Biomedical Sciences and Clinical Medicine 2025;64(3):261-268.
doi: 10.12982/BSCM.2025.24
https://he01.tci-thaijo.org/index.php/CMMJ-MedCMJ/index

Review Article

Open Access

A Narrative Review of the Understanding of Post-operative Wound Care in Ayurveda Literature

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Received: May 30, 2024;
Revised: March 4, 2025;
Accepted: May 23, 2025

ABSTRACT

The intricacies of meticulous wound healing or *Vrana Ropana* has been comprehensively reviewed and diligent attempts have been made at understanding the mechanisms involved in optimal wound healing via the comprehensive explanations of both Ayurveda and contemporary literature to achieve a much sought after integration of post-surgical wound care. Post-operative wound care protocols are regularly and rigorously updated as the burdens of post-surgical wound complications are on the rise. A thorough understanding of surgical wounds, stages of wound healing and optimal wound care along with identifying red flags indicating susceptibility to complications. Classic Ayurveda documents describe specialised wound care strategies associated with the use of surgical instruments as well as para-surgical therapy related to therapeutic cautery, caustic cauterization as well as wounds caused by leeches in blood-letting therapies. This presents an opportunity for the integration of those strategies with conventional knowledge in present-day surgical care which could potentially increase the efficacy and precision of wound care by minimising post-operative complications. Databases like PubMed and Scopus were searched using keywords including Sadyo *Vrana*, *Vrana Ropana*, Sastra Karma, post-operative wound care, post-surgical care and Ayurvedic methods for preventing surgical site infections. Comparison of types of wounds, mechanisms of healing and post-operative care according to evidence-based Ayurveda principles with relevant contemporary literature potentially increase understanding of what is required for a holistically integrated care plan which can help achieve uneventful post-operative surgical wound healing. To that end, it is necessary both to understand the conventional care of surgical wounds and to compare that with the existing care of post-surgical wounds as well as to identify new scopes of care including highlighting areas of bridging integrative approaches to reduce post-operative complications and to attain optimum wound healing.

KEYWORDS *Vrana*, post-operative wound healing, *Sastra Karma*

INTRODUCTION

Post-operative wound care attracts particular attention and exhaustive research interest as it is one of the significant burdens of the health care industry because it can result in undue burden on the health care economy. Achieving an uneventful postoperative wound healing process can be an arduous process which helps determine both surgical outcomes as well as impacts on the expected quality of life. Successful post-operative

care is the result of a harmonious intervention which minimizes microbial colonization and includes both proper diets and lifestyle interventions. The pivotal function of the physiological process of wound healing can be greatly facilitated by minimizing risks of infections and enabling active wound healing through the integration of successful wound care practices. The importance of identifying optimal care for wound healing is higlighted in references which state that patients with post-operative complications can be seriously affected by consequences such as unfavourable psychosocial (1) and functional outcomes which can also increase financial burdens by prolonging the period of hospitalisation (2). Various studies have suggested that there can be up to a six-fold increase of hospitalization costs for patients with surgical site infections (SSI) with the amount depending on the surgery done, the health care setting chosen and the type of infection (3-5). Infections can also account for an increase of up to 6.0% in unplanned readmissions (6) That is particularly disturbing because post-operative complications, including SSIs, are usually preventable. Many medical professionals assert that facilitating patient participation in self-management of wound care practices can help reduce the incidence of these complications (7).

Ayurveda, an ancient Indian traditional system that has withstood the test of time, has its own unique concepts when it comes to the care of wounded individuals. Regarding morbidity from wounds worldwide, it has been reported that of every million patients around 10,000 will die due to microbial infections (8). Studies have also revealed that one in four surgical wounds develops complications within the first 14 days of the post-operative period (9).

