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Evaluation of the Effects of Prontosan and Normal Saline Irrigation Solution on the Healing of Second-Degree Burn Wounds

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ABSTRACT

Background: Second-degree burns involving the epidermis and dermis are commonly associated with pain and risk of infection, and inadequate treatment can lead to serious complications. Bacterial biofilms are a major factor delaying wound healing. Prontosan solution, containing antibacterial and biofilm-disrupting agents, has the potential to accelerate wound healing. Despite preliminary evidence, randomized clinical trials are limited. This study aimed to compare the efficacy of Prontosan and normal saline in the healing of second-degree burn wounds.

Methods: This double-blind randomized clinical trial was conducted at Motahari Burn Hospital in Tehran, enrolling 60 patients with deep second-degree burns. Participants were randomly assigned into two groups of 30: the intervention group received wound irrigation with Prontosan solution and gel, while the control group was treated with normal saline irrigation. Block randomization and assessor blinding were employed to minimize bias. Clinical and microbiological wound outcomes were evaluated on days 7, 14, and 21. Sample size was calculated based on the expected difference in wound healing time.

Results: The intervention group showed significantly reduced wound size, exudate, pain, and infection on days 14 and 21, along with accelerated epithelization ($p<0.01$). Wound appearance was also significantly improved in this group ($p<0.01$). Microbial cultures revealed a higher proportion of negative results in the Prontosan group compared to controls ($p=0.00$).

Conclusion: The findings indicate that Prontosan can accelerate the healing process of burn wounds, reduce pain, infection, and exudate, and improve patients' quality of life. Prontosan is recommended as a safe and effective treatment option in clinical protocols; however, further studies are needed to evaluate its long-term effects.

Introduction

Burn injury is one of the most common traumatic injuries worldwide(1). These injuries impose significant clinical, economic, and psychological burdens on patients and healthcare systems(2). According to the World Health Organization (WHO) report, over 11 million burn cases requiring

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medical treatment are reported annually, with approximately 180,000 deaths(3).

Second-degree burns involve the epidermis and parts of the dermis. These burns are typically associated with severe pain, blistering, edema, and an increased risk of infection(4). Without appropriate treatment, they may lead to severe scarring, functional impairment, and psychological disorders(5). Inadequate or delayed wound healing substantially increases the risk of local and systemic infections such as sepsis(6). Evidence indicates that burn-induced sepsis is the leading cause of mortality among these patients, accounting for up to 65% of deaths in burn centers(7). Moreover, delayed healing results in prolonged hospitalization, increased need for specialized care, and high direct and indirect costs(8). For example, a study in the Netherlands reported that the average treatment cost for burn patients in the first three months is approximately €26,540, a significant portion of which is due to prolonged wound healing (9). Additionally, burn scars are associated with chronic pain, pruritus, and psychological problems such as depression and anxiety, which can reduce patients' quality of life(10).Treatment of second-degree burn wounds is crucial to accelerate healing and prevent infection(11). Normal saline, as a commonly used irrigation solution, is safe but has limitations in combating biofilms and reducing microbial load(12). Biofilms are protected bacterial aggregates that increase resistance to treatments(13). Prontosan solution, containing betaine and polyhexanide (PHMB), is a novel agent with antibacterial and antifungal properties that disrupt biofilms. Unlike older solutions such as povidone-iodine, Prontosan preserves healthy cells and accelerates tissue regeneration(14). Studies have shown that the combination of PHMB and betaine reduces microbial load and biofilms more effectively than normal saline and enhances epithelization(15). Despite preliminary evidence supporting the efficacy of Prontosan in improving burn wound healing, definitive and generalizable results are lacking. Most previous studies have faced limitations such as small sample sizes, non-standardized designs, or focus on specific populations. Furthermore, direct comparisons between Prontosan and normal saline in randomized clinical trials, especially in patients with second-degree burns, have been limited. This research gap necessitates more rigorous studies with valid scientific designs to obtain reliable evidence. The present study was designed to address this need. The aim of this study is to compare the efficacy of two wound irrigation methods Prontosan solution and normal saline in accelerating the healing process of second-degree burn wounds. This research is conducted as a randomized clinical trial to control confounding variables and provide reliable and generalizable results. The main hypothesis is that using Prontosan solution, compared to normal saline, reduces microbial load, enhances faster epithelization, and shortens wound healing time. The findings of this study can serve as a basis for selecting more effective interventions in the clinical management of burn wounds.

