

ORIGINAL RESEARCH



Clinical Research on the Treatment of Post-Appendectomy Incision Infection with Traditional Chinese Medicine Patch Therapy

Sheng Li, Haixia Ren, Yan Li, Huan Liu, Jiang Du, Guangtai Cao

Department of Surgery II, East Hospital, Hebei Cangzhou Hospital of Integrated Traditional Chinese Medicine and Western Medicine, Cangzhou, Hebei, China

* Corresponding Author: Sheng Li; E-mail: lisf1975@163.com

Abstract

Background

This study aimed to evaluate the efficacy and safety of an external Traditional Chinese Medicine patch containing Mirabilite and Borneol for improving incision healing and preventing postoperative infection after appendectomy.

Methods

This prospective randomized controlled trial included 120 patients undergoing appendectomy for acute suppurative appendicitis were randomly assigned to an intervention group and a control group. Both groups received routine postoperative intravenous antibiotics and sterile gauze dressing. The intervention group additionally received an external Traditional Chinese Medicine patch composed of Mirabilite (500 g) and Borneol (10 g), applied over the surgical incision once daily for 5–7 days. Primary outcome was surgical incision healing grade. Secondary outcomes included postoperative pain scores, time to suture removal, swelling area relative to incision length, dressing change frequency, length of hospital stay, postoperative complications, and serum inflammatory cytokine levels including TNF- α , IFN- γ , IL-1 β and IL-8.

Results

The intervention group showed a significantly higher rate of Grade A healing ($P < 0.001$), and a higher rate of Grade B healing ($P = 0.002$). Postoperative VAS pain scores were significantly lower in the intervention group ($P < 0.001$). Time to suture removal, swelling-to-incision length ratio, dressing change frequency, and hospital stay were all significantly reduced in the intervention group ($P < 0.001$). The incidences of incision infection and abdominal abscess were significantly lower in the intervention group ($P = 0.019$ and $P = 0.036$, respectively). Although serum levels of TNF- α , IFN- γ , IL-1 β and IL-8 increased postoperatively in both groups, the magnitudes of increase were significantly smaller in the intervention group ($P < 0.001$).

Conclusions

External application of a Traditional Chinese Medicine patch containing Mirabilite and Borneol significantly improves postoperative wound healing and reduces infection-related complications following appendectomy for acute suppurative appendicitis. The therapeutic effects may be associated with modulation of the postoperative inflammatory response.

Keywords: appendicitis, appendectomy, incision infection, Traditional Chinese Medicine, patch therapy, Mirabilite, Borneol

Introduction

Acute appendicitis, a prevalent surgical emergency characterized by obstructive or infectious inflammation of the appendix, most commonly manifests with migratory right lower quadrant pain, fever, and gastrointestinal symptoms¹. Appendectomy stands as the definitive curative procedure, recommended promptly upon diagnosis due to its relative simplicity and favorable overall prognosis². However, as an operation involving exposure to enteric contents, it is classified as a contaminated surgery. This renders the surgical incision particularly vulnerable to intraoperative contamination by pathogens such as *Escherichia coli*, leading to a high risk of postoperative surgical site infection (SSI)³. Reported SSI rates following appendectomy range from 8.8% in uncomplicated cases to over 20.0% in suppurative or perforated appendicitis, figures that consistently rank among the highest for abdominal procedures⁴. SSI significantly impedes recovery, extends hospitalization, and elevates both the psychological distress and economic cost for patients⁵. Consequently, developing effective strategies to mitigate this

complication remains a persistent and significant challenge in clinical practice.

Traditional Chinese Medicine (TCM) conceptualizes appendicitis as “intestinal abscess”. Its theoretical framework attributes the disease to Qi stagnation and blood stasis within the intestinal tract, which subsequently transforms into pathogenic heat. This accumulated heat-toxicity is believed to cause tissue necrosis and suppuration⁶. The core therapeutic principle is therefore to “unblock the fu-organs and purge heat”. This logic extends to the postoperative state, where infection is interpreted as a persistence of damp-heat and residual toxic stasis, making “clearing heat and purging fire” a relevant therapeutic objective in the recovery phase⁶.