Acharya Sushruta, who is known as the Father of Surgery, has stated that care of wounds requires a multifarious approach. References can be found in the initial chapters of his *Comrstpendium Susruta Samhita*, continuing through to almost the final *sthanas*. This is evidence that Acharya *Susruta* gives importance to *vrana* (wounds) and defines wounds as something which results in the disruption of *shareeradhatu* (body tissues), leaves *vranavastu* (scars) after *ropana* (healing) which remain till the end of life. He describes the classification of *vrana*, *sadya-asadyata* (prognosis) and its management in detail, emphasizing the importance of wound care (10). Studies across the world have revealed that the overall pooled incidence of surgical site infection is 2.5% and that it varies among the WHO regions of the world (11).

The aim of the present review is to explore the types of post-operative wounds in Ayurveda following employment of various surgical modalities such as Shastra Karma (surgical procedures) and Anusastra Karma (para surgical procedures). The objective is to identify protocols that could be integrated to achieve more comprehensive wound management.

METHODS

A comprehensive literary search of the compendium of *Sushruta Samhita* was carried out to identify the steps undertaken in treatment of post-operative wounds. Various clinical conditions which have resulted could potentially result. In substantial contributions to wound healing and reducing infections were identified. An extensive review of published research papers and attempts at correlating them with contemporary research on factors contributing to wound healing was conducted. Various databases, e.g., PubMed and Scopus, were included using keywords like post-operative wound, SSI, *Vrana Ropana*, Sady-*ovrana* and filters like clinical trials, systematic review within five years and free full text.

REVIEW OF LITERATURE

Contemporary classification of surgical wounds

The currently most widely accepted surgical wound classification was initially developed in 1964 by the National Academy of Sciences and the National Research Council with the aim of representing the bacterial load in a surgical field. The Centre for Disease Control and Prevention (CDC) later refined this system by establishing four different classes of wound status as outlined below (12).

- Class 1 wounds - Clean wounds are aptly called so due to the lack of infection, to not exhibiting inflammatory signs and being closed. Examples of clean wounds include an inguinal hernia repair, a thyroidectomy and a mastectomy.

• Class 2 wounds - Clean-contaminated wounds may have a low level of contamination and may involve entry into the respiratory, alimentary, genital, or urinary tracts but only under controlled circumstances.

• Class 3 wounds – Contaminated wounds typically result from a breach in sterile techniques or leakage from the gastrointestinal tract. Incisions resulting from acute or non-purulent inflammation are also considered Class 3 wounds.

• Class 4 wounds – Dirty or infected wounds can result from inadequate treatment of traumatic wounds, gross purulence, and evident infections. When tissues lose vitality, it can lead to Class 4 wounds. These wounds are often caused by surgery or from microorganisms found in perforated organs (12).

This classification system provides a guideline regarding the susceptibility of infection of sites post-operatively, and thus help prepare the surgeon to undertake a different approach to managing them. Each class has a postoperative risk of a surgical site infection (SSI) with scores of 1% to 5.0%, 3.0% to 11.0%, 10.0% to 17.0%, and more than 27.0%, respectively (13).

Acharya Susruta, while discussing the prognosis of wounds, provides a classification based on the site upon which the wound is inflicted of the wound. Acharya classifies wounds as *sadhya*, *yaapya* and *asadhya* (14). Saadhya *vrana* (wounds which are easily healed) : Wounds located on the buttocks (*Sphik*), about the anus (*guda*), the organs of regeneration (*paayu*, *prajanan*), on the back (*prushta*), forehead (*lalaata*), cheek (*ganda*) or lips (*oshta*), and those in the region of the external ears (*karna*), on the testes (*phala kosha*), the abdomen (*udara*), in the cavity of the mouth (*mukhabhyantara*), about the nape of the neck, or above the clavicles (*jatru*) can be easily healed.