Study Design

This study was conducted as a randomized controlled clinical trial to evaluate the efficacy of Prontosan solution compared to normal saline in the healing of second-degree burn wounds. The study took place at Motahari Burn Hospital in Tehran from 2024 to 2025.

Participants

The target population included all patients with superficial or deep second-degree burns, and the study population comprised all such patients presenting to Motahari Burn Hospital. Sixty patients with deep second-degree burns were conveniently selected and randomly assigned into two groups of 30 each.

Inclusion criteria

were age between 12 and 60 years, having superficial or deep second-degree burn wounds, and absence of active chronic diseases.

Exclusion criteria

included underlying conditions affecting wound healing (e.g., uncontrolled diabetes or immunodeficiency), use of immunosuppressive drugs, active wound infection, or any condition potentially influencing wound healing and study outcomes. All patients signed informed consent forms prior to participation.

Randomization

Block randomization with a block size of six was used to allocate participants into the intervention (Prontosan) and control (normal saline) groups, ensuring balanced group sizes throughout the study. Allocation sequences were generated randomly using all possible combinations within six-person blocks. To prevent bias and enhance internal validity, group assignments were concealed in coded, sealed envelopes labeled only with participant numbers, opened sequentially upon patient enrollment. The study was designed as double-blind; both patients and outcome assessors were blinded to group assignments to prevent assessment bias. However, the treatment team was not blinded due to the nature of interventions.

Interventions

The two groups received the following treatments: In the intervention group, second-degree burn wounds were irrigated with Prontosan spray. Two separate products Prontosan solution and

Prontosan gel were used sequentially. Initially, Prontosan solution was applied to soak and cleanse the wounds. The betaine in the solution penetrates and mechanically disrupts biofilm structures by weakening internal bonds, allowing the antimicrobial agent PHMB to infiltrate and exert a more effective disinfectant action. After soaking, the wound area was rinsed again with the solution to achieve proper debridement. Subsequently, Prontosan gel, containing the same active compounds at a higher concentration, was applied directly to the wound to prevent biofilm reformation, followed by secondary dressing. During subsequent dressing changes, the gel was removed using Prontosan solution, repeating the wound preparation process each time. Typically, 5 to 10 sprays of the solution were used per dressing change based on wound size and depth. Wound irrigation was performed only during dressing changes by wound care specialists, with the solution sprayed directly onto the wound bed and cleaned using sterile gauze. Treatment and assessments continued from hospital admission through post-discharge follow-ups. In the control group, second-degree burn wounds were irrigated with standard normal saline. Similar to the intervention group, 5 to 10 sprays of normal saline were applied during dressing changes based on wound size and depth. Irrigation was performed only during dressing changes by wound care specialists, with direct spraying onto the wound bed and cleaning using sterile gauze. Treatment and assessments continued from admission through follow-up. Both groups received appropriate dressings and foams according to wound depth and size after irrigation. Throughout the study, wound caregivers and assessors were different individuals, and assessors were blinded to the irrigation solution used. Prontosan wound irrigation solution is a sterile, ready-to-use product designed to prepare the wound bed and prevent microbial biofilm formation. It contains betaine, a surfactant that reduces biofilm surface tension and facilitates penetration, and polyhexanide (PHMB), which has antibacterial and antifungal effects. PHMB at 0.01% concentration in this product offers high efficacy and safety for healthy cells, including fibroblasts, and is used in various medical products. Prontosan is indicated for infection prevention and debridement of acute, chronic, and first- and second-degree burn wounds. It is supplied sterile in a spray bottle, usable up to 8 weeks after opening, and compatible with advanced dressings. Its advantages include reduced risk of secondary contamination, high tolerance for sensitive skin, and ability to warm to body temperature. Prontosan is an appropriate option for optimizing healing of superficial and partial-thickness wounds, especially second-degree burns.

Microbiological Assessment

To accurately evaluate microbial status and the efficacy of irrigation solutions, wound exudate samples were collected at various treatment stages for microbial culture. Samples were obtained under sterile conditions before dressing changes and after irrigation with Prontosan or normal saline by wound care specialists and sent to the microbiology laboratory. The purpose was to assess microbial load and presence or absence of pathogenic flora in the wound.

