

Review

Application and Reflection of Traditional Chinese Medicine Fumigation-Washing Therapy in Promoting Wound Healing

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Abstract: Wound healing impairment represents a prevalent clinical challenge following surgery, particularly in open wounds associated with anorectal procedures, burns, and diabetic foot ulcers, often manifesting as delayed healing, persistent exudation, and recurrent infection. Traditional Chinese medicine (TCM) fumigation-washing therapy, as a quintessential external treatment modality, leverages the synergistic “drug-heat-pressure” effect to modulate wound repair through multi-target mechanisms. This article reviews the TCM theoretical foundations, modern pharmacological mechanisms, and clinical research progress of fumigation-washing therapy, with emphasis on its roles in improving microcirculation, anti-inflammatory and antibacterial actions, and regulation of growth factor expression. In view of current limitations including insufficient standardization of syndrome differentiation, inconsistent temperature and treatment duration parameters, and low levels of evidence, reflections and recommendations are proposed to facilitate the standardized application of fumigation-washing therapy.

Keywords: traditional Chinese medicine fumigation-washing; wound healing; angiogenesis; anti-inflammation; growth factors

1. Introduction

Wound healing is a highly regulated, dynamic biological process that unfolds in three overlapping yet functionally distinct phases: inflammation, proliferation, and tissue remodeling. Each phase involves tightly coordinated interactions among immune cells, fibroblasts, keratinocytes, endothelial cells, and extracellular matrix components. Disruption at any stage—whether due to persistent infection, impaired microcirculation, metabolic dysregulation such as hyperglycemia, or systemic immunosuppression—can lead to stalled progression and the development of chronic, non-healing wounds. These wounds significantly compromise patients’ quality of life, increase risk of secondary complications including deep tissue infection and sepsis, and impose substantial socioeconomic burdens on healthcare systems. Conventional Western medical approaches typically emphasize wound bed preparation through mechanical, enzymatic, or autolytic debridement; microbial control via topical or systemic antimicrobial agents; and optimization of the wound microenvironment using advanced functional dressings—including hydrogels, foams, alginates, and negative pressure wound therapy devices [1]. While clinically valuable, these modalities often entail high material costs, require specialized training for application and monitoring, and may necessitate frequent clinical visits, thereby contributing to financial strain and reduced accessibility for certain patient populations. In contrast, traditional Chinese medicine offers a long-standing repertoire of external therapeutic strategies rooted in empirical observation and theoretical frameworks developed over millennia. Historical medical texts document early applications of thermal herbal preparations applied externally—for instance, soaking, bathing, and steaming techniques described in foundational works such as the *Huangdi*

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Neijing (Yellow Emperor's Inner Canon), which laid conceptual groundwork for cutaneous absorption and meridian-based delivery. Subsequent classical treatises—including the *Jin Gui Yao Lue* and *Wai Ke Zheng Zong*—systematized principles of syndrome differentiation for external disorders and formalized protocols for fumigation and washing therapies. This modality leverages controlled thermal energy to promote cutaneous vasodilation, enhance local microcirculation, open skin appendages, and facilitate transdermal penetration of bioactive herbal constituents. As a multimodal intervention, it simultaneously delivers pharmacological effects through herbal compounds and physical stimulation through heat and vapor. Contemporary clinical research has increasingly reported favorable outcomes associated with its application in postoperative perianal wound management, diabetic foot ulcers, thermal injuries including burns and scalds, and other complex soft-tissue defects—highlighting benefits such as accelerated epithelialization, reduced exudate volume, diminished pain perception, and improved granulation tissue formation. This article provides a comprehensive synthesis of current understanding regarding the underlying physiological mechanisms, accumulated clinical experience, methodological considerations, and practical challenges associated with integrating fumigation and washing therapy into modern wound care paradigms.

