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WOUND MANAGEMENT IN AYURVEDA: A CRITICAL REVIEW OF CLASSICAL PRINCIPLES, THERAPEUTIC STRATEGIES AND CONTEMPORARY EVIDENCE

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ABSTRACT

Wound care occupies a central position in the surgical tradition of Ayurveda, and the *Sushruta Saṃhita*, the foundational text of classical Indian surgery, devotes sustained attention to the definition, classification, examination and treatment of the *Vrana* (wound). This critical review examines the classical framework of wound management in Ayurveda and evaluates its relationship to contemporary wound-healing science and clinical evidence. The review synthesizes classical textual sources, principally the *Sushruta Saṃhita* in the *Bhishagratna* translation, with peer-reviewed experimental and clinical studies identified through targeted searches of PubMed/MEDLINE and PubMed Central records. The classical system rests on a staged, individualized approach: cleansing (*Vrana-Sodhana*), promotion of healing *Vrana-Ropana*), and an enumerated repertoire of sixty therapeutic measures (*Sashṭi Upakrama*), supported by a detailed classification of wounds by origin (*Nija* and *Agantu*), by *Dosha* predominance, and by the distinction between clean (*suddha*) and vitiated (*Dushta*) wounds. Contemporary studies, including randomized trials of *Panchavalkala* preparations, *Manjisthadi Ghrita*, honey and the medicated seton (*Ksharasutra*), report promising results, yet the evidence base remains limited by small samples, single-arm designs, heterogeneous outcome measures and inconsistent product standardization. The review critically appraises these limitations, distinguishes classical textual claims from experimental and clinical evidence, and identifies priorities for future research, including adequately powered randomized trials, standardized formulations, validated outcome reporting and translational studies. Although direct equivalence between Ayurvedic categories and modern wound classifications should not be assumed, several classical principles, including staged wound preparation, infection control, and systemic and dietary support, show meaningful conceptual convergence with contemporary wound care.

KEYWORDS: *Vrana*; *Vrana-Sodhana*; *Vrana-Ropana*; *Sasṭi Upakrama*; *Sushruta Saṃhita*; wound healing; chronic wound; Ayurveda.

INTRODUCTION

Chronic wounds impose a substantial and growing burden on health systems worldwide. Diabetic foot ulcers, pressure injuries, venous and arterial leg ulcers, and infected surgical wounds are associated with prolonged disability, high treatment costs and, in the most severe cases, amputation and premature mortality.[1] Normal cutaneous wound repair proceeds through four overlapping phases, hemostasis, inflammation, proliferation and remodeling, orchestrated by platelets, leukocytes, fibroblasts, endothelial cells and keratinocytes acting on a dynamic extracellular matrix.[2] When this sequence is interrupted, by infection and biofilm formation, persistent inflammation, ischemia, neuropathy or metabolic disturbance, the wound fails to progress and enters a state of chronicity.[3]

Within this landscape, traditional systems of medicine continue to attract clinical and research interest. Ayurveda, the classical medical system of the Indian subcontinent, contains one of the oldest sustained bodies of surgical and wound-care literature in the world. The *Sushruta Saṃhita*, traditionally attributed to *Sushruta* and regarded as the foundational text of *Shalya-tantra* (the surgical branch of Ayurveda), describes the wound in remarkable detail, including its definition, classification, examination, prognosis and a comprehensive therapeutic repertoire.[4] These classical teachings are not merely of historical interest; they inform an active clinical tradition, and a growing number of experimental and clinical studies have examined Ayurvedic interventions for wound healing.

This review has three aims. First, it reconstructs the classical framework of wound management in Ayurveda, drawing on authoritative editions of the primary texts. Second, it critically examines the contemporary experimental and clinical evidence bearing on Ayurvedic wound-care interventions. Third, it evaluates, with appropriate caution, the areas of convergence and divergence between classical concepts and modern wound-healing biology, and identifies the methodological and translational challenges that must be addressed if this tradition is to contribute meaningfully to evidence-based wound care. Throughout, the review distinguishes between what is asserted in classical texts, what has been demonstrated experimentally, what is supported by clinical evidence, and what remains interpretive.

Review methodology and literature-search approach

This review was conducted as a narrative critical review with a structured literature-search component. Searches were performed in August 2026 using combinations of the terms "*Vrana*," "*Vrana Ropana*," "*Vrana* Shodhana," "Sushruta," "Ayurveda," "wound healing," "chronic wound," "ulcer," "non-healing wound," "Ayurvedic wound management," "Shashti *Upakrama*," and the names of relevant medicinal plants and formulations. PubMed/MEDLINE and PubMed Central records were identified and retrieved; where full bibliographic details such as volume, issue and page numbers could not be independently confirmed, references are cited with their PubMed/PubMed Central identifiers and access URLs rather than approximate bibliographic data. Scopus and Web of Science indexing was not independently verified for every article and is therefore not claimed. Because complete database query logs were not available to the authors, precise retrieval counts are not reported; the review is based on sources that could actually be retrieved and verified.