Outcome Measures

The primary outcome was clinical wound assessment, including characteristics such as appearance, color, odor, depth, and extent, evaluated by wound care specialists through direct examination. Secondary outcomes included overall wound healing progression, absence of infection, antibiotic efficacy in infection control, prevention of microbial biofilm formation, epithelization (regeneration of epithelial cells over the wound), and microbial status based on culture results. These variables were monitored at specified intervals post-intervention, including days 7, 14, and 21, and recorded based on clinical evaluations and observations by trained wound specialists. Outcomes were regularly documented and analyzed to precisely assess intervention effects on wound healing.

Sample Size Calculation

Sample size was calculated using the formula for comparing means between two independent groups, considering a significance level of 0.05 (α=0.05) and a power of 80% (Power=80%). Input parameters included the expected difference in mean wound healing time between groups and pooled standard deviation, based on a similar study with a sample size of 60 reporting a mean healing time difference of approximately 7 days and a pooled standard deviation of 10 days(16). Accounting for potential dropout, a total of 60 participants (30 per group) was determined to provide sufficient power to detect significant differences between groups.

Statistical Analysis: Data analysis and graph plotting were performed using SPSS version 22. A p-value$\leq$0.05 was considered statistically significant.

Results

The normality of continuous data was assessed using the Shapiro–Wilk test. Non-normally distributed data were analyzed using non-parametric tests. Numerical data are presented as mean ± standard deviation, and categorical data as frequency (percentage). Independent t-test or Mann–Whitney test was used for comparing numerical variables, and Chi-square or Fisher's exact test for categorical variables. A p-value less than 0.05 was considered

statistically significant. Baseline characteristics of participants in the intervention (n=...) and control (n=...) groups are presented in Table X. The mean age was 34.47 ± 11.97 years in the control group and 34.37±10.99 years in the intervention group, with no significant difference (p=0.973, t-test). Gender distribution was similar between groups, with 51.6% males in control and 51.7% males in intervention (p=0.796, Chi-square test). Burn type did not differ significantly between groups; for example, the percentage of Deep II burns was 51.9% in control and 48.1% in intervention (p=0.795). Wound locations were also comparable with no significant difference (p=0.528). The average number of wounds was 2.43±1.36 in control and 2.50±1.46 in intervention (p=0.855). Wound color showed no significant difference between groups (p=0.443). Overall, the results indicated homogeneity between the two groups regarding baseline characteristics including age, gender, burn type, wound location, and number of wounds, with no significant differences observed.

Table 1. Baseline Demographic Characteristics and Burn Profiles of Patients in the Intervention and Control Groups

Feature	Intervention Group: Prontosan (n=...)	Control Group: Normal Saline (n=...)	Statistical Test	p-value
Age	34.37 ± 10.99	34.47 ± 11.97	T-test	0.973
Gender - Male, n (%)	15 (51.7%)	16 (51.6%)	Chi-Square Test	0.796
Gender - Female, n (%)	15 (48.4%)	14 (48.3%)	Chi-Square Test	0.796
Burn Type - Deep II (%)	13 (48.1%)	14 (51.9%)	Chi-Square Test	0.795
Burn Type - Superficial II (%)	17 (51.5%)	16 (48.5%)	Chi-Square Test	0.795
Wound Location - Trunk, n (%)	8 (66.7%)	4 (33.3%)	Chi-Square Test	0.528
Wound Location - Upper Limb, n (%)	10 (50%)	10 (50%)	Chi-Square Test	0.528
Wound Location - Lower Limb, n (%)	7 (38.9%)	11 (61.1%)	Chi-Square Test	0.528
Wound Location - Other, n (%)	5 (50%)	5 (50%)	Chi-Square Test	0.528
Number of Wounds	2.50 ± 1.46	2.43 ± 1.36	T-test	0.855
Wound Color - Pink	2 (100%)	0 (0.0%)	Chi-Square Test	0.443
Wound Color - Red	9 (56.3%)	7 (43.8%)	Chi-Square Test	0.443
Wound Color - Yellow	9 (52.9%)	8 (47.1%)	Chi-Square Test	0.443
Wound Color - Brown	9 (42.9%)	12 (57.1%)	Chi-Square Test	0.443
Wound Color - Black	1 (25%)	3 (75%)	Chi-Square Test	0.443

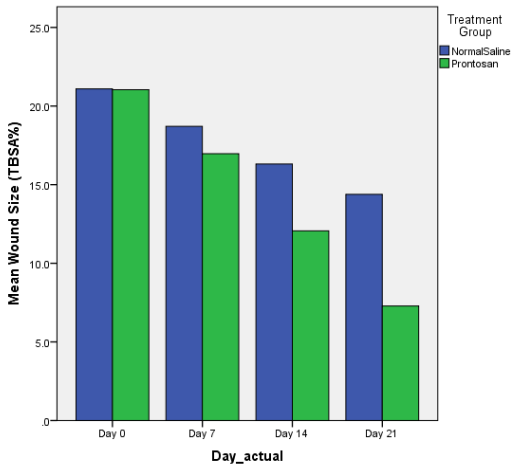

Figure 1. Bar chart illustrating the changes in mean wound size in the study groups on days 0, 7, 14, and 21.

