Journal of Ayurveda and Integrative Medicine 14 (2023) 100719

Contents lists available at ScienceDirect

Journal of Ayurveda and Integrative Medicine

journal homepage: http://elsevier.com/locate/jaim

Original Research Article

Efficacy of *Jatyadi*, *Madhughrita* and honey tulle in wound management: *a three-arm randomized controlled clinical trial*

Dhrushnu Prasannan [a], Pradeep S. Shindhe [a, *], Prashant G. Jadar [b], Ramesh S. Killedar [a], Priyanka K. [a]

[a] *Department of Shalyatantra, KAHER's Shri B M Kankanawadi Ayurveda Mahavidyalaya, Shahapur, Belagavi, Karnataka, India*
[b] *Department of Rasashastra and Bhaishajya kalpana, KAHER's Shri B M Kankanawadi Ayurveda Mahavidyalaya, Shahapur, Belagavi, Karnataka, India*

ARTICLE INFO

Article history:
Received 27 May 2022
Received in revised form
11 April 2023
Accepted 19 April 2023
Available online xxx

Keywords:
Vrana
Wound healing
Jatyadi tulle
Honey tulle
Madhughrita tulle

ABSTRACT

Background: Ayurveda underlines the significance of wounds and wound healing. *Acharya Susruta* has highlighted the need for *shastiupakramas* in the management of the wound. Even with a multitude of therapeutic concepts and formulations in Ayurveda, wound management has yet to gain acceptance.
Objective: To evaluate the effect of Jatyadi tulle, Madhughrita tulle, and honey tulle in the management of *Shuddhavrana* (clean wound).
Materials and methods: A three-arm randomized, parallel group, active-controlled, open-label clinical trial. Randomization was done through online random number generator software to allocate 45 patients treatment into three groups. Trial groups were treated with *Jatyadi* tulle (JT), *Madhughrita* tulle (MG), and control group was treated with Honey tulle (HT) for 10 days, and assessment was done on the 5th and 10th day. The wound was assessed using the Bates Jensen wound assessment tool, and the efficacy of the dressing material was assessed using the Worcestershire tissue viability team dressing assessment form. The study outcomes were early wound healing and clinical cure.
Results: Within-group results were assessed using the Wilcoxon matched pairs test, and between-group results were assessed by Kruskal–Wallis ANOVA and Mann–Whitney U test. Significant results were obtained within-group (p value < 0.05) from day 0 and at various time points. The results between groups were found to be comparable; JT and MG were found to be significant in ease of application, removal, and patient comfort. No adverse drug events were identified throughout the study.
Conclusion: JT and MG tulle have shown significant results in the management of *shuddhavrana*.

1. Introduction

1.1. Scientific background and explanation of rationale

A wound is a rupture in the skin's or tissue's integrity that is typically accompanied by an alteration of structure and function [1]. Wound healing is a natural biological process that occurs in four distinct and well-defined stages: haemostasis, inflammation, proliferation, and remodelling [2]. The wounds that heal within 4 weeks and that progress through normal phases of healing are termed "acute wounds". This study mainly focuses on *shuddhavrana* (clean wound). According to Indian epidemiological data, chronic wounds were reported at 4.5 per 1000 population, whereas acute wounds were nearly doubled at 10.5 per 1000 population [3]. Wounds require proper cleansing and treatment with minimal adherent coverings to avoid infection and to promote healing. Picking the right dressing will speed up the healing process, reduce costs, and improve the patient's quality of life [4]. Modern science employs several forms of wound dressing based on the characteristics of the wound, such as low adherent, semi permeable, foam, hydro gel, hydrocolloid, etc. [5]. Tulle grass is a leno weave fabric gauze made of cotton, and which is categorised under low adherent dressing, being economical, safe, and widely available [6]. In the market, different types of tulles are available, like sofa tulle, bactigrass, paraffin tulle etc. which possess wound healing properties.

The necessity of wounds and wound healing is also emphasized in *Ayurveda*. Acharya Sushruta defined a wound as *gatravichurnane*, i.e., skin discontinuity, and classified it into two types based on *doshadusti: dustavrana* and *shuddhavrana*, where he clearly refers

* Corresponding author.
E-mail: dhrushnu@gmail.com
Peer review under responsibility of Transdisciplinary University, Bangalore.

https://doi.org/10.1016/j.jaim.2023.100719

Shastiupakramas for wound treatment [7]. Under the heading of *shastiupakramas*, the usage of *taila, ghrita, kashaya, rasakriya,* etc. are mentioned as an external application, and the same is being practiced with good clinical results. The use of *Madhughrita* in wound management is mentioned in *Sushruta Samhita* and *Jatyadi taila* is mentioned in *Saranghadara Samhita* as a wound healing agent [8–10].

Jatyadi taila and *madhughrita* are routinely used in day-to-day clinical practice, but these formulations have struggled to acquire mainstream or commercial recognition. This might be owing to the difficulties in creating a homogeneous combination of *madhu* (honey) and *ghrita* (cow ghee), or it could be due to excessive drug loss during its application over the wound, or due to unequal drug distribution over the gauze piece, or due to drug contamination. To address this, we considered developing a readily available *Ayurvedic* surgical dressing material with *jatyadi* ointment and *madhughrita* for the management of *shuddhavrana* (healing wound).

1.2. Specific objectives or hypotheses

The purpose of this study was to formulate and therapeutically evaluate a dressing material made with *Jatyadi* ointment, *Madhughrita*, and compare it to a group of patients treated with honey *tulle.* The secondary objective was to know the efficacy of dressing materials in order to make an effective commercial wound dressing.

