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ORIGINAL RESEARCH

# Assessment of the Anti-Inflammatory Efficacy and Symptom Resolution Time of Kangfuxin Liquid Combined with Metronidazole in Recurrent Oral Ulcers

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**Objective:** To evaluate the clinical efficacy and inflammatory modulation potential of Kangfuxin Liquid (KFXY; a traditional Chinese medicine recovery solution) in combination with metronidazole (MTZ) for the treatment of recurrent oral ulcers (ROU).

**Methods:** A retrospective cohort study was conducted using clinical data from 117 ROU patients admitted between January 2021 and January 2023. Patients were categorized into two groups: a control group (n=58) treated with MTZ oral adhesive patches alone, and an observation group (n=59) receiving KFXY plus MTZ. Primary outcomes included clinical response rates, symptom resolution time (ulcer healing, pain relief, and eating ability), systemic inflammatory biomarkers (C-reactive protein [CRP], tumor necrosis factor-alpha [TNF-α], interleukin-6 [IL-6]), oral microbial flora composition (Veillonella, Streptococcus), and adverse event incidence.

**Results:** Clinical Efficacy: The observation group demonstrated a significantly higher total response rate (94.92% vs 79.31%; P<0.05). Symptom Resolution: The KFXY-MTZ combination accelerated ulcer healing (P<0.05), reduced pain intensity (P<0.05), and improved oral intake (P<0.05) compared to MTZ alone. Inflammatory Modulation: Pre-treatment CRP, TNF-α, and IL-6 levels were comparable (P>0.05); post-treatment, these biomarkers were significantly lower in the observation group (P<0.05). Microbial Flora: Post-treatment levels of Veillonella and Streptococcus were significantly elevated in the observation group (P<0.05), indicating potential probiotic effects. Safety: Adverse event rates were similar between groups (control: 5.17%; observation: 6.78%; P>0.05).

**Conclusion:** The KFXY-MTZ combination therapy exhibits robust anti-inflammatory and probiotic activities, accelerating ROU healing without compromising safety. These findings support its clinical utility as an integrative treatment strategy for ROU.

**Keywords:** Kangfuxin liquid, Metronidazole, recurrent oral ulcers, effectiveness, timeliness

## Introduction

Oral ulcers (OU) are common painful lesions on the oral mucosa, clinically presenting as localized ulcerative vesicular lesions, often shallow with clear margins, typically ranging from 0.5 to 1.0 centimeters in diameter.[1] Recurrent oral ulcers (ROU) represent a particular subtype of OU, characterized by recurrent ulcerations severely affecting patients' quality of life and oral health.[2] ROU affects approximately 10% to 20% of the general population, with a higher prevalence observed among young adults and females.[3] Patients with frequent recurrences may experience a chronic disease course, resulting in persistent pain, repeated tissue injury, and emotional distress.[4] The number and frequency of ulcer episodes are closely linked to overall disease burden, nutritional compromise, and reduced work or school attendance.[5]

The precise etiology of ROU remains unclear but is likely associated with factors such as immune dysregulation, genetic elements, infections (such as alterations in oral microbial flora), and autoimmune abnormalities within the body.[6] Patients often face issues like pain, difficulty in eating, oral functional impairments, anxiety, and mood disturbances,

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significantly impacting their daily lives and mental well-being.[7] Current treatments for ROU mainly encompass local and systemic approaches. Local treatments involve oral rinses, oral patches, oral sprays, while systemic treatments include oral medication. However, the current therapeutic outcomes are not optimal, particularly in reducing ulcer recurrence, alleviating symptoms, and enhancing patients' quality of life.[8]