The horizontal axis represents the follow-up days, and the vertical axis shows the mean wound size (in square centimeters). The height of each bar indicates the average wound size at each time point. This chart demonstrates a greater reduction in wound size over time in the Prontosan group.

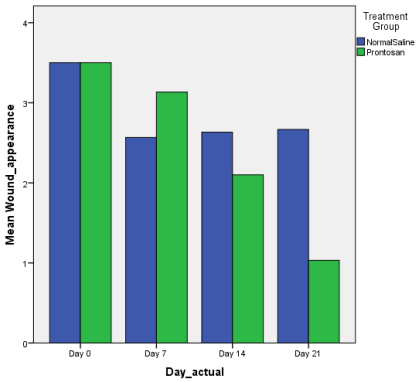

Figure 2. Bar chart illustrating the changes in wound appearance status in the study groups on days 0, 7, 14, and 21.

The horizontal axis represents the follow-up days, and the vertical axis represents the percentage of wounds that are clean, without exudate, and odorless. This chart demonstrates a greater reduction in wound size over time in the Prontosan group.

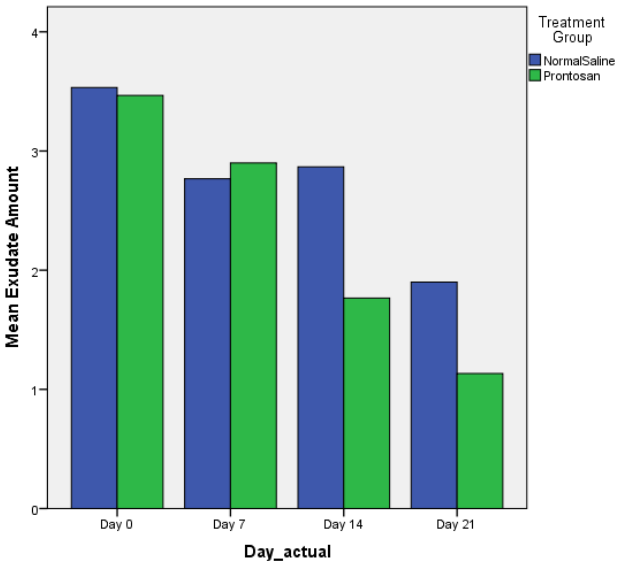

Figure 3. Bar chart illustrating the changes in wound exudate status in the study groups on days 0, 7, 14, and 21.

The horizontal axis represents the follow-up days, and the vertical axis represents the percentage of wounds without exudate. This chart demonstrates a greater reduction in wound exudate over time in the Prontosan group.

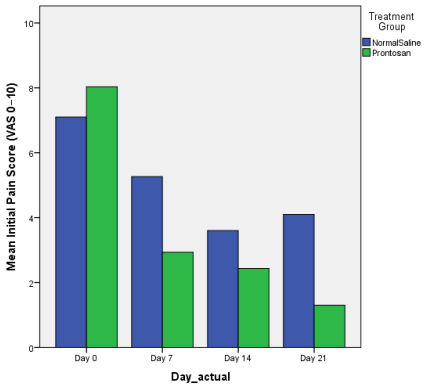

Figure 4. Bar chart illustrating the changes in wound pain status in the study groups on days 0, 7, 14, and 21.

The horizontal axis represents the follow-up days, and the vertical axis represents the percentage of patients reporting reduced pain. This chart demonstrates a greater reduction in wound pain over time in the Prontosan group.

Primary and secondary outcomes of the study are summarized in Table X. There was no significant difference in wound size (TBSA%) on day 0 between the normal saline (control) group and the Prontosan (intervention) group (mean 30.33 in control vs. 30.67 in intervention, p=0.941). However, the intervention group showed a significantly better healing trend on subsequent days; wound size on days 14 and 21 was significantly smaller in the intervention group compared to control (p=0.00).

