Journal of Ayurveda and Integrative Medicine 15 (2024) 100905

Contents lists available at ScienceDirect

Journal of Ayurveda and Integrative Medicine

journal homepage: elsevier.com/locate/jaim

An integrative approach for management of post-traumatic dorsal foot wounds - A case report

Rahul Sherkhane [a,*], Shruti Singh [a], Aadithyaraj K T [a], Anil Kumar [b], Ashish Sharma [c], Shiv Ji Gupta [b]

[a] Dept. of Shalya Tantra, Faculty of Ayurveda, Institute of Medical Sciences Banaras Hindu University, Varanasi, 221005, India
[b] Department of Shalya Tantra, Faculty of Ayurveda, Institute of Medical Sciences, Banaras Hindu University, Varanasi, India
[c] S S Hospital, Institute of Medical Sciences, Banaras Hindu University, Varanasi, India

ARTICLE INFO

Keywords:
Ayurveda
Vrana
Post-traumatic wound
Skin graft
Crush injuries
Case reports

ABSTRACT

Crush injuries to the foot have become increasingly prevalent in contemporary settings, primarily arising from incidents such as the impact of large objects falling onto the foot or involvement in traffic accidents. The complexity of treating these injuries is compounded by the intricate anatomy of the foot. In specific scenarios, the implementation of an integrated management approach could prove advantageous.

In this report, we depict the case of a 23-year-old male who visited the Shalya OPD with a wound on his left foot caused by trauma. The wound covered the medial portion of the foot, involving the dorsal area, and measured roughly 20 cm by 9 cm and was unable to walk. We successfully managed the case by adopting an integrative approach. The Ayurvedic treatment included *Panchavalkala kashaya* for wound irrigation, as well as oral administration of *Amalaki rasayana, Triphala guggulu*, *Shatavari churna* and *Ashwagandha churna*. *Jatyadi taila* was topically applied. For the first seven days, in addition to these ayurvedic medications, we also employed analgesics and antibiotics to treat infection and pain. To accomplish early closure, we employed a split-thickness skin graft after sufficient granulation tissue had appeared.

The wound was completely healed within three months and the patient was able to walk freely without any support. The combined approach yielded a promising result in this case.

1. Introduction

Post-traumatic dorsal foot wounds are quite common in clinical practice but epidemiological studies are scarce on foot injuries in India [1]. The reported incidence of foot injuries to be 7.4% in polytrauma cases. Foot injuries predominantly occur in males as compared to females (ratio >4:1), and are more prevalent in the fourth decade of life [2]. Road traffic accidents are the most common cause of traumatic dorsal foot injuries [3]. The skin and subcutaneous tissue on the dorsum of the foot are relatively thin and loose, thus the tendons and bones are typically exposed in these types of traumatic injuries. Additionally, because the skin is loosely attached to the underlying tendons, ligaments, and bones, the dorsum of the foot is prone to avulsion injuries. It is also challenging to manage these wounds because there aren't enough local tissues available for covering [4]. While there aren't any specific set protocols for treating traumatic injuries to the dorsum of the foot, debridement and reattaching the avulsed flap are usually enough if the blood supply is sufficient [5–7]. However, split and full-thickness grafts and flaps, along with microvascular anastomoses, can be necessary in more complicated cases with significant separation.

Ayurveda, an ancient traditional system of medicine originating from India, is grounded in experiential knowledge and it has been practiced for generations. The elaborate description of the wounds under the term *Vrana* is available in Sushruta Samhita, one of the legendary compilations of Ayurveda. Wounds described in Ayurveda have two origins; one is *Nija* (intrinsic factors) and another is *Agantuja* (exogenous factors e.g. due to trauma) [8]. Traumatic wounds (*Sadyovrana*) in Ayurveda, are categorized into six types: *Chinna* (cut wound), *Bhinna* (perforated wound), *Viddha* (punctured wound), *Kshata* (lacerated wound), *Picchita* (contusion), and *Ghrishta* (abrasion wound). Comprehensive information about each category can be found in the Sushruta Samhita [9]. Sushruta described 60 therapeutic modalities,

Peer review under responsibility of Transdisciplinary University, Bangalore.
* Corresponding author.
E-mail address: rahulsherkhane@gmail.com (R. Sherkhane).

https://doi.org/10.1016/j.jaim.2024.100905
Received 31 October 2023; Received in revised form 25 January 2024; Accepted 12 February 2024

Fig. 1. Wound at various stages.

