Original Research

Comparative Evaluation of a DACC-Coated Hydrophobic Dressing versus Silver Sulfadiazine in the Management of Chemical Burns: A Pilot Comparative Study from a Single Center in Pakistan

Citation: Mujtaba A, Khan S, Tariq MH, Ayub S, Khan MA, Ali MU, Ibrahim M, Komal N, Iqbal T, Rehan M. "Comparative Evaluation of a DACC-Coated Hydrophobic Dressing versus Silver Sulfadiazine in the Management of Chemical Burns: A Pilot Comparative Study from a Single Center in Pakistan" (2026) *International Journal of Wound Research* 2(1): 77-89. DOI: https://doi.org/10.64115/ijwr-2026-257

Received: December 6, 2025

Revised: March 15, 2026

Just accepted: March 27, 2026

Published: March 28, 2026

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Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Conflict of Interest: The author(s) declare(s) no conflict of interest.

Funding: This research received no external funding.

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Abstract

Introduction. Low-and middle-income countries (LMICs) bear a disproportionate burden of burn injuries, which continue to be a major worldwide health concern. A distinct class of burn injuries known as chemical burns is distinguished by the possibility of profound skin degradation and progressive tissue damage. Although delayed epithelialization and cytotoxic effects on regenerating tissue have been concerns, silver sulfadiazine (SSD) has long been regarded as the standard topical antibacterial therapy in burn care. In order to bind germs without releasing active antimicrobial drugs

and perhaps maintain tissue viability, Sorbact® bacteriostatic dressings use hydrophobic interaction technology. The purpose of this pilot comparative study was to evaluate the clinical results of 1% SSD and Sorbact® dressings for patients with partial-thickness chemical burns in a context with limited resources.

Methods. This single-center pilot comparative study was conducted at the Burn Care Centre, Pakistan Institute of Medical Sciences (PIMS), Islamabad. Sixty adult patients who presented within 6 hours of sustaining partial-thickness chemical burns involving ≤30% total body surface area (TBSA) were randomized in a 1:1 ratio in a institutional clinical trial software to receive either Sorbact® dressings or 1% SSD. All patients received standardized supportive management as per institutional protocol including intravenous analgesia, fluid resuscitation, and systemic antibiotics (Piperacillin–Tazobactam) as per institutional protocol. The primary outcome was time to complete epithelialization of the wound. Secondary outcomes included hospital stay duration, need for split-thickness skin grafting (STSG) and dressing frequency.

Results. The study included 60 patients (63.3% female) with a mean TBSA of 23.3%, most commonly involving the trunk (n=22) and face (n=16), with comparable baseline characteristics between groups. Mean time to complete epithelialization was significantly shorter in the Sorbact® group. Hospital stay duration was reduced in the Sorbact® group, and fewer patients required STSG. No systemic infections were documented in either group.

Discussion. In this pilot single-center study, Sorbact® dressings demonstrated favorable clinical outcomes compared with 1% SSD in partial-thickness chemical burns. Given the unique nature of study and limited sample size, large multicenter trials are required to confirm these findings and evaluate cost-effectiveness in LMIC settings.

Keyword: Chemical Burns, Sorbact, Silver Sulfadiazine, Comparative Study, Wound Healing, Split-thickness Skin Graft, Low- and Middle-income Countries, Burn Management

Introduction

Burn injuries continue to pose a substantial global health burden worldwide[1], the majority occurring in low- and middle-income countries (LMICs).[2] In addition to mortality, non-fatal burns contribute significantly to long-term disability, psychological trauma, prolonged hospitalization, and socioeconomic disruption. South Asia, including Pakistan, carries a disproportionately high incidence of burn injuries, reflecting challenges in occupational safety, domestic hazards, and access to specialized burn care facilities.

Chemical burns represent a distinct subset of burn injuries. Unlike thermal burns, chemical injuries may result in ongoing tissue destruction due to continued chemical activity inside the wound bed. Acids, alkalis, and industrial cleaning agents are frequent causes in LMIC environments, where domestic and occupational exposure risks are not properly handled. Immediate irrigation and early wound management are critical in limiting injury progression; however, even with early

intervention, deep dermal destruction usually occurs.[3] The depth of burn injury is a major factor of healing time. Superficial partial-thickness burns typically retain intact epithelial stem cell reservoirs within hair follicles and sweat glands, allowing re-epithelialization of the wound.[4] In contrast, deep dermal burns may involve destruction of adnexal structures, thereby eliminating key regenerative niches necessary for epidermal repair. Loss of these epithelial stem cell populations significantly delays wound closure and increases the chance of surgical intervention such as split-thickness skin grafting (STSG).[5] This pathophysiological distinction underscores the importance of managing topical wound management strategies that preserves viable structures.[6]

