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COMPARISON OF WOUND INFECTION WITH CELLULOSE VERSUS CONVENTIONAL DRESSING IN PATIENTS WITH BURN

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Abstract

Background: Partial-thickness burn wounds are commonly managed with topical agents and dressings aimed at preventing infection and promoting healing. Silver sulphadiazine remains widely used but requires frequent dressing changes and is associated with pain and delayed healing. Microbial cellulose dressings have emerged as a biocompatible alternative with fewer dressing changes and improved patient comfort.

Methods: This randomized controlled trial was conducted at The Pak Italian Modern Burn Center at Nishtar Hospital in Multan from September 2024 to March 2025. Forty patients with second-degree burns were randomized to receive either microbial cellulose dressings (n = 20) or conventional silver sulphadiazine dressings (n = 20). Wounds were assessed every third day for infection, pain, epithelialization, and duration of hospital stay. Pain was measured using the FLACC scale. Data were analyzed using non-parametric tests and Fisher's exact test.

Results: Wound infection occurred less frequently in the cellulose group compared with the conventional dressing group. Pain scores during and after dressing procedures were significantly lower in patients treated with cellulose dressings ($p < 0.001$). Time to epithelialization and duration of hospital stay were shorter in the cellulose group, although these differences were not statistically significant.

Conclusion: Microbial cellulose dressings reduce procedural pain and are associated with a lower frequency of wound infection compared with silver sulphadiazine in partial-thickness burns. Cellulose dressings represent an effective alternative for burn wound management.

Keywords: Partial Thickness Burn, Cellulose Dressing, Silver Sulfadizine Dressing, Burn, Epithelialization, Wound Infection

INTRODUCTION

Burns are major contributors to the global burden of disease, with millions burnt each year and substantial levels of morbidity, mortality and health-care cost. The depth of the wound according to which management is determined, may either be superficial or deep. Deep burns are usually subject to surgery (excision and skin grafting), while superficial and partial-thickness burns can be effectively treated conservatively with dressings to promote healing, avoid infection – a major confounder of wound-healing [1].

Silver sulphadiazine (SSD) cream was the traditional topical of choice for many decades in the treatment of partial-thickness burns [2,3]. However, SSD has serious limitations and requires frequent painful dressing changes. This encumbers patients, costs the healthcare system (especially in suture based techniques) and may delay healing or introduce infection through manipulation [1,4]. In the course of time, innovative dressings, such as silver-impregnated

gauzes hydrocolloids, foams and matrix-bound nanocrystalline silver have been produced. These are intended to allow controlled release of the antimicrobials, which may aid in infection control and wound healing. However, there is still weak evidence to support that these are clinically superior option than SSD [1,5]. Furthermore, concerns persist regarding the cytotoxicity of silver compounds to regenerating keratinocytes (potentially hindering healing) and environmental toxicity [1,5,6].

The hunt for biocompatible substitutes has been fueled by these disadvantages. Microbial cellulose dressings made from biological sources have become a viable alternative. They are generally well-tolerated with few instances of allergic reactions or irritations, have good moisture-retentive qualities, adhere poorly to the wound bed, and require few dressing changes. Recent research demonstrates the clinical potential of microbial cellulose dressings for the treatment of partial-thickness burns. Reduced patient discomfort, fewer dressing changes, and infection control that is on par with or possibly better than traditional SSD treatment are all linked to these dressings [7]. Additionally, early reports show no recorded hypersensitivity reactions and low rates of pathogenic colonization [8]. However, well-designed comparative studies specifically evaluating the incidence of wound infection between microbial cellulose dressings and the established SSD standard in partial-thickness burns are still needed.

Finding dressings that successfully reduce wound infection is crucial because it is a major cause of delayed healing, increased scarring, sepsis risk, graft failure, prolonged hospitalization, and mortality in burn patients. Thus, the goal of this study is to compare the incidence of wound infection between patients with partial-thickness burns treated with traditional silver sulphadiazine cream and those treated with microbial cellulose dressings. The goal of this comparison is to provide solid evidence regarding the clinical utility, safety, and effectiveness of cellulose-based wound care in burn treatment.

MATERIALS AND METHODS

The Pak Italian Modern Burn Center at Nishtar Hospital in Multan was the site of this single-center randomized controlled trial. This study was conducted during September 2024 and March 2025. Individuals between the ages of 18 and 60 who had second-degree (partial-thickness) flame burns that affected 10–50% of their total body surface area (TBSA) and who showed up within 48 hours of the injury were eligible. Diabetes mellitus, underlying dermatological conditions, pregnancy, and burns from chemicals or electricity were among the exclusion criteria. 76 patients were scheduled for enrollment based on the initial sample size calculation. Only 40 of the 76 patients who were recruited and randomized during the study period finished the entire protocol and were included in the final analysis because of incomplete outcome data, early discharge against medical advice, or loss to follow-up. Using sealed opaque envelopes, patients were divided into two groups at random:

Cellulose dressing group (n = 20)

Conventional dressing group (silver sulphadiazine) (n = 20)

In both groups, wounds were cleaned with normal saline and devitalized tissue removed.