Fig. 1. (*continued*).

Fig. 1. (*continued*).

Fig. 1. (*continued*).

ranging from the aseptic dressing of the affected part to rehabilitation for every aspect of the wound and its complications [10]. Several medicinal plants, minerals, metals, and animal products were described which have *Vranashodhaka* (wound cleansing) and *Vranaropaka* (wound healing) properties in various Ayurvedic classics [11]. 153 single herbs along with multiple polyherbal formulations have been described in Sushruta Samhita [12]. In addition to medicines, Sushruta used to cover up large wound areas with skin under the banner of *Sandhana karma* (reconstructive surgery) [13]. *Jatyadi taila* is one the most commonly used formulations for wounds, and it has been proven as an effective wound-healing drug by multiple studies than contemporary formulations [14].

2. Patient information

A 23-year-old male patient reported a complaint of a traumatic wound on his left foot for 12 days. Experiencing pain and mild bleeding, he was unable to walk during this period. The patient had a recent history of a road traffic accident and had initially been admitted to a tertiary trauma care center. Following primary treatment with analgesics and local dressing, limb amputation was proposed, but the patient resisted this option. Seeking alternative treatment, he subsequently sought assistance at the Shalya Outpatient Department.

3. Clinical findings

The wound was located on the medial aspect of the left foot, primarily affecting the dorsal surface, which was extended from the left great toe to the heel and upward up to the middle malleolus. The size of the wound was measured as 20 cm × 9 cm by using the imitoMeasure App (Fig. 1A). The wound floor was covered with blackish foreign particles with ill-defined margins. There was no discharge from the wound and the surrounding skin was normal in appearance. Foreign particles were palpable and resembled small pieces of coal. The local temperature was normal and mild tenderness was present over the affected area. The patient had difficulty in moving his affected leg with a VAS score of 8. In addition, there were no severe injuries to any other body parts. He did not have a history of any drug abuse. His vital signs were within normal limits. After the clinical assessment, we came to a diagnosis of a grade 4 car-tyre injury of the left foot.

4. Diagnostic assessment

Initially, a color Doppler and plain X-ray radiograph of the lower limb was performed to assess the extent of the injury. All routine blood investigations were also within normal limits.

5. Therapeutic intervention

After the primary assessment, wound culture was done. Then,

Fig. 1. (*continued*).

prophylaxis using broad-spectrum antibiotics (Piperacillin and tazobactam) was started [Table 1]. Along with that, oral Ayurvedic medicines were advised to the patient [Table 1]. Primary management of the wound was started with wound irrigation using *Panchavalkala kashaya*. Coarse powder of *Panchavalkala* was prepared and subjected to heat in 8 times of water with continuous stirring and the quantity was reduced to 1/4th of the initial volume. The liquid was filtered through four folded clean cotton cloths and the filtrate was collected as *Kashaya*. Then wound bed was thoroughly irrigated using a 50mL syringe filled with *Panchavalkala kashaya*. The objective of wound irrigation was to eliminate foreign materials, reduce bacterial contamination in the wound, and clear away cellular debris or exudate from the wound's surface [15]. Here the specific usage of *Panchavalkala kashaya* was intended to minimize bacterial contamination of the wound due to its antimicrobial properties [16]. The wound debridement was performed simultaneously to remove remaining foreign particles along with non-viable tissues. Then the wound was covered using gauze soaked in *Panchavalkala kashaya* and bandaging was done with a splint over the plantar surface. Daily cleaning and dressing were continued. The wound was assessed and wound size was measured weekly. After two weeks of continuous dressing, the wound bed became filled with healthy pink granulation tissue (Fig. 1C). Then, dressing with Jatyadi taila was initiated and continued for the next two months. Two months later, a split-thickness skin graft was harvested from the right thigh and transplanted onto the wound (Fig. 1G). Dressings were changed on the third and seventh days, and assessments were conducted on the grafted site (Fig. 1H). Follow-up dressings indicated successful incorporation of the skin graft, leading to the patient's discharge from the hospital [Table 2] [Fig. 1A–I].

