Introduction

Most superficial burns are managed as outpatient cases, but the scenario changes for the partial-thickness burns. Traditionally, the superficial burns are treated by referral to burns and plastic surgery specialist where management comprises alternate-day dressing of wound with or without anesthesia. The conventional dressing of burn includes wound cleaning followed by application of 1% silver sulfadiazine (SSD) cream with occlusive dressing with roller gauze. The dressing is opened on the second day and thereafter every alternate day. The SSD has become a drug of choice in burn dressings due to its broad-spectrum action against Gram-positive and Gram-negative bacteria as well as against fungi. However, there are two concerns associated with SSD dressing: the first problem is the systemic absorption of silver which remains in the body even after dissociation. Another problem with conventional dressing is of repeated daily or alternate-day painful dressings, especially in pediatric population where frequently anesthetic services are needed for dressing change.

The other method of management includes biological dressing which creates a barrier between wound surfaces and

ABSTRACT

Background: The advantages of biological skin dressings like collagen are well-known. It makes wound impermeable to bacteria and creates the most physiological interface between the wound surface and the environment. Silver-sulfadiazine-impregnated collagen (SIC) is a type I collagen impregnated with silver sulfadiazine (SSD)-loaded alginate microspheres to deliver SSD in a controlled fashion to manage infected burn wounds for an extended period of time with lesser dressing changes. Materials and Methods: In this study, we used SIC for the treatment of second-degree burn wounds in 25 patients and compared with similar burn wounds in 25 patients treated with conventional dressings. Results: For SIC-treated group, we observed improved wound healing in all the patients after 7 days except two patients who required skin grafting, and none of them had any serious complications. For conventionally treated group, improved wound healing was seen in 14 patients, whereas the rest of the patients required prolong dressing or skin grafting. All the patients who were treated with SIC were satisfied with healing of wound and pain relief. Conclusion: Second-degree burn wounds are well-treated with SIC in the form of good healing, control of infection, and reducing pain without any serious complications when compared with conventional dressing.

Keywords: Second-degree burn, silver-sulfadiazine-impregnated collagen, wound healing

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environmental bacteria. The collagen dressings have other advantages over conventional dressings in terms of ease of application and being natural, nonimmunogenic, nonpyrogenic, hypoallergenic, and pain-free. It acts by providing a wound bed for migration of fibroblasts, promotion of angiogenesis, and enhancing the metabolic activity of granulation tissue. Many researchers in the past have compared the outcome of wound healing by collagen dressing versus conventional dressings. The collagen dressings have demonstrated variable results when compared with conventional results in terms of wound healing and pain perception. It was superior in terms of completeness of wound healing, need of SSG, and need of repeated dressing which is of more concern in pediatric age group. Although collagen dressings seem to be ideal for second-degree burns, there usually are certain disadvantages associated with them. The collagen dressings may provide excellent environment for the growth of bacterial colonies which leads to exudation and delayed wound healing. Collagen dressing may get infected in 19% of partial-thickness burn wounds leading to removal and redressing. This infection may promote scarring by increasing local release of inflammatory mediators such as prostaglandins and tumor necrosis factor-alpha. This delayed wound healing infection leads to wound dehiscence, low oxygen tension, and destruction of existing cellular matrix. The silver-impregnated collagen dressings are designed to provide the functions of both collagen dressings and conventional dressing. Also, they appear to be more comfortable to patients and are easier to use for care givers.

Keeping all the above-mentioned points in mind, a study was conducted to know the benefits of silver-impregnated collagen dressing over SSD dressings in partial-thickness burns as primary treatment modality as outpatient or day-care services.

**Aims and objectives**

This study was conducted to evaluate the role of SIC dressings when compared with conventional dressings in the management of second-degree burns. This study also compared both groups for pain, wound infection, and associated complications.