Topical antimicrobial therapy remains a major part of burn wound management. Silver sulfadiazine (SSD) has been widely used due to its broad-spectrum antimicrobial activity and affordability.[7] However, current evidence suggests that SSD may delay epithelialization and impair keratinocyte migration due to cytotoxic effects on proliferating cells.[8] Several randomized trials and systematic reviews have questioned whether SSD represents the optimal standard of care, particularly in partial-thickness burns where epithelial regeneration is critical.[9]

Sorbact® bacteriostatic dressings employ a hydrophobic interaction mechanism that irreversibly binds microorganisms to the dressing surface without releasing antimicrobial agents into the wound bed.[10] This mechanism avoids the potential cytotoxicity associated with silver-based compounds while reducing microbial burden. Unlike antimicrobial-releasing dressings, Sorbact® functions through physical bacterial binding, potentially preserving the local cellular environment necessary for re-epithelialization.[11,12]

Clinical data evaluating Sorbact® dressings in burn wounds remain limited, particularly in the context of chemical burns. While some studies have demonstrated favorable outcomes in chronic wounds and surgical site infections, robust randomized data in acute burn treatment, especially within LMIC settings is limited. Furthermore, advanced dressings are often more costly than conventional SSD, raising important considerations in resource-limited healthcare systems. In Pakistan, healthcare resources are constrained, and cost-effectiveness is a critical determinant of therapeutic adoption.[13] Advanced wound care products must demonstrate measurable clinical benefit to justify routine implementation.[14,15]

In this context, evaluating the comparative effectiveness of Sorbact® dressings against SSD is of both clinical and economic importance. The present pilot comparative study was designed to evaluate the clinical outcomes of Sorbact® bacteriostatic dressings compared with 1% silver sulfadiazine in adult patients with partial-thickness chemical burns. The study aimed to assess time to epithelialization, hospital stay duration, need for STSG, and infection-related parameters while contextualizing findings within a single-center of LMIC setting.

Methods

Study Design and Setting

This study was designed as a prospective, single center, pilot blinded comparative study conducted at the Burn Care Centre, Pakistan Institute of Medical Sciences (PIMS), Islamabad. The Burn Care Centre is a tertiary level referral facility providing specialized burn management services for patients from Islamabad and surrounding regions in Pakistan. The study was conducted in accordance with institutional ethical standards and adhered to the principles of the Declaration of Helsinki. Ethical approval was obtained from the Burn Care Centre Ethics Committee prior to initiation of patient recruitment. As per the institutional policy and the pilot nature of the study, a formal approval reference number was not issued. Written informed consent was obtained from all participants before enrollment. This pilot trial was not prospectively registered. The primary objective of the study was to evaluate clinical feasibility and generate preliminary comparative outcome data between Sorbact® dressings and 1% silver sulfadiazine (SSD) in partial-thickness chemical burns.

Participants

Inclusion Criteria

Patients were eligible for inclusion if they met the following criteria:

- Age ≥18 years
- Presentation within 6 hours of sustaining a chemical burn
- Partial-thickness (superficial or deep

dermal) chemical burns confirmed clinically
- Total body surface area (TBSA) involvement ≤30%
- Hemodynamically stable at presentation

Exclusion Criteria

Patients were excluded if they had:
- Full-thickness burns requiring immediate surgical intervention
- TBSA >30%
- Electrical or thermal burns
- Pregnancy
- Significant uncontrolled comorbidities (e.g., uncontrolled diabetes, severe cardiac disease)
- Delayed presentation beyond 6 hours
- Known hypersensitivity to silver-based products

Patients with extensive burns (>30% TBSA) were excluded to reduce heterogeneity and avoid confounding due to systemic inflammatory response and fluid shifts associated with major burns.

Initial Assessment and First 24-Hour Management

Upon presentation to the emergency department, immediate clinical evaluation of the patients was carried out. Lund Browder chart was used to calculate the total burn surface area (TBSA). The depth of the burn was clinically assessed by the attending burn surgeon based on color, capillary refill, blister formation, and sensation. Standardized digital photographs were obtained for documentation and uploaded to the institutional secure server for multidisciplinary review and wound progression monitoring. All wounds were immediately irrigated with copious normal saline to remove residual chemical agents. After irrigation, wounds were gently dried using sterile technique.

Systemic management included:
- Intravenous analgesia as per institutional protocol
- Fluid resuscitation tailored to clinical requirement
- Urine output monitoring to assess hydration status
- Admission to dedicated burn observation rooms for monitoring

All admitted patients received standardized systemic antibiotic therapy (Piperacillin and Tazobactam) according to Burn Care Centre protocol to minimize infection related confounding.