2. Introduction to the Theoretical Basis and Mechanism of Herbal Fumigation and Washing in Traditional Chinese Medicine

2.1. Theoretical Basis of Traditional Chinese Medicine

As documented in classical medical texts, external therapeutic methods share the same foundational principles as internal treatment modalities; the distinction resides solely in the route of administration and delivery. In Traditional Chinese Medicine, chronic or non-healing wounds are understood not merely as localized tissue defects but as manifestations of systemic imbalance and disrupted physiological dynamics [2–4]. Central to this understanding is the concept that wound repair fundamentally depends on the successful resolution of pathological stagnation and the restoration of functional vitality—specifically, the removal of necrotic material and the robust regeneration of healthy granulation tissue. The underlying pathomechanisms commonly involve a triad of interrelated disturbances: obstruction within the collaterals accompanied by blood stasis, accumulation of damp-heat in the affected region, and constitutional insufficiency of qi and blood. Traumatic injury—whether resulting from sharp instruments, thermal exposure, or protracted disease states—depletes the body's vital resources, impairing the smooth flow of qi and causing localized stagnation. This stagnation impedes the proper transformation and transportation of body fluids, leading to pathological dampness and impaired nourishment of muscles, skin, and connective tissues. When damp-heat pathogens coexist with such deficiency and stasis, the local microenvironment becomes unfavorable for tissue renewal: necrotic debris persists due to compromised phagocytic activity and impaired metabolic clearance, while the formation of new tissue is hindered by insufficient qi to propel regeneration and inadequate blood to nourish nascent cells. Consequently, wound progression stalls at the inflammatory or proliferative phase, increasing susceptibility to secondary infection and delayed epithelialization.

Fumigation and washing therapy constitutes a sophisticated integrative modality grounded in TCM's holistic physiology, combining thermoregulatory, pharmacological, and biomechanical actions. The warm vapor generated during fumigation induces gentle cutaneous hyperemia, dilating superficial capillaries and transiently increasing local perfusion. This thermal stimulus facilitates transdermal absorption of bioactive compounds while simultaneously opening the sweat pores—termed 'xuan fu' in classical terminology—which enhances the penetration of medicinal constituents into deeper dermal layers and collateral networks. Concurrently, the liquid medicament serves a dual mechanical and biochemical function: it physically debrides the wound surface by loosening exudate and desquamated tissue, while delivering concentrated phytochemical

agents directly to the lesion site. Key herbal categories employed include acrid-warm dispersants and bitter-cold herbs that collectively dry excess dampness, astringe ulcerated surfaces, clear heat from the blood level, and neutralize toxic influences; additionally, blood-activating and stasis-resolving herbs—often containing volatile oils, flavonoids, and diterpenoid lactones—enhance microcirculatory perfusion, dissolve fibrin deposits, reduce inflammatory cytokine expression (e.g., TNF- α , IL-6), and upregulate growth factors such as VEGF and TGF- β 1. These pharmacodynamic effects synergize across three coordinated therapeutic axes: unblocking (tong), clearing (qing), and tonifying (bu). Unblocking restores dynamic continuity in the meridian-collateral system, thereby resolving stasis and enabling nutrient delivery; clearing eliminates pathogenic heat and toxins that impede cellular proliferation and induce oxidative stress; tonifying replenishes depleted qi and blood substrates essential for fibroblast migration, collagen synthesis, and keratinocyte differentiation. This tripartite action establishes a physiologically conducive milieu for orderly wound healing—progressing through hemostasis, inflammation, proliferation, and remodeling—while minimizing scar formation and optimizing functional recovery.