Guided by this theory, the present study investigates an external treatment modality. The intervention is derived from Bingpeng San (Borneol and Borax Powder), a classic external formula for throat inflammation documented in Chen Shigong’s Ming Dynasty surgical text, *Orthodox Manual of Surgery*⁷. Adapted to target the pathogenesis of “intestinal abscess”, the simplified formula comprises two

principal herbs: Mirabilite (Mang Xiao) as the monarch herb and Borneol (Bing Pian) as the adjuvant and guide herb. In TCM pharmacology, this combination is posited to work synergistically to clear heat, resolve abscesses, disperse accumulations, and alleviate pain at the local site.

Despite the long-standing theoretical basis and the documented use of its components, there is a paucity of clinical reports in China specifically evaluating TCM patch therapy for SSI prevention post-appendectomy. Consequently, this study aims to empirically assess the impacts of a Mirabilite and Borneol external patch on wound healing and the prevention of incision infection following appendectomy. The findings are intended to generate clinical evidence and contribute to the experiential knowledge base regarding this integrative treatment approach.

Materials and Methods

Study design

This prospective, randomized controlled trial with a parallel-group design was carried out at the Cangzhou Hospital of Integrated Traditional Chinese and Western Medicine, Hebei Province, China. The study protocol received approval from the hospital's Ethics Committee/Institutional Review Board, and written informed consent was obtained from all enrolled participants.

Participants

This study enrolled 120 patients admitted to our hospital between January 2023 and December 2024 who underwent appendectomy for acute suppurative appendicitis.

Inclusion criteria: (1) Age 20-40 years; (2) Clinical and pathological diagnosis of acute suppurative appendicitis; (3) Symptom duration < 1 week; (4) Met the surgical indications for appendectomy.

Exclusion criteria: (1) Pre-existing skin lesions, ulcers, or known hypersensitivity to the study medications; (2) Severe primary cardiac, hepatic, or renal disease; (3) Concurrent other abdominal surgery; (4) Receiving other treatments that might interfere with the study outcomes; (5) Pregnancy or lactation (due to the traditional contraindications and potential abortifacient effects of the study herbs); (6) Poor adherence to the treatment protocol; (7) Incomplete data affecting outcome assessment; (8) Occurrence of severe adverse events or complications necessitating treatment discontinuation; (9) Voluntary withdrawal by the patient.

Randomization and blinding

A computer-generated random number sequence was produced by an independent biostatistician using SPSS (version 27.0). Participants were randomly assigned in a 1:1 ratio to either the intervention group or the control group. Allocation concealment was ensured by placing the group assignments in sequentially numbered, opaque, sealed envelopes, which were opened only after the patient had completed baseline assessments and was ready to receive the allocated intervention. Given the characteristics of the topical intervention, blinding of the patients and performing surgeons was not feasible. However, the outcome assessors who evaluated wound healing, swelling, and other clinical parameters, as well as the laboratory personnel who performed the cytokine assays, remained blinded to group allocation throughout the study.

Interventions

Patients in the control group received postoperative intravenous drip of a second-generation cephalosporin plus ornidazole (Hunan Jiudian Pharmaceutical Co., Ltd., Specification: 0.25 g). The surgical incision was managed solely with external sterile gauze dressing.

Patients in the intervention group received the same postoperative prophylactic medication as the control group. Additionally, starting on the day of surgery, they underwent external TCM patch therapy using a cloth pouch containing Mirabilite (Mang Xiao) and Borneol (Bing Pian). The formula consisted of 500 g of Mirabilite and 10 g of Borneol. The herbs were ground into a fine powder, placed into a double-layer gauze pouch, and soaked in 75% medical-grade alcohol for 1 to 2 hours. After removal, the pouch was allowed to stand at room temperature for 20 minutes before application. The gauze pouch was then applied externally over the abdominal incision for 6 hours per session, once daily, for a continuous period of 5 to 7 days. Observation commenced on postoperative day 3, and dressing changes were performed based on the patient's infection status.