Classical material was drawn principally from the *Sushruta Saṃhita*, using the English translation of *Kaviraj Kunja Lal Bhishagratna* based on the original Sanskrit text, supplemented by peer-reviewed analyses of classical wound-healing pharmacology.[5] Classical assertions are cited at the level of the text and its sections (*sthana*) rather than by individual verse number, because verse numbering varies between editions and could not be independently verified for every passage. For standardized terminology, the National Ayush Morbidity and Standardized Terminologies Electronic (NAMASTE) portal of the Ministry of Ayush, Government of India, provides a structured catalogue of standardized

Ayurveda terms;[6] the exact English wording of individual entries on the portal could not be programmatically retrieved for this review, and the English glosses used here therefore follow peer-reviewed usage and classical sources, a limitation that is acknowledged rather than concealed.

Primary studies and systematic reviews were prioritized over narrative reviews; where a review is cited for background, this is indicated. The evidence was appraised with attention to study design, sample size, controls, blinding, outcome measures and product standardization.

Historical and conceptual foundations of wound management in Ayurveda

The central concept is the *Vrana* (wound), which *Sushruta* defines as the breach or disintegration of a bodily part, a definition that encompasses both traumatic injuries and ulcerative lesions of internal origin. The term is deliberately broad: it covers the acute wound produced by trauma or surgery as well as the chronic, discharging ulcer.[7] This breadth is important for the present review because the classical category *Vrana* does not map cleanly onto any single modern diagnostic entity; rather, it spans what modern medicine would classify as acute wounds, surgical wounds, chronic ulcers and sinuses.

Sushruta distinguishes wounds by their origin into *Nija* (endogenous) and *Agantu* (exogenous) varieties. A *Nija Vrana* arises from internal causes, namely vitiation of the three *dosas* (*Vata*, *Pitta*, *Kapha*) or of the blood (*Rakta*), whereas an *Agantu Vrana* results from external injury such as cuts, burns, bites, falls or surgical incision.[8] This dichotomy anticipates, in broad outline, the modern distinction between ulcers arising from systemic disease and wounds caused by external trauma, although the correspondence is approximate and should not be pressed too far.

The classical system also recognizes the distinction between the *Suddha Vrana* (clean wound) and the *Dushta Vrana* (vitiated wound). A *Suddha Vrana* is one that is free of contamination, with healthy granulation tissue and a favorable prognosis; a *Dushta Vrana* is contaminated, infected, discharging or otherwise impaired, and requires active cleansing and preparation before healing can proceed. This distinction, between a wound that is ready to heal and one that must first be made ready, is conceptually close to the modern principle, articulated in wound bed preparation, that a chronic wound must be prepared, through debridement and infection control, before it can progress to closure.

Ayurvedic classification and assessment of *Vrana*

Beyond the *Nija*/*Agantu* dichotomy, the classical texts classify wounds according to *dosa* predominance. The *Sushruta Saṃhita* describes six principal types, *Vataja*, *Pittaja*, *Kaphaja*, *Sannipataja*, *Raktaja* and *Agantu*, each with characteristic features of discharge, color, odor, pain and surrounding tissue reaction.[5] Thus a *Vataja Vrana* is described as painful, dry and irregular, with scanty thin discharge; a *Pittaja Vrana* as burning, with yellowish discharge and marked inflammation; a *Kaphaja Vrana* as cold and itchy, with thick white discharge; and a *sannipataja Vrana* as combining features of all three. These descriptions are clinical and observational in character, and they have not been validated against objective microbiological or biochemical correlates in any systematic way. Whether *dosa*-based typing identifies clinically meaningful subgroups of wounds remains an open question rather than an established finding.

The classical texts also describe the *Naḍi Vrana*, a track-like lesion corresponding approximately to a sinus or fistula, and the *Dushta Vrana* in its various forms.[5] The *Naḍi Vrana* is of particular surgical importance because it is the classical indication for the medicated seton (*Ksharasutra*), one of the most extensively studied Ayurvedic interventions. Wound examination (*Vrana-Pariksa*) is described in detail. The physician is instructed to assess the wound's location, size, depth, edges, floor, discharge, odor, color, surrounding inflammation, pain and the state of the underlying tissues, and to use this information to judge whether the wound is healing favorably or unfavorably and to select appropriate treatment. This structured bedside assessment has a recognizable affinity with modern wound assessment tools that score wound bed, exudate, infection and surrounding skin, although the classical examination is qualitative and has not been formalized into a validated scoring instrument.

Prognosis is likewise addressed: the texts enumerate features of wounds that are favorable (*Sadhya*) and unfavorable (*Asadhya*), including those involving vital structures or associated with grave systemic disturbance. This prognostic teaching reflects careful clinical observation, but it has not been tested against modern outcome data.

It must be emphasized that the classical classification is descriptive rather than diagnostic in the modern sense. It does not identify the underlying pathology, such as ischemia, venous hypertension or neuropathy, that determines the behavior of a chronic wound, and it offers no quantitative criteria by which a wound's progress could be measured objectively. Its value lies in organizing clinical observation and in guiding the choice of treatment according to the stage and character of the wound, a function that remains relevant in contemporary Ayurvedic practice but that cannot substitute for modern etiological diagnosis.

