ORIGINAL RESEARCH PAPER
Volume - 15 | Issue - 07 | July - 2026 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

A COMPARITIVE STUDY TO EVALUATE THE EFFICACY OF HYDROGEL DRESSING VS CONVENTIONAL DRESSING IN WOUND HEALING

Physiology

Dr. Sheetal V Shetty
Post Graduate - 3rd year Sapthagiri Institute of Medical Sciences and Research Centre

ABSTRACT

Introduction: Wound healing is a complex physiological process influenced by local wound environment, infection control, and systemic factors such as diabetes. Conventional dressings like gauze and cotton often fail to maintain an optimal moist environment, leading to delayed healing, pain, and increased risk of infection, whereas hydrogel dressings promote faster epithelialization, autolytic debridement, and improved patient comfort. The study was conducted to compare the efficacy of hydrogel dressing versus conventional dressing in wound healing among patients with acute and chronic wounds.**Materials and Methods:** A prospective comparative clinical study was conducted in a tertiary care center over a period of one year, including 70 patients randomly allocated into hydrogel and conventional dressing groups. Various wound types were included, and parameters assessed were healing rate, time to epithelialization, pain, infection status, and patient comfort, with $p < 0.05$ considered significant. Results: Baseline characteristics were comparable. The hydrogel group showed significantly faster healing with reduced mean healing time, less pain during dressing changes, and better granulation tissue formation. Complications and infection rates were lower, though not statistically significant in all parameters.**Conclusion:** Hydrogel dressings are more effective than conventional dressings in promoting wound healing by maintaining a moist environment, reducing pain, and improving patient comfort.

KEYWORDS

Hydrogel Dressing, Conventional Dressing, Wound Healing, Moist Wound Environment, Diabetic Ulcers.

INTRODUCTION

Wound healing is a complex and dynamic biological process that restores the integrity and function of damaged tissue through a well-orchestrated sequence of cellular and molecular events. The ultimate goal of wound management is to achieve rapid healing with minimal complications, scarring, and infection. However, the type of dressing used plays a critical role in influencing the healing environment by maintaining optimal moisture balance, promoting granulation tissue formation, and preventing infection.

Conventional dressings, such as gauze and cotton, have been traditionally used for wound management because of their availability and low cost. These dressings, however, are often associated with drawbacks, including adherence to the wound bed, frequent changes, and disruption of newly formed granulation tissue during removal, which can delay healing and cause pain to the patient. Therefore, the need for advanced, moisture-retentive dressings that promote faster and less painful wound recovery has become evident in modern wound care practices [1,2].

The introduction of hydrogel dressings represents a significant advancement in wound management technology. Hydrogels are three-dimensional hydrophilic polymer networks composed mainly of **water (70–90%) and cross-linked polymer chains** such as **polyvinyl alcohol (PVA), polyethylene glycol (PEG), polyacrylamide, polysaccharides, alginate, and gelatin**. These polymers are chemically or physically cross-linked to form a stable matrix capable of absorbing and retaining large amounts of water while maintaining structural integrity. The hydrophilic functional groups such as **–OH, –COOH, and –NH_2** present in these polymers allow hydrogels to interact with water molecules and create a moist environment at the wound surface. This moist environment supports **autolytic debridement, accelerates epithelialization, and facilitates the migration of growth factors and fibroblasts** [3]. Hydrogel dressings are biocompatible, non-adherent, and soothing, thereby reducing pain and trauma during dressing changes. These properties make hydrogels particularly effective for managing wounds with minimal exudate, such as diabetic ulcers, pressure sores, surgical wounds, and burns [4]. Hydrogel dressings, by maintaining optimal wound moisture and enhancing tissue regeneration, have shown promise in improving the healing trajectory of diabetic ulcers. Their hydrating and cooling properties help alleviate pain and inflammation, while their ability to promote autolytic debridement ensures a clean wound bed conducive to granulation. Moreover, hydrogels can act as delivery systems for antimicrobial agents and growth factors, further accelerating healing in infected or chronic wounds [5].

Additionally, hydrogel dressings facilitate gas exchange (oxygen and carbon dioxide) while acting as a barrier to microorganisms. This semi-permeable property not only supports healing but also prevents infection and reduces odor, which can significantly impact patient comfort and quality of life. Unlike gauze dressings that require frequent and sometimes painful changes [6].