2. Methods and materials

(a) **Trial design:** The study was a three-arm randomized, parallel group, active-controlled, open-label clinical trial. Randomization was done through online random number generator software to allocate 45 patients treatment into three groups.

(b) Institutional Ethics Committee approval was obtained for the study (Protocol number - BMK/19/PG/ST/6) along with CTRI Registration (CTRI/2020/11/029090). The information regarding the treatment, risks, benefits were explained to the patients and written informed consent was obtained from them. No modifications to the methods were made after the trial commencement. Adherence to the designed study was present until the completion of the study. In reporting the study findings, the CONSORT statement guidelines were followed [11].

Sample size: A total of 45 patients were selected and divided into three groups (15 each).

Randomization: The study was a randomised controlled trial, and patients were randomly divided into three different groups by computer generated random number software. The CONSORT flow diagram of the study is provided in Fig. 1.

Allocation of concealment mechanism: The patients were allocated to control and trial groups in a 1:1:1 ratio. The central case registration numbers were allotted to the patients as per the randomisation chart obtained by computer-generated random number.

Implementation: The patients were screened as per the inclusion and exclusion criteria by the investigators and treatment to the recruited patients were allotted as per the randomization chart.

Blinding: Study was open labeled and no blinding techniques were used.

3. Participants and preparation of formulations

3.1. Eligibility criteria for participants

Inclusive criteria - Patients with *shuddhavrana* [12] features, such as *jihvatalobham* (granulation tissue), *mrudu* (granulation tissue with a soft consistency), *snighda* (unctuous), *slekshna* (uniform epithelialization), *vigatvedana* (no pain), *nirasrava* (no abnormal discharge) and an age group between 20 years and 70 years were selected for the study from the OPD, IPD department of Shalyatantra, KAHER's Shri B.M.K Ayurveda Hospital and Research Centre, Belagavi. The types of wounds included in the study were post-fistulectomy wound, traumatic wound, post incision and drainage wound, infected cyst excised wound, post pilonidal sinus excised wound, diabetic foot ulcer, and bedsore.

Exclusive criteria - Patients who were suffering from *dustavrana* (non healing wound) or with any known case of systemic diseases, malignant wounds, uncontrolled diabetes, HbsAg, HIV I and II were excluded from the study.

3.2. Settings and locations for the collection of the data

Irrespective of sex, caste and socio-economic status, a total of 45 patients (15 patients in each group) of *shuddhavrana* (acute clean wound) who visited the OPD and IPD department of Shalyatantra KAHER's Shri B.M.K Ayurveda Hospital and Research Centre, Belagavi were enrolled for the study.

3.3. Raw drugs and finished products

3.3.1. Procurement

Drugs like *madhuchista* (bee wax), *madhu* (honey), *ghrita* (cow ghee) and *jatyadi* ointment were procured from GMP-certified KLE Ayurveda Pharmacy Khasbag, Belagavi. Leno weave gauze was procured from Lotus Surgical, Aurangabad. Identification and authentication of drugs were done at the AYUSH-certified ASU drug testing central research faculty of KAHER's Shri BMK Ayurveda Mahavidyalaya, Belagavi. The *Jatyadi* tulle and *Madhughrita* tulle were prepared and packed in the GMP-certified KLE Ayurveda Pharmacy. Standard honey tulles were purchased from the market. Finished products were sent for gamma radiation sterilization at Microtrol Solutions, Bengaluru.

3.3.2. Preparation of the tulle

The preparation of tulle was done as per the prepared Standard Operation Procedure [13]. All the materials were autoclaved 24 h before the procedure, and the room was sterilized with potassium permanganate and formalin.

3.3.2.1. Jatyadi tulle. Jatyadi ointment was obtained from a GMP certified KLE Ayurveda pharmacy and was impregnated over autoclaved 10 × 10 cm tulle grass while following all aseptic precautions [14]. Excess material was removed from the tulle by applying pressure, and the tulle was kept in between sheets of butter paper, followed by sterile packing. The weight of the tulle was measured before and after the procedure, and the ointment present in the tulle was 3.54 g. Prepared tulle material was kept in between the butter papers and packed in an alu-plastic bag. These sealed packets were sent for 25 kGy gamma sterilization [15]. A diagram of finished products is provided in supplementary material.

3.3.2.2. Madhughrita tulle. Madhu and *ghrita* were taken in equal quantities for the preparation of tulle. 70 g of *maduchista* (beeswax) was heated under a low flame and, after it melted, 350 g of *ghrita* was added to it. After it was allowed to cool, 350 g of honey was added and stirred well to make an ointment. Separately, prepared madhughrita ointment was placed in the vessel, followed by dipping 10 × 10 cm tulle grass in the vessel and removing excess material from the tulle with pressure. The weight of the tulle was