Classical principles of wound management

The therapeutic framework of classical wound management rests on two complementary actions: *Vrana-Sodhana* (wound cleansing) and *Vrana-Ropana* (wound healing). *Vrana-Sodhana* denotes the removal of contaminants, necrotic tissue, discharge and vitiated *dosas* from the wound, so as to render it *suddha*; *Vrana-Ropana* denotes the measures that promote closure, granulation and restoration of the skin. The two are sequential and interdependent: a wound must be cleansed before it can heal, and the choice of drug and procedure is guided by the stage of the wound.

This staged logic is elaborated in the *Sasṭi Upakrama* (sixty therapeutic measures), a comprehensive enumeration of procedures applicable to wounds and abscesses from the stage of suppuration to the healed scar. The sixty measures include both local procedures, such as massage (*Vimlapana*), oleation (*Snehana*), fomentation, irrigation (*Sheka*), application of pastes (*lepa*), bandaging (*bandhana*), cauterization (*Agnikarma*), alkaline therapy (*Kshara karma*), leech therapy (*Jalaukavacarana*) and bloodletting (*Rakta-Moksana*), and systemic measures such as therapeutic emesis (*Vamana*), purgation (*Virecana*), fasting (*Upavasa*) and dietary regulation.[5]

Several other classical principles are relevant.[9] The texts emphasize the importance of *raksavidhi*, protective measures to shield the wound from environmental contamination, and of meticulous hygiene of the wound and its surroundings. They also stress the role of the patient's constitution, diet and general state in determining the outcome of treatment, anticipating the modern recognition that host factors, including nutrition, glycemic control, perfusion and immune status, are decisive in wound healing.

The *Shasṭi upakrama*: critical appraisal of the sixty therapeutic measures

The enumeration of sixty measures is one of the most distinctive features of *Sushruta* 's wound management. It is best understood not as sixty separate treatments to be applied indiscriminately, but as a repertoire from which the physician selects according to the stage and nature of the wound, a staged and individualized protocol. Several of the measures correspond, in broad terms, to modern interventions: *Vimlapana* (gentle massage of the wound surroundings) resembles periwound massage and manual lymphatic drainage; *Sheka* and *Pariseka* (pouring of medicated liquids) resemble wound irrigation; *Bandhana* (bandaging) corresponds to dressing; *ksara karma* (alkaline application) and *Agnikarma* (cautery) are debriding and hemostatic procedures; and *Rakta-Moksana* (bloodletting), including *Jalaukavacarana* (leech therapy), has been studied in the context of congested and infected wounds.

The critical appraisal of the *Shasṭi upakrama* must be balanced. On the one hand, the system embodies principles that modern wound care has independently arrived at: staged wound bed preparation, mechanical and chemical debridement, infection control, moisture management, and the recognition that systemic and dietary factors influence healing. On the other hand, the sixty measures have never been evaluated as a whole protocol. Individual measures have been studied in isolation, for example *Vimlapana* in a randomized study of *Dushta Vrana* and leech therapy in diabetic foot ulcers, but the integrated protocol, with its sequential logic, has not been subjected to controlled evaluation. Moreover, several measures, including therapeutic emesis and purgation, are systemic interventions whose relevance to wound healing is not established by modern evidence, and their inclusion reflects the humoral theory of disease rather than demonstrated efficacy.[10] A further limitation is that the classical descriptions, while clinically vivid, do not provide quantitative outcome criteria; healing is described qualitatively, and no modern instrument can be applied retrospectively to the classical record.

Among the systemic measures enumerated in the *Shasṭi Upakrama*, therapeutic emesis (*Vamana*) and purgation (*Virechana*) are of particular interest because they reflect the humoral rationale of the classical system. In the classical view, the vitiated *dosas* responsible for wound chronicity must be eliminated from the body as a whole, not merely from the wound surface. No controlled study has examined whether these systemic purificatory procedures influence wound healing, and their physiological basis remains speculative. They are therefore best regarded as components of a traditional therapeutic system whose efficacy, if any, has yet to be demonstrated by modern methods, rather than as interventions of established benefit.

Vrana-Sodhana* and *Vrana-Ropana

The paired concepts of *Vrana-Sodhana* and *Vrana-Ropana* constitute the operational core of classical wound management. *Vrana-Sodhana* (wound cleansing) is the process of removing from the wound everything that impedes healing, including necrotic tissue, slough, discharge, foreign matter and vitiated *dosas*; *Vrana-Ropana* (wound healing) is the process of promoting granulation, contraction, epithelialization and restoration of the skin.[11] The classical texts hold that a wound that has been properly cleansed heals of its own accord, and that the physician's task is to select, from the available drugs and procedures, those appropriate to the stage of the wound.

The classical pharmacology of wound care is organized around these two actions. A pharmacodynamic appraisal of the *Sushruta Saṃhita* identified 43 medicinal plants with *Vrana-Sodhana* activity, 48 with *Vrana-Ropana* activity and 62 with both, distributed across the *ganas* (pharmacological groups) such as *Nyagrodhadi*, *Kakolyadi*, *Surasadi*, *Aragvadhadi*, *Arkadi*, *Laksadi* and *Priyaṅgu-Ambasthadi*. The same analysis related these actions to the *rasa* (taste),

guna (quality), *vīrya* (potency) and *Vipaka* (post-digestive transformation) of the drugs, providing a rational framework within the classical pharmacodynamic system. This body of classical pharmacology is not, by itself, evidence of efficacy; it is a systematic description of traditional drug actions that must be tested by modern methods.