6. Follow-up and outcomes

During the time of discharge, VAS was 0 and the patient was advised to visit the hospital every 15 days to assess the graft. He was told to continue the internal medications for 1 month along with proper foot care until full healing was attained. The skin graft was successful, and the wound healed completely within a month of graft application. After that, he was advised to visit in 6 months. The patient did not report any pain, discomfort, or discharge during the period and normal contour of the foot was maintained.

7. Discussion

This case addresses a complex traumatic wound on the left foot caused by a road traffic accident, classified as a grade 4 car-tyre injury. The wound, with indistinct margins and foreign particles, posed a serious threat, prompting conventional medical advice recommending limb amputation. The patient denied it and opted for an alternative approach.

Our approach involved a blend of conventional and Ayurvedic methods, commencing with antibiotic prophylaxis to prevent infection risks in traumatic wounds. The primary objective was the meticulous preparation and reconstruction of the wound bed. The wound bed was prepared by a step-by-step treatment process involving *Vrana shodhana* and *Vrana ropana.* Ayurvedic literature encompasses numerous medicines and formulations designed to facilitate *Shodhana* and *Ropana*. When the wound bed became sufficiently granulated with healthy margins, split-thickness grafting was undertaken as the choice of reconstruction.

Wound irrigation, a crucial component of wound management, stands out as one of the most effective interventions in wound care, significantly reducing the risk of infection [14]. It aims to remove foreign objects, minimize bacterial contamination of the wound, and remove cellular debris or exudate from the wound's surface [15]. Therefore, in this study, *Panchavalkala kashaya* was chosen for the

