Original Article

A Comparative Study Between Amniotic Membrane and Hydrocolloid in the Healing of Partial Thickness Burn Wounds

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Abstract:
Background: Management of partial thickness burn wounds is mostly conservative, and rapid wound healing is desirable to obtain a good functional and cosmetic outcome. Wound dressing materials play an important role in maintaining an optimal wound milieu and avoiding complications from delayed healing. **Methods:** From January 2018 to December 2018, the study was conducted as a clinical trial over 100 patients at Dhaka Medical College Hospital. The patients who sustained partial thickness burn < 15% TBSA were included in the study, equally allocated between two (2) comparison groups (Group A: amniotic membrane and Group B: hydrocolloid), and the clinical efficacy and functionality of the two groupsregarding the rapidity of wound healing, frequency of dressing changes, requirement of analgesics, rate of infections, and need for a skin graft were assessed. **Results:** Hydrocolloid dressing showed a shorter healing time ($p<0.002$), less frequent dressing change ($p<0.001$), lower requirements of pain medication ($p<0.001$), and improved patients comfort which were statistically significant. **Conclusion:** Amniotic membrane showed comparable clinical and functional efficacy with hydrocolloid in burn wound healing, with superior healing time and comfort in favor of the later.

Key words: amniotic membrane; hydrocolloid; partial thickness burn wound; healing.

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Introduction:
Burn wounds often pose a challenge for reconstructive surgeons since they cause significant tissue damage and demand resource-intensive management. Partial-thickness burn (PTB) wounds are a common phenomenon in emergency rooms. These involve the whole of the epidermis and a part of the dermis. Blisters, edema, and redness of the skin are the hallmarks of PTBs. It damages the skin and vital structures underneath it, such as neurovascular structures, and hair follicles. Superficial nerve endings are typically exposed, which makes these injuries extremely painful.[1] Partial-thickness burns are expected to heal in 14–21 days to avoid complications such as hypertrophic scarring and/or contractures, dyschromic changes, and malignant transformation. The risks of hypertrophic scarring are extremely high if healing is delayed beyond 3 weeks[2]. Therefore, rapid and undisturbed wound healing is beneficial to obtain a good functional and cosmetic outcome. Selection and use of appropriate skin substitutes play a crucial role in the treatment of partial thickness burn wounds and often significantly improve the odds of survival for major burned patients[3].

A burn wound is a dynamic one; the depth and surface area of the burn area may increase depending on early resuscitative measures, the onset of infection, and the quality of the wound's handling. Drying out or desiccation of the wound, dehydration, systemic

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hypotension, and cooling may deepen the initial injury and incorporate surrounding tissue, causing an expansion of the zone of injury[4]. Determining the exact burn wound depth and extent at admission is crucial for selecting the appropriate dressing materials. The purpose of dressing material is to cover burn injuries, encourage the growth of new tissue, shield the wound from infection and mechanical stress, maintain moisture in the area, and lessen discomfort. A plethora of wound care products, including biologic, biosynthetic, and synthetic materials, are now readily available to achieve burn wound resurfacing and tissue repair, but no one has proved to be an unmixed blessing. Each dressing material has its own advantages and limitations.

The Basic attributes of an ideal burn wound dressing should include [5, 6, 7]

1. Readily available in various sizes.
2. Easy application and removal
3. Patient's comfort: minimal pain or pain-free dressing change
4. Non-adherence, non-antigenic
5. Control of the bacterial burden
6. Unhindered clinical evaluation of burn depth,
7. Protection of the wound from physical damage and microorganisms.
8. Preservation of an ideal moist wound milieu

For everyday burn care, commonplace supplies include silver SSD, Vaseline gauze, and paraffin dressings (like Mepitel®). Topical silver sulfadiazine is widely used. It's a popular choice for 2nd and 3rd-degree burn wounds. It is readily available and inexpensive, and its safety and tolerability are well known. Nevertheless, SSD lacks the benefits of anon-permeabledressing, and many bandages are required to maintain its place in the wound.[8,9] In contrast to SSD, contemporary advanced dressings offer the benefits of maintaining a moist environment surrounding burn injuries and successfully shielding the wound from harmful bacterial invasion. Some of the modern dressing materials include hydrocolloid, hydrogel, silicon, alginates, polyurethane, and biological dressings like amniotic membrane. For the best possible healing, each of these newer generation dressings offers unique qualities that leave the reconstructive physicians with a selection bias. Although the comparative study on clinical efficacy anddownside of advanced dressing materials have not studied yet[9].