Metronidazole, as a commonly used topical oral treatment, has been applied to some extent in the treatment of ROU. However, the sole application of Metronidazole exhibits limitations in controlling inflammatory responses and promoting ulcer healing.[9] Metronidazole exerts its therapeutic effects primarily through antimicrobial and anti-inflammatory mechanisms. It inhibits DNA synthesis in anaerobic bacteria and protozoa, thereby reducing pathogenic microbial load in the oral cavity and mitigating local inflammation. Kangfuxin Liquid, a traditional Chinese medicine preparation extracted from Periplaneta americana (American cockroach), is recognized for its wound-healing, anti-inflammatory, and tissue-regenerative properties. According to the traditional Chinese medicine theory, it functions by "nourishing yin and promoting regeneration" and is commonly applied in the treatment of mucosal and cutaneous ulcerations.[10] Therefore, there is an urgent need in current ROU therapy to explore more effective and comprehensive treatment methods. Kangfuxin Liquid, as a novel therapeutic agent, possesses functions including immune modulation, improvement of oral microbial flora, and promotion of tissue repair.[11] Notably, the oral microbial environment, particularly genera (eg, *Veillonella* and *Streptococcus*), plays a dual role in oral health. While these genera are commensal and participate in normal microbial homeostasis, imbalances or overgrowth may contribute to mucosal inflammation and delayed healing.[12] Therefore, targeted modulation rather than complete suppression may be more beneficial in therapeutic interventions.

With multiple effective components, it intervenes at various stages in the pathogenesis of ROU, offering new hope for its treatment. Despite individual evidence supporting the efficacy of Kangfuxin Liquid and Metronidazole, there is a lack of clinical research specifically evaluating the synergistic effects of their combined use in ROU management.[13] To date, no published studies have systematically examined the therapeutic outcomes of this combination, leaving a critical gap in the evidence base.

This study aims to assess the clinical effects of combining Kangfuxin Liquid with Metronidazole in treating ROU. We retrospectively analyzed clinical data of 117 ROU patients, dividing them into a control group (treated solely with Metronidazole oral adhesive patches) and an observation group (treated with a combination of Kangfuxin Liquid and Metronidazole). By comparing the treatment effects, improvement in clinical symptoms, inflammatory marker levels, oral microbial flora, and occurrence of adverse reactions between the two groups, we aim to explore the advantages and clinical application value of combining Kangfuxin Liquid with Metronidazole in treating ROU. Through an in-depth exploration in this study, we aim to provide a more scientific and comprehensive treatment strategy for ROU in clinical practice, aiming to improve the life quality of ROU patients, and offer references for the treatment of similar diseases in the future.

# Materials and Methods

## Study Participants

This retrospective analysis included clinical data from 117 patients diagnosed with ROU who were admitted to our hospital between January 2021 and January 2023. Eligible patients were those clinically diagnosed with ROU based on relevant examinations, aged 18 years or older, and had complete and reliable clinical data available for analysis.

Patients were excluded if they had concurrent digestive ulcers, respiratory infections, or systemic chronic inflammatory diseases. Individuals with severe organ dysfunctions or recent histories of immunotherapy, anti-infective therapy, or anti-inflammatory treatments within the past three months were also excluded. Furthermore, those with known allergies or contraindications to the medications or methods used in this study, as well as individuals with cognitive or consciousness disorders, were not considered for inclusion.

Based on the treatment received, patients were categorized into a control group (n=58) treated exclusively with Metronidazole oral adhesive patches, and an observation group (n=59), which received Kangfuxin Liquid in addition to the same treatment provided to the control group.

The diagnosis of ROU was based on standardized clinical criteria as described in the *Chinese Guidelines for Oral Mucosal Diseases*, including recurrent shallow round or oval ulcers with erythematous halos, typically ≤1 cm in diameter, localized to non-keratinized mucosa, recurring at least three times per year. Patients included in this study had at least three documented episodes of oral ulceration in the previous 12 months, with each episode confirmed by clinical examination and patient history. This retrospective analysis was non-randomized; treatment grouping was based on the actual clinical regimen received during hospitalization. No random allocation was performed. However, outcome assessors responsible for evaluating symptom improvement, clinical efficacy, and laboratory results were blinded to treatment assignment to reduce assessment bias. To mitigate treatment selection bias, patients with comparable baseline ulcer severity, recurrence frequency, and inflammatory profiles were matched between groups to the extent possible. Additionally, patients with significantly more severe baseline symptoms or systemic comorbidities were excluded during the screening process.