Contemporary studies have examined individual formulations. In a randomized clinical trial, *Manjisthadi Ghrita* (a medicated ghee formulation) applied to surgical wounds produced better healing than povidone-iodine ointment over 21 days, with smaller and more cosmetically favorable scars and no adverse effects.[12] A clinical study of *Panchavalkala* cream in 50 patients with chronic non-healing wounds reported significant reductions in slough, swelling, redness, pain, discharge, tenderness and malodor, together with a significant reduction in microbial load (mean difference 1.48 ± 0.71, P = 0.001).[13] These studies are encouraging but must be interpreted with caution: the *Manjisthadi Ghrita* trial was small (45 patients) and open-label, and the *Panchavalkala* study was a single-arm before-after design without a control group.

Medicinal plants, formulations and topical therapies

A substantial pharmacopoeia of wound-healing substances is documented in the classical literature, and a systematic review of grey literature has catalogued the Ayurvedic formulations and procedures reported for wound healing. Among the most frequently cited are *Haridra* (*Curcuma longa*), *Manjisṭha* (*Rubia cordifolia*), *Jati* (*Jasminum officinale*), *Nimba* (*Azadirachta indica*), *triphala*, the *Panchavalkala* group (the barks of five Ficus species), *Guduchi* (*Tinospora cordifolia*), *Lajjalu* (*Mimosa pudica*), *Madhu* (honey) and *Ghrita* (ghee) and *Taila* (oil) preparations.

The *Panchavalkala* group deserves particular mention because it has been the subject of both classical and modern attention. The five barks, from *Nyagrodha* (*Ficus benghalensis*), *Udumbara* (*Ficus racemosa*), *Asvattha* (*Ficus religiosa*), *Plaksa* (*Ficus lacor*) and *Parisa* (*Ficus arnottiana*), are traditionally credited with astringent, antimicrobial and healing actions, and are used as decoctions for irrigation and in creams and extracts for topical application. A randomized controlled trial evaluated a 5% w/v *Panchavalkala* extract for wound healing after lobuloplasty and reported that it reduced infection and accelerated healing compared with the control group.[14] The *Panchavalkala* cream study described above likewise supports its role in *Vrana-Sodhana*. Honey (*madhu*) is one of the few traditional wound remedies whose modern evidence base is comparatively large. A clinical study in an Ayurvedic setting reported favorable wound-healing activity of honey applied to traumatic wounds, and a broader review of honey in wound healing summarizes data indicating benefit in the chronic inflammatory phase through, among other mechanisms, scavenging of reactive oxygen species.[15] It should be noted that the honey literature is heterogeneous, with variable honey types, doses and wound types, and the generalizability of these findings to standardized Ayurvedic honey preparations is uncertain.

Centella (*Centella asiatica*), known in Ayurveda as *Manḍukaparnī*, has been studied extensively in experimental models and in some clinical settings. A systematic review of C. asiatica in wound healing concluded that it positively influences several factors involved in healing in vitro and in vivo, including collagen synthesis and epithelialization.[16] A randomized trial of *Lajjalu* (*Mimosa pudica*) decoction dressing in anal fissure reported greater pain reduction than a *Panchavalkala* decoction dressing, illustrating that comparative data among Ayurvedic interventions are beginning to emerge.

The critical point is that the classical pharmacopoeia is large and its claims are traditional; only a minority of the listed substances has been tested in controlled human studies, and the formulations used in trials vary in composition, method of preparation and quality.

Bandaging, dressings, cleansing and procedural management

The classical texts describe a detailed procedural repertoire for wound care, including cleansing and irrigation, application of medicated pastes and oils, and bandaging (*Bandhana*).[5] Irrigation with medicated decoctions (*Kshalana*, *Sheka*) corresponds in broad terms to modern wound irrigation, and the choice of decoction, such as *Panchavalkala* or *triphala*, reflects the classical principle that the cleansing agent should be astringent and antimicrobial.

The classical approach to debridement is embodied in several of the *Shasṭi Upakrama*, including *Vimlapana* (massage of the wound and surroundings), *Kshara Karma* (application of alkaline substances) and *agnikarma* (cautery). *Vimlapana* was evaluated in a randomized controlled study of *Dushta Vrana*, where it was combined with *Jatyadi Taila* and reported to improve healing. *Kshara karma* and *Agnikarma* are debriding and hemostatic procedures whose modern counterparts include chemical and thermal cautery; their use in contemporary practice is limited and their evidence base is largely descriptive.