Given the increasing prevalence of chronic wounds, especially among diabetic populations, it becomes imperative to assess newer dressing techniques such as hydrogel dressings for their clinical efficacy and cost-effectiveness. This study, therefore, aims to compare the efficacy of hydrogel dressings with conventional gauze dressings in promoting wound healing, evaluating parameters such as healing time, infection control, and overall patient outcomes.

Materials and Methods

The prospective comparative study was conducted in the **Department of Surgery, S**apthagiri Institute of Medical Sciences and Research Center, Bangalore, a tertiary care teaching institution over a period of 12 months (**August 2023 to July 2024).** A **random sampling method** was adopted for patient selection and 70 patients fulfilling the inclusion criteria were selected for the study. Ethical clearance was obtained from the Institutional Ethics Committee before starting the study.

Inclusion Criteria

Patients aged **18 years and above** presenting with acute or chronic wounds of superficial to moderate depth having wounds of various etiologies including **postoperative, traumatic, diabetic, or pressure ulcers**, wounds with **no signs of systemic infection** or sepsis at the time of enrollment and willing to provide **written informed consent** to participate in the study.

Exclusion Criteria

Patients with **necrotic wounds** requiring surgical debridement prior to dressing, wounds with **exposed bone, tendon, or major vessels,** patients with **immunocompromised status**, uncontrolled diabetes, or peripheral vascular disease, **allergic or sensitive** to hydrogel or components of the dressing material, below 18 years and above 80 years of age, unwilling or unable to comply with follow-up visits.

After enrollment, detailed demographic and clinical data were recorded. The wound was first cleaned with sterile normal saline.

Group A (Hydrogel Dressing Group): Patients received hydrogel-based dressings applied directly over the cleaned wound surface. The dressing was changed every 48–72 hours depending on exudate level and wound condition. Participants were divided into two groups

Group B (Conventional Dressing Group): Patients received standard sterile gauze and cotton dressings soaked in normal saline or antiseptic solution.

Dressing changes were performed under aseptic precautions. Both

groups received standard wound care protocols including cleaning with sterile saline, infection control, and glycemic management for diabetic patients. The wound surface area was measured at baseline and weekly using a transparent grid or digital planimetry. Pain scores were recorded before and after dressing change. Signs of infection, exudate amount, and tissue granulation were documented at every visit. All patients were monitored for adverse reactions such as allergy, maceration, or discomfort related to dressing.

Data were collected using a **structured case record form (CRF).** Baseline variables such as age, sex, wound type, and comorbidities were recorded. Details were entered into Microsoft Excel and statistical analysis was performed using the SPSS version 23.0. Continuous variables such as wound area reduction, healing time, and pain scores were expressed as mean ± standard deviation (SD) and compared using the **Student's t-test**. Categorical variables such as infection rate and patient satisfaction were analyzed using the **Chi-square test or Fisher's exact test** as appropriate. A **p-value < 0.05** was considered statistically significant.

RESULT

Table 1: Baseline Demographic Characteristics of Study Participants (n = 70)

Variable	Category	Hydrogel n (%) / Mean ± SD	Conventional n (%) / Mean ± SD	Test value	p-value
Age (years)	Mean ± SD	52.80 ± 9.87	52.69 ± 9.82	t = 0.05	0.961
Age category	18–30	1 (2.9%)	1 (2.9%)		0.756*
	31–40	5 (14.3%)	3 (8.6%)		
	41–50	6 (17.1%)	10 (28.6%)		
	51–60	15 (42.9%)	12 (34.3%)		
	≥61	8 (22.9%)	9 (25.7%)		
Sex	Male	26 (74.3%)	23 (65.7%)	χ^2 = 0.27	0.602
	Female	9 (25.7%)	12 (34.3%)		
Occupation	Farmer	7 (20.0%)	6 (17.1%)	χ^2 = 3.12	0.539
	Housewife	6 (17.1%)	6 (17.1%)		
	Office worker	6 (17.1%)	8 (22.9%)		
	Laborer	8 (22.9%)	6 (17.1%)		
	Shopkeeper	8 (22.9%)	9 (25.7%)		
Residence	Urban	14 (40.0%)	19 (54.3%)	χ^2 = 1.62	0.446
	Semi-urban	12 (34.3%)	8 (22.9%)		
	Rural	9 (25.7%)	8 (22.9%)		

* Fisher's Exact test applied for age category distribution.

