removal of foreign and devitalized material, drainage, reduction of excessive exudate and odour, protection of viable tissue, and encouragement of healthy granulation. *Vrana Ropana* follows when the wound bed and patient are ready for repair.

This sequence resembles wound-bed preparation, but the methods cannot be assumed to be equivalent in dose, mechanism, sterility, or clinical effect. The value of the comparison lies in the shared therapeutic logic: assess, cleanse, remove barriers, reassess, and only then promote closure.

Ayurvedic principle	Modern functional parallel	Shared purpose
Vrana Shodhana	Wound-bed preparation	Create conditions compatible with repair
Kshalana	Irrigation	Remove loose debris and dilute exudate
Lekhana	Selected debridement methods	Remove barriers and expose viable tissue
Prakshalana	Repeated cleansing and reassessment	Respond to recolonization and wound change
Lepa	Topical treatment or dressing	Protect tissue and manage local conditions

Ayurvedic principle	Modern functional parallel	Shared purpose
Vrana Ropana	Repair-focused care	Support granulation and epithelialization

Table 2. Functional comparison of wound-cleansing principles. Similar purpose does not establish therapeutic equivalence.

9. *Kshalana* and *Prakshalana*

Kshalana refers to therapeutic irrigation, while *Prakshalana* emphasizes repeated cleansing during the course of care. Irrigation can remove loose debris and dilute exudate, but it should be performed with an appropriate solution, safe pressure, and attention to cross-contamination. A heavily contaminated solution, excessive pressure, or a cytotoxic concentration may injure tissue rather than help it.

Traditional materials include *Triphala*, *Panchavalkala*, *Nimba*, *Haridra*, and *Daruharidra*. Their laboratory antimicrobial or anti-inflammatory activity is not sufficient to establish clinical biofilm disruption. Research on traditional remedies has begun to test antibiofilm potential more directly, but translation from an assay to an open chronic wound remains a substantial step [33].

10. *Lekhana*, Debridement, and Drainage

Lekhana and related removal of unhealthy tissue offer the clearest procedural parallel with debridement. Both aim to expose viable tissue, release retained material, improve assessment, and reduce barriers to healing. The required depth and method depend on what is present; callus, slough, eschar, infected tissue, exposed tendon, and ischemic necrosis cannot be managed as though they were the same.

Debridement is not automatically safe. Dry, stable eschar on a poorly perfused limb may require vascular assessment before removal. Sharp treatment near vessels, nerves, joints, or tendons demands suitable expertise. Spreading infection, crepitus, systemic toxicity, rapidly increasing pain, or suspected necrotizing infection requires urgent surgical and medical care.

11. *Lepa* and Topical Therapy

Lepa refers to a topical application selected according to the wound state. A modern comparison may be made with topical antimicrobial or protective dressings, but formulation quality is decisive. Particle contamination, incorrect concentration, poor sterility, batch variation, allergens, and retained paste can all compromise a wound.

Contemporary reviews of chronic wound biofilm discuss the limitations of diagnosis and the range of therapeutic strategies under investigation [34]. A broader review of evidence likewise cautions that no single topical approach has solved the problem of biofilm in wounds [35]. Any Ayurvedic topical product intended for a chronic ulcer should therefore be standardized, manufactured to an appropriate microbiological standard, and tested against both wound healing and safety outcomes.

12. Selected Medicinal Materials

Triphala and *Panchavalkala* are traditionally used for cleansing and astringent effects. *Nimba* (*Azadirachta indica*) is studied for antimicrobial and anti-inflammatory activity. *Haridra* (*Curcuma longa*) contains curcuminoids with broad experimental effects on inflammation and repair, while *Daruharidra* (*Berberis aristata*) contains berberine, which has shown antimicrobial and antibiofilm activity in laboratory systems.

These findings are hypothesis-generating. Extract, solvent, dose, contact time, delivery system, pH, sterility, and wound type can change the result. Evidence from planktonic bacteria should not be labelled antibiofilm evidence, and animal wound closure should not be presented as proof of benefit in diabetic foot ulcers, venous leg ulcers, or pressure injuries.

13. An Integrative Clinical Pathway

An integrative pathway should begin with diagnosis rather than product selection. The clinician should identify the wound type, duration, size, depth, tissue condition, exudate, pain, surrounding skin, perfusion, sensation, pressure exposure, oedema, infection risk, glycaemic status, nutrition, medicines, and the patient's goals.