Amniotic membrane (AM) has long been used as a dressing in partial thickness burn wounds.10 and considered an ideal skin substitute. It can achieveacceptablecoverage of burn wounds as a temporary measure (skin substitute) until healing and in preparation of skin graft when there is a relative or absolute scarcity of donor sites. There are amplepromising reports of AM use in patients with major burn injury (superficial or deep dermal wounds), where ithas been proven to be safe and sound, comfortable, and immensely satisfying in allowing rapid regeneration of damaged epithelium.[11] It is collected from the human placenta, cleansed, prepared, and sterilized by gamma radiation. Both fresh and cryopreserved amniotic membranes are in use. Fresh amniotic membranes have a relatively shorter life span than preserved membranes. There is a growing concern about the possibility of transmission of bacterial, viral, and fungal diseases of donor origin with a non-sterilized amniotic membrane.[12] To circumvent these disadvantages, amniotic membranes are irradiated with gamma ray.[13] Gamma-ray sterilization has neither been found to adversely affect clinical efficacy nor significantly reduce the bioactive molecule contents in the human amniotic membrane. The amniotic membrane creates a physiologically moist microenvironment in the wound that is conducive to healing.[3]

The amniotic membrane is comprised of a multi-layered epithelium and a basement membrane that serve as a warehouse for pluripotent stem cells and bioactive molecules. These components are thought to stimulate the formation, maturation and differentiation of epithelial cells and help retain their original cellular phenotypes. Its use is associated with reduced bacterial colonization in burn wounds and promotes epithelialization. The amniotic membrane also induces neovascularization, dampens local inflammatory responses at the wound site, and accelerates wound healing.[10] Hydrocolloid is an advanced wound product. The term hydrocolloid was first used in 1960. When a mucoadhesive based on carboxymethylcellulose (CMS) was being developed to treat oral ulcers. Hermans and Hermans (1986) documented an early experience of hydrocolloid use in the treatment of thermal injuries and concluded that hydrocolloid showed comparable healing rates with silver sulfadiazine crem (SSD) and allogenic skin substitutes in both superficial and deep dermal burn wounds.[14] Aside from burn wounds, hydrocolloids have long been used in a wide array of clinical conditions, such as skin graft donor sites, after laser resurfacing, chronic refractory wounds, diabetic foot ulcers, and pressure ulcers.[15]

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Hydrocolloid is widely available as an adhesive-coated, opaque or transparent sheet-like product, mainly consisting of gelatin, pectin, and sodium carboxymethylcellulose in acomposi teadhesive synthetic polymer. When the hydrocolloid dressings are placed in the wound, wound exudate forms a gel, facilitating the autolytic debridement of wounds. The advantage of polyurethane lies in that it is breathable to water vapor, oxygen, and carbon dioxide but impervious to water or pathogenic bacteria. However, polyurethane is not suitable for wounds with copious exudate or profound wound infection.[9] A few days after the application of hydrocolloids to wounds, it produces a thick, yellow malodorous secretion that can be mistaken for wound infection. This gel-like substance maintains a padding effect, prevents the dressing from sticking to the wound, and favors relatively pain-free dressing removal. This phenomenon is inherent to all hydrocolloid preparations and is produced due to the breakdown products of gelatin. This can be mistakenly regarded as purulent discharge. Clinicians should use other parameters such as local wound condition (warmth and erythema of the surrounding skin and wound tenderness) and systemic features to assess for wound infection.16In the present study, we planned to make a comparisonof the different attributes of amniotic membrane and hydrocolloid regarding the rate of wound healing, frequency of dressing changes, need for pain medication in dressing, infection, and the requirement of surgical interventions.