2.2. Modern Pharmacological Mechanisms

From the perspective of modern pharmacology, the pro-healing effects of fumigation and washing therapy are underpinned by a synergistic integration of physical, pharmacokinetic, and molecular biological mechanisms. First, thermal modulation serves as a foundational physiological stimulus: immersion in medicated liquid maintained at a controlled temperature range of 40–42°C induces localized cutaneous and subcutaneous vasodilation, thereby elevating regional blood flow velocity and capillary perfusion density. This hemodynamic enhancement improves tissue oxygen partial pressure, facilitates the delivery of glucose, amino acids, and essential micronutrients to injured sites, and concurrently accelerates the removal of metabolic waste products—including lactic acid, hydrogen ions, and other acidic byproducts of anaerobic glycolysis—thereby mitigating local tissue acidosis and creating a more favorable microenvironment for cellular repair. Furthermore, mild thermal stimulation exerts neuromodulatory effects by decreasing the firing threshold and conduction velocity of unmyelinated C-fiber nociceptors, contributing to analgesia; it also promotes relaxation of the external and internal anal sphincters, reducing spastic resistance and improving venous and lymphatic drainage, which collectively supports restoration of microcirculatory homeostasis. Second, transdermal delivery is significantly augmented under damp-heat conditions: elevated ambient humidity and sustained warmth increase stratum corneum hydration, reduce keratinocyte cohesion, and transiently widen intercellular lipid lamellae, thereby diminishing the natural barrier function of the epidermis and facilitating enhanced percutaneous transport of bioactive phytochemical constituents. Commonly employed herbal components—including rhubarb (*Rhei Radix et Rhizoma*), phellodendron (*Phellodendri Chinensis Cortex*), and *Sophora flavescens* (*Sophorae Flavescens Radix*)—contain structurally diverse secondary metabolites such as anthraquinone glycosides, prenylated flavonoids, and quinolizidine alkaloids, all of which demonstrate favorable lipophilicity–hydrophilicity balance and molecular weight profiles conducive to passive diffusion across intact skin layers and subsequent accumulation within dermal and subdermal wound beds. Third, multi-level molecular modulation occurs through coordinated transcriptional and post-translational signaling events: experimental evidence indicates that active compounds from fumigation formulations can stimulate upregulation of angiogenic growth factors—including vascular endothelial growth factor (VEGF) and basic fibroblast growth factor (FGF)—within granulation tissue, thereby promoting endothelial cell migration, tubule formation, and neovascular network maturation. Concurrently, these preparations exert anti-inflammatory actions by suppressing the synthesis and release of key pro-inflammatory mediators such as tumor necrosis factor- α (TNF- α) and interleukin-6 (IL-6), while modulating intracellular signal transduction pathways—including attenuation of nuclear factor-kappa B (NF- κ B) nuclear translocation

and downstream gene transcription—thus shortening the duration of the acute inflammatory phase and enabling timely progression into proliferative and remodeling stages. Additionally, certain optimized fumigation regimens have been observed to fine-tune extracellular matrix dynamics by adjusting the enzymatic activity ratio between matrix metalloproteinases (MMP-2 and MMP-9) and their endogenous inhibitors (tissue inhibitor of metalloproteinases-1, TIMP-1), supporting orderly collagen deposition, improved fiber alignment, reduced cross-linking irregularities, and diminished risk of hypertrophic scarring or keloid formation.

3. Clinical Research Progress

In contemporary clinical practice, Chinese herbal fumigation has been extensively integrated into a wide array of therapeutic settings, demonstrating significant versatility and efficacy across multiple medical disciplines. The most prevalent application of this modality is as a postoperative sitz bath following anorectal surgical procedures, where it has become a standard adjunctive therapy in numerous healthcare institutions. Extensive clinical observations and comparative studies have consistently demonstrated that sitz baths utilizing carefully formulated decoctions of traditional herbs—including rhubarb, phellodendron, sophora, and dandelion, which are traditionally classified as agents that clear heat and dry dampness—yield substantially superior therapeutic outcomes when compared to conventional interventions such as plain warm water baths or potassium permanganate solution soaks. These herbal formulations have been shown to effectively alleviate postoperative pain, significantly reduce wound exudate production, and meaningfully accelerate the overall healing timeline, thereby improving patient comfort and recovery trajectories. Furthermore, mechanistic investigations have revealed that following fumigation sitz bath therapy with Phellodendron Decoction, measurable biochemical and immunological changes occur at the wound site, including a notable decrease in interleukin-6 levels within wound exudate, favorable modulation of the local CD4+ to CD8+ lymphocyte ratio, and significant enhancement of capillary proliferation within granulation tissue. These findings collectively indicate that herbal fumigation exerts not only potent anti-inflammatory and immunomodulatory effects but also actively promotes tissue regeneration and microvascular development [5–7]. Beyond anorectal applications, fumigation therapy has been widely adopted for the management of diabetic foot ulcers, a particularly challenging clinical condition characterized by impaired wound healing due to compromised peripheral blood circulation and associated neuropathic complications. Research evidence indicates that fumigation protocols incorporating herbs such as astragalus, angelica, and spatholobus—traditionally recognized for their properties in tonifying qi and activating blood circulation—when combined with standard foundational treatments, can dramatically increase ulcer healing rates, substantially improve the ankle-brachial index as an objective measure of lower extremity vascular function, and significantly reduce the risk of limb amputation. In the context of burn injuries and chronic non-healing ulcers, external washing protocols utilizing decoctions of honeysuckle, garden burnet root, and arnebia, which are traditionally employed to cool blood and detoxify, have demonstrated remarkable efficacy in effectively inhibiting the proliferation of common pathogenic bacteria such as *Pseudomonas aeruginosa* and *Staphylococcus aureus* on wound surfaces. Additionally, these formulations have been shown to reduce bacterial biofilm formation, thereby creating more favorable physiological conditions for subsequent skin grafting procedures or facilitating spontaneous wound closure through natural healing mechanisms.