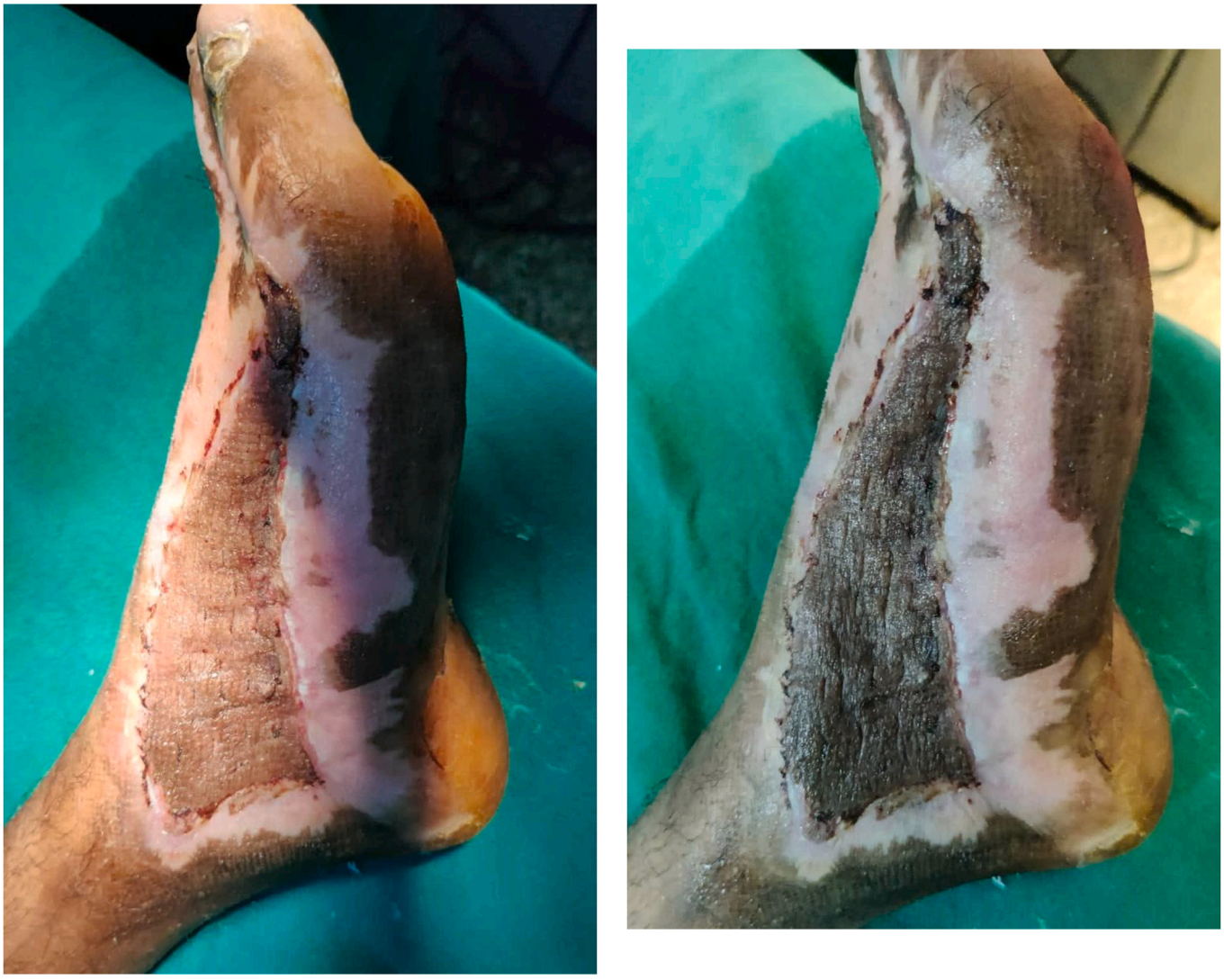

Fig. 1. (*continued*).

Fig. 1. (*continued*).

Table 1
Medicines given to the patient.

Drug	Route	Dose
Inj. Piperacillin + tazobactam	I/V	4.5g 12hrly for 7 days
Amalaki rasayana	Oral	5 gm twice daily (post meals with lukewarm water)
Triphala guggulu	Oral	250mg twice daily (post meals with lukewarm water)
Ashwagandha churna	Oral	5 gm twice daily (post meals with milk)
Shatavari churna	Oral	5 gm twice daily (post meals with milk)

irrigation of wounds as *Panchavalkala kashaya* has *Vrana shodhana* properties [17]. Recent studies indicate that *Panchavalkala kashaya* possesses anti-inflammatory, analgesic, and antibacterial properties making it beneficial in the management of infected wounds [16].

After a proper *Shodhana* of the wound, the subsequent step of *Ropana* can be achieved. When healthy granulation tissue started to cover the wound bed, dressing with *Jatyadi taila* started. *Jatyadi taila* has been proven in numerous trials to be effective in wound healing, when it was applied externally [18]. Also, ingredients included in *Jatyadi taila*, such as *Jati* (*M. fragrans*), *Patola* (*Trichosanthes dioica Roxb)* and *Kushta* (*Saussurea lappa*), have *Shothahara* (anti-inflammatory) properties [19]. The *Jatayadi taila* contains *Katuka* (*Picrorhiza kurroa*), which enhances neovascularization, endothelial cell migration, and fibroblast migration into the wound bed [20]. Also, one of the ingredients *Tuttha* (CuSO4) stimulates angiogenic responses, which aids in the quick covering of wound areas by granulation tissue [21].

Classical literature of Ayurveda describes various herbs with anti-aging and wound-healing properties [22]. Therefore, herbal formulations like *Ashwagandha churna*, *Shatavari churna* and *Amalaki rasayana* were given orally. *Ashwagandha* (*Withania somnifera)* is a well-known adaptogen and stress reliever. The body is more resilient to stress because of its strong adaptogenic qualities. Cell-mediated immunity, which fortifies the body's defenses against illness, is improved by *Ashwagandha*. Also, it is a drug with antioxidant properties that helps to protect cells from damage caused by free radicals. It is advantageous in the treatment of *Shotha* (inflammation) [23]. *Shatavari*, or *Asparagus racemosus*, has several health benefits, including immunomodulation, adaptogens, antioxidants, anticarcinogens, and general tonic [24]. Because of its immunomodulator and antioxidant qualities, it promotes wound healing. *Amalaki* (*Emblica officinalis*) *rasayana* has been shown to possess cytoprotective, analgesic, immunomodulatory, and antioxidant properties by a study conducted on Wistar strain albino rats [25]. It is among the best providers of minerals, amino acids, and vitamin C. Collagen fiber production depends on vitamin C. It is also necessary for tissue restoration and healing. *Amalaki Rasayana* exhibits both moderate cytoprotective efficacy and strong immunostimulant activity [25]. Furthermore, *Triphala guggulu* was orally administered, given its demonstrated capability to inhibit the growth of both gram-negative and gram-positive bacteria, as established by previous research [26]. Study on *Triphala* revealed a reduction in the bacterial count within granulation tissue and an increase in collagen [27]. It is well known that *Triphala guggulu* reduces discomfort and edema. Because *Triphala guggulu* has antibacterial, analgesic, and anti-inflammatory properties, it was used internally.