Given the retrospective nature of the study, potential confounding factors, such as individual differences in oral hygiene practices, treatment adherence, and lifestyle behaviors (eg, smoking, diet, sleep quality), were not fully controlled and may have influenced treatment outcomes.

## Methods

### Control Group

Patients in the control group received treatment solely with Metronidazole oral adhesive patches. After meals, Metronidazole oral adhesive patches (Zhengzhou Kangli Pharmaceutical Co., Ltd.; National Medicine Standard H20067130) were applied. After drying the mucosa with a cotton swab, the patch was adhered to the affected area in the oral cavity, 1 patch/time, 3 times/day, administered after each meal and could be swallowed after dissolution.

### Observation Group

Patients in the observation group received Kangfuxin Liquid in addition to the treatment received by the control group. The administration method, manner, and frequency of Metronidazole oral adhesive patches in the observation group were consistent with the control group. In addition, Kangfuxin Liquid (Kunming Sino Pharmaceutical Co., Ltd.; National Medicine Standard Z53020054) was used concurrently. After rinsing the mouth with water, patients in the observation group held 10 mL of Kangfuxin Liquid in the oral cavity for 5 minutes before swallowing, followed by the administration of Metronidazole oral adhesive patches, 3 times/day. Both groups were treated for 7 days, and patients were instructed to maintain the efficacy of the medication by refraining from eating or drinking for 30 minutes after treatment, abstaining from smoking, alcohol, spicy foods, maintaining a balanced diet, and increasing intake of fresh fruits and vegetables.

## Observational Indices

The clinical symptom improvement indices in this study include ulcer healing time, pain improvement time, and improvement in eating time, all uniformly recorded by relevant medical personnel in our hospital. These parameters were selected to quantitatively assess healing kinetics and symptom resolution time, thereby providing a precise measure of therapeutic response rather than general treatment timeliness.

### Clinical Treatment Efficacy

Cured: After treatment, the ulcer surface heals, clinical symptoms disappear, and inflammatory marker levels return to normal. Significantly Effective: Post-treatment, the ulcer surface is close to healing, clinical symptoms are nearly absent, and inflammatory marker levels approach normal values. Effective: After treatment, there's significant improvement in the ulcer surface, notable alleviation of clinical symptoms, and a decrease in inflammatory marker levels. Ineffective: Post-treatment, there's no apparent improvement in the ulcer, or even a tendency towards enlargement. Clinical symptoms either remain poor or show a tendency to worsen. Total effective rate = (Cured + Significantly Effective + Effective) cases/total cases × 100%.

### Improvement in Clinical Symptoms

The clinical symptom improvement indices in this study include ulcer healing time, pain improvement time, and improvement in eating time, all uniformly recorded by relevant medical personnel in our hospital.

### Inflammatory Marker Assessment

Prior to and following treatment, 5 mL of fasting blood was drawn from the cubital vein of each patient. The samples were centrifuged to obtain serum, which was then analyzed for levels of C-reactive protein (CRP), tumor necrosis factor-alpha (TNF-α), and interleukin-6 (IL-6) using the enzyme-linked immunosorbent assay (ELISA) technique.

### Oral Microbial Flora Analysis

Oral samples were collected from patients before and after treatment, ensuring a fasting period of at least two hours without any beverages. Patients rinsed their mouths with distilled water, after which approximately 1 mL of saliva was gathered in a sterile centrifuge tube and stored at 4°C for subsequent analysis. Fluorescent quantitative PCR technology was employed to evaluate the levels of Veillonella and Streptococcus in the oral cavity, and results were expressed in copies/mL.