**Materials and Methods**

It is a prospective, randomized case–control study conducted over a period of 6 months in burns and plastic surgery department in a tertiary healthcare setup in urban western India. Patients with less than 20% second-degree burns who presented within 48 h of were included in the study. The cases were then randomized into two groups based on surgical dressing they received, that is, group 1 silver-sulfadiazine-impregnated collagen (SIC) dressing group and group 2 conventional dressing with SSD cream group.

**Sample size**

A total of 50 cases with less than 20% BSA of second-degree burns were included in the study.

**Randomization**

Cases were randomized into two groups. In the first group, the dressing was done by SSD-impregnated collagen. In the second group, routine dressing with 1% SSD was done.

**Inclusion criteria**

All the clinically and hemodynamically stable patients with less than 20% second-degree burns presented within 48 h and patients who are willing for and giving consent for this procedure were included in this study.

**Exclusion criteria**

Cases with full-thickness burns, cases involving >20% BSA, patients presented after 48 h of burn, hemodynamically unstable patients, and patients with debilitating chronic medical disorders were excluded from the study.

**Methodology**

**Group 1:** Under all aseptic precautions, we cleaned the wound with normal saline, and some patients required anesthesia for this procedure. Then we applied SIC which was covered by paraffin gauze and dressing. We gave antibiotics for 7 days according to their swab for culture and sensitivity which was taken before applying SIC. We monitored the patients according to clinical parameters (wound discharge, soaking, pain, and fever) and hematological parameters (complete blood counts on alternate days). In all the patients of group 1, we opened the dressing on the seventh day and compared the wound with that of group 2 in the form of signs of healing, size, discharge, epithelisation, slough, and granulation tissue.

**Group 2:** In this group, the patients were treated with conventional method of dressing. We applied 1% SSD cream over the cleaned wound followed by occlusive dressing with gauze pad and roller bandage. The patients were asked to take bath with soap once in every 2 days and the dressings were changed along with application of ointment. The first dressing was changed after 48 h and the subsequent dressing was done on the alternate day.

Antibiotics were given according to swab culture, and follow-up was done in the both groups.

**Outcome criteria**

1. Patients were assessed for pain with Visual Analog Scale (VAS) on days 2, 7, and 14
2. Healing was assessed on day 7 in both the groups, and complete healing (evidenced by appearance of epithelization in 90% of wound) was compared in both the groups
3. Any complication such as infection, scarring, and incomplete healing was documented.

**Statistical analysis**

An analysis was performed using SPSS software for Windows (version 11.0, 2001; SPSS Inc., Chicago, IL, USA). All
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the variables were tested for normality by Kolmogorov–Smirnov test before statistical comparisons. Chi-square test and logistic regression were used for analyses.

**Results**

A total of 50 cases with second-degree burns of <20% body surface area were included for study in our hospital during a period of 6 months. The cases were randomized into two groups. Both the groups were comparable in terms of age groups and mean ages. The male-to-female ratio in the both groups was 0.66:1 and 0.78:1, respectively, showing more number of females presenting with second-degree burns. Two age peaks were noted, that is, <5 years age and 15–60 years age. It shows that toddlers and young females who frequently work around fire are at greater risk [Table 1].

Of 25 cases in SIC group, 22 cases were completely healed on day 7, whereas only 14 cases were completely healed during that interval in conventional dressing group \(P = 0.027\). Furthermore, a reduction in wound size was noticed in SIC-treated group [Table 2]. The mean complete healing time in SIC group was 7.476 ± 3.134 days which was significantly lower \(P < 0.0001\) than control group which was 12.88 ± 4.912 days [Table 3].

The day 2 and day 7 pain scores on VAS were compared in both the groups. The cases in SIC groups experience much lesser degree of pain than the SSD group. Most of the cases had pain scores below 4 in SIC group, whereas in SSD group the mean pain score was around 4.194 ± 1.7 which was significantly higher \(P < 0.0001\) [Table 4].

Similarly, on the seventh day most of the cases in SIC group were pain-free. But in SSD group, the average pain score was 2.846 ± 1.002. This pain was more attributed to repeated removal and reaplication of dressings [Table 5].