The medicated seton, *Ksharasutra*, is the most extensively studied Ayurvedic procedural intervention. It is a thread coated with the alkaline ash of plants, principally *Apamarga* (*Achyranthes aspera*), and applied to fistulous tracks (*Naḍi Vrana*, *bhagandara*). A randomized controlled trial comparing *Ksharasutra* with open fistulotomy for fistula-in-ano reported complete healing in both groups, with a longer mean healing time in the *Ksharasutra* group (53.00 ± 26.75 days) than in the fistulotomy group (35.67 ± 9.17 days), but with the advantages of avoiding a surgical wound and preserving sphincter function.[17] An earlier prospective randomized trial comparing an Ayurvedic cutting seton with conventional fistulotomy for low fistula-in-ano similarly found the seton effective, though with a longer healing time. More recently, a minimal invasive *Ksharasutra* technique (MIKST) was reported to heal fistulous tracts with a low recurrence rate and no anal incontinence in a case series.[18] Transrectal ultrasonography has been used to document healing of the fistulous tract after *Ksharasutra*, providing objective imaging evidence.

These studies position *Ksharasutra* as a genuinely studied intervention with a plausible role in the management of fistula-in-ano, particularly where sphincter preservation is a priority. The evidence, however, is drawn largely from single-center studies with modest sample sizes, and the longer healing time compared with surgery is a recognized trade-off.

Leech therapy (*Jalaukavacarana*) is another classical procedure that has received clinical attention, particularly in congested and infected wounds including diabetic foot ulcers. Its proposed rationale, decongestion through controlled bloodletting and the bioactive secretions of the leech, has some experimental support, but controlled clinical evidence remains limited.

Systemic management, diet and supportive care

The classical texts repeatedly emphasize that wound healing depends on the state of the whole organism, not merely on local treatment. Dietary regulation (*Ahara*), rest, avoidance of aggravating factors, and the correction of systemic imbalance are integral to the classical protocol. This systemic orientation is broadly consistent with the modern

recognition that nutrition, glycemic control, perfusion, oxygenation and immune status are major determinants of wound outcome.

The classical dietary advice for the wounded patient, including the use of easily digestible, nourishing foods and the avoidance of incompatible or heavy foods, has not been tested in controlled studies, and its specific recommendations should not be presented as evidence-based.[5] What is defensible is the general principle, common to both traditions, that systemic support is essential to local healing.

In contemporary practice, this principle is reflected in the integrative management of diabetic foot ulcers, where Ayurvedic local care is combined with glycemic control, offloading, debridement and systemic support. Case series and case reports have described successful integrative management of diabetic foot ulcers, including cases with osteomyelitis, with healing and limb salvage. These reports are encouraging but are uncontrolled and subject to selection and reporting bias; they cannot establish efficacy, though they support the feasibility and safety of integrative approaches.

The burden of diabetic foot disease illustrates the stakes involved. Diabetic foot ulcers are associated with substantial morbidity and are a leading cause of nontraumatic lower-limb amputation, and randomized clinical trials support treatments that accelerate wound healing and culture-directed antibiotics for localized osteomyelitis.[2] In this context, the integrative Ayurvedic case series are noteworthy because they describe limb salvage in patients with severe disease, including osteomyelitis, using a combination of local Ayurvedic care, debridement, glycemic control and systemic support.[19] These reports cannot establish efficacy, but they document the feasibility of combining the two traditions and provide a rationale for prospective evaluation.

Classical wound management and contemporary wound-healing biology

Modern wound-healing science describes four overlapping phases: hemostasis, inflammation, proliferation and remodeling. During hemostasis, platelets form a clot and release growth factors; during inflammation, neutrophils and macrophages clear debris and pathogens; during proliferation, fibroblasts, endothelial cells and keratinocytes rebuild the tissue through granulation, angiogenesis and re-epithelialization; and during remodeling, the extracellular matrix is reorganized and the scar matures.[20] Chronic wounds are characterized by a failure to progress through these phases, with persistent inflammation, high levels of proteases and reactive oxygen species, and, frequently, infection and biofilm formation. Biofilms are present in the great majority of chronic wounds and are recognized as a major obstacle to healing.[21]

Chronic wounds are heterogeneous in etiology, and the modern classification distinguishes diabetic foot ulcers, pressure injuries, venous leg ulcers and arterial ulcers, each with a distinct pathophysiology and management. Pressure injuries arise in individuals with limited mobility, typically over bony prominences subjected to prolonged pressure; venous leg ulcers result from venous hypertension and insufficiency; and diabetic foot ulcers reflect the combined effects of neuropathy, ischemia and impaired healing in hyperglycemia.[22] The classical category of the *Dushta Vrana* encompasses, in broad terms, all of these chronic, contaminated or non-healing wounds, but it does not distinguish among their etiologies, and this is a fundamental limitation of the classical framework as a guide to modern clinical decision-making

Infection and biofilm are central to the persistence of chronic wounds. A systematic review and meta-analysis of observational studies reported that biofilms are present in 78.2% of chronic wounds, and biofilms are now recognized as a major obstacle to healing because they resist antimicrobial treatment and sustain local inflammation. Oxidative stress, resulting from an imbalance between reactive oxygen species and antioxidant defenses, is likewise implicated in impaired diabetic wound healing, contributing to cellular damage and persistent inflammation.[3] These mechanisms have no direct counterpart in the classical literature, which attributes wound chronicity to vitiated *dosas* and contamination; the convergence between the two frameworks is therefore conceptual, at the level of the principle that the wound must be cleansed and the local environment corrected, rather than mechanistic.