Outcome measures

The healing rate of the surgical incision was compared between the two groups, with reference to the standardized wound healing classification criteria: (1) Grade A Healing: The incision edges are well-approximated and smooth, with no induration, redness, swelling, pain, or dehiscence. (2) Grade B Healing: The incision exhibits scarring, induration, or redness/swelling, but without purulent discharge. (3) Grade C Healing: The incision is partially or completely dehiscent and non-healed, with the presence of purulent exudate.

The visual analogue scale (VAS) scores for pain, the time of suture removal, the area of swelling/length of incision, the frequency of dressing changes and the hospital stay were compared in both groups.

The incidence rates of adverse healing outcomes such as incision infection, incision dehiscence, stump leakage, and abdominal abscess were compared between the two groups. The criteria for incision infection: the incision shows typical inflammatory manifestations such as redness, swelling, heat, and pain, pus is discharged after needle puncture, or the body temperature is $\geq 38^{\circ}$, or the pathogen culture of the secretions is positive for bacteria, meeting any one of these conditions is considered incision infection.

The levels of tumor necrosis factor- α (TNF- α), interferon- γ (IFN- γ), interleukin-1 β (IL-1 β), as well as interleukin-8 (IL-8) were compared in both groups. On the day of admission and the morning after the end of treatment, 3.0 mL of fasting venous blood was drawn from each patient. The blood was centrifuged at 3000 r/min for 10 minutes to extract the serum. Then, the serum levels of TNF- α , IFN- γ , IL-1 β as well as IL-8 were determined by enzyme-linked immunosorbent assay (ELISA, Shanghai Hengyuan Biotechnology Co., Ltd).

Statistical analysis

Data were analyzed using SPSS software (version 27.0). Continuous variables were presented as mean $\pm$ standard deviation and compared using Student's t-test. Categorical variables will be presented as frequencies (percentages) and compared using the Chi-square test. A two-sided p-value < 0.05 was considered statistically significant.

Table 1 Baseline data between the two groups

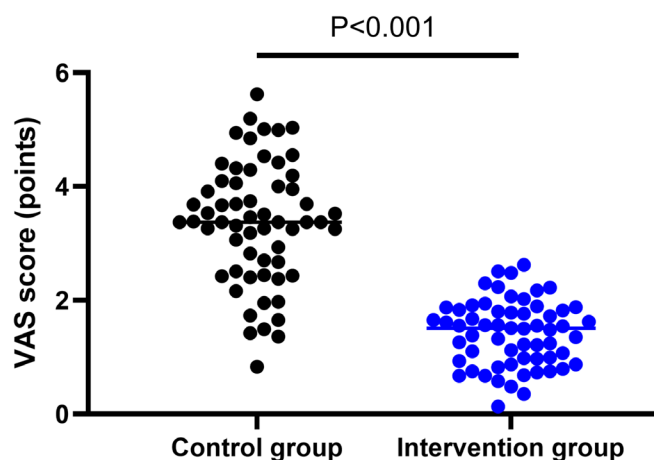
Item	Control group (n=60)	Intervention group (n=60)	χ^2/t	P
Gender			0.035	0.853
Male	34 (56.67)	35 (58.33)		
Female	26 (43.33)	25 (41.67)		
Age (years)	31.35±6.58	31.47±6.64	0.099	0.921
Course of disease (days)	2.23±0.52	2.19±0.50	0.429	0.668
Operation time (min)	32.15±10.32	31.68±10.42	0.248	0.804

Table 2 Surgical incision healing rate between the two groups

Groups	Cases	Healing rate		
		Grade A	Grade B	Grade C
Control group	60	43 (71.67)	15 (25.00)	2 (3.33)
Intervention group	60	57 (95.00)	3 (5.00)	0 (0.00)
χ^2		11.760	9.411	0.508
P		<0.001	0.002	0.475