Randomization and Allocation

Participants were allocated into randomized groups using computer-based randomization software available for clinical studies at the Burn Care Centre. Patients were assigned in a 1:1 ratio to either:
- Sorbact® bacteriostatic dressing group
- 1% silver sulfadiazine (SSD) group

Randomization was done after confirmation of eligibility and initial wound irrigation. Due to the visible differences between dressing types, blinding of treating clinicians and patients was not feasible. However, outcome assessments were performed by independent clinicians working within the burn care team who were not involved in allocation decisions. Statistical analysis was conducted by a statistician who was blinded to treatment allocation.

Interventions

Sorbact® Group

Following wound irrigation and drying, Sorbact® dressings were applied directly to the wound surface according to manufacturer recommendations. Dressings were secured with sterile secondary gauze (Figure 1, Figure 2 and Figure 3).

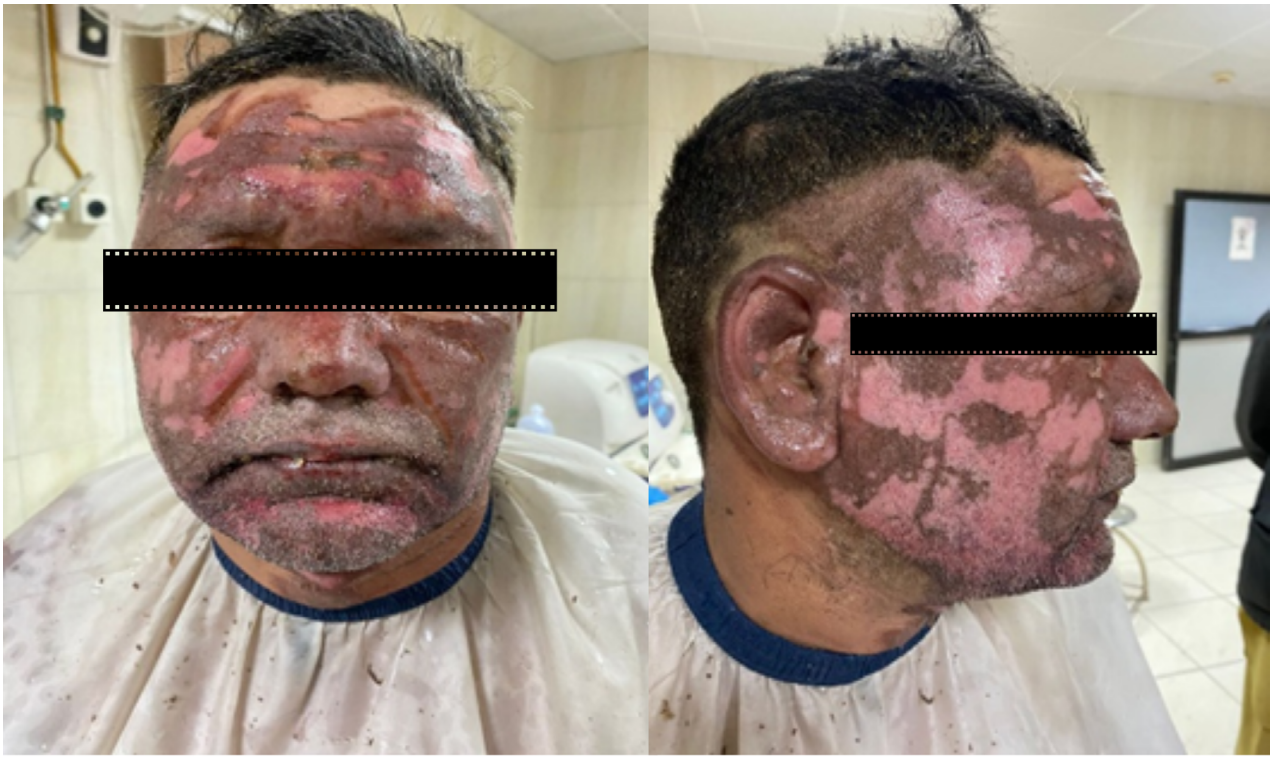
Silver Sulfadiazine Group

In the control group, 1% silver sulfadiazine cream was applied evenly over the wound bed following irrigation and drying. The wound was then covered with sterile gauze dressing.

Dressing Protocol

Dressings were changed when clinically indicated based on exudate saturation or loss of dressing integrity. In practice:
- SSD dressings were typically changed on alternate days.
- Sorbact® dressings were generally changed every third day.

All dressing procedures were conducted in the operating theatre under mild procedural sedation to standardize wound care conditions and minimize patient discomfort.



↑ Figure 1. Acid burn injury on the face at day 1.

← Figure 2. Acid burn patient after the application of Sorbact® Bacteriostatic Dressings at day 19.