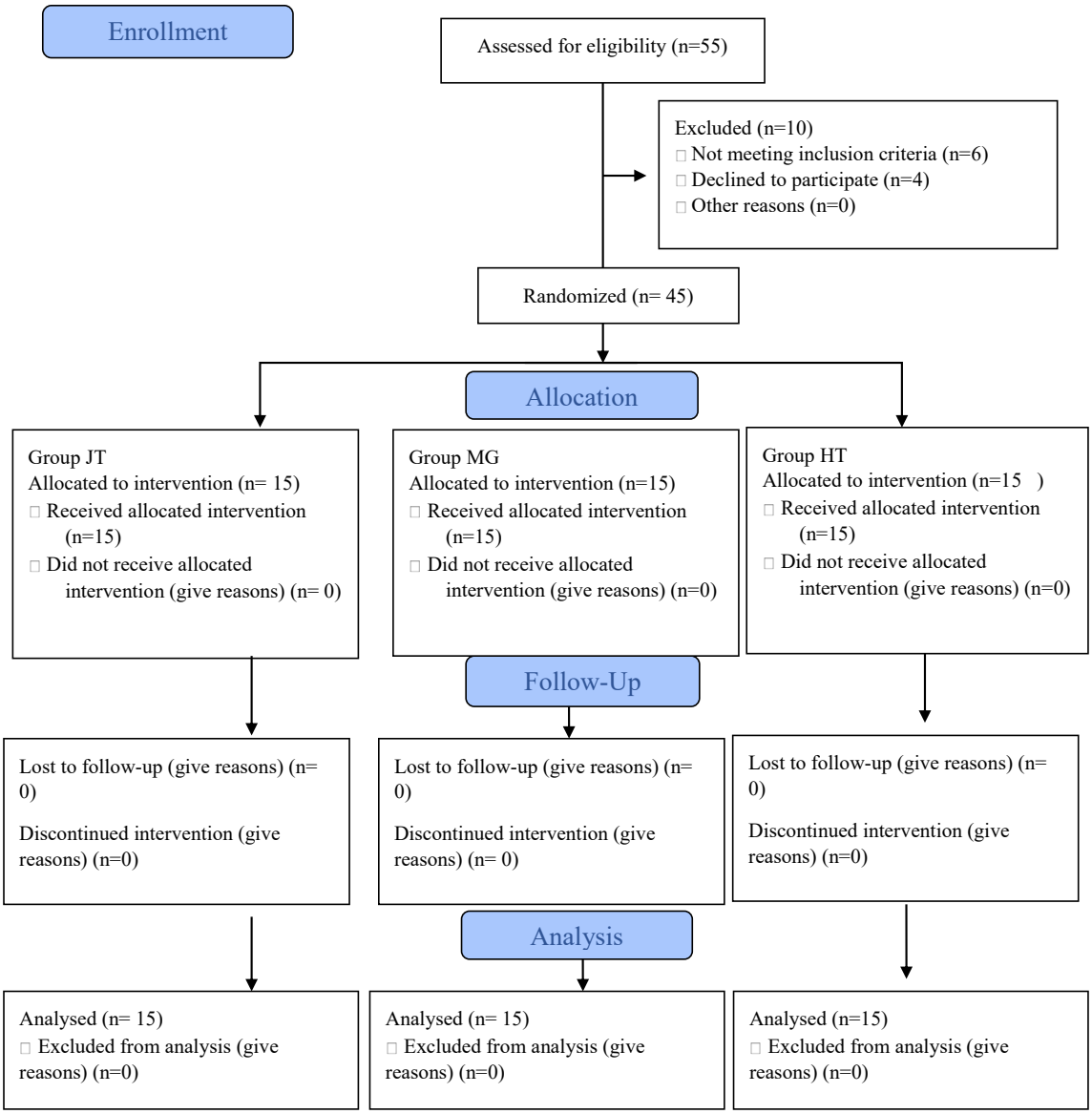

Fig. 1. CONSORT flow diagram of the study

measured before and after the procedure, and the ointment present in the tulle was 3.54 g. Prepared tulle material was kept between the butter papers and packed in an alu-plastic bag. These sealed packets were sent for 25 kGy gamma sterilization.

4. Interventions

45 patients were randomly divided into three different groups, group JT - *Jatyadi tulle* (trial), group MG - *Madhughrita tulle* (trial), and group HT - *Honey tulle* (control group). In all the three groups, application of tulle was done once a day for duration of 10 days. The assessments were done on the 0^{th} day, 5th day, and 10th day, and data was recorded systematically.

Data collection was done from March 2021 to January 2022. Patients were advised to inform any adverse events (AE) that occurred during the study to the principal investigator. In case of any AE, the patient was withdrawn from the study after following proper documentation, and providing information to the institutional ethical committee through the medical research centre.

5. Outcomes

5.1. Primary outcome

Assessment of the wound was done with Bates Jensen's wound evaluation criteria, which is an internationally recognized and more reliable wound assessment tool (Supplementary material) [16]. The study focused on *shuddhavrana* (healing wounds); therefore, wounds were assessed using Bates Jensen's criteria 1, 3, 7, 9, 10, 12, and 13 (size, edge, exudates type, skin colour surrounding wound, peripheral tissue oedema, granulation tissue, and epithelialization) at various time periods (baseline, 5th and 10th day).

5.2. Secondary outcome

Assessment of the dressing material was done with a Worcestershire tissue dressing assessment form (Supplementary material), which was assessed on the 10th day of treatment. The parameters like ease of application, ease of removal, dressing stay as longer or shorter, patient comfort, and wound bed were analyzed

using a questionnaire. The Worcestershire tissue dressing assessment form is used because it is found to be an internationally accepted and easiest method of assessment. Pre and Post treatment photography was taken to comment on the changes in the healing process.

6. Statistical methods

SPSS version 20.0 was used for the statistical analysis. Within the group, results were obtained using the Wilcoxon matched pairs test in different parameters like size, edge, exudates type, skin colour surrounding area, peripheral tissue oedema, granulation tissue, and epithelialization of the wound. The Kruskal–Wallis ANOVA and Mann–Whitney U test were performed to compare the three groups at different time points on assessment parameters. The Kruskal–Wallis ANOVA and Mann–Whitney U were used to assess the dressing material using the Worcestershire tissue viability team dressing assessment form.