Table 3 Incidence rates of adverse healing outcomes between the two groups

Groups	Cases	Incision infection	Incision dehiscence	Stump leakage	Abdominal abscess
Control group	60	7 (11.67)	2 (3.33)	3 (5.00)	6 (10.00)
Intervention group	60	0 (0.00)	0 (0.00)	1 (1.67)	0 (0.00)
χ^2		5.461	0.508	0.258	4.386
P		0.019	0.475	0.611	0.036

**Figure 1 Postoperative VAS score between the two groups**

Results

Baseline data

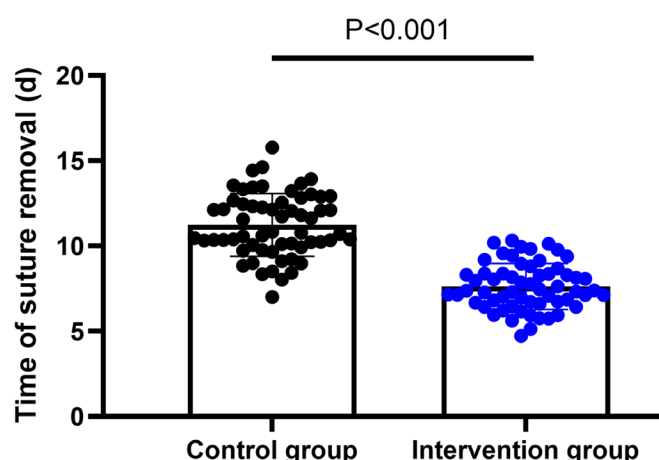
No differences were seen in baseline data (gender, age, course of disease and operation time) between both groups ($P>0.05$, Table 1).

Surgical incision healing rate

In contrast to the control group, the intervention group showed a significantly higher rate of Grade A healing (95.00% vs. 71.64%, $P < 0.001$), and a higher rate of Grade B healing (25.00% vs. 5.00%, $P = 0.002$) (Table 2).

Postoperative VAS score

Postoperative VAS pain scores were significantly lower in the intervention group (mean $\pm$ SD, 1.41 ± 0.57 vs. 3.36 ± 1.06) compared with the control group ($P<0.001$, Figure 1).

**Figure 2 Time of suture removal between the two groups**

Time of suture removal

In contrast to the control group, the time of suture removal in the intervention group was significantly shorter (7.62 ± 1.35 vs. 11.23 ± 1.84 days) ($P<0.001$, Figure 2).

Area of swelling/length of incision

In contrast to the control group, the area of swelling/length of incision in the intervention group was significantly smaller (0.64 ± 0.28 cm²/cm vs. 2.32 ± 0.51 cm²/cm) ($P<0.001$, Figure 3).

Frequency of dressing changes

In contrast to the control group, the frequency of dressing changes in the intervention group was significantly less (3.46 ± 0.53 vs. 5.00 ± 0.52 times/week) ($P<0.001$, Figure 4).