### Monitoring Adverse Reactions

This study systematically recorded any adverse reactions, including nausea, vomiting, skin irritations, dizziness, headaches, changes in taste, fatigue, and somnolence. All observations were documented by qualified medical personnel at our institution.

## Statistical Analysis

Data visualization was performed using GraphPad Prism 8, while SPSS 22.0 facilitated statistical analysis. For quantitative measures, means and standard deviations were computed, and comparisons were made using the *t*-test. Categorical data were expressed as frequencies and percentages, with analyses conducted using the Chi-square test. A p-value of less than 0.05 was deemed statistically significant.

To further reduce bias, subgroup analyses were performed post hoc to compare outcomes across similar severity strata. Potential confounding variables, such as baseline ulcer size, frequency of recurrence, and inflammatory marker levels were tested for between-group balance before outcome analysis.

# Results

## Baseline Data Comparison

Both study groups exhibited comparable baseline characteristics, indicating no significant differences in demographic or clinical parameters ($P > 0.05$) (Table 1). This study did not incorporate comparisons with established mainstream

**Table 1** Baseline Data Comparison

| | Control (n=58) | Observation (n=59) | $t/x^2$ | P |
|---|---|---|---|---|
| Gender | – | – | 0.205 | 0.650 |
| Male | 32 | 35 | – | – |
| Female | 26 | 24 | – | – |
| Age (years) | 36.79±5.83 | 37.26±5.91 | 0.433 | 0.665 |
| Duration (days) | 5.84±0.92 | 5.91±0.87 | 0.422 | 0.673 |
| Ulcer Quantity | – | – | 0.430 | 0.511 |
| Single | 25 | 29 | – | – |
| Multiple | 33 | 30 | – | – |
| Ulcer Severity | – | – | 0.785 | 0.375 |
| Mild | 18 | 14 | – | – |
| Moderate | 26 | 30 | – | – |
| Severe | 14 | 15 | – | – |

**Table 2** Comparison of Clinical Treatment Efficacy

| Group | n | Cured | Significant Effect | Effective | Ineffective | Total Effective Rate (%) |
|---|---|---|---|---|---|---|
| Control | 58 | 10 | 21 | 15 | 12 | 79.31% |
| Observation | 59 | 17 | 30 | 9 | 3 | 94.92% |
| $x^2$ | – | – | – | – | – | 6.372 |
| P | – | – | – | – | – | 0.011 |

therapies, such as corticosteroid patches or probiotic buccal tablets. The selected treatment regimens reflected prevailing clinical practices at the study institution, where metronidazole oral adhesive patches are routinely used as the first-line therapy for ROU. Although the addition of Kangfuxin Liquid demonstrated promising efficacy, the absence of direct comparison with guideline-recommended alternatives limits the broader applicability of the findings. Future randomized controlled trials should include these standard treatments to more robustly assess the relative clinical value of the proposed therapeutic approach.

## Comparison of Clinical Treatment Efficacy

The analysis revealed that the total effective rate for the control group was 79.31%, whereas the observation group achieved a notably higher rate of 94.92%. This substantial difference underscores the enhanced efficacy of the combined treatment approach utilized in the observation group ($P < 0.05$) (Table 2).

## Comparison of Improvement in Clinical Symptoms

Figure 1 illustrates the timeframes for healing and symptom relief. In the control group, the average ulcer healing time was recorded at 5.23 ± 0.74 days, with pain improvement and eating enhancement taking 4.32 ± 0.67 days and 4.67 ± 0.71 days, respectively. Conversely, the observation group demonstrated significantly improved outcomes, with healing