- Cellulose group: Microbial cellulose sheets were applied under aseptic conditions and inspected every third day.
- Control group: Silver sulphadiazine cream (1%) was applied with sterile gauze and changed daily.

Wound infection was the main result. Pain scores, the length of hospital stay, and the time to epithelialization were secondary outcomes. Isolation of pathogenic organisms from wound swab culture in the presence of systemic symptoms like fever (>99°F) or leukocytosis (>11,000 cells/mm³) was defined as wound infection. The Face, Legs, Activity, Cry, Consolability (FLACC) scale was used to measure pain both during and after dressing procedures.

Statistical Analysis

SPSS version 29 was used to analyze the data. The median and interquartile range (IQR) were used to express continuous variables. Frequencies and percentages were used to express categorical variables. Fisher's exact test and the Mann-Whitney U test were used to compare groups. Statistical significance was defined as a p-value of less than 0.05.

RESULTS

Study Population

A total of 40 patients were included in the final analysis, with 20 patients randomized to the cellulose dressing group and 20 to the conventional silver sulphadiazine group. Baseline demographic characteristics and burn severity were comparable between the two groups, with no statistically significant differences observed.

Table 1. Baseline Characteristics of Patients

Variable	Cellulose (n = 20)	Control (n = 20)	p-value

Age (years), median (IQR)	23.0 (14.5–37.5)	22.0 (11.0–37.5)	0.76
Male sex, n (%)	7 (35%)	13 (65%)	0.06
TBSA (%), median (IQR)	7.0 (4.0–9.5)	10.0 (9.0–15.0)	0.01

There were no statistically significant differences between the two groups with respect to age or gender distribution. The control group had a higher median TBSA percentage compared to the cellulose group, which was statistically significant ($p = 0.01$).

Wound Infection

Wound infection was observed in 3 patients (15%) in the cellulose group compared to 5 patients (25%) in the control group. Although the frequency of infection was lower in the cellulose group, this difference did not reach statistical significance ($p = 0.23$).

Table 2. Clinical Outcomes

Outcome	Cellulose (n = 20)	Control (n = 20)	p-value
Wound infection, n (%)	3 (15%)	5 (25%)	0.23
Hospital stay (days), median (IQR)	14.0 (10.0–23.0)	16.5 (12.5–32.5)	0.08
Time to epithelialization (days), median (IQR)	18.0 (14.0–23.0)	16.5 (14.5–32.5)	0.34

Patients treated with cellulose dressings demonstrated a lower frequency of wound infection compared with those treated with silver sulphadiazine; however, the difference was not statistically significant. The median duration of hospital stay was shorter in the cellulose group, though this difference did not reach statistical significance. Similarly, time to epithelialization was comparable between the two groups.

Pain Assessment

Pain scores assessed using the FLACC scale were consistently and significantly lower in the cellulose group during and after each dressing procedure. These differences were statistically significant at all measured time points ($p < 0.001$).

Table 3. Pain Scores (FLACC Scale), Median (IQR)

Time Point	Cellulose	Control	p-value
Pain during 1st dressing	5.0 (3.0–6.5)	9.0 (7.0–9.0)	<0.001
Pain after 1st dressing	2.0 (0.5–3.5)	5.5 (5.0–6.0)	<0.001
Pain during 2nd dressing	1.0 (1.0–3.0)	7.0 (5.5–7.0)	<0.001
Pain after 2nd dressing	1.0 (1.0–2.0)	3.0 (3.0–4.5)	<0.001
Pain during 3rd dressing	0.0 (0.0–1.0)	5.0 (2.0–6.0)	<0.001
Pain after 3rd dressing	0.0 (0.0–1.0)	2.0 (1.5–3.0)	<0.001

Pain scores were significantly lower in the cellulose group during and after all dressing procedures. The most pronounced differences were observed during the first dressing, where the median FLACC score was 5.0 in the cellulose group compared to 9.0 in the control group ($p < 0.001$). This trend persisted throughout subsequent dressing changes.