7. Results

7.1. Subject characteristics

Age - In group JT out of 15 patients, 46.66% of patients were between the ages of 20 and 35 years, 20% were between the ages of 36 and 55 years, and 33.33% were between the ages of 56 and 70 years. In group MG, out of 15 patients, 40% were between the age groups of 20–35 years, 46.66% with an age group of 36–55 years, and 13.33% with an age group of 56–70 years. In Group HT, out of 15 patients, 46.66% were in the age group of 20–35 years, 26.66% in the age group of 36–55 years, and 26.66% in the age group of 56–70 years.

Gender - In terms of gender, 75.56% were men, while 24.44% were females, i.e., Group JT (12:3), Groups MG and HT (11:4). The overall majority of the patients (53.33%) were undergraduates as per education status.

Type of wound - Post fistulectomy wound (group JT - 46.66%, group MG - 53.33%, group HT - 26.66%), traumatic injury (JT: 13.33%, MG: 26.66%, HT: 20%), post incision and drainage wound (JT - 13.333%, MG - 20%, HT - 33.33%), excised wound from an infected cyst (JT - 13.33%), excised wound from a post pilonidal sinus (HT - 6.66%), bedsore (JT - 6.66%, HT - 6.66%), diabetic foot ulcer (JT - 6.66%, HT - 6.66%).

7.2. Primary outcome

Within the group's results were statistically significant with a p-value <0.05 in all the three groups in relation to the assessment criteria like size, edge, exudates type, peripheral tissue oedema, granulation tissue, and epithelialization except in the case of skin colour surrounding the area of wound (Tables 1 and 2). In the comparison of three groups by Kruskal–Wallis Anova, the mean size of the wound was 2.73, 2.67, and 2.53 in respect to groups JT, MG, and HT (Table 2). Percentage - wise, Group JT (45.45%) had higher efficacy than groups MG (38.71%) and HT(35.48%) from Day 0 to Day 10 in terms of wound size and change in exudate type, i.e., groups JT (64.29%) and MG (65.91%) had more efficacy than group HT (42.31%). However, in terms of change in epithelialization, Group HT (53.62%) exceeded Groups JT (46.38%) and MG (40.28%). Between the groups, results were found to be comparable across all three groups (JT, MG, and HT). Before and after photographs were taken and shown in Fig. 2 - group treated with JT; Fig. 3 - group treated with MG; and Fig. 4 - group treated with HT.

7.3. Secondary outcome

Groups JT and MG were found to be statistically significant with a p-value <0.05 in relation to ease of application, ease of removal, and patient comfort (Table 3). All the groups are comparable in relation to dressing stay and wound bed changes.

Harms - No adverse drug events were reported during the study.

8. Discussion

Wound healing would be a dynamic process that includes haemostasis, inflammation, proliferation, and remodelling [17]. Since the beginning of time, numerous kinds of dressings and dressing materials have been used to treat wounds. Optimal wound healing is dependent on the finest dressing material. A wide variety of dressing materials are available in modern science based on the features of the wound, of which only a few have potential data to back up their efficacy in improving wound healing [18]. Even with

Table 1
Comparison (within the group) from day 1 to day 10 with parameters of Bates Jensen wound assessment tool.

Sl. No	Parameter	Changes From	Group	Mean Diff.	SD Diff.	% Of Change	Z-Value	p-Value
01	Size of Wound	Day 0 – Day 10	JT	1.00	0.53	45.45	3.1798	0.0015*
			MG	0.80	0.56	38.71	2.9341	0.0033*
			HT	0.73	0.46	35.48	2.9341	0.0033*
02	Edge of Wound	Day 0 – Day 10	JT	1.60	0.51	58.54	3.4078	0.0007*
			MG	1.53	0.52	57.50	3.4078	0.0007**
			HT	1.40	0.74	55.26	3.1798	0.0015*
03	Exudates Type	Day 0 – Day 10	JT	1.80	0.86	64.29	3.4078	0.0007*
			MG	1.93	0.80	65.91	3.4078	0.0007*
			HT	1.73	0.80	63.41	3.2958	0.0010*
04	Skin Colour Surrounding Area	Day 0 – Day 10	JT	0.13	0.35	11.76	1.3416	0.1797
			MG	0.27	0.46	21.05	1.8257	0.0679
			HT	0.20	0.41	16.67	1.6036	0.1088
05	Peripheral Tissue Oedema	Day 0 – Day 10	JT	0.27	0.46	21.05	1.8257	0.0289*
			MG	0.47	0.52	31.82	2.3664	0.0180*
			HT	0.47	0.52	31.82	2.3664	0.0180*
06	Granulation Tissue	Day 0 – Day 10	JT	1.60	0.63	52.17	3.4078	0.0007*
			MG	1.87	0.92	53.85	3.3226	0.0009*
			HT	1.67	0.90	56.82	3.1798	0.0015*
07	Epithelialization	Day 0 – Day 10	JT	2.13	1.30	46.38	3.2958	0.0010*
			MG	1.93	0.80	40.28	3.4078	0.0007*
			HT	2.47	1.46	53.62	3.1798	0.0015*

Table 2
Comparison (between the groups) from day 1 to day 10 with parameters of Bates Jensen wound assessment tool.