Exudate levels also differed significantly between groups on days 14 and 21 (p=0.00), with the intervention group exhibiting lower exudate. Pain intensity (Pain VAS) was significantly lower in the intervention group at all measured time points (p<0.01).

Pain severity was measured at different times in both groups. On day 0, pain intensity was significantly higher in the intervention group than in the control group (p=0.009). However, on days 7, 14, and 21, pain was significantly lower in the intervention group, with highly significant differences reported (p<0.001). These results indicate that Prontosan intervention effectively reduced pain in burn patients and provided significant pain relief throughout the treatment period.

Epithelization improved significantly in the intervention group on days 14 and 21 compared to control (p=0.00), indicating accelerated wound healing. Wound culture results on days 7, 14, and 21 also showed significant differences, with the intervention group demonstrating a higher percentage of negative (no infection) results (p=0.00).

Specifically, all wound culture samples in the intervention group were negative on days 7 and 14, whereas a considerable portion of samples in the control group were positive. This trend continued on day 21, with the intervention group showing 58.8% negative cultures and the control group showing a higher percentage of positive cultures (p=0.00).

Clinical infection rates on days 14 and 21 were significantly lower in the intervention group compared to control (p=0.02). Wound appearance also differed significantly between groups on days 7, 14, and 21 (p<0.01), with the intervention group showing better wound status. Wound appearance was assessed at various time points. On day 0, wound status distribution was similar between groups with no significant difference (p=1.00). However, on day 7, a significant difference was observed (p=0.002), with a higher percentage of patients in the intervention group having clean, infection-free wounds, while the control group had a higher percentage of contaminated wounds with exudate and unpleasant odor. This pattern continued on day 14 (p=0.002), with the intervention group maintaining better wound appearance compared to control. On day 21, the difference was highly significant (p=0.00), with the intervention group showing a higher percentage of clean, infection-free wounds and the control group exhibiting more wounds with exudate and odor. Overall, the study results demonstrated that Prontosan intervention significantly improved clinical burn indicators including wound size reduction, pain relief, decreased exudate, infection control, and enhanced wound appearance. These findings suggest accelerated healing and reduced complications in patients treated with Prontosan compared to the control group.

Table 2. Primary and Secondary Clinical Outcomes and Statistical Comparison Between Study Groups

Variable	Prontosan (Intervention)	Normal Saline (Control)	Statistical Test	P-value
Wound Size (TBSA%)_0	30.67	30.33	Mann-Whitney Test	0.941
Wound Size (TBSA%)_7	16.967 ± 16.967	18.713 ± 2.6389	T-TEST	0.083
Wound Size (TBSA%)_14	18.67	42.33	Mann-Whitney Test	0.00*
Wound Size (TBSA%)_21	15.50	45.50	Mann-Whitney Test	0.00*
Exudate_level_0	Moderate: 16 (53.3%) High: 14 (46.7%)	Moderate: 14 (46.7%) High: 16 (53.3%)	Chi-Square Test	0.60
Exudate_level_7	Low: 3 (30%) Moderate: 27 (54%)	Low: 7 (70%) Moderate: 23 (46%)	Chi-Square Test	0.16
Exudate_level_14	None: 12 (100%) Low: 13 (59.1%) Moderate: 5 (23.8%) High: 0 (0.00%)	None: 0 (0.00%) Low: 9 (40.9%) Moderate: 16 (76.2%) High: 0 (100%)	Chi-Square Test	0.00*
Exudate_level_21	None: 26 (89.7%) Low: 4 (12.9%)	None: 3 (10.3%) Low: 27 (87.1%)	Chi-Square Test	0.00*
pain_VAS_initial_0	36.23	24.77	Mann-Whitney Test	0.009*
pain_VAS_initial_7	17.02	43.98	Mann-Whitney Test	0.00*
pain_VAS_initial_14	18.38	42.62	Mann-Whitney Test	0.00*
pain_VAS_initial_21	15.63	45.37	Mann-Whitney Test	0.00*
epithelization_7	None: 27 (50.9%) Partial: 3 (42.9%)	None: 26 (49.1%) Partial: 4 (57.1%)	Chi-Square Test	0.68
epithelization_14	None: 1 (100%) Partial: 26 (46.4%) Complete: 3 (100%)	None: 0 (0.00%) Partial: 30 (53.6%) Complete: 0 (0.00%)	Chi-Square Test	0.11
epithelization_21	Partial: 3 (10%) None: 27 (90%)	Partial: 27 (90%) None: 3 (10%)	Chi-Square Test	0.00*
culture_result_7	Positive: 0 (0.00%) Negative: 30 (58.8%)	Positive: 9 (100%) Negative: 21 (41.2%)	Chi-Square Test	0.00*
culture_result_14	Positive: 0 (0.00%) Negative: 30 (56.6%)	Positive: 9 (100%) Negative: 23 (43.4%)	Chi-Square Test	0.00*
Culture_result_21	Positive: 0 (0%) Negative: 21 (41.2%)	Positive: 7 (100%) Negative: 0 (0.00%)	Chi-Square Test	0.00*
Clinical_infection_7	No: 11 (52.4%) Yes: 19 (48.7%)	No: 10 (47.6%) Yes: 20 (51.3%)	Chi-Square Test	0.78
Clinical_infection_14	No: 30 (54.4%) Yes: 0 (0.00%)	No: 25 (45.5%) Yes: 5 (100%)	Chi-Square Test	0.02*
Clinical_infection_21	No: 30 (54.4%) Yes: 0 (0.00%)	No: 25 (45.5%) Yes: 5 (100%)	Chi-Square Test	0.02*
Wound_appearance_0 Clean	Exudative: 15 (50%) Odor: 15 (50%)	Exudative: 15 (50%) Odor: 15 (50%)	Chi-Square Test	1.00
Wound_appearance_7 Infected	Infected: 6 (31.6%) Exudative: 14 (45.2%) Odor: 10 (100%)	Infected: 13 (68.4%) Exudative: 17 (54.8%) Odor: 0 (0.00%)	Chi-Square Test	0.002*
Wound_appearance_14 Exudative	Infected: 27 (64.3%) Exudative: 3 (21.4%) Odor: 0 (0.00%)	Infected: 15 (35.7%) Exudative: 11 (78.6%) Odor: 4 (100%)	Chi-Square Test	0.002*
Wound_appearance_21 Odor	Clean: 29 (90.6%) Infected: 1 (7.7%) Exudative: 0 (0.00%) Odor: 0 (0.00%)	Clean: 3 (9.4%) Infected: 12 (92.3%) Exudative: 7 (100%) Odor: 8 (100%)	Chi-Square Test	0.00*