In this case, wound care interventions were explored, emphasizing the efficacy of *Panchavalkala kashaya* for wound irrigation due to its wound-cleansing properties. It also incorporated the use of Ayurvedic herbal formulations such as *Ashwagandha*, *Shatavari*, *Triphala guggulu*, and *Amalaki rasayana* for oral consumption, each offering unique benefits. While *Jatyadi taila* was applied externally to aid in wound healing.

Table 2
Timeline of events.

Date	Observations	Interventions
20/2/23	The patient visited OPD with a crushed wound over his left foot. The wound floor was covered with black foreign particles (size ~ 20 × 9 cm) (Fig. 1A)	Antibiotic prophylaxis & Ayurvedic internal medicines started [Table 1] Wound debridement + irrigation with *Panchavalkala kashaya* + dressing with *Panchavalkala kashaya* done
27/2/23	Significant reduction of foreign particles from the wound bed. (size ~20 × 9cm) (Fig. 1B)	Debridement & dressing with *Panchavalkala kashaya* continued. Previous internal medications continued
6/3/23	Healthy granulation tissue started to cover the Wound bed (size ~20 × 9cm) (Fig. 1C)	Dressing with *Jatayadi taila* was started. Internal medicines continued.
27/3/23	Significant wound contraction with healthy granulation noted (size ~18 × 7cm) (Fig. 1D)	Dressing with *Jatayadi taila* and internal medicines continued.
10/4/23	Significant wound contraction with healthy granulation (size ~15 × 5 cm) (Fig. 1E)	Dressing with *Jatayadi taila* and internal medicines continued.
17/4/23	Healthy wound margin, appropriate for skin grafting (size ~ 10 cm × 3 cm) (Fig. 1F)	Skin graft is taken from the right thigh & Skin grafting done (Fig. 1G)
24/4/23	Successful acceptance of skin graft (Fig. 1H)	The wound dressing was opened & changed on the 7th day. Internal medicines continued.
29/4/23	Healed wound	The patient was discharged with advice to continue Ayurvedic oral medications for 1 month.
8/5/23	Healed wound	Follow up after 21 days
24/11/23	Healed wound (Fig. 1I)	Follow up after 6 months

Overall, the case demonstrated successful wound healing through a comprehensive approach that combined Ayurvedic treatments with modern medicine.

8. Conclusion

The post-traumatic wound in this case was effectively treated through an integrative approach, eliminating the need for drastic measures such as severe amputation. Remarkably, the wound achieved complete healing within three months. This integrated strategy not only minimized the duration of hospital stay but also significantly enhanced the overall wound-healing process. While this case serves as a noteworthy example, future research in this field must encompass a larger sample size to further validate and refine the effectiveness of such holistic approaches in diverse clinical scenarios.

Patient perspective

"Initially, I was unable to walk properly and was brought to OPD in a wheelchair. There was severe pain in my left foot due to which it was difficult for me to even sleep at night, but after treatment my wound healed completely, and I can walk properly and perform my all-routine work by myself. Although it was a long journey and I was admitted to the hospital for more than two months I am satisfied with the outcome."

Informed consent

Written informed consent was obtained before starting therapy.

Source of funding

None.

Sources of support and grant

No special grant has been received for the purpose.