Sl. No	Parameter	Treatment	Groups	Mean	Sd	Mean Rank	H-Value	p-Value
1	Size of wound	BT	JT	2.73	0.46	24.77	0.6990	0.7050
			MG	2.67	0.62	22.87		
			HT	2.53	0.64	21.37		
		AT	JT	1.13	0.35	23.00	0.0000	1.0000
			MG	1.13	0.35	23.00		
			HT	1.13	0.35	23.00		
2	Edge of Wound	BT	JT	2.73	0.46	24.77	0.6990	0.7050
			MG	2.67	0.62	22.87		
			HT	2.53	0.64	21.37		
		AT	JT	1.13	0.35	23.00	0.0000	1.0000
			MG	1.13	0.35	23.00		
			HT	1.13	0.35	23.00		
3	Exudate Type	BT	JT	2.80	0.86	21.97	0.3760	0.8290
			MG	2.93	0.80	24.50		
			HT	2.73	0.80	22.53		
		AT	JT	1.00	0.00	23.00	0.0000	1.0000
			MG	1.00	0.00	23.00		
			HT	1.00	0.00	23.00		
4	Skin colour surrounding area	BT	JT	1.13	0.35	21.50	0.8150	0.6650
			MG	1.27	0.46	24.50		
			HT	1.20	0.41	23.00		
		AT	JT	1.00	0.00	23.00	0.0000	1.0000
			MG	1.00	0.00	23.00		
			HT	1.00	0.00	23.00		
5	Peripheral tissue oedema	BT	JT	1.27	0.46	20.00	1.6300	0.4430
			MG	1.47	0.52	24.50		
			HT	1.47	0.52	24.50		
		AT	JT	1.00	0.00	23.00	0.0000	1.0000
			MG	1.00	0.00	23.00		
			HT	1.00	0.00	23.00		
6	Granulation tissue	BT	JT	3.07	0.88	21.50	2.4790	0.2890
			MG	3.47	0.64	27.03		
			HT	2.93	1.03	20.47		
		AT	JT	1.47	0.52	24.77	1.3150	0.5180
			MG	1.60	1.06	23.87		
			HT	1.27	0.46	20.37		
7	Epithelialization	BT	JT	4.60	0.74	21.93	0.3260	0.8500
			MG	4.80	0.41	23.90		
			HT	4.60	0.91	23.17		
		AT	JT	2.47	1.36	22.47	3.7320	0.1550
			MG	2.87	0.92	27.73		
			HT	2.13	1.25	18.80		

diverse medical formulations and various kinds of dressing materials, wound care is still a concern for a surgeon.

Size and edge of the wound - Significant size reduction was observed in JT and MG (Figs. 2 and 3; Tables 1 and 2). *Tikta* (bitter), *kashaya* (astringent), *rasa* (taste), *laghu* (lightness), *ruksha* (roughness), *gunas* (properties) of JT act as *vranaropana*. Active phytochemicals like flavonoids, crucial oils (terpenoids), tannins (phenolics), glycosides, steroids, and alkaloids also help in early healing [19,20]. *Ghrita* in MG acts as *vranaropana* (healing) and *kantivardhana* (improving lustre) [21,22]. Honey's *vranaropana* capability, and its anti-bacterial and anti-inflammatory properties, aid in size reduction [23].

Significant results were observed in JT and MG. *Jati* (*Myristica fragrans* Houtt), *Kushta* (Saussurea lappa CB Clarke), *Padmaka* (*Prunus puddum* Roxb Ex. Wall), and *Daruhardira* (Berberis aristate DC.) are present in JT. It has *kashaya* (astringent), *tikta* (bitter), *rasa* (taste), *kleda shoshana* (drying of exudates) as well as *lekhana* (scraping) properties that help in the reduction of exudates [24]. The *Alpa-abhishayandi* (less oozing) property of *ghrita* and the *vranashodana* property of honey together helped in the reduction of exudate. Glucose oxidase present in honey produces hydrogen peroxide, which enhances the reduction of exudates [25].

Skin colour surrounding area -Significant results were not observed because most of the patients enrolled in our study had acute wounds of short duration. Only a few enrolled patients had chronic wounds with skin colour surrounding the area.

Peripheral tissue oedema - The significant results were observed in JT and MG. Ingredients like *Patola* (*Trichosanthes dioica* Roxb), *Jati* (*M. fragrans* Houtt), and *Kushta* (Saussurea lappa CB Clarke), present in JT, have *shothahara* (anti-inflammatory) property. Curcumin, present in *haridra* (*Curcuma longa* Linn) and salicylic acid, present in *Jati*, act as anti-inflammatory and anti-microbial agents, helping in the reduction of peripheral tissue oedema [26,27]. *Sheeta* (cold) guna and *Kashaya rasa* of honey act as *vrana sothahara* and *ghrita* acts as *tridoshangna*. Honey's activity of cyclooxygenases 1 and 2 (COX1 and COX2) that intervene in the synthesis of prostaglandins helps in peripheral tissue odema [20]. Linoleic acid found in *ghrita* plays an important chemotaxic effect on microphages and promotes wound healing [28].