Methods:

This study was a clinical trial. One hundred patients (OPD and admitted) with burn injuries less than fifteen percent (< 15%) TBSA to the department of plastic surgery and burn, Dhaka Medical College, over a period of one year from January 2018 to December 2018 were included in this study. The patients were resuscitated and managed according to standard burn care protocol. It entails good analgesia, tetanus prophylaxis, nutrition support, and parenteral fluid resuscitation where mandated. The admitted adult and pediatric patients were managed on the general surgical ward and HDU (high dependency unit). All patients were attended to by a doctor trained in burn management. The extent and depth of the burn wound were determined by the Lund Browder chart. The wound was cleaned with normal saline, and high-resolution photographs were taken. Every patient was selected for one of the two dressing materials (an amniotic membrane and hydrocolloid). Every alternate patient was provided with the same type of dressing material. Dressing was changed every 3–4 days until re-epithelialization occurred. Subsequent dressing changes were made in a dedicated dressing room in a ward setting. During dressing changes, the clinical condition of the wound, pain perception on removal of dressing materials, ease of dressing change, pain medication requirements in each session, and photographs of the wound were documented.Relevant investigations (full blood count, coagulation profile, blood grouping (ABO and Rh), blood glucose level, renal function test (s. creatinine and s. electrolytes), and s. albumin) were carried out in all patients, and any biochemical abnormalities were corrected accordingly.

A routine wound swab for culture and sensitivity was done for every patient (OPD and admitted) on the 3rd post-burn day, and antibiotic prophylaxis started according to the sensitivity pattern.Informed, written, and voluntary consent was obtained from all patients and from guardians of minors.Demographic data and clinical parameters of the patients were documented on predesigned data collection sheets. Confidentiality was strictly maintained for all patients' data.The qualitative data were shown as frequency distributions and percentages, while the quantitative data were reported as means and standard deviations. The analysis was performed using SPSS version 22. The percentages of different outcome variables were compared using the chi-square test, with a p-value of less than 0.05 considered statistically significant.The study protocol received approval from the Ethics Committee of Dhaka Medical College, Bangladesh.

Results:

One hundred patients (100) with a M:F ratio of 1.08:1 (Group A: amniotic membrane) and 1.17:1 (Group B: hydrocolloid) were managed during the study period. Table 1 presents the demographic information of the study participants, including age, gender, total burned surface area (TBSA), and cause of injury. The ages of the patients ranged from 9 months to 73 years, with a median age of 21.4 years in group A and 19.3 years in group B. The causes of burns included scalds, chemical burn, electric flash burn, and flame burn.No significant difference was found between the two groups.

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Table-I: Baseline characteristics

Baseline characteristics	Group A (n=50)	Group B (n=50)	p-value
Age in years (mean SD)	21.4±18.3	19.3±15.8	0.533[ns]
Sex			
Male	26(52.0%)	27(54.0%)	0.841[ns]
Female	24(48%)	23(46.0%)	
Patients type			
Inpatient	33(66.0%)	31(62.0%)	0.677[ns]
OPD	17(17.0%)	19(38.0%)	
Cause of burn			
Chemical burn	6(12.0%)	3(6.0%)	
Electric flash burn	11(22.0%)	10(20.0%)	
Flame burned	19(38.0%)	17(34.0%)	0.528[ns]
Scald	14(28.0%)	20(40.0%)	
TBSA			
≤ 10%	15(30.0%)	16(32.0%)	
> 10%	35(70.0%)	34(68.0%)	

Table- II: Frequency of dressing changes

Frequency of dressing changes	Group A (Amniotic membrane) (n=50)No. (%)	Group B (Hydrocolloid) (n=50) No. (%)	p- value
3 days interval	23(46.0%)	0(0.0%)	<0.001[s]
4 days interval	19(38.0%)	1(2.0%)	
5 days interval	6(12.0%)	7(14.0%)	
6 days interval	1(2.0%)	26(52.0%)	
7 days interval	1(2.0%)	15(30.0%)	
8 days interval	0(0.0%)	1(2.0%)	
Total	50(100%)	50(100%)	

The frequency of dressing changes for Group A (amniotic membrane) and Group B (hydrocolloid) revealed significant differences (p<0.001). In Group A, most patients had their dressings changed every 3 days (46.0%) or every 4 days (38.0%). In contrast, Group B predominantly had dressing changes every 6 days (52.0%) and 7 days (30.0%). Dressing changes at intervals of 5 days or longer were more common in Group B, highlighting a significantly different protocol compared to Group A. This suggests that hydrocolloid dressings may require fewer frequent changes compared to amniotic membrane dressings.