4. Problems and Prospects

Despite the remarkable clinical efficacy of fumigation therapy in managing a wide range of musculoskeletal, dermatological, and gynecological conditions, its evolution from an empirically grounded external treatment modality into a rigorously standardized, mechanism-informed precision intervention faces several interrelated scientific and

methodological challenges [8, 9]. A primary obstacle lies in the substantial heterogeneity across clinical practice and research protocols concerning syndrome differentiation criteria and treatment parameter selection [10–12]. Variability is evident not only in herbal formula composition—where differences in herb species, origin, processing methods, and compatibility patterns influence pharmacological profiles—but also in operational parameters including thermal intensity, duration of exposure, frequency of administration, and anatomical site of application [9, 13]. Such inconsistencies severely impede cross-study comparability, meta-analytic synthesis, and regulatory evaluation [6]. To address this, future efforts must prioritize the development of comprehensive quality control frameworks anchored in reproducible chemical fingerprinting of core therapeutic formulas, supported by systematic investigations into the quantitative relationships between physical variables—such as thermal gradient, exposure time, and vapor saturation—and biological endpoints including skin permeation kinetics, local microcirculatory response, and cytokine modulation [2]. Furthermore, the current evidence base remains methodologically constrained: the majority of published reports originate from single-center observational or small-scale interventional designs with limited statistical power and susceptibility to selection and performance bias [6]. High-quality, multicenter, randomized controlled trials are urgently needed to substantiate therapeutic claims; however, the distinctive sensory characteristics of fumigation—including olfactory stimulation, thermal perception, and cutaneous humidification—pose nontrivial difficulties in designing credible placebo controls [2]. Innovative methodological adaptations may include the use of physicochemically matched inert controls—for instance, aqueous solutions possessing identical visual appearance and thermal profile but devoid of bioactive phytochemical constituents—as a means to isolate specific pharmacological effects from nonspecific physiological and psychological responses [8]. Equally important is the incomplete understanding of underlying biological mechanisms [12]. Present mechanistic studies tend to adopt reductionist approaches, focusing narrowly on isolated signaling cascades such as NF- κ B or JAK-STAT pathways, or measuring a limited panel of inflammatory mediators like IL-6, TNF- α , or COX-2 expression [3]. This fragmented perspective fails to capture the systemic, multi-target, and network-level interactions characteristic of traditional compound fumigation formulas [1, 8]. Advancing mechanistic insight therefore requires integration of complementary high-throughput methodologies—including transcriptomics, proteomics, metabolomics, and gut microbiota profiling—alongside computational strategies such as network pharmacology modeling and molecular docking simulations [2, 5]. Such integrative analyses hold promise for mapping the complex synergy among multiple herbal constituents, their biotransformation products, and diverse molecular targets across organ systems, thereby laying the scientific foundation for rational formula optimization, individualized dosing, and translational validation [13].

5. Conclusion

Chinese herbal fumigation-washing therapy is a distinctive external modality rooted in traditional Chinese medicine (TCM) principles centered on unblocking obstructed channels, clearing pathogenic accumulations, and tonifying underlying deficiencies. This integrative approach uniquely combines controlled thermal exposure with the topical delivery of bioactive phytochemical constituents. Unlike conventional monocomponent topical agents, this therapy leverages the synergistic interplay between physical stimuli—primarily mild hyperthermia—and complex herbal matrices containing diverse secondary metabolites. The therapeutic effect emerges not from isolated pharmacological actions but from the dynamic convergence of biophysical, biochemical, and physiological responses across multiple hierarchical levels—from macroscopic tissue perfusion to subcellular signaling events.