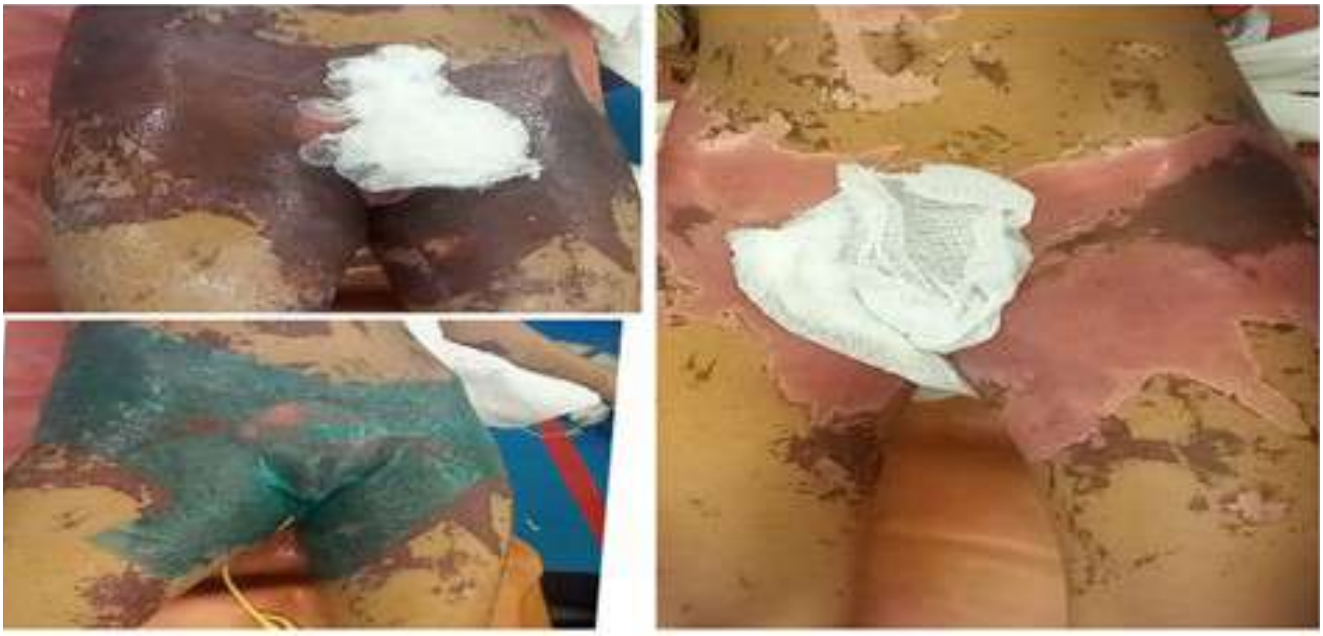


Figure 3. Results observed on applying the Sorbact® Bacteriostatic Dressings in a female patient.

Outcome Measures

Primary Outcome

Time to complete epithelialization, defined as 100% re-epithelialization of the wound surface without residual raw areas. Healing status was assessed clinically by the attending burn team during routine wound evaluations.

Secondary Outcomes

- Duration of hospital stay (days)
- Need for split-thickness skin grafting (STSG)
- Dressing frequency
- Infection-related parameters
-

Indication for Split-Thickness Skin Grafting (STSG)

STSG was indicated when:

- No evidence of progressive epithelialization was observed till post burn day 14
- Clinical assessment suggested failure of spontaneous wound closure

The decision was made by the treating burn surgeon based on standardized institutional criteria.

Infection Assessment

Wound infection was evaluated both clinically and microbiologically.

- Routine wound swab cultures were obtained at the time of second dressing.
- Patients were monitored for systemic signs of infection including fever.
- Total leukocyte count (TLC) and C-reactive protein (CRP) were measured.

No patient developed fever or leukocytosis (TLC remained <10,000/mm^3). Although CRP elevation was observed in some cases, no systemic infections were documented.

Sample Size Considerations

As this was a pilot study, the sample size was based on feasibility and institutional patient flow rather than formal power calculation. A total of 60 patients (30 per group) were enrolled to generate preliminary comparative outcome data and inform future adequately powered trials.

Statistical Analysis

Data were analyzed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation (SD). Categorical variables were presented as frequencies and percentages. Between-group comparisons were performed using:

- Independent t test for continuous variables
- Chi-square test for categorical variables

Relative risk (RR) with 95% confidence intervals

(CI) was calculated for grafting outcomes (Table 1). A p-value <0.05 was considered statistically significant.

Table 1. Comprehensive Statistical Analysis.