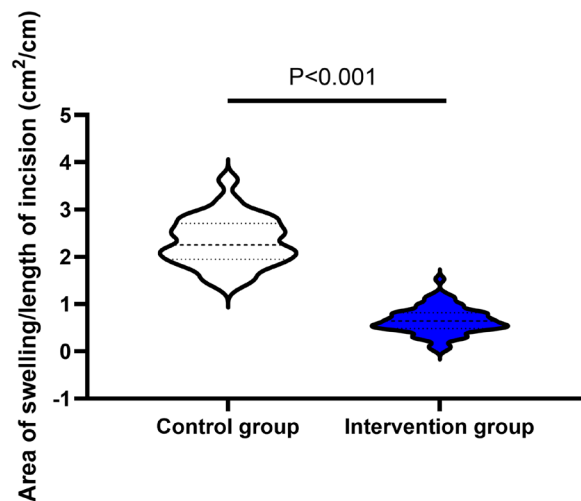


Figure 3 Area of swelling/length of incision between the two groups

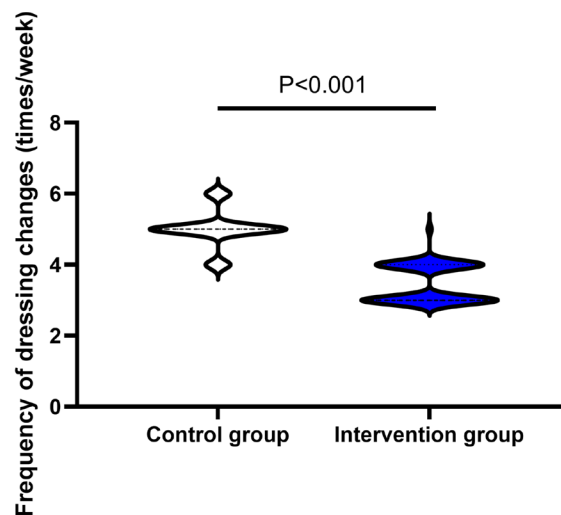


Figure 4 Frequency of dressing changes between the two groups

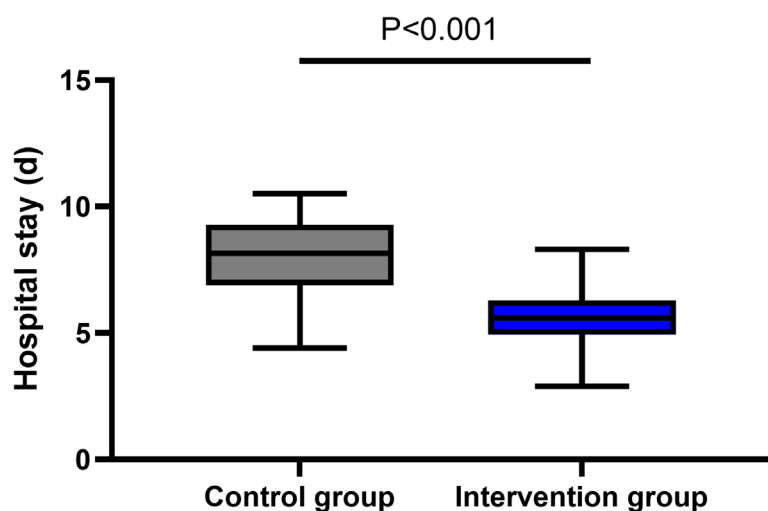


Figure 5 Hospital stay between the two groups

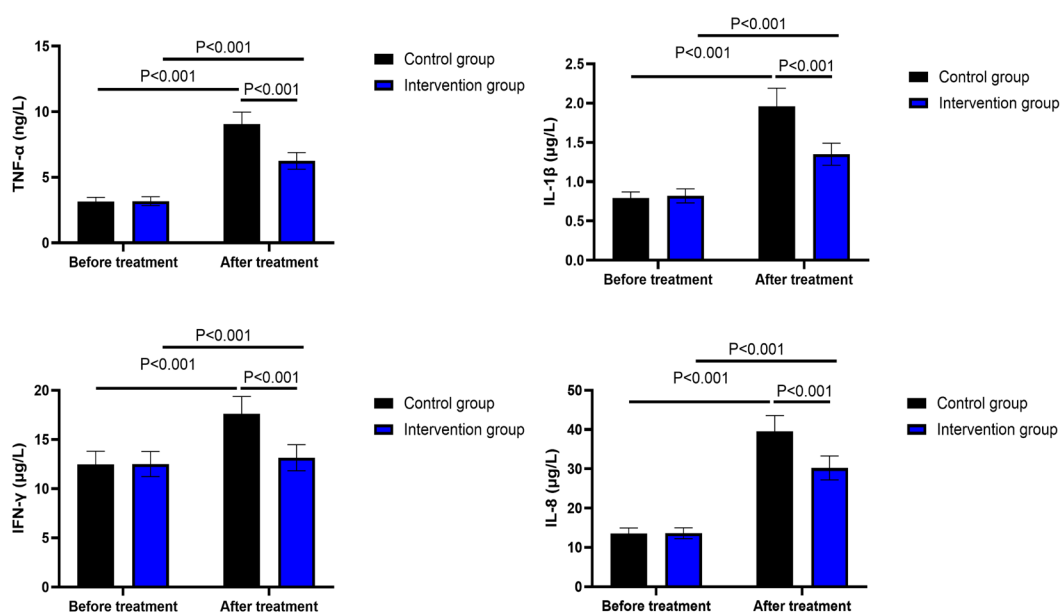


Figure 6 Serum levels of TNF- α , IFN- γ , IL-1 β and IL-8 between the two groups