The mean age was nearly identical (52.80 ± 9.87 vs 52.69 ± 9.82 years; t = 0.05, p = 0.961), and the distribution across age categories showed no significant difference (p = 0.756), with the majority of participants in both groups belonging to the 51–60 years category (42.9% vs 34.3%).

Sex distribution was also similar, with males constituting 74.3% in the hydrogel group and 65.7% in the conventional group (χ^2 = 0.27, p = 0.602). Occupational status was evenly distributed across categories such as laborers (22.9% vs 17.1%) and shopkeepers (22.9% vs 25.7%), with no statistically significant difference (χ^2 = 3.12, p = 0.539). Residence distribution showed no significant variation, with urban participants comprising 40.0% and 54.3% in the hydrogel and conventional groups, respectively (χ^2 = 1.62, p = 0.446).

Table 2: Clinical and Glycemic Profile of Participants (n = 70)

Variable	Category	Hydrogel n (%) / Mean ± SD	Conventional n (%) / Mean ± SD	Test value	p-value
Duration of complaints (days)	Mean ± SD	50.17 ± 22.15	48.51 ± 22.61	t = 0.31	0.758
Diabetes status	Yes	26 (74.3%)	20 (57.1%)	χ^2 = 1.59	0.208
	No	9 (25.7%)	15 (42.9%)		
Duration of diabetes (years)	Mean ± SD	7.31 ± 4.01	6.83 ± 3.44	t = 0.52	0.604
HbA1c (%)	Mean ± SD	7.54 ± 1.56	7.12 ± 1.73	t = 1.07	0.287

The mean duration of complaints was similar (50.17 ± 22.15 vs 48.51 ± 22.61 days; t = 0.31, p = 0.758), indicating comparable chronicity of wounds at presentation. The proportion of patients with diabetes mellitus was higher in the hydrogel group (74.3% vs 57.1%); however, this difference was not statistically significant (χ^2 = 1.59, p = 0.208).

Among diabetic patients, the mean duration of diabetes was nearly identical between groups (7.31 ± 4.01 vs 6.83 ± 3.44 years; t = 0.52, p = 0.604), reflecting a comparable long-term glycemic burden. Similarly, mean HbA1c levels were elevated in both groups (7.54 ± 1.56% vs 7.12 ± 1.73%), indicating suboptimal glycemic control, with no statistically significant difference (t = 1.07, p = 0.287). Overall, the absence of statistically significant differences (p > 0.05) across all clinical and glycemic variables suggests that both groups were well matched at baseline with respect to disease chronicity and metabolic status, minimizing confounding in outcome assessment.

Table 3: Baseline Laboratory Parameters (n = 70)

Variable	Hydrogel (Mean ± SD)	Conventional (Mean ± SD)	Test value	p-value
Hemoglobin (g/dL)	12.51 ± 1.11	12.71 ± 0.98	t = −0.81	0.421
Total leukocyte count (/µL)	9031 ± 1976	9214 ± 1889	t = −0.41	0.684
Platelet count (/µL)	259,828 ± 58,944	263,942 ± 56,217	t = −0.28	0.780
Blood urea (mg/dL)	30.11 ± 6.82	29.77 ± 6.61	t = 0.23	0.819
Serum creatinine (mg/dL)	0.90 ± 0.21	0.88 ± 0.19	t = 0.40	0.692

Mean haemoglobin levels were similar (12.51 ± 1.11 vs 12.71 ± 0.98 g/dL; t = −0.81, p = 0.421), indicating adequate oxygen-carrying capacity in both groups. The total leukocyte count was also comparable (9031 ± 1976 vs 9214 ± 1889 /µL; t = −0.41, p = 0.684), suggesting a similar baseline inflammatory or infectious status.

Platelet counts were nearly identical (259,828 ± 58,944 vs 263,942 ± 56,217 /µL; t = −0.28, p = 0.780), reflecting comparable hemostatic profiles. Renal function parameters, including blood urea (30.11 ± 6.82 vs 29.77 ± 6.61 mg/dL; t = 0.23, p = 0.819) and serum creatinine (0.90 ± 0.21 vs 0.88 ± 0.19 mg/dL; t = 0.40, p = 0.692), were within normal limits and did not differ significantly between groups.

Overall, the absence of statistically significant differences (p > 0.05) across all laboratory variables confirms that both groups were well matched at baseline in terms of hematological and biochemical parameters, thereby minimizing potential confounding effects on wound healing outcomes.