Variable	SSD (Mean±SD)	Sorbact® (Mean±SD)	Mean Difference	95% CI	p-value
Age	31.10 ± 9.89	29.77 ± 6.32	-1.33	-5.53 to 2.87	0.5366
Healing_time	19.27 ± 2.86	18.00 ± 1.64	-1.27	-2.45 to -0.09	0.0410
Hospital_stay	18.90 ± 3.11	17.47 ± 1.78	-1.43	-2.72 to -0.15	0.0335

Results

Participant Flow

A total of 106 patients with chemical burns were assessed for eligibility during the study period. Of these, 46 patients were excluded based on predefined criteria, including pregnancy (n=3), significant comorbidities (n=16), delayed presentation beyond 6 hours (n=3), and other exclusion parameters including extensive TBSA involvement and ineligibility based on burn depth.

Sixty eligible patients were enrolled and randomized in a 1:1 ratio:

- 30 patients were allocated to the Sorbact® group
- 30 patients were allocated to the 1% silver sulfadiazine (SSD) group

All randomized patients completed the allocated intervention and were included in the final analysis. No patients were lost to follow-up after allocation. The participant flow is illustrated in the CONSORT diagram (Diagram 1).

Baseline Characteristics

Baseline demographic and clinical characteristics were comparable between groups (Table 2). The mean age of participants did not differ significantly between the Sorbact® and SSD groups (p=0.536). Gender distribution was similar (p=1.000). The majority of burns were caused by acid exposure, with most injuries occurring in domestic settings involving household chemicals such as detergents. A smaller proportion involved industrial-grade chemicals. Burn site distribution, including upper limb, lower limb,

Table 2. Demographic Data of the studied patients.

Column1	Total (n=60)	Experimental Group (n=30)	Control Group (n=30)
Age (Years)	28 (19-55	23 (20-51)	25 (21-50)
TBSA%	23.3% (5%-29%)	21.4% (5%-28%)	24.5% (5%-29%)
Male	36.6% (n=22)		
Female	63.3% (n=38)		
Site of burns			
Trunk	22	12	10
Face	16	6	10
Leg	6	2	4
Arm	12	8	4
Hand	14	8	6
Neck	9	2	4
Excisions and skin grafts	19	4	15
Hospital Stay (Days)	18	17	19
Healing Time (Days)	20	19.5	22.5