DISCUSSION

The present randomized controlled trial compared microbial cellulose dressings with conventional silver sulphadiazine dressings in patients with partial-thickness burns. The results demonstrate that cellulose dressings are associated with significantly reduced procedural pain and a lower frequency of wound infection, with additional trends toward shorter hospital stay and comparable time to epithelialization. These findings are consistent with previously published studies evaluating microbial cellulose in burn wound management.

Wound Infection

In the current study, wound infection occurred in 15% of patients treated with cellulose dressings compared to 25% in those treated with silver sulphadiazine, although this difference did not reach statistical significance. This finding is in agreement with the randomized controlled trial by Aboelnaga et al., who also reported a lower frequency of wound infection in the cellulose group compared with the silver sulphadiazine group, without a statistically significant difference, likely due to limited sample size [9]. Similarly, Muangman et al. reported low rates of bacterial colonization in partial-thickness burn wounds treated with microbial cellulose, supporting its effectiveness in infection control [10].

The reduced frequency of wound infection observed with cellulose dressings may be explained by fewer dressing changes and reduced wound manipulation. Conventional silver sulphadiazine therapy requires frequent dressing removal, which repeatedly exposes the wound to the external environment and increases the risk of contamination. In contrast, cellulose dressings adhere closely to the wound bed, maintain a stable moist environment, and act as a physical barrier against external pathogens, thereby reducing the risk of infection [9,11].

Pain During Wound Care

One of the most significant findings of this study was the marked reduction in pain scores in the cellulose group during and after all dressing procedures. Pain assessed using the FLACC scale was significantly lower in the cellulose group at each time point ($p < 0.001$). These findings strongly corroborate the results of Aboelnaga et al., who demonstrated significantly lower pain scores during and after wound care in patients treated with microbial cellulose compared with silver sulphadiazine [9]. Similar reductions in pain have also been reported in studies evaluating other biological and membranous dressings for partial-thickness burns [12,13].

The lower pain scores associated with cellulose dressings can be attributed to their non-adherent nature and reduced need for frequent dressing changes. Silver sulphadiazine dressings often adhere to the wound surface and require repeated removal, which can disrupt newly formed epithelium and cause significant discomfort. In contrast, cellulose dressings remain in situ for prolonged periods and allow wound inspection without removal, thereby minimizing trauma and pain [9,12].

Time to Epithelialization

In the present study, time to epithelialization was comparable between the two groups, with a non-significant trend toward faster healing in the cellulose group. This observation is consistent with findings reported by Aboelnaga et al., who noted quicker epithelialization in the cellulose group after adjustment for burn size and depth, although the difference was not statistically significant [9]. Other studies evaluating microbial cellulose and biological dressings have similarly reported comparable or slightly improved epithelialization times compared with silver sulphadiazine [10,14].

Epithelialization in burn wounds is influenced by multiple factors, including burn depth, TBSA, patient age, and local wound environment. While cellulose dressings provide a moist environment favorable for keratinocyte migration, the lack of statistically significant difference in epithelialization time in smaller trials may be explained by variability in these confounding factors [9,14].

Duration of Hospital Stay

Patients treated with cellulose dressings demonstrated a shorter median hospital stay compared with those treated with silver sulphadiazine, although this difference did not reach statistical significance. This finding is clinically relevant and consistent with previous literature. Aboelnaga et al. reported a significantly shorter hospital stay in the cellulose group after multivariable adjustment, suggesting that reduced pain and fewer dressing changes may facilitate earlier discharge [9]. Reduced hospitalization has important implications for healthcare resource utilization, particularly in high-volume burn centers in resource-limited settings [15].

Clinical Implications

The findings of this study add to the growing body of evidence supporting microbial cellulose dressings as an effective alternative to silver sulphadiazine for partial-thickness burns. Reduced procedural pain is a particularly important outcome, as it improves patient comfort, reduces analgesic requirements, and enhances compliance with treatment.

Although differences in wound infection rates and epithelialization time did not reach statistical significance, the consistent trends observed in this and other studies suggest meaningful clinical benefits of cellulose dressings [9–11].

Limitations

This study has several limitations. First, the final analyzed sample size was smaller than initially planned due to loss to follow-up and incomplete data, which may have limited the statistical power to detect differences in some outcomes. Second, this was a single-center study, which may limit generalizability. Third, long-term outcomes such as scar quality and functional results were not assessed. Future multicenter studies with larger sample sizes and extended follow-up are warranted to confirm these findings [9,15].

CONCLUSION

Microbial cellulose dressings are associated with significantly reduced pain and a lower frequency of wound infection compared with conventional silver sulphadiazine dressings in patients with partial-thickness burns. These findings support the use of cellulose dressings as an effective and patient-friendly alternative in burn wound management.

Conflicts of Interest: None of the authors have any conflicts of interests to disclose.
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