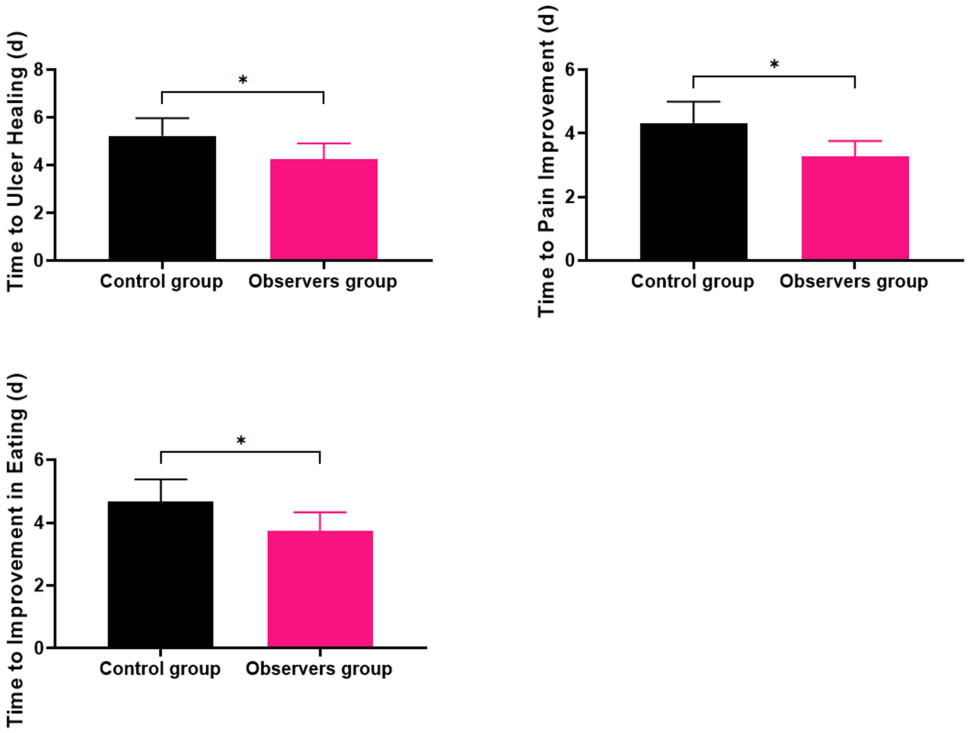


**Figure 1** Comparison of Improvement in Clinical Symptoms.
**Note**: * indicates intergroup comparison P<0.05.


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times of 4.26 ± 0.65 days, pain relief in 3.27 ± 0.49 days, and eating improvement at 3.74 ± 0.59 days. The reductions in healing and relief times in the observation group were statistically significant compared to the control group ($P < 0.05$).

## Comparison of Inflammatory Factor Levels

As depicted in Figure 2, the levels of inflammatory markers before and after treatment were assessed. In the control group, the CRP levels were recorded at 16.37 ± 2.54 mg/L pre-treatment and decreased to 6.19 ± 1.05 mg/L post-treatment. TNF-α levels showed a similar pattern, with initial values of 46.73 ± 10.52 pg/mL reducing to 32.13 ± 5.38 pg/mL. IL-6 levels also decreased from 161.43 ± 15.89 pg/mL to 107.64 ± 11.12 pg/mL. In the observation group, baseline CRP levels were slightly higher at 16.85 ± 2.47 mg/L but fell to 5.46 ± 0.82 mg/L after treatment. TNF-α levels in this group decreased from 46.65 ± 10.57 pg/mL to 22.41 ± 4.35 pg/mL, and IL-6 levels dropped from 162.53 ± 14.91 pg/mL to 71.39 ± 10.26 pg/mL. Initially, there were no significant differences in CRP, TNF-α, or IL-6 levels between the two groups ($P > 0.05$). However, post-treatment evaluations revealed that the observation group had significantly lower levels of these inflammatory markers compared to the control group ($P < 0.05$).