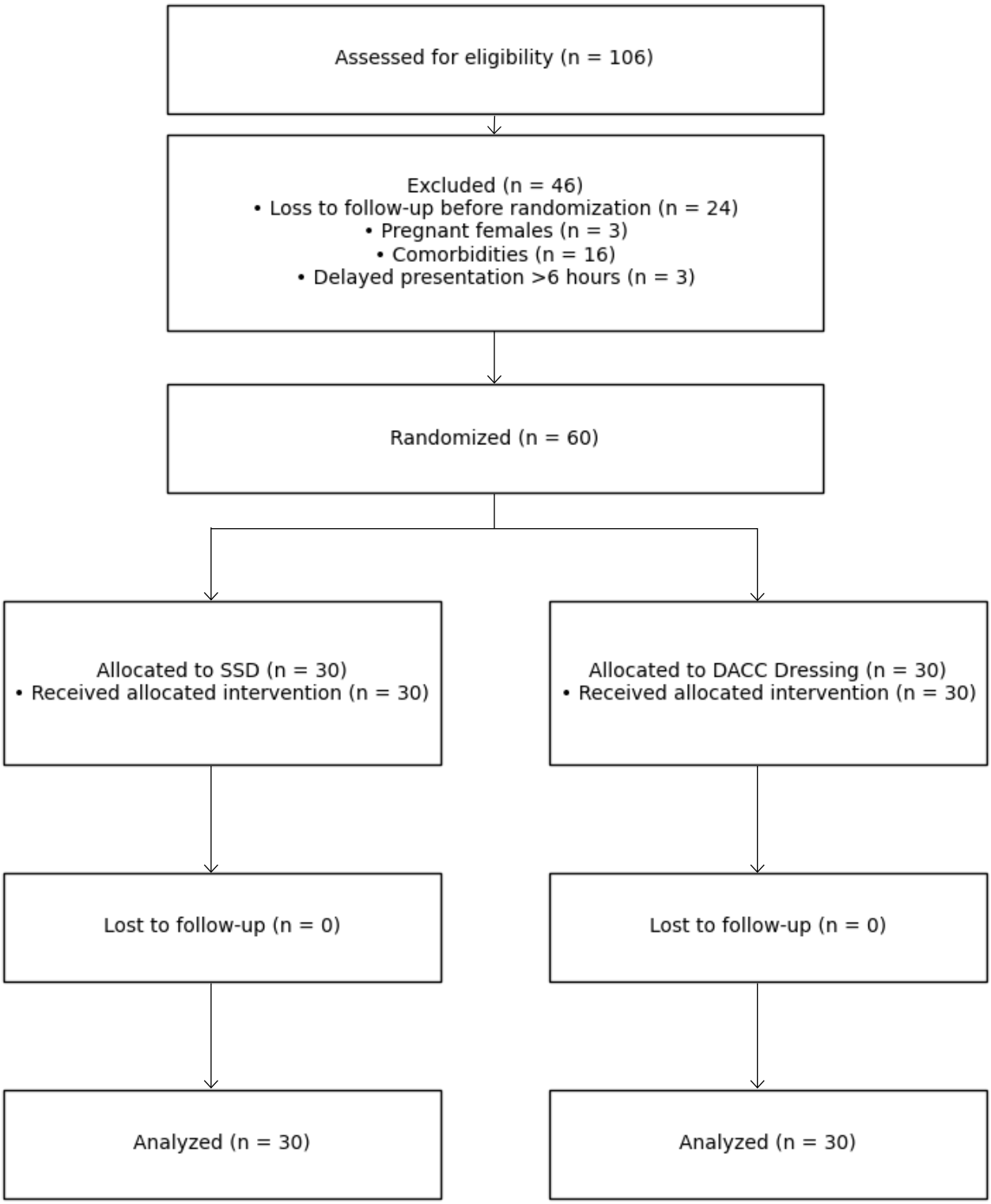


Diagram 1. CONSORT flow diagram.

and trunk involvement, showed no statistically significant difference between groups (p=0.202). TBSA involvement was comparable and remained ≤30% in all enrolled participants. These findings indicate appropriate baseline comparability between groups and minimize confounding due to demographic or injury-related variables.

Primary Outcome: Time to Complete Epithelialization

The primary endpoint was time to complete epithelialization, defined as 100% re-epithelialization of the wound surface without residual raw areas.

The mean healing time in the Sorbact® group

was significantly shorter compared with the SSD group:

- Sorbact® group: 18.00 ± 1.64 days
- SSD group: 19.27 ± 2.86 days

The difference was statistically significant (p=0.0399). The narrower standard deviation observed in the Sorbact® group suggests more consistent healing trajectories compared with the SSD group. Although the absolute difference in days may appear modest, even a one day reduction in epithelialization in burn patients can translate into earlier mobilization, reduced hospital burden, and decreased risk of secondary complications.

Secondary Outcomes

Duration of Hospital Stay

Mean duration of hospital stay was significantly reduced in the Sorbact® group compared with the SSD group:

- Sorbact® group: 17.47 ± 1.78 days
- SSD group: 18.90 ± 3.11 days

This difference was statistically significant (p=0.0324). Shorter hospital stay may reflect earlier wound closure and reduced need for surgical intervention. In LMIC settings where bed availability is limited, even small reductions in inpatient days have important resource implications.

Need for Split-Thickness Skin Grafting (STSG)

A significant difference was observed in the proportion of patients requiring STSG:

- SSD group: 50% (15/30 patients)
- Sorbact® group: 13.3% (4/30 patients)

Relative risk (RR) of requiring grafting in the Sorbact® group compared with SSD was: RR = 0.27. 95% Confidence Interval: 0.10–0.71. This indicates a substantially lower likelihood of grafting in the Sorbact® group. The confidence interval does not cross unity, supporting statistical significance. The reduction in grafting requirement is clinically meaningful, as STSG involves operative intervention, additional anesthesia exposure, donor site morbidity, and increased healthcare costs.

Dressing Frequency

Dressing changes were performed when clinically indicated based on exudate saturation and wound assessment.

In practice:

- SSD dressings were changed approximately on alternate days.
- Sorbact® dressings were typically changed every third day.

Although dressing frequency was not a predefined primary outcome, reduced frequency in the Sorbact® group may reflect better exudate control and dressing integrity.

Infection and Safety Outcomes

Routine wound cultures were obtained at the time of the second dressing. No bacterial growth was observed in either group. Patients were monitored for systemic signs of infection. No participant developed:

- Fever
- Leukocytosis (TLC remained <10,000/mm^3)
- Documented systemic infection

Although mild elevation in C-reactive protein (CRP) was noted in some patients, this was not accompanied by clinical or hematological evidence of systemic infection. No adverse reactions attributable to either dressing type were documented during the study period. The pain level of patients was rated using VRS (0 = no pain at all to 10=extreme pain). Patients in the experimental group using Sorbact Bacteriostatic Dressings had low wound-related pain scores, while in the case of SSD wound wound-related pain scores were high on day 1, P=0.02 . The pain score decreased during the healing process, as shown in graph 1, with a difference between the 2 groups on day 8, which was 2.9 in the case of the experimental group and 4.1 in the case of the control group (Figure 4).