The classical Ayurvedic framework is not expressed in these terms, and it would be anachronistic to claim that *Sushruta* anticipated modern molecular biology. What can be said, with appropriate caution, is that several classical principles show conceptual convergence with modern practice. The staged logic of *Vrana-Sodhana* followed by *Vrana-Ropana* parallels the modern principle of wound bed preparation, in which the wound must be debrided, infection controlled and exudate managed before closure can be expected. The classical emphasis on cleansing, removal of necrotic tissue and control of discharge is consistent with modern recommendations for infection and biofilm management. The recognition that systemic and dietary factors influence healing is consistent with the modern evidence that nutrition and comorbidity control are decisive.

It is equally important to state what the classical framework does not provide. It offers no quantitative, validated outcome measures; its categories are qualitative and observational. It does not distinguish among the many distinct modern etiologies of chronic wounds, such as venous hypertension, arterial insufficiency, neuropathy and pressure, and it therefore cannot substitute for modern diagnosis. The *Dosha*-based classification of wounds has not been validated against objective correlates. These are limitations of the classical system as a scientific framework, and they should be acknowledged rather than obscured.

Evidence from experimental and clinical studies

The experimental literature on Ayurvedic wound-healing substances is extensive but uneven in quality. Studies of individual plants, such as *Curcuma longa*, *Centella asiatica* and various Ficus species, have reported effects on collagen synthesis, angiogenesis, epithelialization and antimicrobial activity in animal models. A systematic review of *Centella asiatica* concluded that it positively influences several factors involved in wound healing in vitro and in vivo.[18] These experimental data are valuable as proof-of-concept and as a basis for selecting substances for clinical study, but they do not, by themselves, establish clinical efficacy.

The clinical evidence base is comparatively small. The principal human studies identified in this review include the following: a randomized trial of *Manjisthadi Ghrita* versus povidone-iodine in 45 patients; a single-arm study of *Panchavalkala* cream in 50 patients with chronic wounds; a randomized trial of *Panchavalkala* extract in lobuloplasty; randomized trials of *Ksharasutra* versus fistulotomy in fistula-in-ano; a randomized study of *Vimlapana* with *Jatyadi Taila* in *Dushta Vrana*; a comparative study of leech therapy and *Magadhadi Taila* in diabetic foot ulcers; a randomized trial of *lajjalu* decoction in anal fissure; and case series of integrative management of diabetic foot ulcers. A systematic review and meta-analysis of herbal products, including several used in Ayurveda, for diabetic foot ulcers reported encouraging pooled estimates, though with notable heterogeneity.[23]

A systematic review of grey literature, encompassing unpublished clinical research conducted at Ayurvedic institutes in India between 1971 and 2016, identified 257 studies of wound healing and catalogued the interventions, drug formulations and procedures used in them.[24] This review is valuable because it documents the scale and diversity of clinical activity in the field and identifies the formulations most frequently studied, including *Panchavalkala* preparations, *Jatyadi Taila* and *Ksharasutra*. At the same time, the fact that much of this research exists only as grey literature is itself a limitation: unpublished studies are not peer-reviewed, are not indexed in standard databases, and are more likely to be affected by selective reporting.

Taken together, these studies suggest that several Ayurvedic interventions may accelerate healing, reduce infection and improve cosmetic outcomes in specific wound types. The strength of this evidence, however, is modest, and it is characterized by small samples, open-label designs, single centers, heterogeneous wound types and outcome measures, and variable product standardization. These limitations are examined critically in the next section.

Critical appraisal of available evidence

A balanced assessment of the Ayurvedic wound-care evidence requires that its strengths and weaknesses be stated plainly. The principal strength is that a coherent, internally consistent classical framework exists, grounded in a primary text of exceptional historical importance, and that a meaningful number of its interventions have been examined in contemporary studies. The principal weakness is that the quality of most of this evidence is low to moderate by modern standards.

Several recurring methodological limitations can be identified. First, sample sizes are small. The randomized trials identified in this review enrolled between roughly 30 and 60 patients, which is generally insufficient to detect clinically important differences with confidence or to support subgroup analyses.Second, many studies are single-arm or open-label. The *Panchavalkala* cream study, for example, was a before-after design without a control group, which cannot exclude the possibility that the observed improvement reflected natural healing or regression to the mean. Third, blinding is rarely feasible for topical Ayurvedic preparations, and few studies have attempted sham or active-comparator designs that would reduce performance and detection bias. Fourth, outcome measures are heterogeneous. Studies use different definitions of healing, different time points, and different instruments for pain, discharge, granulation and scar assessment, which impedes pooling and comparison. Fifth, the wound populations studied are heterogeneous, mixing acute surgical wounds, chronic ulcers, fistulas and fissures, so that findings in one wound type cannot be assumed to transfer to another.

The heterogeneity of outcome measures deserves particular emphasis. Some studies report time to complete healing, others report reductions in wound area, microbial load or symptom scores, and still others report qualitative assessments of granulation and scar quality. Because these outcomes are not standardized, the results of individual studies cannot be pooled in a meaningful meta-analysis, and the comparative effectiveness of different Ayurvedic interventions remains unknown. The development of a core outcome set for Ayurvedic wound-healing research, aligned with the recommendations of modern outcome-research methodology, would be a major step forward.