Dushchikitsya vrana (14) (wounds which are difficult to treat/heal): wounds in areas like the eyes (*akshi*), in tooth area (*danta*), the nostrils (*nasa*), the outer canthus eye (*apanga*), in the cavity of the ears (*shrotra*), the abdomen or the umbilicus(*nabhi*), or about any suture of the body (*sevani*), hips (*nitamba*), ribs (*parshwa*), abdomen (*kukshi*), chest (*vaksha*), axillary region (*kakshanta*) or the joints (*sandhi*). In addition, if the wounds are found to have exudates like frothy blood or pus with a gurgling sound, or to contain any foreign matter embedded in their inside, are healed only with the greatest difficulty. Some of the clinical scenarios like an abscess or an ulcer appearing in the nether region of the body and pointing upward, or appearing on the extremity of the scalp (*romanta*) or about the end of a finger-nail, or in any of the vulnerable parts of the body (*marma*), as well as those affecting either of the thigh bones (*femurs*), should be looked upon as equally hard to cure. Similarly, an abscess or an ulcer affecting a bone of the pelvis (*shronikanda*-acetabulum), as well as a fistula in ano opening inward should be regarded as hard to cure.

Yapya vrana (14) (requires treatment for a long duration): an ulcer incidental to, and affecting the seat of any of the following diseases, e.g., avapathika (paraphimosis), or niruddha-prakash (phimosis), or sanniruddha-*guda* (constriction of the anus), or jathara (abdominal-dropsy), or granthi (glandular inflammation), and are characterised by the germination of parasites in their interior, as well as those appearing in the cavity of the abdomen, affecting the mucous linings of the intestines, or brought about by the corrosive secretions of a *nasa*l catarrh (pratishyava), and infestations with parasites should be considered as only admitting of a palliative treatment.

Asadhya *vrana* (14) (incurable or involving a non-healing criteria): an ulcer (*vrana*) cropping up like a fleshy tumour which is painful and containing pus in its inside, and which is characterised by a copious secretion, with its edges raised like those of the genitals of a mare, should be understood as belonging to the incurable type. A condylomatous (papillomatous) ulcer which is soft and raised like the horn of a cow, or one which is moderately raised or elevated at its base and which secretes an exudation of vitiated blood or a thin slimy secretion, should be likewise regarded as incurable. An ulcer with an embossed or heaved up centre, and one dipped or fissured at its extremity should be regarded as past all remedy. An ulcer covered over with shreds of ligaments and looking as if studded with loose shreds of hemp should be given up as incurable. Similarly, an ulcer due to the deranged condition of any of the fundamental humours and secreting an exudation composed of coagulated blood, fat, marrow and brain matter should be deemed incurable. Surgical procedures of this type can result in a wound of such status, so must be judiciously handled.

Classification of wounds by Acharya *Susruta* (Ayurveda)

1. *Vranas* are broadly classified into one of two types based on their origin and etiology (15).

a. Nija*vrana* (Shareera) are caused by involvement of Doshas including combination of two or three doshas) and

b. Aganthuja*vranas* are caused by environmental or extrinsic elements including those caused by incision, punctures, lacerations, poisoned cuts, bruises etc. It can also be caused by bites of humans, animals, birds, reptiles, etc.)

2. Based on the involvement of Doshas and amount of dushti, *Vranas* are classified into either Dushta *vrana* or Shudha *vrana*. Those with considerable features of dosha dushti are called Dushta *vrana* and those with minimal to minor features of dosha dushti are called as shudha *vranas* (16).

3. *Vrana* is also classified into the *Sadyo vrana* variety which is initiated by external causes including accidental wounds, traumatic wounds and surgical wounds. They are further sub-divided into six types which are synonymously addressed as aganthuja*vranas* or sudha*vranas* (17).

a) Chinna vrana - Vrana is oblique/straight, separation of body parts.

b) Bhinna vrana - Perforation puncture of Aashayas, exuding mild Sraava

c) Vidha Vrana - Injury to any part of the body other than Aashaya or Uttundita.

d) Kshata Vrana - Vrana which is neither Ati Chinna nor Ati-Bhinna, but having features of both and being irregular in shape.

e) Pichita Vr*ana* - Flattening of any part of body along with Asthi, filled with Rakta and Majja.

f) Ghrusta V*rana* – Caused by rubbing on a rough and hard surface causing any part of the body to lose its skin. It is accompanied by watery exudation and is called ghrista *vrana* (abrasive wounds).