Table-III: Pain medication administration during dressing change

Pain medication	Group A (Amniotic membrane) (n=50) No. (%)	Group B (Hydrocolloid) (n=50)No. (%)	p- value
Yes	25(50.0%)	3(6.0%)	<0.001[s]
No	25(50.0%)	47(94.0%)	
Total	50(100%)	50(100%)	

The use of pain medication between Group A (amniotic membrane) and Group B (hydrocolloid) was significantly different (p<0.001). In Group A, half of the patients (50.0%) required pain medication, whereas only a small fraction (6.0%) in Group B needed it. Conversely, 94.0% of patients in Group B did not require pain medication, compared to 50.0% in Group A. This significant disparity suggests that patients treated with hydrocolloid dressings experience less pain and thus require less pain medication than those treated with amniotic membrane dressings.

Table-IV: Healing time

Healing time (days)	Group A (Amniotic membrane) (n=50) No. (%)	Group B (Hydrocolloid) (n=50)No. (%)	p- value
< 10 days	8(16.0%)	13(26.0%)	
11-20 days	22(44.0%)	30(60.0%)	
21-30 days	12(24.0%)	5(10.0%)	
31-40 days	8(16.0%)	2(4.0%)	
Total	50 (100%)	50 (100%)	
Mean ± SD Median	19.38±9.06 18.0 days	14.48±5.74 13.0 days	0.002[s]

The healing time for patients treated with amniotic membrane (Group A) and hydrocolloid (Group B) dressings shows a statistically significant difference (p=0.002). In Group A, 16.0% of patients healed in less than 10 days, compared to 26.0% in Group B. Most Group B patients (60.0%) healed within 11-20 days, while 44.0% of Group A healed within the same period. A longer healing time of 21-30 days was more common in Group A (24.0%) compared to Group B (10.0%). Similarly, 16.0% of Group A patients took 31-40 days to heal, compared to only 4.0% in Group B. The mean healing time was significantly shorter for Group B (14.48±5.74 days) compared to Group A (19.38±9.06 days), with medians of 13.0 and 18.0 days, respectively, indicating faster healing with hydrocolloid dressings.

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Table-V: wound infection

Inpatient/ OPD	Wound infection	Group A (Amniotic membrane) (n=50) No. (%)	Group B (Hydrocolloid) (n=50)No. (%)	p- value
In patients	Yes	4(12.5%)	3(7.7%)	0.499ns
	No	28(87.5%)	36(92.3%)	
Total		32(100.0%)	39(100.0%)	
OPD	Yes	1(5.6%)	0(0.0%)	0.426ns
	No	17(94.4%)	11(100.0%)	
Total		18(100.0%)	11(100.0%)	

The incidence of wound infection among inpatients and outpatients treated with amniotic membrane (Group A) and hydrocolloid (Group B) dressings was assessed. Among inpatients, 12.5% of Group A and 7.7% of Group B experienced wound infections, with no statistically significant difference (p = 0.499). For outpatients, wound infections were reported in 5.6% of Group A, whereas none were observed in Group B (p = 0.426). Most patients in both treatment groups did not develop wound infections, indicating that both treatments are comparably effective in preventing infections in inpatient and outpatient settings.

Table-VI: STSG

STSG	Group A (Amniotic membrane) (n=50) No. (%)	Group B (Hydrocolloid) (n=50) No. (%)	p- value
Yes	6(12.0%)	3(6.0%)	0.295ns
No	44(88.0%)	47(94.0%)	
Total	50(100%)	50(100%)	

The need for split-thickness skin grafts (STSG) in Group A (amniotic membrane) and Group B (hydrocolloid) was assessed and showed no statistically significant difference (p = 0.295). In Group A, 12.0% of patients required STSG, compared to 6.0% in Group B. Most patients in both groups did not require STSG, with 88.0% in Group A and 94.0% in Group B not needing the procedure. This indicates that both treatments are similarly effective in reducing the need for STSG, with a slight, non-significant trend favoring hydrocolloid dressings.