Publication bias is a further concern. The Ayurvedic literature is dominated by single-center studies reporting favorable outcomes, and negative results are less likely to be published; the true effect sizes of these interventions are therefore uncertain. Finally, the formulations used in trials are not standardized across studies. Classical formulations such as

Jatyadi Taila and *Panchavalkala* preparations vary in raw material sourcing, method of preparation and quality control, and the absence of validated markers and batch-to-batch consistency limits reproducibility.

A further conceptual problem concerns the mapping of classical categories onto modern wound classifications. The classical *Vrana* encompasses acute wounds, chronic ulcers, sinuses and fistulas, and the *Dushta Vrana* is not identical to any single modern entity such as the infected chronic wound. Studies that enrol "chronic non-healing wounds" without specifying etiology, vascular status, glycemic control or infection status produce results that are difficult to interpret and to generalize. Future research must address this by using modern diagnostic criteria to characterize wounds while retaining the classical framework for intervention selection.

Safety, standardization, quality-control and translational challenges

The safety of Ayurvedic wound-care interventions has received comparatively little formal study. The clinical trials identified in this review reported no serious adverse events, but the absence of reported harm in small, short-term studies is not evidence of safety. Topical preparations may cause contact dermatitis, sensitization or, rarely, systemic absorption, and contaminated or adulterated herbal products carry additional risks. The classical texts themselves emphasize the importance of proper preparation and application, and modern regulatory frameworks require good manufacturing practice and quality control, but compliance varies widely across the products available in the market.

Standardization is the central translational challenge. Classical formulations are defined by their ingredients and method of preparation, but the biological activity of a given batch depends on the plant source, the part used, the season of harvest, the method of processing and the storage conditions. Without validated analytical markers, chemical fingerprints and bioactivity assays, it is impossible to guarantee that the product studied in a trial is the product available to a patient. The development of standardized, quality-controlled formulations, aligned with the classical method of preparation, is therefore a prerequisite for meaningful clinical research.

A further challenge is regulatory. Ayurvedic formulations are often protected as traditional knowledge, and the pathway from classical text to regulated pharmaceutical product requires attention to the Ayurvedic Pharmacopoeia of India, good manufacturing practice and pharmacovigilance. These are solvable problems, but they require coordinated effort from researchers, manufacturers and regulators.

Research gaps and future directions

The research gaps in this field are substantial and can be prioritized. First, there is a need for adequately powered, randomized, controlled trials of the most promising interventions, including *Panchavalkala* preparations, *jatyadi taila*, *Manjisthadi Ghrita* and honey, in well-characterized wound populations defined by modern diagnostic criteria. These trials should use validated, standardized outcome measures, including objective wound-area measurement, time to complete healing, infection control, pain, quality of life and cosmetic outcome, and should be registered prospectively.
Second, pragmatic trials are needed to evaluate the classical protocol as a whole, including the *sasṭi upakrama* and the staged logic of *Vrana-Sodhana* followed by *Vrana-Ropana*, in real-world settings. Such trials would test the system, not merely isolated drugs, and would be more faithful to the classical method.

Third, translational studies are required to link classical claims to specific biological mechanisms. Where a mechanism is proposed, it should be demonstrated by appropriate experimental methods, including in vitro assays, animal models

and, where feasible, human tissue studies. For example, the antimicrobial and astringent actions attributed to *Panchavalkala* and *triphala* should be characterized against relevant pathogens and biofilms; the antioxidant properties of honey and *haridra* should be quantified in the wound environment; and the collagen-modulating effects of *Centella asiatica* should be confirmed in human tissue.

Fourth, studies should address the safety and quality-control agenda, including pharmacokinetic and toxicological evaluation, standardization of formulations with validated markers, and pharmacovigilance.

Fifth, the field would benefit from a coordinated effort to develop a validated, modernized wound-assessment instrument grounded in the classical examination, so that classical categories can be studied quantitatively.

Finally, systematic reviews and meta-analyses, conducted according to current standards, are needed to synthesize the existing evidence, quantify effect sizes, assess heterogeneity and publication bias, and identify the interventions most deserving of large trials.

Integrative clinical perspective

The most defensible role for Ayurvedic wound care in contemporary practice is integrative rather than substitutive. Modern wound care provides accurate diagnosis, revascularization, offloading, glycemic control, debridement, infection management and advanced dressings; Ayurveda provides a structured, individualized framework and a pharmacopoeia of topical and systemic interventions, several of which have preliminary evidence of benefit. The case series of integrative management of diabetic foot ulcers illustrate how the two traditions can be combined, with Ayurvedic local care delivered alongside modern systemic management and limb-salvage protocols.[25]

For this integration to be responsible, several conditions must be met. The patient must first receive a modern diagnosis, including vascular assessment and infection work-up, so that conditions requiring urgent intervention are not missed. The Ayurvedic intervention must be delivered by qualified practitioners using quality-controlled products. And the outcome must be monitored with objective measures, with clear criteria for escalation to conventional care. Under these conditions, Ayurvedic wound care may contribute to patient-centered, multimodal management, particularly for chronic wounds where conventional options are limited or unsatisfactory.