Discussion

This pilot comparative study evaluated the comparative clinical outcomes of Sorbact® bacteriostatic dressings and 1% silver sulfadiazine (SSD) in adult patients with partial-thickness chemical burns in a lower middle-income country (LMIC) setting. The findings demonstrated significantly shorter healing time, reduced hospital stay, and a lower requirement for split-thickness skin grafting (STSG) in the Sorbact® group.[16] No systemic infections were documented in either treatment arm.

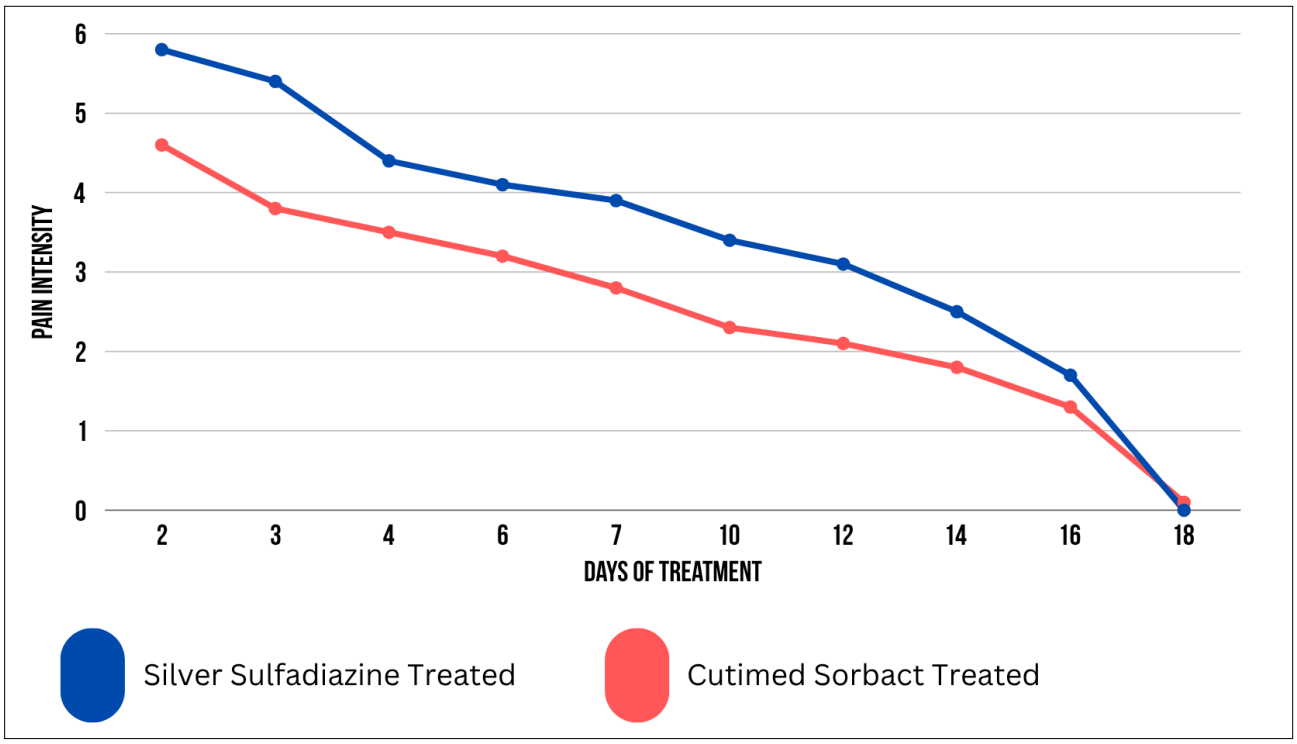


Figure 4. Pain Intensity during wound healing process (verbal rating scale 0-10).

Interpretation of Primary Outcome

The observed reduction in time to complete epithelialization in the Sorbact® group, although modest in absolute days, is clinically meaningful in burn management. Delayed epithelialization is associated with increased risk of infection, hypertrophic scarring, and prolonged hospitalization.[17] In partial thickness burns, preservation of viable dermal structures and epithelial stem cell niches is critical for spontaneous wound closure.[18]

Silver sulfadiazine has long been considered standard topical therapy due to its broad antimicrobial coverage. However, several studies have raised concerns regarding delayed epithelialization associated with SSD use. Experimental data have suggested that silver ions may exert cytotoxic effects on keratinocytes and fibroblasts, potentially impairing re-epithelialization. Clinical trials comparing SSD with modern occlusive or biosynthetic dressings have reported prolonged healing times in SSD-treated wounds.[19]