CRediT authorship contribution statement

Rahul Sherkhane: Conceptualization, Validation, Resources, Writing – original draft, Writing – review & editing, Supervision. **Shruti Singh:** Writing – original draft, Data curation, Writing – review & editing. **Aadithyaraj K T:** Writing – review & editing, Supervision. **Anil Kumar:** Writing – review & editing, Supervision. **Ashish Sharma:** Conceptualization, Validation, Resources, Writing – original draft, Writing – review & editing, Supervision. **Shiv Ji Gupta:** Conceptualization, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] Tadros AM, Eid HO, Abu-Zidan FM. Epidemiology of foot injury in a high-income developing country. Injury 2010;41(2):137–40. https://doi.org/10.1016/j.injury.2009.05.031. Epub 2009 Jun 30. PMID: 19570532.
[2] Dhillon MS, Aggarwal S, Dhatt S, Jain M. Epidemiological Pattern of foot injuries in India: preliminary assessment of Data from a tertiary hospital. J Postgrad Med Educ Res 2012;46(3):144–7.
[3] Khan MM, Cheruvu VPR, Krishna D, Laitonjam M, Minz R, Joshi R. Post-traumatic wounds over the dorsum of the foot - our experience. Int J Burns Trauma 2020;10(4):137–45. PMID: 32934868; PMCID: PMC7486566.
[4] Elshahat A. Management of complex avulsion injuries of the dorsum of the foot and ankle in pediatric patients by using local delayed flaps and skin grafts. Eplasty 2010;10:e64. PMID: 20976209; PMCID: PMC2955433.
[5] Zgonis T, Cromack D, Roukis T, Orphanos J, Polyzois V. Severe degloving injury of the sole and heel treated by a reverse flow sural artery neurofasciocutaneous flap and a modified off-loading external fixation device. Inj Extra 2007;38:187–92. https://doi.org/10.1016/J.INJURY.2006.08.067.
[6] Libermanis O. Replantation of the heel pad. Plast Reconstr Surg 1993;92:537–9. https://doi.org/10.1097/00006534-199309000-00026.
[7] Sanger JR, Matloub HS. Successful replantation of the heel pad: a seven-year follow-up. Ann Plast Surg 1989;22:350–3. https://doi.org/10.1097/00000637-198904000-00012.
[8] Shanti K, R S. Ayurvedic management of venous ulcer - a case report. J Ayurveda Integr Med 2023 May-Jun;14(3):100723. https://doi.org/10.1016/j.jaim.2023.100723. Epub 2023. PMID: 37244010; PMCID: PMC10220395.
[9] Lodhi S, Jain AP, Rai G, Yadav AK. Preliminary investigation for wound healing and anti-inflammatory effects of Bambusa vulgaris leaves in rats. J Ayurveda Integr Med 2016;7(1):14–22. https://doi.org/10.1016/j.jaim.2015.07.001. Epub 2016 Apr 11. PMID: 27297505; PMCID: PMC4910292.
[10] Singh V. Sushruta: the father of surgery. Natl J Maxillofac Surg 2017;8(1):1–3. https://doi.org/10.4103/njms.NJMS_33_17. PMID: 28761269; PMCID: PMC5512402.
[11] Biswas TK, Mukherjee B. Plant medicines of Indian origin for wound healing activity: a review. Int J Low Extrem Wounds 2003;2(1):25–39. https://doi.org/10.1177/1534734603002001006. PMID: 15866825.
[12] Kumar V, Nesari TM, Ghildiyal S, Sherkhane R. Pharmacodynamic appraisal of wound-healing herbs of *Sushruta Samhita*. Ayu 2021;42(1):1–18. https://doi.org/10.4103/ayu.AYU_34_20. Epub 2022 Dec 7. PMID: 36743272; PMCID: PMC9893898.
[13] Singh V. Sushruta: the father of surgery. Natl J Maxillofac Surg 2017;8(1):1–3. https://doi.org/10.4103/njms.NJMS_33_17. PMID: 28761269; PMCID: PMC5512402.
[14] Shailajan S, Menon S, Pednekar S, Singh A. Wound healing efficacy of Jatyadi Taila: in vivo evaluation in rat using excision wound model. J Ethnopharmacol 2011;138(1):99–104. https://doi.org/10.1016/j.jep.2011.08.050. Epub 2011 Aug 30. PMID: 21907784.
[15] Lewis K, Pay JL. Wound irrigation [Updated 2023 Mar 27]. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2023 [Internet], https://www.ncbi.nlm.nih.gov/books/NBK538522/.
[16] Aphale S, Pandita S, Raina P, Mishra JN, Kaul-Ghanekar R. Phytochemical standardization of panchavalkala: an ayurvedic formulation and evaluation of its anticancer activity in cervical cancer cell lines. Phcog Mag 2018;14:554e6.
[17] Meena RK, Dudhamal T, Gupta SK, Mahanta V. Wound healing potential of Pañcavalkala formulations in a postfistulectomy wound. Ancient Sci Life 2015;35(2):118–21. https://doi.org/10.4103/0257-7941.171673. PMID: 26865745; PMCID: PMC4728863.