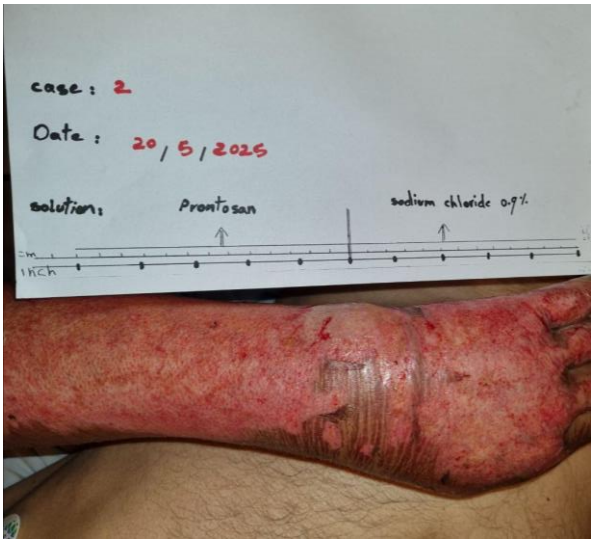

Figure 5. Clinical images of burn wounds after patient 1 treatment with Prontosan and Normal Saline

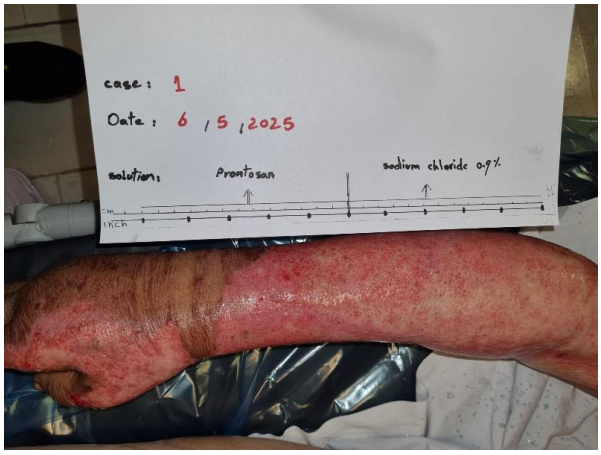

Figure 6. Clinical images of burn wounds after patient 2 treatment with Prontosan and Normal Saline