Granulation tissue - Significant results were observed in JT and MG. *Manjishta* (*Rubia cordifolia* Linn) and *Sariva* (*Hemidesmus indicus* R. Br) enhance the *raktadhatu*, which improves circulation and strengthens the *sira* (blood vessel) [29]. *Katuka* (*Picrorhiza kurroa*) found in the JT improves re-epithelialization, neovascularization, and migration of endothelial cells, dermal myofibroblasts, and fibroblasts into the wound bed [30]. *Tuttha* ($CuSO_4$) promotes angiogenic responses in vitro and in vivo wound models, thus helping in the rapid filling of wound area with granulation

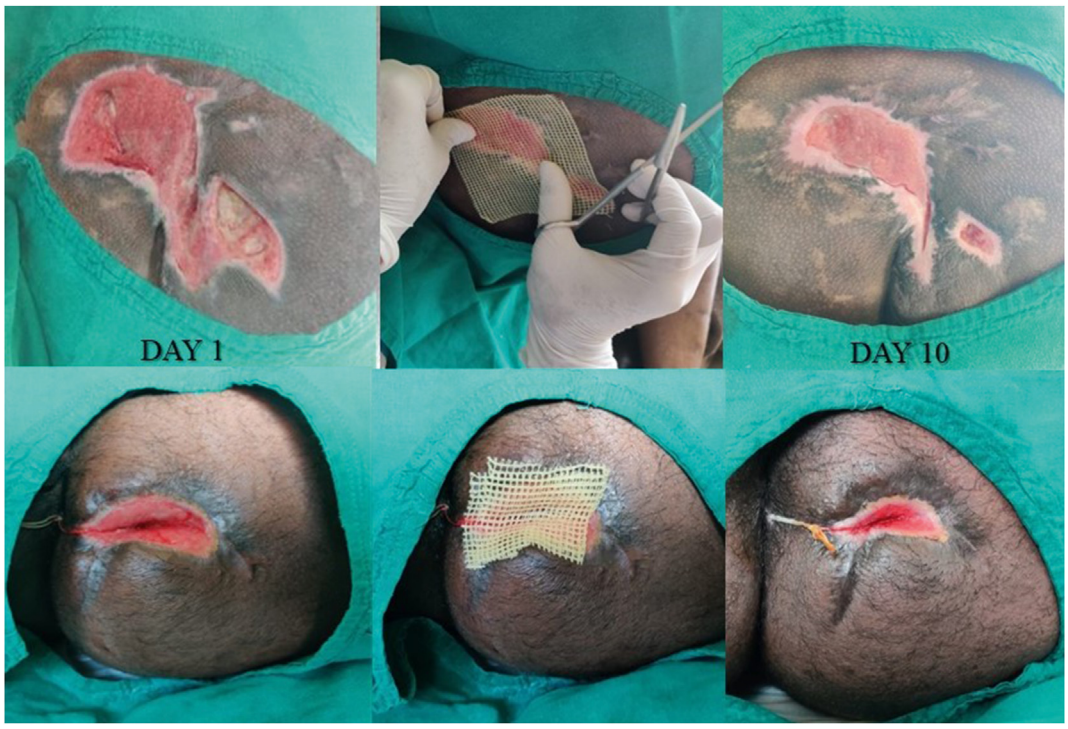

Fig. 2. Wound of Trial group JT (0th day and 10th day)

Fig. 3. Wound of Trial group MG (0th day and 10th day)

tissue [31]. *Tikta* and *kashaya rasa* of honey aids in *rakta shodhana* (purification of blood) property. The *Pittashamana* and *twak prasadana* (to make skin healthy) properties of *ghrita* also play a role in improving local blood circulation. Honey's osmotic impact keeps the wound moist and clean, and promotes healthy granulation tissue growth [32].

Epithelialization - Significant findings were observed in JT and MG. The presence of tannins and phytosterols in JT material accelerates wound healing by boosting capillary production and fibroblast proliferation, hence accelerating the rate of epithelisation [33]. *Madhura rasa* of *ghrita* and honey help in *prinana* (nutrition), *dhatuvardhana* (tissue growth) and *poshana* (nourishment) of wounds, thus helping in epithelialization. Wound healing and cell migration experiments revealed that honey significantly increases the regeneration potential of skin cells, which can enhance the re-epithelialization of the wound [34,35].

Fig. 4. Wound of Control group HT (0th day and 10th day)

Table 3
Comparison of three groups (JT, MG, HT) with status of Ease of application, Ease of removal, Patient comfort, Dressing stay as long/shorter and wound bed by Kruskal Wallis ANOVA.

Groups	Ease of application		Ease of removal		Patient comfort		Dressing stay as long/shorter as recommended		Wound bed	
	Mean ± SD	Mean rank	Mean ± SD	Mean rank	Mean ± SD	Mean rank	Mean ± SD	Mean rank	Mean ± SD	Mean rank
Group JT	3.87 ± 0.35	30.90	3.67 ± 0.62	29.80	3.67 ± 0.49	26.00	1.93 ± 0.26	22.00	3.00 ± 0.00	23.00
Group MG	3.60 ± 0.51	25.70	3.53 ± 0.52	26.67	3.73 ± 0.46	27.50	2.00 ± 0.00	23.50	3.00 ± 0.00	23.00
Group HT	2.73 ± 0.70	12.40	2.73 ± 0.46	12.53	3.20 ± 0.41	15.50	2.00 ± 0.00	23.50	3.00 ± 0.00	23.00
H-value	19.5620		17.9000		9.9520		2.0000		0.0000	
P-value	0.0001*		0.0001*		0.0070*		0.3680		1.0000	

Pair wise comparisons of groups A,B,C in relation to the Ease of application, Ease of removal, Patient comfort, Dressing stay as long/shorter as recommended by Mann–Whitney U test

Groups	Ease of application	Ease of removal	Patient comfort	Dressing stay as long/shorter as recommended	Wound bed
Group JT vs Group MG	p = 0.2211	p = 0.4429	p = 0.7716	p = 0.7716	p = 0.9835
Group JTvs Group HT	p = 0.0003*	p = 0.0006*	p = 0.0310*	p = 0.7716	p = 0.9835
Group MG vs Group HT	p = 0.0037*	p = 0.0023*	p = 0.0136*	p = 0.9835	p = 0.9835