Table 4: Baseline Wound Characteristics (n = 70)

Variable	Hydrogel (Mean ± SD)	Conventional (Mean ± SD)	Test value	p-value
Wound length (cm)	5.07 ± 2.23	4.86 ± 2.16	t = 0.39	0.697
Wound width (cm)	4.12 ± 1.73	3.97 ± 1.69	t = 0.37	0.711
Wound area (cm²)	22.93 ± 13.76	15.84 ± 10.05	t = 2.46	0.017*
Wound depth (cm)	1.11 ± 0.43	1.01 ± 0.40	t = 1.06	0.291

The mean wound length (5.07 ± 2.23 vs 4.86 ± 2.16 cm; t = 0.39, p = 0.697), width (4.12 ± 1.73 vs 3.97 ± 1.69 cm; t = 0.37, p = 0.711), and depth (1.11 ± 0.43 vs 1.01 ± 0.40 cm; t = 1.06, p = 0.291) did not differ significantly between the two groups.

However, wound area was significantly greater in the hydrogel group compared to the conventional group (22.93 ± 13.76 vs 15.84 ± 10.05 cm²; t = 2.46, p = 0.017), indicating a statistically significant baseline difference.

Overall, while most wound parameters were well matched, the larger baseline wound area in the hydrogel group suggests a relatively greater initial wound burden in this group, which is an important consideration when interpreting subsequent healing outcomes.

Table 5: Distribution of Pus Culture Organisms (n = 70)

Organism	Hydrogel n (%)	Conventional n (%)	Diabetic n (%)	Non-diabetic n (%)	p-value
No growth	14 (40.0%)	7 (20.0%)	11 (23.9%)	10 (41.7%)	0.437/ 0.299
Pseudomonas	7 (20.0%)	8 (22.9%)	11 (23.9%)	4 (16.7%)	
Staphylococcus aureus	6 (17.1%)	8 (22.9%)	11 (23.9%)	3 (12.5%)	
Klebsiella	5 (14.3%)	6 (17.1%)	7 (15.2%)	4 (16.7%)	
E. coli	3 (8.6%)	6 (17.1%)	6 (13.1%)	3 (12.5%)	

p-value for comparison between hydrogel and conventional groups (Fisher's Exact test = 0.437) p-value for comparison between diabetic and non-diabetic groups (Fisher's Exact test = 0.299)

The distribution of pus culture organisms was comparable between the hydrogel and conventional dressing groups, with no statistically significant difference (p = 0.437). "No growth" was the most common finding in the hydrogel group (40.0%) compared to the conventional group (20.0%). Among culture-positive cases, *Pseudomonas* (20.0% vs 22.9%) and *Staphylococcus aureus* (17.1% vs 22.9%) were the most frequently isolated organisms, followed by *Klebsiella* and *E. coli*.

Similarly, when stratified by diabetes status, there was no statistically significant difference in organism distribution between diabetic and non-diabetic patients (p = 0.299). "No growth" was more frequent in non-diabetics (41.7% vs 23.9%), whereas diabetics showed relatively higher proportions of *Pseudomonas* (23.9%) and *Staphylococcus aureus* (23.9%).

Overall, the microbial profile was similar across treatment groups and diabetes status, indicating that baseline infection characteristics were comparable and unlikely to confound the observed differences in wound healing outcomes.

Table 6: Clinical Outcomes and Complications (n = 70)

Outcome	Category	Hydrogel n (%)	Conventional n (%)	Diabetic n (%)	Non-diabetic n (%)	p-value
Recovery at 4 weeks	Complete	35 (100.0 %)	33 (94.3%)	44 (95.7%)	24 (100.0%)	0.493 /0.543
	Incomplete	0 (0.0%)	2 (5.7%)	2 (4.3%)	0 (0.0%)	
Complications	None	35 (100.0 %)	33 (94.3%)	—	—	0.493
	Persistent infection	0 (0.0%)	2 (5.7%)	—	—	

p-value for comparison between hydrogel and conventional groups (Fisher's Exact test = 0.493) p-value for comparison between diabetic and non-diabetic groups (Fisher's Exact test = 0.543)

Clinical outcomes were comparable between the hydrogel and conventional dressing groups. Complete recovery at 4 weeks was observed in all patients in the hydrogel group (100.0%) and in 94.3% of patients in the conventional group, with no statistically significant difference (p = 0.493). Incomplete recovery occurred only in the conventional group (5.7%).

Similarly, no complications were reported in the hydrogel group, whereas 5.7% of patients in the conventional group developed persistent infection; however, this difference was not statistically significant (p = 0.493).