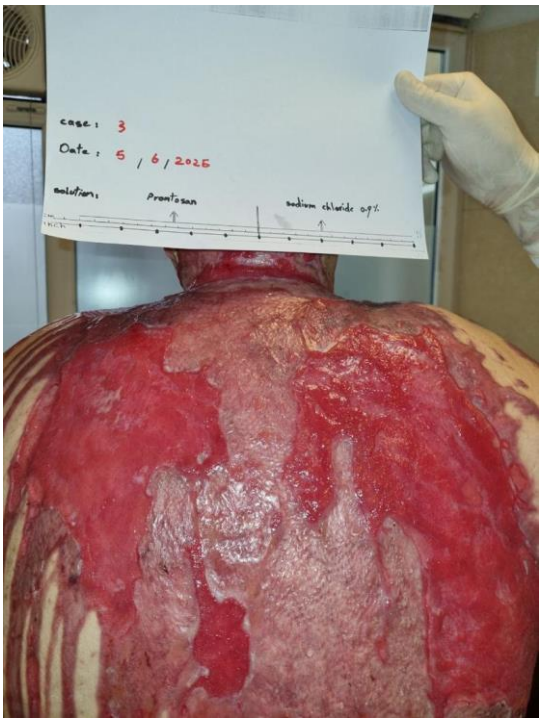

Figure 7. Clinical images of burn wounds after patient 3 treatment with Prontosan and Normal Saline

The area of the burn treated with Prontosan solution demonstrates significantly greater healing compared to the area treated with normal saline.

Discussion

Effect of Prontosan Solution on Burn Wound Healing and Reduction of Wound Size.The present study demonstrated that the use of Prontosan solution significantly reduced burn wound size on days 14 and 21. This finding aligns with previous studies reporting the positive effects of Prontosan in accelerating thermal wound healing and decreasing the extent of the damaged area(17, 18). The mechanism of action is primarily attributed to its ability to remove bacterial biofilms and provide a moist, favorable environment for epithelial cell growth(19). Improvement in wound size not only reduces infection risk but also accelerates the healing process and prevents abnormal scarring. These results highlight the importance of using antiseptic and moisturizing solutions like Prontosan in managing second-degree and higher burn wounds. Pain Reduction and Improvement of Patients' Quality of Life with Prontosan an important outcome of wound treatment is pain control, which was significantly reduced in the intervention group in this study. Pain intensity on days 7, 14, and 21 was significantly lower than in the control group, consistent with previous clinical studies(20). Pain reduction may result from Prontosan's anti-inflammatory effects and decreased microbial load, which in turn reduce inflammation and nerve stimulation(21). This pain relief not only enhances patients' quality of life but also facilitates frequent dressing changes and better wound care. Therefore, Prontosan can be considered an effective therapeutic option for alleviating discomfort in burn patients. Role of Prontosan in Infection Control and Improvement of Wound Microbiological Status .Controlling wound infections is a major challenge in burn treatment. The present study showed that Prontosan use significantly shifted wound culture results toward negativity and reduced clinical infection rates. These findings are consistent with previous research confirming Prontosan's role in disrupting bacterial biofilms and reducing microbial burden in wounds(22). Since biofilms are a key factor in chronicity and treatment resistance of wound infections, Prontosan's ability to break down these structures is central to its success in managing burn infections. Infection control not only accelerates healing but also prevents serious complications such as sepsis. Improved Epithelization and Wound Appearance with Prontosan This study found that epithelization was significantly faster and more complete in the intervention group compared to control. Additionally, wound appearance was better in the Prontosan group, with a higher percentage of clean wounds free from exudate and odor. These results correspond with the stages of wound healing, including inflammation, reconstruction, and maturation phases(23,24). Prontosan maintains wound moisture and facilitates removal of necrotic tissue, creating optimal conditions for new cell growth. Improved wound appearance is important not only cosmetically but also as an indicator of reduced inflammation and infection, which can decrease scarring and enhance skin function.

Clinical Significance and Future Applications of Prontosan in Burn Wound Management

Given the positive outcomes of this and prior studies, Prontosan solution is considered an effective and low-adverse treatment method for managing burn wounds(25). Besides its antiseptic effects, its moisturizing and biofilm-removing properties can help reduce healing time, pain, infection, and improve patients' quality of life. Considering the complexity of burn wound healing and the need for specialized care, Prontosan can be recommended as an effective adjunct in standard treatment protocols. Future studies may explore its long-term effects and compare it with other therapies to better define its precise role in wound healing.