*p < 0.05

Worcestershire wound assessment form - An ideal dressing material should keep the wound moist, protect it from trauma and infection, be simple to apply and remove, and be physically acceptable, or even pleasant [36]. The Worcestershire wound assessment form helped us to evaluate the excellence of the dressing material. *Tulle* grass, being a non-adherent substance, aids in the removal of dressing [37]. Taila and *maduchista* (bee wax) are present in JT and *Ghrita* present in MG with its *Sneha* (oleation) guna helps to keep the wound moist and promote wound healing. Beewax, being the non-adherent base material in both the groups (JT and MG), has the property to solidify the emulsified solutions and increase the water prevent capacity along with soothes and calms the skin [37]. The *snighda* (unctuous) *guna* of bee wax also aided in easy application, removal, and patient comfort [38].

Limitations - The study was conducted on acute clean wounds, but efficacy in all types of wounds, like chronic non-healing wounds, burns, etc., should be assessed to generate evidence-based practice and for global acceptance. The small sample size and short observation period are the other limitations of the study.

9. Conclusion

Ayurveda topical medicaments (Jatyadi tulle, *Madhughrita tulle*, Honey tulle) showed significant results within the group and between the groups results were comparable. *Jatyadi tulle* and *Madhughrita tulle* were found to be significant in relation to ease of application, ease of removal, and patient comfort. *Jatyadi tulle* and *Madhughrita tulle* were found effective in the management of *shuddhavrana* and can be considered as a good dressing material.

Source of funding

None.

Declaration of Competing Interest

None.

Acknowledgement

Dr.Suhas Kumar Shetty, Principal, KAHER's Shri B. M. Kankanawadi Ayurveda Mahavidyalaya, Shahapur, Belagavi and Microtrol Sterilisation Service, Bengaluru.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jaim.2023.100719.