**Complication**

Two patients of the 25 cases in SIC showed discharge on the second day for which the dressing was removed and redressing was done. This value was significantly lesser (Chi-square statistic = 4.5 and \(P = 0.033895\)) than SSD dressing group in which eight cases showed soakage of wound on day 2.

**Discussion**

In India, the annual burn incidence is around 6–7 million which is based on the data from major hospitals of the country.\[1\] The burn incidences tend to be more common in children, females, and people from low socioeconomic status.\[18\] This can be attributed to the practices of open burning flame for cooking in rural India and synthetic flowing garments (sari).\[14\] The higher incidence in children is due to their impulsiveness, lack of awareness, higher activity levels because of natural curiosity, and total dependency on caregivers.\[19\] Although there are well-equipped burn centers throughout India, they are overwhelmed by the burden of cases over them. The majority of cases are still treated in the centers that do not have established burn unit.\[20\] There is a need in the current scenario to develop an effective treatment methodology for partial-thickness burns of lesser BSA involvement so that they can be dealt with at primary health centers or at district hospitals. This will not only reduce the burden on burn units but also save the inconvenience of travel and prolonged admission on patients themselves.

This study has clearly demonstrated the superiority of SIC dressing over conventional dressings. They were not only associated with better healing and decreased infection rate but also pain suffered by patients was significantly lowered. Barret et al.\[23\] described the pain of conventional dressing significant in pediatric age group. They compared dressing of 1% SSD with Biobrane in pediatric population for the management of partial-thickness burns. They concluded that the treatment of partial-thickness burns with Biobrane is superior to topical therapy with 1% SSD. Pain, pain medication requirements, wound healing time, and length of hospital stay were significantly reduced.

| Table 1: Age and sex distribution |
|--------------------------|--------------------------|---------------------|---------------------|---------------------|
| Age in years          | Group 1 | Total | Group 2 | Total | \(P\) |
|                       | Female | Male |          | Female | Male |          |
| <5                    |        | 4    | 3       | (28%)  | 5    | 3       | (32%)  | 0.6681 |
| 5-15                  | 2      | 2    | 4       | (16%)  | 2    | 1       | (12%)  | 0.5383 |
| 15-60                 | 7      | 4    | 11      | (44%)  | 7    | 5       | 12     | (48%)  | 0.6889 |
| >60                   | 2      | 1    | 3       | (12%)  | 0    | 2       | 2      | (8%)   | 0.46   |
| Mean                  | 23.112±20.668 | years | 22.947±20.185 | years | 0.9773 |

| Table 2: Healing at seventh day |
|--------------------------|--------------------------|
| Type of dressing | Healed | Not healed | Total |
| SIC                    | 22    | 3          | 25    |
| SSD                    | 14    | 11         | 25    |
| Total                  | 36    | 14         | 50    |

| Table 3: Mean complete healing time |
|--------------------------|--------------------------|---------------------|
| Group | \(n\) | Mean | Std. dev. | \(T\) | df | \(P\) |
| SIC    | 25   | 7.476 | 3.134 | 8.622 | 24 | <0.0001 95% CI for mean |
| SSD    | 25   | 12.88 | 4.912 | 6.18-8.76 | 25 |

| Table 4: Day 2 pain score |
|--------------------------|--------------------------|---------------------|
| Group | \(n\) | Mean | Std. dev. | \(T\) | df | \(P\) |
| SIC    | 25   | 2.154 | 1.333 | 7.669 | 24 | <0.0001 95% CI for mean |
| SSD    | 25   | 4.194 | 1.727 | 1.6050-2.7030 | 25 |