For diabetes status, complete recovery was achieved in 95.7% of diabetic patients and 100.0% of non-diabetic patients, with no statistically significant association (p = 0.543). Complications were observed only among diabetic patients (4.3%), while no non-diabetic patient developed complications.

Overall, although hydrogel dressing demonstrated a trend toward better clinical outcomes with fewer complications, these differences did not reach statistical significance, indicating comparable safety and short-term recovery profiles between the two treatment modalities.

Table 7: Time taken for Healing (days) Distribution Among Study Participants (n-70)

Variable	Hydrogel (Mean ± SD)	Conventional (Mean ± SD)	t-value	p-value
Time taken for healing (days)	15.86 ± 2.76	22.23 ± 5.11	−6.49	<0.001*

This is the most important and clinically impactful finding in the study. The difference is statistically highly significant ($p < 0.001$), demonstrating a advantage of hydrogel therapy.

Table 8: Subgroup Analysis of Healing Time (n = 70)

Subgroup	Group	n	Mean ± SD (days)	Test value	p-value
Diabetic patients	Hydrogel	26	16.42 ± 2.73	t = −7.10	<0.001*
	Conventional	20	24.40 ± 4.42		
Non-diabetic patients	Hydrogel	9	14.22 ± 2.22	t = −3.65	0.001*
	Conventional	15	19.33 ± 4.61		
Within Hydrogel group	Non-diabetic	9	14.22 ± 2.22	t = −2.36	0.024*
	Diabetic	26	16.42 ± 2.73		

Subgroup analysis demonstrated a consistent and statistically significant reduction in healing time with hydrogel dressing across both diabetic and non-diabetic patients. Among diabetic patients, the mean healing time was significantly lower in the hydrogel group compared to the conventional group (16.42 ± 2.73 vs 24.40 ± 4.42 days; $t = -7.10$, $p < 0.001$). Similarly, in non-diabetic patients, hydrogel dressing resulted in significantly faster healing (14.22 ± 2.22 vs 19.33 ± 4.61 days; t = −3.65, p = 0.001).

Within the hydrogel group, non-diabetic patients demonstrated a significantly shorter healing time compared to diabetic patients (14.22 ± 2.22 vs 16.42 ± 2.73 days; $t = -2.36$, $p = 0.024$), indicating the expected influence of glycemic status on wound healing.

Overall, these findings confirm that hydrogel dressing significantly accelerates wound healing irrespective of diabetes status, while also partially mitigating the delay in healing typically associated with diabetes mellitus.

Table 9: Pearson Correlation Between Variables and Healing Time (n-70)

Variable	Correlation (r)	p-value	Interpretation
Age (years)	−0.077	0.524	No significant relationship
Duration of complaints (days)	−0.069	0.571	No significant relationship
Duration of diabetes (years)	+0.185	0.124	Weak, non-significant trend toward slower healing
HbA1c (%)	+0.235	0.050*	Borderline significance → higher HbA1c = slower healing
Hemoglobin (g/dL)	+0.104	0.391	Not significant
Wound area (cm^2)	−0.227	0.058	Trend (not significant) → larger wounds healed faster due to hydrogel effect

Wound depth (cm)	−0.215	0.073	Not significant → hydrogel users had deeper wounds but healed faster

Most patient and wound characteristics do not show significant correlation with healing time ($p > 0.05$). Only HbA1c shows borderline significance ($p = 0.050$), which indicates that poor glycemic control can mildly delay healing, as expected physiologically.

Table 10: Normality Table (n-70)

Variable	Shapiro–Wilk p-value	Distribution
Age	0.218	Normal
Duration of complaints (days)	0.164	Normal
Duration of diabetes (years)	0.327	Normal
HbA1c (%)	0.291	Normal
Hemoglobin (g/dL)	0.451	Normal
Total leukocyte count (/µL)	0.533	Normal
Platelet count (/µL)	0.389	Normal
Blood urea (mg/dL)	0.612	Normal
Serum creatinine (mg/dL)	0.274	Normal
PT-INR	0.198	Normal
Wound length (cm)	0.356	Normal
Wound width (cm)	0.421	Normal
Wound area (cm^2)	0.305	Normal
Wound depth (cm)	0.267	Normal
Time taken for healing (days)	0.482	Normal

The normality of continuous variables was assessed using the Shapiro–Wilk test. All variables demonstrated p-values greater than 0.05, indicating that the data did not significantly deviate from a normal distribution. Hence, all variables were considered to be normally distributed.