References

[1] Sriram Bhat M, editor. SRB'S manual of surgery. 6th ed. New Delhi: Jaypee Brothers and Medical Publishers; 2017 [chapter 1] page.
[2] Guo S, Dipietro LA. Factors affecting wound healing. J Dent Res 2010;89(3): 219–29. https://doi.org/10.1177/0022034509359125.
[3] Gupta N, Gupta SK, Shukla VK, Singh SP. An Indian community-based epidemiological study of wounds. J Wound Care 2004 Sep;13(8):323–5. https://doi.org/10.12968/jowc.2004.13.8.26657. PMID: 15469216.
[4] Britto EJ, Nezwek TA, Robins M. Wound Dressings. [Updated 2021 Jun 5]. In: statpearls [Internet]. Treasure Island (FL): statpearls Publishing, https://www.ncbi.nlm.nih.gov/books/NBK470199/#; 2022 Jan.
[5] Dabiri G, Damstetter E, Phillips T. Choosing a wound dressing based on common wound characteristics. Adv Wound Care 2016 Jan 1;5(1):32–41. https://doi.org/10.1089/wound.2014.0586. PMID: 26858913; PMCID: PMC4717498.
[6] Kumarjain Sudhir, Stoker David l, Ramantanwar, editors. Basic surgical skills and techniques. 3rd ed. New Delhi: Jaypee Brothers and Medical Punlishers; 2008. p. 117 [chapter 15].
[7] (reprint edition 2017) English translated, Susruta Samhita of Acharya Susruta Sutra Sthana [Chapter 22] Verse 6. In: Murthy KR Srikanta, editor. Varanasi: Chaukhamba Orientalia; 2017. p. 165.
[8] (reprint edition 2017) English translated, Susruta Samhita of Acharya Susruta, Sutrastana Sthana [Chapter 16] Verse 15. In: Murthy KR Srikanta, editor. Varanasi: Chaukhamba Orientalia; 2017. p115.
[9] (reprint edition 2017) English translated, Susruta Samhita of Acharya Susruta Chikista, Sthana [Chapter 1] Verse 4. In: Murthy KR Srikanta, editor. Varanasi: Chaukhamba Orientalia; 2017. p. 03.
[10] Ravindra Angadi, editor English translated, Sharangadara Samhita of Acharya Sharanghadara, Madhyama Khanda, [Chapter 9], Verse 168, 1st ed. 2017. Varanasi: Chaukhamba subharati prakashan. p 323.
[11] Schulz KF, Altman DG, Moher D. CONSORT Group CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. BMC Med 2010;8:18.
[12] (reprint edition 2017) English translated, Susruta Samhita of Acharya Susruta Chikista Sthana [Chapter 1] Verse 7. In: Murthy KR Srikanta, editor. Varanasi: Chaukhamba Orientalia; 2017. p. 5.
[13] Ramo Cusumano F, Baltimore MD. Antimicrobial impregnated Gauze pads and method of making same. United States Patent Office Serial No. 11,328. Patented; 1954.
[14] Pradeep Shindhe, Killedar RS, Laxmikant SD, Santosh Y, Madiwalar M. Evaluation of wound healing activity of jatyadi ointment and jatyadi taila in the management of shuddha vrana - a randomised controlled trial. AAM 2020;9(2): 98–107. https://doi.org/10.5455/AAM.85523 [cited April 29, 2022];.
[15] Nguyen H, Morgan DA, Forwood MR. Sterilization of allograft bone: is 25 kGy the gold standard for gamma irradiation? Cell Tissue Bank 2007;8(2):81–91. https://doi.org/10.1007/s10561-006-9019-7. Epub 2006 Jul 5. PMID: 16821106.
[16] Bates-Jensen BM, McCreath HE, Harputlu D, Patlan A. Reliability of the Bates-Jensen wound assessment tool for pressure injury assessment: the pressure ulcer detection study. Wound Repair Regen 2019 Jul;27(4):386–95. https://doi.org/10.1111/wrr.12714. Epub 2019 Mar 18. PMID: 30828890; PMCID: PMC6693585.
[17] Guo S, Dipietro LA. Factors affecting wound healing. J Dent Res 2010;89(3): 219–29. https://doi.org/10.1177/0022034509359125.
[18] Frykberg Robert G, Banks Jaminelli. Challenges in the treatment of chronic wounds. Adv Wound Care 2015;4(9):560–82. https://doi.org/10.1089/wound.2015.0635.
[19] Comparative study on the antibacterial activity of phytochemical flavanones against methicillin resistant Staphylococcus aureus. J Ethnopharmacol 1996;50(1):27–34. PMID: 8778504 16.
[20] Satheesh V Dev, Shailaja S, Sharma Vishwanath. A comparative clinical study on the effect of JatyadiTaila in varicose ulcer and diabetic ulcer. IAMJ 2015;3(7):1952–8.
[21] Dr Ganesh Krushna Garde Editor(s). Ashtang Hrudya of Vagbhat, Sutrasthan; Dravadravya vidnyaniya: Chapter 5, Verse 37-38. Pune-2. Anmol Prakashan; 2007. p. 20 (reprint 2007 Ed.).
[22] Kaviraj Ambikadatta Shastri Editor(s). Sushruta Samhita of Sushruta, Sutrasthana; Drava dravya vidhi: Chapter 45, Verse 96. Varanasi: Chaukhambha Sanskrit Sansthana; 2009. p. 228 (Reprint 2009 Ed.).
[23] Naureen I, Iqbal H, Aslam F, Jamal S, Sattar A, Zahid M. Antimicrobial and antioxidant activity of honey. Am Acad Scientif Res J Eng Technol Sci 2022;87(1):204–17.
[24] Satheesh V Dev, Shailaja SV, Sharma Vishwanath. A comparative clinical study on the effect of JatyadiTaila in varicose ulcer and diabetic ulcer. IAMJ 2015;7: 52–8.
[25] Minden-Birkenmaier BA, Bowlin GL. Honey-based templates in wound healing and tissue engineering. Bioengineered 2018;5(2):46.
[26] Gokhale AB, Damre AS, Kulkami KR, Saraf MN. Preliminary evaluation of anti-inflammatory and anti-arthritic activity of *S. lappa*, *A. speciosa* and *A. aspera*. Phytomedicine 2002;9(5):433–7. PMID: 12222664.
[27] Salehi B, Stojanović-Radić Z, Matejić J, Sharifi-Rad M, Kumar NV, Martins N, et al. The therapeutic potential of curcumin: a review of clinical trials. Eur J Med Chem 2019 Feb 1;163:527–45.
[28] Nooh HZ, Nour-Eldien NM. The dual anti-inflammatory and antioxidant activities of natural honey promote cell proliferation and neural regeneration in a rat model of colitis. Acta Histochem 2016;118:588–95.
[29] Moch D, Schewe Tankred, Kühn Hartmut, Schmidt D, Buntrock P. The linoleic acid metabolite 9DS-hydroxy-10, 12(E, Z) – octadecadienoic acid is a strong proinflammatory mediator in an experimental wound healing model of the rat. Biomed Biochim Acta 1990;49:201–7.
[30] Waghmare S. D, Londhe Gaurav P, Dakhore Rajesh N, Patange Gauri P. Varicose Ulcer managed with Panchavalkala Kashaya and Jatyadi Taila- A Case Study 2019; 8(5):1321-1327.
[31] Singh AK, Sharma A, Warren J, Madhavan S, Steele K, Rajesh Kumar NV, et al. Source of support: nil conflict of interest: none Maheshwari RK.picroliv accelerates epithelialization and angiogenesis in rat wounds. Planta Med 2007;73(3):251–6. PMID: 17318779.
[32] Raju Katari S, Alessandri Giulio, Ziche Marina, Pietro M, Ceruloplasmin Gullino. Copper Ions, and angiogenesis. J Natl Cancer Inst 1982;69(5):1183–8.
[33] Vijaya KK, Nishteswar K. Wound healing activity of honey: a pilot study. Ayu 2012;33(3):374–7. https://doi.org/10.4103/0974-8520.108827.
[34] Ibrahim N', Wong SK, Mohamed IN, Chin KY, Ima-Nirwana S, Shuid AN, et al. Wound healing properties of selected natural products. Int J Environ Res Publ Health 2018;15(11):2360–PMC6266783.
[35] Martinotti S, Ranzato E. Cellular and molecular mechanisms of honey wound healing. Hauppauge, NY, USA: Nova Publishers Inc.; 2014.
[36] Ranzato E, Martinotti S, Burlando B. Honey exposure stimulates wound repair of human dermal fibroblasts. Burns Trauma 2013;1:32–8. https://doi.org/10.4103/2321-3868.113333.
[37] Kristo Nuutila, Elof Eriksso. Advances in wound care. Dec 2021. p. 685–98. https://doi.org/10.1089/wound.2020.1232.
[38] Mishra Kumar Abhaya, Krishnapriya NV Ramesh. Therapeutic uses of bees wax in Ayurveda and its physico chemical analyses: a review. Int J Res Ayurveda Pharm 2017;8(1):25–6.