| Table 5: Day 7 pain score |
|--------------------------|--------------------------|---------------------|
| Group | \(n\) | Mean | Std. dev. | \(T\) | df | \(P\) |
| SIC    | 25   | 0.746 | 0.822 | 12.774 | 24 | <0.0001 95% CI for mean 0.4067-1.0853 |
| SSD    | 25   | 2.846 | 1.002 | 0.5383 | 25 |
Shanmugasundaram et al. evaluated the cost-effectiveness of enclosed silver dressings and 1% SSD dressings. According to their study, enclosed silver dressings are a cost-effective means of treating partial-thickness burns. In a large multicenter randomized study, Silverstein et al. evaluated the cost-effectiveness, performance, tolerance, and safety of a silver-containing soft silicone foam dressing versus SSD cream (control) in the treatment of partial-thickness thermal burns. Both treatments were well tolerated; however, the total incidence of adverse events was higher in the control group. The silver-containing soft silicone foam dressing was as effective in the treatment of patients as the standard care (SSD). In addition, the group of patients treated with the soft silicone foam dressing demonstrated decreased pain and lower costs associated with treatment. In a randomized controlled trial (RCT) by Muangman et al. in 70 outpatient cases with partial-thickness burns of less than 15% BSA, they showed that silver-impregnated hydrofiber dressing increased time to healing, decreased pain symptoms, and increased patient convenience because of limiting the frequency of replacement of the dressing at lower total cost when compared with 1% SSD dressing. This study confirms the efficacy of silver-impregnated hydrofiber dressing for the treatment of partial-thickness burns at an outpatient clinic.

A large systematic review conducted by Heyneman et al. concluded that the use of SSD in the conservative treatment of burn wounds can no longer be supported. Their review clearly demonstrated that a faster wound healing, optimal function, and good aesthetic outcome are obtained with the newly developed burn dressings. They also concluded that these new dressings tend to be more comfortable for patients and are easier to use for care givers. The minor differences in antibacterial activity between SSD and the new products did not seem to have any influence on the rate of wound healing. In another systematic database review by Wasiak et al. which included 30 RCTs, it was concluded that conventional SSD dressings were associated with poorer outcome when compared with biosynthetic (skin substitute) dressings, silver-containing dressings, and silicon-coated dressings for the treatment of superficial and partial-thickness burns.

**Conclusion**

Our study clearly demonstrated that SIC dressing is a better alternative than the conventional dressing. The pain, infection, and early complications were significantly lesser in SIC group, and the advantage of lesser dressings was also desirable in high-volume burn centers as well as to patients' comfort. However, to opine SIC dressing as first-line management for superficial burns in primary care centers, multicenter parallel larger randomized studies will be needed for better conclusion.

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**Conflicts of interest**

There are no conflicts of interest.

**References**

1. Harrison HN. Pharmacology of sulfadiazine silver. Its attachment to burned human and rat skin and studies of gastrointestinal absorption and extension. Arch Surg 1979;114:281-5.
2. Carr HS, Wlodkowski TJ, Rosenkranz HS. Silver sulfadiazine: *In vitro* antibacterial activity. Antimicrob Agents Chemother 1973;4:585-7.
3. Wlodkowski TJ, Rosenkranz HS. Antifungal activity of silver sulfadiazine. Lancet 1973;2:739-40.
4. Coward JE, Carr HS, Rosenkranz HS. Silver sulfadiazine: Effect on the growth and ultrastructure of staphylococci. Chemotherapy 1973;19:348-53.
5. Sano S, Fujimori R, Takashima M, Itokawa Y. Absorption, excretion and tissue distribution of silver sulfadiazine. Burns 1982;8:278-85.
6. Boosalis MG, McCall JT, Ahrenholz DH, Solem LD, McClain CJ. Serum and urinary silver levels in thermal injury patients. Surgery 1987;101:40-3.
7. Park SN, Lee HJ, Lee KH, Suh H. Biological characterization of EDC-crosslinked collagen-hyaluronic acid matrix in dermal tissue restoration. Biomaterials. 2003;24:1631-41.
8. Motta G, Ratto GB, De Barbieri A, Corte G, Zardl I, Sacco A, *et al.* Can heterologous collagen enhance the granulation tissue growth? An experimental study. Ital J Surg Sci 1983;13:101-8.
9. Lazovic G, Colic M, Grubor M, Jovanovic M. The application of collagen sheet in open wound healing. Ann Burns Fire Disasters 2005;18:151-6.
10. Singh O, Gupta SS, Soni M, Moses S, Shukla S, Mathur RK. Collagen dressing versus conventional dressings in burn and chronic wounds: A retrospective study. J Cutan Aesthet Surg 2011;4:12-6.
11. Bullen EC, Longaker MT, Updike DL, Benton R, Ladin D, Hoeu Z, *et al.* Tissue inhibitor of metalloproteinases-1 is decreased and activated gelatinases are increased in chronic wounds. J Invest Dermatol 1995;104:236-40.
12. Falanga V. Classifications for wound bed preparation and stimulation of chronic wounds. Wound Repair Regen 2000;8:347-52.
13. Guthrie KM, Agarwal A, Tackes DS, Johnson KW, Abbott NL, Murphy CJ, *et al.* Antibacterial efficacy of silver-impregnated polyelectrolyte multilayers immobilized on a biological dressing in a murine wound infection model. Ann Surg 2012;256:371-7.
14. Bowler PG, Duerden BI, Armstrong DG. Wound microbiology and associated approaches to wound management. Clin Microbiol Rev 2001;14:244-69.