Hospital stay

In contrast to the control group, the hospital stay in the intervention group was significantly shorter (5.67 ± 1.06 vs. 8.12 ± 1.36 days) ($P < 0.001$, Figure 5).

Incidence rates of adverse healing outcomes

The incidences of incision infection (0.00% vs. 11.67%) and abdominal abscess (0.00% vs. 10.00%) were significantly lower in the intervention group ($P = 0.019$ and $P = 0.036$, respectively) compared with the control group. There was no statistically significant difference in the incidence of incision dehiscence (0.00% vs. 3.33%) and stump leakage (1.67% vs. 5.00%) between the two groups ($P = 0.475$ and $P = 0.611$), as shown in Table 3.

Serum levels of TNF- α , IFN- γ , IL-1 β and IL-8

Prior to treatment, no significant differences were seen in the serum levels of TNF- α , IFN- γ , IL-1 β and IL-8 between both groups ($P > 0.05$). After treatment, the serum levels of TNF- α , IFN- γ , IL-1 β and IL-8 in both groups significantly increased ($P < 0.001$), but those in the intervention group were lower compared with the control group (TNF- α : 6.25 ± 0.63 vs. 9.05 ± 0.92 ng/L; IFN- γ : 13.15 ± 1.32 vs. 17.60 ± 1.78 μ g/L; IL-1 β : 1.35 ± 0.14 vs. 1.96 ± 0.23 μ g/L; IL-8: 30.24 ± 3.05 vs. 39.52 ± 4.05 μ g/L) ($P < 0.001$, Figure 6).

Safety outcomes

No local or systemic adverse events attributable to the Mirabilite-Borneol patch were reported in the intervention group. Specifically, no cases of skin erythema, pruritus, blistering, maceration, or allergic contact dermatitis were observed at the patch application site. All patients tolerated the once-daily 6-hour application well, with no discontinuations due to discomfort.

Discussion

This research demonstrates that the adjunctive use of a TCM patch containing Mirabilite and Borneol, in addition to standard antibiotic prophylaxis, significantly improved several key outcomes following appendectomy for acute suppurative appendicitis. The intervention group showed a higher rate of Grade A wound healing, reduced postoperative pain (VAS scores), shorter time to suture removal, decreased localized inflammation (swelling area/incision length), lower frequency of dressing changes, shorter hospital stays, and a reduced incidence of incision infection and abdominal abscess. Furthermore, the intervention was associated with a more favorable modulation of postoperative inflammatory markers, including lower serum levels of TNF- α , IFN- γ , IL-1 β along with IL-8.

The primary finding of enhanced wound healing aligns with the accumulating evidence supporting the role of TCM external therapies in postoperative recovery⁸. However, direct comparisons are limited as few studies have specifically investigated the Mirabilite-Borneol combination for SSI prevention after appendectomy. Our results extend the applicability of principles historically used for conditions like sore throat to the management of postoperative wounds⁹, validating the TCM tenet that “the principles of external treatment are the same as those of internal treatment” when the pathogenesis aligns.