## Comparison of Oral Microbial Index Levels

Figure 3 presents the levels of oral microbial flora, specifically Veillonella and Streptococcus, before and after treatment. In the control group, pre-treatment levels of Veillonella were recorded at 7.04 ± 0.47, increasing to 7.42 ± 0.53 after treatment (a 1.05-fold increase). Streptococcus levels showed a rise from 7.15 ± 0.47 to 8.12 ± 0.59 (a 1.14-fold increase). In the observation group, the initial levels of Veillonella were slightly lower at 7.02 ± 0.45 but increased to 7.95 ± 0.56 post-treatment (a 1.13-fold increase). Streptococcus levels also rose from 7.21 ± 0.49 to 8.86 ± 0.63 (a 1.23-fold increase). These fold changes were more pronounced in the observation group, indicating a stronger probiotic-associated microbiota response to the intervention. Prior to treatment, there were no significant differences in the levels of these microorganisms between the two groups ($P > 0.05$). However, after treatment, the observation group demonstrated significantly elevated levels of both Veillonella and Streptococcus compared to the control group ($P < 0.05$).

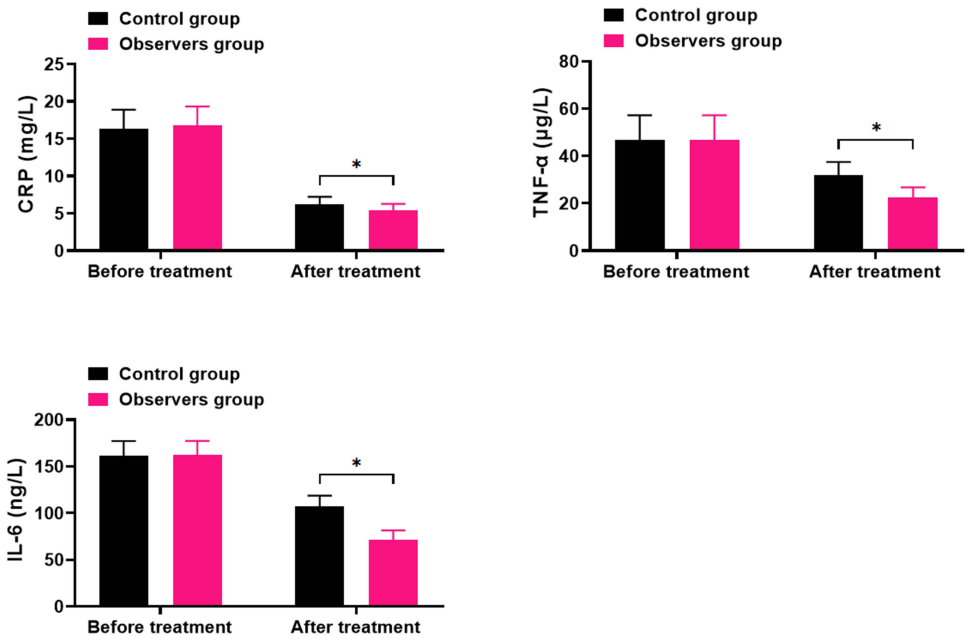


**Figure 2** Comparison of Inflammatory Factor Levels.
**Note**: * indicates intergroup comparison P<0.05.

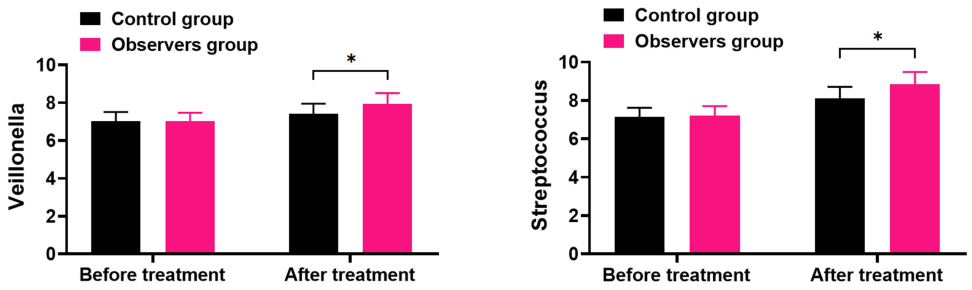


**Figure 3** Comparison of Oral Microbial Index Levels (copies/mL).
**Note**: * indicates intergroup comparison P<0.05.

## Comparison of Adverse Reaction Incidence

The incidence of adverse reactions was monitored throughout the study. In the control group, the incidence was reported at 5.17%, while the observation group experienced a slightly higher incidence of 6.78%. However, statistical analysis indicated no significant differences in the rates of adverse reactions between the two groups (P > 0.05) (Table 3).