Understanding the mechanism of wound healing

The healing of an acute wound (post-operative wound) proceeds through to healing "in an orderly and timely reparative process". Orderliness refers to the healing sequence of inflammation, angiogenesis, matrix deposition, wound contraction, epithelialisation, and scar remodelling (18). A critique of comprehending the process of surgical wound healing elucidates that it takes place via deep synergy of diverse overlapping phases: haemostasis, inflammation, proliferation, and tissue remodelling or resolution. Interferences or disruption interruptions, oddities or undue delay in this sequence can prolong the process and can lead to delayed wound healing or a non-healing chronic wound (19). In a healthy adult the stages of wound healing as depicted in the literature include swift stability in attaining haemostasis, appropriate inflammatory response, cell differentiation mainly (mesenchymal) followed by the spread and migration of differentiated cells into the wound site. Neo angiogenesis brings in more blood supply to the wound and it is then followed by rapid reepithelialization and collagen cross linking, providing ample strength to the healing tissues at the site of surgical wounds (20). Wound healing is described as consisting of three phases irrespective of the factors that resulted in the injury: the inflammatory, the proliferative and the remodelling phases (21-23).

The first stage constitutes the body's first line response to the injury and its immediate reaction triggers the localised release of inflammatory mediators thereby inducing a local vasodilation at the site of injury which then aids an influx of phagocytic leucocytes, such as neutrophils and macrophages, which are essential in digesting bacteria and autolysing devitalised tissue. The inflammatory phase of wound healing is responsible for the classical signs of inflammation that occur in response to an injury: erythema, heat, oedema, pain and decreased function.

In the second stage, the wound rebuilds itself in the proliferative phase. The major contributory steps in this phase include filling the wound surface with granulation tissue comprised of collagen and extracellular matrix, and angiogenesis starts to set in. In this stage, the wound edges approach each other via contraction of epithelial tissues. The finishing of this stage is marked by epithelial cells fully resurfacing the wound.

The final stage is remodelling which starts when the wound is closed and attains tensile strength with the help of collagen fibres remodelling and reorganizing themselves. This phase also witnesses devascularisation of the wound and surrounding structures returning to their original state of blood supply (24).

Conceptual understanding of stages of healing (*Vrana Ropana*) as per Ayurveda

The process of the stages in wound healing can be drawn from the references where Acharya *Susruta* details the type of *Vrana* based on evident features of wound progression towards healing.

1. Dushta *vrana*. Acharya's first description of features of a non-healing wound include that it is innately affected by Tridoshas and has purulent and profuse discharge, a foul odour. The discharge shows traces of blackish, greenish, and yellowish colours and inflicts pain. All these features are suggestive of an infected non-healing ulcer or, in a post-operative wound, they are signs of the wound being microbially infected.

2. Shuddha *vrana*. A conceptual understanding includes that this type of wound is actually devoid of doshic involvement with minimal pain and the features of the wound include pinkish granulation tissue with minimal discharge or sloughing at the wound base. These are, in fact, features of an intentional wound created as in a surgical procedure. They are also comparable to the clinical features indicative of the process of wound healing.

3. Ruhyamana *vrana* – In this stage in the progression of wound healing the wound is pale or grayish in colour and the margins are healthy. There is minimal discharge or evidence of sloughing. The borders are devoid of induration and granulation tissue from around the margins and floor indicates an uneventful healing process comparable to the repair phase of contemporary understanding of wound healing.

4. Rudha *vrana* – This stage can be perceived as the final phase of healing of a wound. There is an approximation of wound edges and the beginning of scar formation with the wound and periphery attaining an even skin tone with no swelling or pain in the wound (25).

Care of post-operative wounds

The key components in facilitating an optimal wound healing are attained mainly by reviewing the post-operative wound from time to time. Care should be given to include thorough cleaning and wound dressing. It is essential to recognize challenges early and provide effective treatment for the complications that are associated with wound healing. Whatever principles are adopted in wound care, the aim is ideal wound healing without complications and with the best aesthetical and functional results (26).