Discussion:

In this study, the distribution of the sample according to their demographic profileindicates that males and females are almost equally affected by burn incidents. Females are more affected with flame burns and scalds. These incidents usually occur in and around the household and are mostly owing to economic constraints, inherently unsafe cooking practices (ground-level open fire cooking with biofuels), and wearing traditional loose clothing like sarees and long kamiz, etc. Similar observations are documented by Kajal Mehta et al. (2022) in their study. [17] In contrast to this phenomenon, the male population sustained mostof the burn accidents at work, and the predominant etiologies are high-voltage electric burn, chemical burn, and flame burn. Lisa Blom et al. (2016) reproduced comparable results.[18] Burns often presentsignificant tissue injuries. Spontaneous re-epithelialization within 14–21 days is particularly desirable to achieve a satisfactory functional and aesthetic outcome. Several scientific reviews demonstrate that burn wound healing beyond 21 days presents a higher risk of hypertrophic scar development in about 80% of cases and creates profound functional disability.[19, 20,21]

To achieve unimpeded burn wound healing, maintaining a moist wound environment by applying occlusive and/or semi-occlusive dressing materials is of utmost importance.Sir G. Winter first documented the phenomenon of expedited wound healing in moist environments, and this finding revolutionized traditional wound healing practices.[22] Moist dressings modulate the microenvironment of the burn wound and make it more favorable for spontaneous healing. When hydrocolloid contacted the wound, it absorbs wound exudate and forms hydrophilic gel-like substances that facilitates autolytic debridement, cleaning of wound necrotic tissue and holds moisture that is conducive to healing. This shields the wound from the external environment, prevents stress and mechanical deformation, and prevents microbial invasion.[23] Biological dressing is considered gold standard for temporary wound coverage.[24] Amniotic membranes are the most frequently used biologic wound dressing and are considered an ideal skin substitute. It provides physiological barrier action with concomitantly high wound adherence properties. It is bacteriostatic and immunologically inert. Amniotic membranes aid in healing by maintaining a physiologically moist microenvironment.[25]

In this study, in the amniotic membrane group, most patients (84%) had their dressing changed every 3 to 4 days interval. This result shows slight disagreement with other studies that advocate for dressing changes in a 5–7-day interval for optimal healing. Hydrocolloid groups predominantly had dressing changes every 6 to 7 days. This finding demonstrates significantly less

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frequent dressing changes compared to amniotic membrane. Hydrocolloid functions favorably with the spontaneous healing of the scalds, shorter healing time, reduced mean number of dressings required for healing, and less frequent need for split-thickness skin grafting at three weeks.These results are consistent with several published studies.[26, 27,28,29]

Our study revealed a striking difference in healing times between patients treated with amniotic membrane dressings (Group A) and hydrocolloid dressings (Group B) ($p = 0.002$). The average healing time was notably shorter in Group B, with a mean of 14.48±5.74 days, compared to 19.38±9.06 days in Group A. The median healing times were 13.0 days for Group B and 18.0 days for Group A, indicating that hydrocolloid dressings resulted in faster wound healing. These results conform with other published studies. In 2005, Christi Cassidy et al. showed hydrocolloid reduces the healing time of intermediate thickness burn wounds and improves pain scores in children. Patients in the Duoderm (Hydrocolloid) group showed complete wound healing in terms of re-epithelialization (mean healing time 11.21 (6.5) days, compared to 12.24 (5.1) days in case of Biobrane).[31]

The use of gamma-irradiated amniotic membrane in partial-thickness burn wounds promotes epithelia lization, leading to complete wound healingin an average of 15 to 25 days. Its easy availability, minimal cost, and ability to enhance wound healing make it a superior temporary skin substitute compared to cadaver skin allografts or pig skin xenografts. Human amniotic membrane offers protection against evaporative loss and serves as a physical barrier, while the extracellular matrix components (fibronectin and collagen) provide some structural support. Through this physiological effect, the amniotic membrane protects wounds from invasive microbial infections and speeds up wound healing. The findings of this study indicate that amniotic membrane dressings possess these essential properties for successful burn wound management.[30]

Conclusion: Amniotic membrane showed comparable clinical and functional efficacy with hydrocolloid in burn wound healing, with superior healing time and comfort in favor of the later.

Limitation:

1. Small sample size
2. The study was conducted in a single tertiary center, so it could not be representative for the whole country.

Conflict of interest: We declare to have no conflict of interest.

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