# Discussion

ROU are prevalent mucosal disorders encountered in dental practice. OU is characterized by the complete disruption of the epithelium, typically presenting as a white lesion surrounded by necrotic fibrin and erythematous margins.[14] The etiology and pathogenesis of ROU remain partially understood, with studies indicating potential associations with psychological stress, environmental factors, hormonal imbalances, and GI abnormalities.[15] ROU is marked by its recurrent nature and persistent pain, which can lead to significant discomfort, adversely affecting the patient's physical health, daily activities, education, and professional life.[16] Current clinical management primarily involves pharmacological interventions, including vitamins, hormones, immunomodulators, analgesics, and topical anti-inflammatory agents aimed at reducing inflammation and pain, promoting ulcer healing, and preventing secondary infections.[17]

Metronidazole, a widely utilized antibiotic, acts by disrupting the DNA structure and function of bacteria and protozoa, ultimately inhibiting their growth and reproduction.[18] Additionally, metronidazole possesses anti-inflammatory properties, which can alleviate inflammatory symptoms associated with certain infections.[19] In this study, metronidazole patches were employed for the treatment of ROU, targeting harmful oral microbes and infections. These patches, formulated with a polymer containing polyacrylic bond-linked hexyl glucoside and tetraethylene glycol divinyl ether, adhere effectively to the mucosal surface at the ulcer site, providing continuous drug release and therapeutic benefits. However, some studies suggest that monotherapy with metronidazole patches may fall short of achieving optimal outcomes in ROU management. Clinical practice often advocates for combined pharmacological approaches to enhance patient outcomes and expedite pain relief.

According to TCM, the onset of ROU is frequently attributed to congenital predispositions, irregular dietary habits —such as excessive intake of spicy and rich foods—smoking, and alcohol consumption.[20] Factors, such as overexertion, emotional disturbances, and internal imbalances can adversely affect the spleen and stomach, which are believed to play critical roles in this condition. The spleen meridian is connected to the tongue root, and influences

**Table 3** Comparison of Adverse Reaction Incidence

| Adverse Reactions | Control (n=58) | Observation (n=59) | $x^2$ | P |
|---|---|---|---|---|
| Dizziness and nausea | 1 | 0 | – | – |
| Skin reactions | 0 | 1 | – | – |
| Headache and dizziness | 1 | 1 | – | – |
| Taste changes | 0 | 1 | – | – |
| Fatigue and drowsiness | 1 | 1 | – | – |
| Total Incidence (%) | 5.17% | 6.78% | 0.000 | 0.982 |


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such as external pathogens and emotional stress can weaken spleen and stomach function, leading to disruptions in normal physiological processes. When the essence fails to ascend due to this weakness, it can result in virtual heat along the meridians, ultimately causing oral ulceration.[21,22] Kangfuxin Liquid, a pure TCM biopharmaceutical derived from the dried bodies of the American cockroach (Blattidae family), is commonly used to treat blood stasis, gastric bleeding, and gastric/duodenal ulcers.[23,24] This formulation acts directly on ulcerated tissue, promoting blood circulation, reducing inflammation, possessing sterilizing properties, and facilitating tissue regeneration, thereby enhancing clinical efficacy.[25] Based on these insights, this study aimed to integrate Recovery Solution into the treatment regimen for ROU patients, in conjunction with metronidazole patches, to evaluate the synergistic effects of this combined approach. Results indicated that the total effective rate in the observation group was significantly higher than in the control group (94.92% vs 79.31%). Post-treatment, the observation group exhibited significantly reduced ulcer healing times, pain relief durations, and improved eating times compared to the control group. These findings align with previous research suggesting that the combination of Kangfuxin Liquid and metronidazole yields superior outcomes in ROU patients.[26,27]