Wound Cleaning: The protocol includes cleansing of a wound which is attained by clearing the wound of debris, e.g., devitalised tissue or excessive exudates, which may otherwise delay wound healing (27). Wound irrigation should be gentle to avoid further tissue trauma and should be done with warm saline or water (as per NICE recommendations) using a syringe, rather than swabbing or bathing, which maintains an optimum healing environment (28).

Wound dressings: Dressings are considered another important step in diligent efforts to achieve wound healing as they sustain a moist wound environment while at the same time absorbing excess exudates that might lead to maceration of the wound. Dressings in place also provide a physical barrier against bacterial or fluid contamination, and can be adherent to the skin but atraumatic on removal (29).

Care of wounds in Ayurveda

The sequence of wound care in Ayurveda is detailed in *Paschat Karma* and explained by Acharya *Susruta* in *Agropaharaneeya Adhyaya* in *Sutra Sthana*. He mentions that post operatively after consoling the patient by sprinkling cold water on the wound, the post-surgical wound must be slightly circumferentially pressed to remove all clots and exudates, and to approximate the edges of the wound to make the surface even. The next stage includes *vrana prakshalana* (irrigating the wound) with *Kashayas* (medicated water) which include *tikta* rasa and *sheeta veerya*. Then the wound is mopped with sterile gauze and medicated *Alepa* (wound dressings) containing *tila kalka*, *madhu*, *sarpi* should be made into a wick and placed in the wound. This facilitates maintaining wound moisture and also provides adequate draining of collected exudates. A paste of medicines effective in healing *sadyo vrana* should be smeared over the wound and the wound should be covered with thick dressings secured by bandaging. Additionally, it is also advised to do *dhoopana*, a proven technique to attain a sterile environment so as to promote ample healing (30).

Importance of Raksha Karma.

Acharya Sushruta explained *Dhoopana* as fumigation with *rakshoghna Dravyas* e.g., *Guggulu* (*Comiphora mukkul*), Agaru (*Aquilaria agollocha*), Sarjarasa (*Vateria indica*), Vacha (*Acorus calamus*), Sarshapa (*Brassica nigera*), Lavana, Nimba (*Azadirachta indica*) mixed in cow ghee (31). He also mentions the chanting of mantras and advocates various dos and don't's for *Vranita* (the wounded).

Practising post-operative pain management

Acharya *Susruta* mentioned that severe pain which is caused by Shastras (surgical instruments) can be managed by irrigation with lukewarm ghee processed with Yashti *Madhu* as a general line of management (32). In wounds that are by Vyadhana, Karma, Acharya advocates irrigation of wounds with Ama Taila (unprocessed, non-heated sesame oil) (33). In wounds created by thermal cautery, the wound should be smeared with a combination of *madhu* and Sarpi (34). He also mentions the use of medicated ghee prepared from tug*akshi*ri (*Curcuma angustifolia* Roxb), plaksha (*Ficus virens*), Chandana (*Santalum album*), gairika (red oxide of iron) and amruta (*Tinospora cordifolia*) (35). For *vrana* caused by Kshara karma, Acharya recommends washing with Amla varga Dravyas and lepana with *tila kalka*, *Madhu* and ghrita Sushruta (36). In wounds inflicted by treatment with jalouka, after blood-letting smearing the wound with Shata dhouta ghrita is advised (37). In the bleeding in wounds caused by application of blood-letting therapy, the control of haemorrhaging is attained by four principles, mainly sandhana by irrigating with Kahsyaa rasa Dravyas, sheet veerya dravyas. Skandana application of Hima and dahana by Agni karma of the bleeding vessel and Pachana is attained by sloughing the blood and thus forming clots by application of Bhasma. Sushruta (38).