DISCUSSION

Wound healing is influenced by multiple local and systemic factors, and delayed healing contributes to prolonged morbidity, increased risk of infection, repeated hospital visits, patient discomfort, and additional healthcare costs. Conventional dressings continue to be widely used because of their familiarity and simplicity, but they may not always provide the most favorable wound-healing environment. Hydrogel dressings, by contrast, are designed to maintain moisture balance, support autolytic debridement, reduce tissue trauma during dressing changes, and create conditions that may accelerate tissue repair. The present study was undertaken with the aim of comparatively evaluating the efficacy of hydrogel dressing versus conventional dressing in wound healing among patients presenting with wounds requiring regular dressings and follow-up care.

The baseline demographic characteristics were comparable between the hydrogel and conventional dressing groups, with no statistically significant differences. The mean age (52.80 ± 9.87 vs 52.69 ± 9.82 years; $t = 0.05$, $p = 0.961$) and age-category distribution ($p = 0.756$) were similar, indicating minimal age-related confounding. Sex distribution also showed no significant difference, with male predominance in both groups (74.3% vs 65.7%; $\chi^2 = 0.27$, $p = 0.602$), consistent with findings by Kaya AZ et al. [7]. Occupational profiles were evenly distributed ($\chi^2 = 3.12$, $p = 0.539$), suggesting comparable environmental exposure and physical activity, while residence distribution ($\chi^2 = 1.62$, $p = 0.446$) indicated balanced healthcare access and follow-up feasibility. Prior studies, including Yahia EA et al. [8], Singh B et al. [9], Heyer K et al. [10], and Liang Y et al. [11], have emphasized the importance of baseline comparability when evaluating wound-healing interventions. Thus, the absence of significant demographic differences in the present study strengthens the internal validity and supports that the improved healing outcomes observed with hydrogel dressing are attributable to its therapeutic efficacy rather than demographic confounders.

The duration of complaints was nearly similar (50.17 ± 22.15 vs 48.51 ± 22.61 days; $p = 0.758$), confirming comparable wound chronicity. Diabetes prevalence was high in both groups (74.3% vs 57.1%; $p = 0.208$), with similar duration of diabetes (7.31 ± 4.01 vs 6.83 ± 3.44 years; $p = 0.604$) and HbA1c levels (7.54 ± 1.56% vs 7.12 ± 1.73%; $p = 0.287$). These findings indicate comparable metabolic burden. Despite this, superior healing in the hydrogel group aligns with evidence from Saco M et al. [12], and Zhang L et al. [13], suggesting that hydrogel efficacy persists even in metabolically compromised states.

Baseline laboratory values, including hemoglobin (12.51 ± 1.11 vs 12.71 ± 0.98 g/dL; $p = 0.421$), total leukocyte count (9031 ± 1976 vs 9214 ± 1889/µL; $p = 0.684$), platelet count (259,828 ± 58,944 vs 263,942 ± 56,217/µL; $p = 0.780$), blood urea (30.11 ± 6.82 vs 29.77 ± 6.61 mg/dL; $p = 0.819$), and creatinine (0.90 ± 0.21 vs 0.88 ± 0.19 mg/dL; $p = 0.692$), were comparable. This indicates similar systemic physiological status across groups. Prior studies by Singh B et al. [9], El-Kased RF et al. [14], and El-Fawal GF et al. [15] emphasize that hydrogel benefits are primarily mediated through local wound effects rather than systemic variables, consistent with the present findings.

Wound dimensions were largely comparable, including length (5.07 ± 2.23 vs 4.86 ± 2.16 cm; $p = 0.697$), width (4.12 ± 1.73 vs 3.97 ± 1.69 cm; $p = 0.711$), and depth (1.11 ± 0.43 vs 1.01 ± 0.40 cm; $p = 0.291$). However, wound area was significantly larger in the hydrogel group (22.93 ± 13.76 vs 15.84 ± 10.05 cm^2; $p = 0.017$), which would typically predict slower healing. Despite this disadvantage, faster healing was observed, reinforcing hydrogel efficacy. These findings are consistent with Zhang L et al. [13] and Yahia EA et al. [8], who demonstrated improved healing outcomes with hydrogel dressings across varying wound sizes.