15. Bowler P. The anaerobic and aerobic microbiology of wounds: A review. Wounds 1998;10:170-8.

16. Heyneman A, Hoeksema H, Vandekerckhove D, Pirayesh A, Monstrey S. The role of silver sulphadiazine in the conservative treatment of partial thickness burn wounds: A systematic review. Burns 2016;42:1377-86.

17. Gupta JL, Makhija LK, Bajaj SP. National programme for prevention of burn injuries. Indian J Plastic Surgery: Official Publication of the Association of Plastic Surgeons of India 2010;43(Suppl):S6-S10.

18. Dogra BB. Initial management of burns. MJAFI 2004;60:277-80.

19. Dhopre A, Tiwari VK, Patel P, Bamal R. Epidemiology of pediatric burns and future prevention strategies – A study of 475 patients from a high-volume burn center in North India. Burns Trauma 2017;5:1.

20. Sarma BP, Sarma N. Epidemiology, morbidity, mortality and treatment of burn injuries – A study in a peripheral industrial hospital. Burns 1994;20:253-5.

21. Barret JP, Diewulski PR, Ramzy PI, Wolf SE, Desai MH, Herndon DN. Biobrane versus 1% silver sulfadiazine in second-degree pediatric burns. Plast Reconstr Surg 2000;105:62-5.

22. Shanmugasundaram N, Sundaraseelan J, Uma S, Selvaraj D, Babu M. Design and delivery of silver sulfadiazine from alginate microspheres-impregnated collagen scaffold. J Biomed Mater Res B Appl Biomater 2006;77:378-88.

23. Sheckter CC, Van Vliet MM, Krishnan NM, Garner WL. Cost-effectiveness comparison between topical silver sulfadiazine and enclosed silver dressing for partial-thickness burn treatment. J Burn Care Res 2014;35:284-90.

24. Silverstein P, Heimbach D, Meites H, Latenser B, Mozingo D, Mullins F, Garner W, et al. An open, parallel, randomized, comparative, multicenter study to evaluate the cost-effectiveness, performance, tolerance, and safety of a silver-containing soft silicone foam dressing (intervention) vs silver sulfadiazine cream. J Burn Care Res 2011;32:617-26.

25. Muangman P, Pundee C, Opasanon S, Muangman S. A prospective, randomized trial of silver containing hydrofiber dressing versus 1% silver sulfadiazine for the treatment of partial thickness burns. Int Wound J 2010;7:271-6.

26. Wasiak J, Cleland H, Campbell F, Spinks A. Dressings for superficial and partial thickness burns. Cochrane Database Syst Rev 2013:CD002106.