The occurrence of ROU often triggers an inflammatory response, with CRP serving as an acute-phase protein that is markedly elevated during tissue damage and inflammation. Increased CRP levels are indicative of a more severe inflammatory response in ROU patients. TNF-α acts as a pro-inflammatory mediator, attracting inflammatory cells to sites within the oral mucosa and exacerbating tissue damage. IL-6, a key immune-inflammatory regulatory factor, promotes B-cell differentiation and proliferation while participating in neutrophil responses to inflammation. Elevated IL-6 levels correlate with more severe manifestations in ROU patients.[28,29] Additionally, maintaining a balanced oral microecology is vital for oral health, as imbalances in microbial populations can lead to the rapid proliferation of pathogenic bacteria and subsequent oral diseases. Research indicates that ROU is associated with oral microbial imbalances, which can worsen immune-inflammatory reactions.[30] Beneficial bacteria such as Veillonella and Streptococcus play crucial roles in promoting immune responses, resisting pathogens, and providing anti-inflammatory and antioxidant effects, thereby contributing to a healthier oral environment. Enhancing the oral microbiota structure positively influences patient outcomes.

Modern pharmacological studies have shown that Kangfuxin Liquid contains biologically active substances, including polyols, amino acids, and peptides, which stimulate protein collagen and nucleic acid synthesis at the lesion site. This promotes microcirculation, granulation tissue growth, and angiogenesis, facilitating the repair of damaged mucosa and enhancing immune responses.[31] The study results indicated that after treatment, levels of CRP, TNF-α, and IL-6 were significantly lower in the observation group compared to the control group. Furthermore, post-treatment levels of Veillonella and Streptococcus in the oral cavity were significantly higher in the observation group than in the control group. These findings suggest that the combined application of Kangfuxin Liquid and metronidazole effectively mitigates inflammatory responses and maintains oral microbiota balance, thereby enhancing therapeutic efficacy. The similar safety profile indicates that the addition of Kangfuxin Liquid does not increase the risk of adverse reactions, highlighting its safety profile, likely due to its gentle nature and minimal irritation to ulcerated tissue.

While the 7-day treatment period was sufficient for evaluating short-term outcomes, such as ulcer healing, pain relief, and inflammatory marker reduction, it did not allow for the assessment of long-term efficacy, particularly in terms of ulcer recurrence. Future studies with extended follow-up periods are warranted to determine whether the combined treatment of Kangfuxin Liquid and Metronidazole can reduce the frequency of ROU recurrence and sustain clinical benefits over time.

## Conclusion

The combination of Kangfuxin Liquid and metronidazole demonstrated enhanced short-term efficacy in the treatment of ROU, as evidenced by greater symptom relief, reduced inflammatory markers, and improved oral microbial profiles, particularly elevated levels of Veillonella and Streptococcus. These changes suggest a potential probiotic benefit associated with the intervention. Additionally, the combination therapy did not increase the incidence of adverse reactions, indicating a favorable safety profile. However, given the retrospective nature of this study and the relatively small sample size, these findings should be interpreted with caution. Further validation through large-scale, prospective,

randomized controlled trials is necessary to establish the efficacy and long-term safety of this combined treatment approach. Moreover, the potential role of microbial modulation in the prevention or recurrence of ROU warrants additional investigation. Future studies should also explore the long-term impact of oral microbiota modulation on ROU recurrence and its potential therapeutic role as a probiotic-targeted strategy.

## Ethical Approval Statement

This study was approved by the ethics committee of The General Hospital of Western Theater Command of the Chinese People's Liberation Army. Informed consent was obtained from all study participants. All the methods were carried out in accordance with the Declaration of Helsinki.

## Disclosure

The authors report no conflicts of interest in this work.

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