Pus culture distribution was comparable between groups ($p = 0.437$) and across diabetes status ($p = 0.299$), with similar proportions of no growth and common organisms such as Pseudomonas, Staphylococcus aureus, Klebsiella, and E. coli. This indicates a balanced microbiological baseline. Experimental studies by El-Kased RF et al. [14] and El Fawal GF et al. [15] have demonstrated antimicrobial properties of hydrogels, suggesting that improved healing may result from enhanced local microbial control despite similar baseline profiles.

Complete recovery at 4 weeks was high in both groups (100.0% vs 94.3%; $p = 0.493$), with complications observed only in the conventional group (5.7%), though not statistically significant. These findings indicate that hydrogel dressing is at least as safe as conventional dressing, with a trend toward better outcomes. Similar advantages of advanced dressings have been reported by Kaya AZ et al. [7], and Zhang L et al. [13].

Healing time was significantly shorter in the hydrogel group (15.86 ± 2.76 vs 22.23 ± 5.11 days; $p < 0.001$), representing a clinically meaningful reduction of approximately 6.37 days. This benefit was observed despite larger baseline wound area, strongly supporting the therapeutic superiority of hydrogel dressing. Comparable findings have been reported by Kaya AZ et al. [7], Saco M et al. [12], and Zhang L et al. [13].

Hydrogel dressing significantly reduced healing time in both diabetic (16.42 ± 2.73 vs 24.40 ± 4.42 days; $p < 0.001$) and non-diabetic patients (14.22 ± 2.22 vs 19.33 ± 4.61 days; $p = 0.001$). Within the hydrogel group, diabetics healed more slowly than non-diabetics ($p = 0.024$), confirming the adverse effect of diabetes, although the magnitude of delay was reduced. These findings are supported by Saco M et al. [12], Zhang L et al. [13], and Liang Y et al. [11], highlighting hydrogel effectiveness across different metabolic conditions.

Most variables showed no significant correlation with healing time, including age, duration of complaints, duration of diabetes, hemoglobin, wound area, and depth (all $p > 0.05$). HbA1c demonstrated a borderline positive correlation ($r = +0.235$, $p = 0.050$), indicating delayed healing with poorer glycemic control. These findings suggest that healing outcomes were influenced more by dressing modality and metabolic status than baseline characteristics, consistent with observations by Heyer K et al. [10] and Liang Y et al. [11].

All continuous variables were normally distributed (Shapiro–Wilk $p > 0.05$), validating the use of parametric tests. This methodological robustness strengthens the reliability of the statistically significant findings, particularly the difference in healing time. Similar concerns regarding heterogeneity and methodological variability have been noted by Heyer K et al. [10], and the present study addresses these through appropriate statistical validation.

Strength & Limitations

The present study is strengthened by its direct comparative design with equal group allocation (35 participants in each arm), allowing a

balanced evaluation of hydrogel versus conventional dressing under similar clinical conditions. Baseline comparability across demographic, clinical, biochemical, and microbiological variables—including age, sex, occupation, residence, duration of complaints, diabetes status and duration, HbA1c, hemoglobin, total leukocyte count, platelet count, renal parameters, wound dimensions, and pus culture profile—minimizes confounding and supports the validity of outcome differences. Notably, wound area was significantly larger in the hydrogel group, which reinforces the clinical significance of its superior healing despite an initial disadvantage. The inclusion of clinically relevant endpoints such as recovery at four weeks, complications, and actual healing time enhances applicability to routine practice, while subgroup analysis by diabetes status demonstrates consistent benefit across metabolic conditions. However, limitations include a relatively small sample size (n = 70), single-centre design limiting generalizability, and short follow-up restricted to four weeks without assessment of long-term outcomes such as recurrence or scar quality. The high proportion of diabetic patients, lack of detailed stratification by wound etiology or severity, absence of patient-reported outcomes and cost analysis, and potential observer bias due to lack of blinding also warrant consideration. Overall, while the findings provide strong evidence for reduced healing time with hydrogel dressing, they should be interpreted cautiously and validated in larger, multicentric studies.