The significant reduction in infection rates (incision infection and abdominal abscess) is a critical outcome. This finding may be explained through several interconnected mechanisms

rooted in both TCM theory and modern pharmacology: (1) Anti-inflammatory and edema-reducing action: The observed decrease in the swelling-to-incision length ratio and the more moderated rise in pro-inflammatory factors (TNF- α , IL-1 β , IL-8) point to a potent anti-inflammatory effect. Mirabilite (sodium sulfate), through its hyperosmotic property, can draw tissue exudate and reduce edema, thereby improving local microcirculation¹⁰. Borneol (d-borneol) has documented anti-inflammatory properties, likely inhibiting key inflammatory pathways¹¹. The synergy of these actions can create a local microenvironment less conducive to the propagation of infection and more favorable for tissue repair². Antimicrobial and biofilm-disrupting potential: While not directly measured in this study, both herbs possess purported antimicrobial qualities. The alcohol-soaking process of the patch may further enhance antiseptic properties at the wound interface. More importantly, by reducing inflammation and edema, the therapy may indirectly hinder bacterial colonization and biofilm formation, which are pivotal in the development of SSI^{12,13,3}. Analgesic effect and improved patient comfort: The lower VAS scores in the intervention group are clinically meaningful. Borneol is known for its analgesic and cooling sensory effects. Reduced pain can lead to better patient mobility, deeper breathing, and reduced physiological stress, all of which can indirectly support immune function and recovery, potentially contributing to the lower infection rates observed¹⁴.

The significant attenuation of the postoperative cytokine surge (TNF- α , IFN- γ , IL-1 β , IL-8) in the intervention group provides a plausible biochemical correlate for the clinical improvements. Surgery itself triggers a systemic inflammatory response. Excessive or prolonged inflammation is detrimental to healing and can increase susceptibility to infection¹⁵. The Mirabilite-Borneol patch appears to exert a modulating effect on this response. IFN- γ , a key Th1 cytokine, and the potent neutrophil chemoattractant IL-8 were notably lower^{16, 17}. This suggests the intervention might help in tempering the early aggressive immune cell recruitment and activation at the wound site, promoting a shift towards a more balanced healing phase.

Interpretation of contrasting findings and study limitations

It is noteworthy that while infection-related complications decreased, the rates of incision dehiscence and stump leakage were not significantly different between groups. This suggests that the Mirabilite-Borneol patch may be more effective in preventing infectious complications mediated by inflammation and microbial growth rather than in influencing mechanical healing factors related to surgical technique or tissue integrity.

Our study has several limitations. First, the single-center design may affect generalizability. Second, the lack of blinding for participants and surgeons, though unavoidable due to the nature of the intervention, introduces potential for performance bias. Third, while we measured systemic cytokines, a more comprehensive analysis of the local wound microenvironment (e.g., bacterial load, levels of specific cytokines or growth factors in wound fluid) would provide deeper mechanistic insight. Finally, the optimal concentration, duration, and frequency of the patch application warrant further investigation to standardize the protocol.

Conclusion and future directions

This study clarifies that adjunctive Mirabilite-Borneol TCM patch therapy is safe and well tolerated, and can enhance postoperative recovery and reduce infection rates after appendectomy, potentially through mechanisms involving anti-inflammatory, edema-reducing, and immunomodulatory effects. No patch-related adverse events were observed, indicating a favorable local safety profile. These results support the integration of this TCM modality into enhanced recovery after surgery (ERAS) protocols for abdominal operations. Future research should focus on multi-center validation, direct investigation of antimicrobial efficacy and local wound biology, and cost-effectiveness analyses to solidify its role in evidence-based surgical practice.

Declarations

Acknowledgements

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Author Contributions

Sheng Li conceived and designed the study. Haixia Ren, Yan Li and Huan Liu collected the clinical data. Jiang Du and Guangtai Cao performed data analysis and interpretation. Sheng Li drafted the manuscript. All authors reviewed the manuscript critically for important intellectual content and approved the final version for publication.

Access to Data

The corresponding author had full access to all data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Conflict of Interest

The authors declare that they have no conflicts of interest related to this study.

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Ethical Approval

The study protocol was approved by the Ethics Committee of Hebei Cangzhou Hospital of Integrated Traditional Chinese Medicine and Western Medicine. All procedures were conducted in accordance with the principles of the Declaration of Helsinki.

Informed Consent

Written informed consent was obtained from all participants prior to inclusion in the study.

Data Availability

The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request.

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