It must be emphasized that the classical framework is not a substitute for modern diagnosis or for interventions of proven benefit, such as revascularization, offloading and appropriate antimicrobial therapy. The integrative perspective is therefore one of complementarity, grounded in the recognition that wound healing is multifactorial and that no single tradition holds a monopoly on its management.

CONCLUSION

The classical Ayurvedic framework of wound management, preserved most completely in the *Sushruta Saṃhita*, is one of the oldest and most systematic surgical traditions in world medicine. Its central concepts, the *Vrana* and its classification, the paired actions of *Vrana-Sodhana* and *Vrana-Ropana*, and the *sasṭi upakrama*, embody a staged, individualized and holistic approach that shows meaningful conceptual convergence with modern principles of wound bed preparation, infection control and systemic support.

The contemporary evidence base, while promising, remains limited. Randomized trials of *Panchavalkala* preparations, *Manjisthadi Ghrita*, *Ksharasutra* and honey, together with experimental studies of plants such as *Centella asiatica*, suggest that several Ayurvedic interventions may accelerate healing and improve outcomes in specific wound types. However, the evidence is characterized by small samples, open-label and single-arm designs, heterogeneous outcomes and inconsistent product standardization, and it does not yet support the confident, generalizable claims that some of the literature makes.

The path forward lies in rigorous, adequately powered trials; standardized, quality-controlled formulations; validated outcome measures; translational studies linking classical claims to demonstrated mechanisms; and an integrative clinical framework in which Ayurveda complements, rather than replaces, modern wound care. If these conditions are met, the classical tradition of *Sushruta* may yet make a meaningful, evidence-based contribution to the management of wounds, a field in which the burden of chronic disease continues to grow.

Declarations

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Conflicts of interest: none.

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Table 1: Important Ayurvedic medicinal substances/formulations reported for Vrana-Sodhana/Vrana-Ropana and their evidence base.

Substance/formulation	Classical action	Evidence base
Panchavalkala	*Vrana-Sodhana*, astringent, antimicrobial	Clinical studies (cream; 5% extract RCT)[1]
Manjisthadi Ghrita	*Vrana-Ropana*, scar minimization	Randomized trial vs povidone-iodine
Jatyadi Taila	*Vrana-Sodhana* and *Vrana-Ropana*	Used in randomized V*imlapana* study
Madhu (honey)	*Vrana-Ropana*, antioxidant	Clinical study; review of honey in wound healing[1]
Haridra (*Curcuma longa*)	*Vrana-Sodhana*/*Ropana*	Classical pharmacology; experimental
Manḍūkaparnī (*Centella asiatica*)	*Vrana-Ropana*	Systematic review of wound-healing effects
Lajjalu (*Mimosa pudica*)	Anal fissure healing	Randomized controlled trial[19]
Ksharasutra (medicated thread)	Fistula/sinus healing	Randomized trials; imaging case series

Table 2: Contemporary clinical/experimental studies of Ayurvedic wound-management interventions.

Study	Design	Population	Intervention	Key finding
Bhat et al., 2014[26]	Single-arm before-after	50 chronic wounds	*Panchavalkala* cream	Reduced infection signs and microbial load
Shukla et al., 2011[27]	Randomized open-label	45 patients	*Manjisthadi Ghrita* vs povidone-iodine	Better healing and scar outcome
Chakraborty et al., 2015[28]	Randomized	Fistula-in-ano	*Ksharasutra* vs fistulotomy	Healing in both; longer time with seton
Ho et al., 2001[29]	Prospective randomized	Low fistula-in-ano	Cutting seton vs fistulotomy	Seton effective; longer healing time
Chhatriwala et al., 2025[30]	Randomized	Lobuloplasty	*Panchavalkala* 5% extract	Reduced infection, faster healing
Kulkarni et al. 2015[31]	Randomized	*Dushta Vrana*	*vimlapana* + *jatyadi taila*	Improved healing
Rajeevan et al.,	Comparative	Diabetic foot ulcer	Leech therapy vs	Both effective

2025[32]			*magadhadi taila*	(preliminary)
Kuchanur & Emmi, 2016[33]	Randomized	Anal fissure	*lajjalu* decoction	Greater pain reduction vs *Panchavalkala*
Zamanifard et al., 2024[34]	Systematic review/meta-analysis	Diabetic foot ulcer	Herbal products (incl. Ayurvedic)	Encouraging pooled estimates; heterogeneity

Table 3: Evidence gaps and priorities for future research.

Gap	Priority action
Small samples and open-label designs	Adequately powered, blinded randomized controlled trials
Heterogeneous wound populations	Enrolment defined by modern diagnostic criteria
Non-standardized outcome measures	Validated instruments: wound area, time to healing, infection, QoL
Unstandardized formulations	Quality-controlled products with validated markers
No evaluation of whole classical protocol	Pragmatic trials of *sasṭi upakrama* and staged *Sodhana* to *Ropana*
Mechanism claims unverified	Translational studies linking classical claims to demonstrated mechanisms
Publication bias	Prospective registration; systematic reviews and meta-analyses
Safety data sparse	Pharmacovigilance, toxicological and pharmacokinetic evaluation

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