The mechanism of Sorbact® differs fundamentally from silver based dressings. Rather than releasing antimicrobial agents, Sorbact® utilizes hydrophobic interaction technology to irreversibly bind bacteria to the dressing surface.[20] This mechanism helps in preserving the wound microenvironment and avoid cytotoxic effects on regenerating epithelial cells. The shorter healing time observed in the Sorbact® group in this study may reflect this preservation of cellular viability.[21]

Grafting Requirement and Biological Plausibility

One of the most clinically significant findings of this study was the markedly lower requirement for STSG in the Sorbact® group. Deep dermal chemical burns are characterized by destruction of adnexal structures like hair follicles and sweat glands which harbor epithelial stem cell populations responsible for regeneration. When these regenerative reservoirs are compromised, spontaneous epithelialization becomes limited, and surgical grafting may be required.[22] The reduced grafting rate observed in the Sorbact® group may suggest improved preservation of viable dermal structures or more favorable wound healing dynamics. While the study was not designed to assess histological differences, the findings align with theoretical advantages of non-cytotoxic dressings in preserving residual regenerative capacity. It is important to interpret this finding cautiously given the pilot design; however, the relative risk reduction observed

is clinically relevant and warrants further investigation in adequately powered trials.

Comparison with Existing Literature

Several randomized trials have compared SSD with alternative modern dressings in burn care. Studies evaluating hydrocolloid, hydrofiber, and biosynthetic dressings have reported shorter healing times and fewer dressing changes compared with SSD. A systematic review and meta-analysis by Nímia et al. suggested that alternative dressings may be associated with improved epithelialization outcomes compared with SSD. Evidence specifically evaluating dialkylcarbamoyl chloride (DACC)-coated dressings such as Sorbact® in burn wounds remains limited. Totty et al. reported favorable outcomes with DACC dressings in wound management, noting reduced bacterial burden without cytotoxic effects. However, blinded randomized controlled data in acute burn management remain sparse, particularly in chemical burns.

The present study contributes to the literature by providing randomized pilot data specifically in chemical burns within an LMIC context.

Infection Outcomes

Routine wound cultures obtained during the second dressing revealed no bacterial growth in either group. Additionally, no patients developed fever or leukocytosis during hospitalization. Although C-reactive protein (CRP) levels were elevated in some patients, no systemic infections were documented. Chemical burns often result in deep dermal injury with destruction of skin adnexal structures. Early irrigation combined with standardized systemic antibiotic therapy in this cohort may have contributed to the absence of documented infections. Given that no infection events occurred in either arm, no conclusions can be drawn regarding differential infection control between dressings. Importantly, this study does not claim superiority in infection prevention but rather reports comparable safety profiles between groups.

Dressing Frequency and Resource Implications

Dressing frequency was clinically guided based on exudate saturation and wound condition. In practice, Sorbact® dressings required fewer changes compared with SSD dressings. Reduced dressing frequency may decrease patient discomfort, procedural sedation exposure, and healthcare workload. In LMIC settings such as Pakistan, resource optimization is critical. Although advanced dressings may have higher unit cost compared with SSD, potential reductions in grafting procedures, operative time, hospital stay, and dressing frequency may offset initial expense. Economic evaluation was beyond the scope of this pilot study; however, the findings support the need for future cost-effectiveness analysis.

Strengths of the Study

This study has several strengths:

- Prospective randomized controlled design
- Clear outcome definitions
- Independent clinical assessment
- Blinded statistical analysis
- Standardized antibiotic and sedation protocols
- Focus on a clinically relevant LMIC population

Limitations

This study has important limitations that must be acknowledged. First, it was conducted at a single tertiary burn center, which may limit generalizability to other institutions and healthcare settings. Second, as a pilot comparative study, the sample size was limited and based on feasibility rather than formal power calculation. While statistically significant differences were observed, to confirm these findings. Larger adequately powered trials must be conducted. Third, blinding of treating clinicians was not feasible due to visible differences in dressing types. Although outcome assessments were performed independently and statistical analysis was blinded, performance bias cannot be completely excluded. Fourth, allocation concealment was not formally implemented beyond institutional software randomization. Finally, no infection events were documented, limiting interpretation of antimicrobial comparative effectiveness.

Conclusion

In this single center pilot comparative study, Sorbact® bacteriostatic dressings demonstrated

favorable clinical outcomes compared with 1% silver sulfadiazine in the management of partial-thickness chemical burns. Patients treated with Sorbact® experienced shorter healing time, reduced hospital stay, and lower requirement for split-thickness skin grafting. Given the exploratory nature of this study and limited sample size, these findings should be interpreted cautiously. Larger multicenter, adequately powered randomized trials are required to confirm clinical effectiveness and evaluate cost effectiveness in lower-middle-income healthcare settings.

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