[18] Sunita Shailajan, Menon Sasikumar, Suhas Pednekar. Wound healing efficacy of Jatyadi Taila: in rat using excision wound model. J Ethnopharmacol 2011;138(1):99e104.
[19] Prasannan D, Shindhe PS, Jadar PG, Killedar RS, Priyanka K. Efficacy of Jatyadi, Madhughrita and honey tulle in wound management: a three-arm randomized controlled clinical trial. J Ayurveda Integr Med 2023;14(3):100719. https://doi.org/10.1016/j.jaim.2023.100719. Epub 2023. PMID: 37271064; PMCID: PMC10242641.
[20] Singh AK, Sharma A, Warren J, Madhavan S, Steele K, RajeshKumar NV, Thangapazham RL, Sharma SC, Kulshreshtha DK, Gaddipati J, Maheshwari RK. Picroliv accelerates epithelialization and angiogenesis in rat wounds. Planta Med 2007;73(3):251–6. https://doi.org/10.1055/s-2007-967119. Epub 2007. PMID: 17318779.
[21] Sen CK, Khanna S, Venojarvi M, Trikha P, Ellison EC, Hunt TK, Roy S. Copper-induced vascular endothelial growth factor expression and wound healing. Am J Physiol Heart Circ Physiol 2002;282(5):H1821–7. https://doi.org/10.1152/ajpheart.01015.2001. PMID: 11959648.
[22] Datta HS, Mitra SK, Patwardhan B. Wound healing activity of topical application forms based on ayurveda. Evid Based Complement Alternat Med 2011;2011:134378. https://doi.org/10.1093/ecam/nep015. Epub 2011 May 26. PMID: 19252191; PMCID: PMC3136177.
[23] Mukherjee PK, Banerjee S, Biswas S, Das B, Kar A, Katiyar CK. Withania somnifera (L.) dunal - modern perspectives of an ancient rasayana from ayurveda. J Ethnopharmacol 2021;264:113157. https://doi.org/10.1016/j.jep.2020.113157. Epub 2020 Aug 9. PMID: 32783987.
[24] Pise MV, Rudra JA, Upadhyay A. Immunomodulatory potential of shatavarins produced from Asparagus racemosus tissue cultures. J Nat Sci Biol Med 2015;6(2):415–20. https://doi.org/10.4103/0976-9668.160025. PMID: 26283842; PMCID: PMC4518422.
[25] Rajani J, Ashok BK, Galib, Patgiri BJ, Prajapati PK, Ravishankar B. Immunomodulatory activity of Āmalaki Rasāyana: an experimental evaluation. Ancient Sci Life 2012;32(2):93–8. https://doi.org/10.4103/0257-7941.118546. PMID: 24167334; PMCID: PMC3807964.
[26] Peterson CT, Denniston K, Chopra D. Therapeutic uses of Triphala in ayurvedic medicine. J Alternative Compl Med 2017;23(8):607–14. https://doi.org/10.1089/acm.2017.0083. Epub 2017. PMID: 28696777; PMCID: PMC5567597.
[27] Kumar MS, Kirubanandan S, Sripriya R, Sehgal PK. Triphala promotes healing of infected full-thickness dermal wound. J Surg Res 2008;144(1):94e101. https://doi.org/10.1016/j.jss.2007.02.049. Epub2007Jul27. PMID: 17662304.