Strengths and Limitations of the Study

One of the key strengths of this study is its randomized controlled clinical trial design, which enhances the validity of the results and allows for precise comparison between the intervention and control groups. Additionally, patient follow-up at multiple time points and the use of diverse clinical outcome measures such as wound size, pain intensity, wound appearance, and microbiological culture results improved the comprehensiveness of treatment effect assessment. However, several limitations should be considered when interpreting the findings. The relatively small sample size may reduce the statistical power of the study and limit the generalizability of the results to larger populations. Furthermore, the inability to fully control for confounding factors affecting wound healing such as nutrition, underlying diseases, and concurrent care could have influenced the outcomes. The limited duration of follow-up also restricted the evaluation of long-term treatment effects. These limitations suggest that future studies with larger sample sizes, more rigorous control of influential variables, and longer follow-up periods are necessary to obtain more definitive and generalizable results.

Conclusion

Overall, the results of this study demonstrated that the use of Prontosan solution can significantly accelerate the healing process of burn wounds and improve patients' quality of life by reducing pain, infection, exudate, and enhancing wound appearance. These findings align with previous

evidence and confirm the effective role of this solution as a safe and efficient therapeutic option in the management of burn and chronic wounds. Given its lower side effects and high efficacy, incorporating Prontosan into treatment protocols can contribute to better clinical outcomes for patients. However, further studies with larger sample sizes and longer follow-up periods are recommended to evaluate its long-term effects and compare it with other treatment methods.

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Appendices

Patient Demographic and Baseline Characteristics Form

Section	Variable / Item	Value / Options
1. Demographic and Baseline Information	Patient Code	……
	Treatment Group	☐ Prontosan ☐ Normal Saline
	Age	…… years
	Gender	☐ Male ☐ Female
	Admission Date	
	Hospital Ward	
	Time from Injury to Treatment	…… days
2. Initial Wound Characteristics	Burn Type	☐ Superficial Second Degree ☐ Deep Second Degree
	Wound Location	☐ Trunk ☐ Upper Limb ☐ Lower Limb ☐ Other: ……
	Wound Size (TBSA%)	
	Number of Wounds	
	Wound Depth	
	Wound Appearance	☐ Clean ☐ Infected ☐ Exudative ☐ Malodorous
	Wound Color	☐ Pink ☐ Red ☐ Yellow ☐ Brown ☐ Black
	Exudate Level	☐ None ☐ Low ☐ Moderate ☐ High
	Pain Intensity (VAS: 0–10)	……

Patient Follow-up and Clinical Assessment Form During Treatment (Days 7, 14, and 21)

Variable / Assessment Indicator	Day 7	Day 14	Day 21
Remaining wound size (TBSA%)	……	……	……
Wound exudate status (None, Low, Moderate, High)	☐ None	☐ None	☐ None
Wound appearance (color, cleanliness)	……	……	……
Pain intensity (VAS: 0–10)	……	……	……
Epithelization status (None, Partial, Complete)	☐ None	☐ None	☐ None
Microbial culture from wound	☐ Positive ☐ Negative Type: ……	☐ Positive ☐ Negative Type: ……	☐ Positive ☐ Negative Type: ……
Clinical infection occurrence	☐ Yes ☐No Symptoms: ……	☐ Yes ☐No Symptoms: ……	☐ Yes ☐ No Symptoms: ……
Antibiotic usage	☐ Yes ☐ No Drug type: ……	☐Yes ☐No Drug type: ……	☐ Yes ☐ No Drug type: ……

Materials and Methods

Study Design:

This research was designed as a prospective observational cohort study conducted in a tertiary care hospital. The study aimed to evaluate the contribution of various risk factors to the development of postoperative delirium in elderly patients undergoing total hip arthroplasty. The duration of the study spanned 12 months, from [Insert Start Month and Year] to [Insert End Month and Year], ensuring adequate follow-up and sample representation.

Conclusion

In conclusion, delirium remains a common and serious complication following hip arthroplasty in elderly patients. Advanced age, pre-existing cognitive impairment, and comorbid conditions such as heart failure, hypertension, and chronic kidney disease significantly increase the risk. Delirium not only impairs recovery but also contributes to greater healthcare utilization and poorer short-term outcomes. Early identification and implementation of preventive strategies are critical to improving patient outcomes and reducing the burden on healthcare systems.

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Authors' Contributions

All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all the aspects of this work.

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