The current body of evidence indicates that fumigation-washing therapy supports wound repair through three interrelated domains of action. First, thermal modulation induces localized vasodilation, thereby augmenting microvascular perfusion and

improving oxygen availability within hypoxic wound beds; concurrently, it reduces spastic resistance in smooth muscle elements such as anal sphincters, facilitating mechanical relaxation and reducing ischemic stress. Second, the warm, humid environment created during treatment enhances cutaneous permeability, enabling more efficient transdermal delivery of pharmacologically active compounds—including anthraquinones with anti-inflammatory properties, flavonoids exhibiting antioxidant and endothelial-protective effects, and alkaloids influencing cellular proliferation and immune cell activity. Third, at the molecular level, the therapy initiates coordinated shifts in gene expression and protein activity: upregulation of pro-angiogenic mediators such as vascular endothelial growth factor (VEGF) and basic fibroblast growth factor (bFGF) promotes neovascularization, while suppression of pro-inflammatory cytokines—including tumor necrosis factor- α (TNF- α) and interleukin-6 (IL-6)—occurs via modulation of the nuclear factor kappa B (NF- κ B) signaling cascade. Furthermore, the therapy contributes to extracellular matrix homeostasis by adjusting the equilibrium between matrix metalloproteinases (MMPs) and their endogenous inhibitors (TIMPs), thereby supporting structured collagen deposition and tensile strength restoration. Clinically, consistent improvements have been observed across heterogeneous wound types—including postoperative anorectal wounds, diabetic foot ulcers, partial-thickness burns, and chronic non-healing ulcers—with measurable reductions in subjective pain intensity, quantitative exudate volume, time to complete epithelialization, and overall healing success rates. Its favorable safety profile, minimal systemic absorption, low resource requirements, and accessibility further reinforce its pragmatic value in both primary and tertiary care settings. However, several methodological and translational barriers impede broader integration into standardized clinical practice. Existing studies are largely limited to single-institution designs with modest sample sizes, and exhibit substantial variability in key procedural parameters—including solution temperature, duration of exposure per session, frequency of application, and compositional consistency of herbal formulations. Such heterogeneity severely limits cross-study synthesis and generalizability. Moreover, the overall quality of clinical evidence remains constrained by the absence of large-scale, multicenter, randomized, double-blind, placebo-controlled investigations. Designing methodologically sound control conditions presents particular difficulty due to the multisensory nature of the intervention—distinctive olfactory, thermal, and tactile cues make blinding challenging; however, innovative approaches—such as using color-matched, thermally equivalent, pharmacologically inert diluents at subthreshold concentrations—offer promising avenues for future trial design. At the mechanistic level, much of the existing research adopts reductionist strategies, focusing narrowly on individual biomarkers or isolated pathways rather than capturing system-wide interactions. A comprehensive understanding necessitates adoption of integrative frameworks—such as network pharmacology to map herb-compound-target-disease relationships, molecular docking to predict binding affinities, metabolomic profiling to identify functional metabolic shifts, and multi-omics data fusion to reveal emergent regulatory patterns. Future research priorities should therefore be structured around three complementary pillars: (1) development of consensus-based operational standards—including validated fingerprint chromatographic profiles for core formulae, systematic dose-response characterization for thermal parameters and exposure durations, and harmonized definitions of treatment endpoints; (2) execution of high-fidelity clinical trials employing adaptive blinding protocols, prospectively registered outcome measures aligned with Core Outcome Sets for wound healing, and prespecified statistical analysis plans; and (3) deployment of systems-level biological methodologies to decode the polypharmacological architecture of compound herbal preparations and elucidate how combinatorial effects translate into macroscopic tissue regeneration.

Collectively, these strategic advances—spanning standardization, rigorous clinical validation, and deep mechanistic interrogation—will enable fumigation-washing therapy to evolve beyond its historical foundation in empirical observation toward a rigorously characterized, reproducible, and precisely deployable component of modern regenerative

wound management. Its transition from tradition to translational science hinges not on discarding ancestral knowledge, but on subjecting it to contemporary scientific scrutiny – thereby affirming its relevance, refining its application, and expanding its utility across diverse clinical contexts and global healthcare systems.

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