Why Tila, *Madhu*, ghrita and Yashti *Madhu*

Honey is widely used as topical wound dressing and its efficacy is evidenced by various meta-analyses of use of honey as a topical wound dressing agent (39). The mode of action could be explained by its anti-oxidant, anti-bacterial and anti-inflammatory properties. Honey has numerous properties: a natural anti-inflammatory effect, a stimulatory effect on granulation tissue and an antibacterial effect (against many strains of bacteria, e.g., Staphylococcus, Streptococcus and Helicobacter pylori) (40). Honey also has high acidity which provides secondary benefits in addition to the osmotic effect in addition to its anti-oxidant properties and its hydrogen peroxide content. Thus the use of honey leads to improved wound healing in acute cases, pain relief in burn patients and decreased inflammatory response in many patients (41). Cow ghee has antioxidant properties as it contains fat-soluble vitamin E and beta carotene (42). It also possesses antibacterial, anti-inflammatory, and antiseptic properties that are beneficial in treating various skin-associated problems. Because of that, it helps treat blisters, inflammatory swellings, and wounds, helping to speed the healing process (43).

Tila (*Sesamum indicum*) kalka aids in the healing of wounds by accelerating skin border contraction. Also it helps in achieving an even covering of granulation tissue and regeneration of epidermis. Sesame oil contains active ingredients with anti-oxidant and antibacterial properties, especially in the inflammatory phase due to its acidic PH. Acidic Ph also helps new skin growth by promoting cell migration and proliferation. Wound healing is finally brought about by the fibroblast activity, and collagen restructuring (44).

Yashti*madhu* has proven healing, anti-ulcerogenic, anti-inflammatory and skin regeneration activity. Sodium glycyrrhizate possesses anti-ulcer activity and stimulates regeneration of skin. Yashti*madhu* contains glycyrrhizin acid and ammonium salt [GA] which has demonstrated ulcer healing activity according to some pharmacological articles (45). The effect of yashti*madhu* on post operation wounds was tested in previous studies where it was shown to give positive results following the use of Yashti *Madhu* on post-operation wounds. It reduces the number of inflammatory cells and enhances fibroblasts maturation and tissue alignment and ulcer healing where it has shown an increase in the percentage of ulcer contraction and epithelization (46).

DISCUSSION

The review of ancient writings by Acharya *Susruta* paves a pathway for critical thinking which encompasses versatile aspects of wound healing including the comprehensive perspectives of the

role of mental, emotional and spiritual wellbeing of the patient rather than focussing on the physiology of wound healing and pathophysiology related to surgical infections, dehiscence and other similar challenges. This comprehensive approach however, is often disdained. The evidence of polyherbal formulations with essential components containing pharmacologically active substances are still a grey area and requires exhaustive reviews and research, including clinical trials. The role of advocated diet and lifestyle changes are also of utmost importance, but are typically often overlooked as patient education is a necessary compontent in this regard. The type of wounds caused by surgical instruments, medicinal leech therapy, thermal and caustic cautery have all been identified. This sort of detailed identification of mechanisms affecting post-surgical wounds and entrusting different protocols for the same should be given due consideration so that wound healing approaches to various wounds can be tailor-made after surgeries. Moreover, research results support the essential role of improving patient morale and self-dependency to post-operative care. There exists a continuing need for multidisciplinary efforts to provide safe and effective use of herbal compounds which are explained by Acharyas and to timely integrate this traditional wisdom into contemporary practices. The role of integrating this know-how about wound care can have complimentary results that aid in optimizing post-operative wound outcomes.

CONCLUSIONS

Comprehension of the mechanisms supporting optimal wound healing is the paramount need of the hour. Various ambiguities still exist in spite of exhaustive research on the subject. There is a need to extend the review of conventional treatises to explore concepts regarding various methods used in post-operative wound healing. The basic principles encompass methodical assessment, adopting modalities for wound cleansing and identifying signs of wound healing and, most of all, recognition of any red flags indicating possible wound complications and the need for timely interventions.

ACKNOWLEDGEMENTS

None

FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

CONFLICT OF INTERESTS

The are no conflicts of interest to report.

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