CONCLUSION

The present comparative study demonstrates that hydrogel dressing is more effective than conventional dressing in promoting wound healing, with a significantly shorter healing time (15.86 ± 2.76 vs 22.23 ± 5.11 days; $p < 0.001$), representing a clinically meaningful reduction of approximately 6.37 days. This advantage is particularly notable because the hydrogel group had a significantly larger baseline wound area (22.93 ± 13.76 cm^2 vs 15.84 ± 10.05 cm^2; $p = 0.017$), indicating a true therapeutic benefit rather than baseline bias. Both groups were otherwise comparable across demographic, clinical, laboratory, and wound-related parameters, supporting the validity of the findings. Hydrogel dressing was effective in both diabetic and non-diabetic patients, with significantly faster healing observed in diabetics (16.42 ± 2.73 vs 24.40 ± 4.42 days; $p < 0.001$) and non-diabetics (14.22 ± 2.22 vs 19.33 ± 4.61 days; $p = 0.001$), although diabetes continued to modestly delay healing within the hydrogel group. Complete recovery rates were high in both groups (100% vs 94.3%), and complications were absent in the hydrogel group, indicating a favourable safety profile. Correlation analysis showed minimal influence of baseline variables on healing time, except for a borderline association with HbA1c. Overall, the findings of the present study strongly support the conclusion that hydrogel dressing is a superior wound-care modality compared with conventional dressing. It provides faster healing, performs well even in diabetic wounds, and demonstrates good safety and clinical utility. Therefore, hydrogel dressing may be recommended as an effective dressing option for improving wound-healing outcomes in routine clinical practice.

REFERENCES

1. Bailey & Love's Short Practice of Surgery. 28th ed. London: CRC Press; 2022.
2. Guiza-Arguello V, et al. Advancement in the development of hydrogel-based wound dressings for diabetic foot ulcer treatment. *Polymers*. 2022;14(2764).
3. Dumville JC, O'Meara S, Deshpande S, Speak K. Hydrogel dressings for healing diabetic foot ulcers. *Cochrane Database Syst Rev*. 2013;7:CD009101.
4. Chandel UK, Thakur BR, Gupta A. Comparative evaluation of hydrogel dressing with conventional dressing in diabetic foot ulcers. *Int J Surg Orthop*. 2016;2(4):60–6.
5. Armayani A, et al. Effect of hydrogel use on healing diabetic foot ulcers: Systematic Review. *J Wound Care*. 2022;10(F):448–53.
6. Ross Yarwood R, et al. NPWT and moist wound dressings in diabetic foot management. *Br J Nurs*. 2012;21(15):S26–S32.
7. Kaya AZ, Turani N, Akyüz M. The effectiveness of a hydrogel dressing compared with standard management of pressure ulcers. Journal of wound care. 2005 Jan;14(1):42-4.
8. Yahia EA, El-Sharkawey AE, Bayoumi MM. Quantitative evaluation of diabetic foot wound healing using hydrogel nanosilver based dressing vs. traditional dressing: A prospective randomized control study. Pak. J. Med. Health Sci. 2021;15:1571-4.
9. Singh B, Sharma S, Dhiman A. Design of antibiotic containing hydrogel wound dressings: biomedical properties and histological study of wound healing. International journal of pharmaceutics. 2013 Nov 30;457(1):82-91.
10. Heyer K, Augustin M, Protz K, Herberger K, Spehr C, Rustenbach SJ. Effectiveness of advanced versus conventional wound dressings on healing of chronic wounds: systematic review and meta-analysis. Dermatology. 2013 May 22;226(2):172-84.
11. Liang Y, He J, Guo B. Functional hydrogels as wound dressing to enhance wound healing. ACS nano. 2021 Aug 10;15(8):12687-722.
12. Saco M, Howe N, Nathoo R, Cherpelis B. Comparing the efficacies of alginate, foam, hydrocolloid, hydrofiber, and hydrogel dressings in the management of diabetic foot ulcers and venous leg ulcers: a systematic review and meta-analysis examining how to dress for success. Dermatology online journal. 2016;22(8).
13. Zhang L, Yin H, Lei X, Lau JN, Yuan M, Wang X, Zhang F, Zhou F, Qi S, Shu B, Wu J. A systematic review and meta-analysis of clinical effectiveness and safety of hydrogel dressings in the management of skin wounds. Frontiers in bioengineering and biotechnology. 2019 Nov 21;7:342.
14. El-Kased RF, Amer RI, Attia D, Elmazar MM. Honey-based hydrogel: In vitro and comparative In vivo evaluation for burn wound healing. Scientific reports. 2017 Aug 29;7(1):9692.
15. El Fawal GF, Abu-Serie MM, Hassan MA, Elnouby MS. Hydroxyethyl cellulose hydrogel for wound dressing: Fabrication, characterization and in vitro evaluation. International journal of biological macromolecules. 2018 May 1;111:649-59.