Standard care remains the foundation: vascular referral when perfusion is impaired; off-loading for neuropathic foot wounds; compression when appropriate for venous disease; pressure redistribution; debridement when safe; moisture-balanced dressings; treatment of clinical infection; and management of systemic illness. Ayurvedic cleansing or topical measures may be studied as adjuncts within this pathway, with the treating team aware of every product used.

Progress should be documented with the same objective method over time. Wound area, depth, undermining, tissue type, exudate, pain, infection signs, adverse reactions, and quality of life are more informative than an impression that the wound looks cleaner. Failure to improve should prompt reassessment of diagnosis, perfusion, pressure, adherence, malignancy, inflammatory disease, and osteomyelitis.

14. Antimicrobial Stewardship and Safety

A chronic wound is commonly colonized, and a positive culture alone does not establish invasive infection. Systemic antibiotics should be reserved for appropriate clinical indications and selected according to current guidance, likely pathogens, culture data when useful, renal and hepatic status, allergy, and local resistance patterns.

An integrative approach must not delay urgent treatment. Fever, hemodynamic instability, rapidly spreading erythema, severe or disproportionate pain, new tissue necrosis, exposed or infected bone, loss of

perfusion, or rapidly progressive swelling warrants prompt medical or surgical assessment. Patients with diabetes, immunosuppression, or peripheral arterial disease may deteriorate with fewer obvious signs.

Traditional products also require pharmacovigilance. Clinicians should record ingredients, manufacturer, batch, preparation, dose, duration, co-interventions, and adverse events. Unknown powders, non-sterile liquids, irritant concentrations, and products containing undeclared metals or pharmaceuticals should not be placed in open wounds.

15. Evidence Gaps

The classical rationale for repeated cleansing is coherent, and several medicinal materials show promising experimental activity. The clinical evidence remains limited by small samples, mixed wound types, poorly described standard care, variable formulations, short follow-up, and outcomes that do not distinguish antimicrobial activity from ordinary wound contraction.

Biofilm measurement is another challenge. Routine swabs may identify organisms but do not demonstrate their spatial organization. Microscopy, molecular methods, tissue sampling, and specialized assays each answer different questions and may not be feasible in everyday care. Trials should avoid claiming biofilm eradication when only surface culture counts were measured.

A credible study must also control the cause of the wound. An adjunct cannot compensate for untreated ischemia, persistent pressure, uncontrolled oedema, or inadequate off-loading. Outcomes should include time to healing, proportion healed, recurrence, infection, antibiotic exposure, pain, function, quality of life, and adverse events.

16. Research Priorities

Standardized *Vrana Shodhana* protocols should specify wound eligibility, cleansing method, formulation identity, concentration, contact time, frequency, dressing, co-interventions, and stopping rules. Laboratory work should use mature mono- and polymicrobial biofilm models and distinguish prevention of attachment from disruption of established biofilm.

Early clinical studies should focus on safety, tolerability, feasibility, and signals of wound-bed improvement. Larger randomized trials can then compare a standardized adjunct plus best standard care with best standard care alone. Blinded outcome assessment, allocation concealment, prospective registration, microbiological methods suited to the research question, and sufficiently long follow-up are essential.

Collaboration among Ayurvedic surgeons, wound specialists, vascular and orthopaedic surgeons, microbiologists, pharmacologists, nurses, and methodologists would make the work more clinically relevant. Patients should also help select outcomes and acceptable treatment burdens.

17. Conclusion

Dushta Vrana offers a detailed clinical account of an unhealthy, non-healing wound and places repeated cleansing before repair. Modern biofilm science explains one important mechanism by which microorganisms can persist, sustain inflammation, and reduce treatment responsiveness. The two frameworks meet most convincingly in their emphasis on wound-bed preparation and continuing reassessment.

They should not be collapsed into a single concept. *Dushta Vrana* is broader than biofilm, and classical cleansing measures are not proven antibiofilm treatments merely because their purpose appears similar. Responsible integration keeps established wound care, diagnosis, debridement, vascular management, pressure relief, and antimicrobial stewardship at the centre while testing standardized Ayurvedic interventions as carefully monitored adjuncts.

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