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CALCIUM ALGINATE DRESSINGS VERSUS CHLORHEXIDINE GAUZE DRESSINGS FOR MANAGEMENT OF SKIN GRAFTED DONOR SITE WOUNDS IN THE RURAL GENERAL HOSPITAL: A COMPARATIVE STUDY

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ABSTRACT

Background: Split-thickness skin graft donor site wounds are associated with pain, risk of infection, and delayed healing. An ideal dressing should promote rapid epithelialization, reduce pain, and prevent infection while remaining cost-effective. Calcium alginate dressings have shown promising results compared to conventional chlorhexidine gauze dressings. The aim is to compare the efficiency of calcium alginate and chlorhexidine gauze dressings in the management of donor site wounds following split-thickness skin grafting in a rural general hospital.
Materials and Methods: A prospective observational study was conducted on 62 patients undergoing split-thickness skin grafting. Patients were randomly allocated into two groups: Group A (n=31) received calcium alginate dressings, and Group B (n=31) received chlorhexidine gauze dressings. Baseline demographic and clinical data was recorded. Wound healing was assessed using standardized scores at postoperative day 14. Pain was measured using the Visual Analogue Scale (VAS) on days 1, 5, and 14. Incidence of infection and cost of dressings were also analyzed. Statistical tests included were Student's t-test, Chi-square/Fisher's exact test, and Mann-Whitney U test, with $p < 0.05$ considered significant.
Results: Baseline characteristics between groups were comparable. Calcium alginate group showed significantly better wound healing scores (6.08 ± 2.14 vs. 7.74 ± 2.44; p = 0.03) and a higher proportion of excellent healing (48.4% vs. 16.1%; p < 0.01). Pain scores were significantly lower in the calcium alginate group on day 5 (2.01 ± 1.01 vs. 2.55 ± 1.00; p = 0.011) and day 14 (0.68 ± 0.65 vs. 1.48 ± 1.36; p < 0.01). Infection rates were not significantly different between groups. The cost of treatment was substantially higher with calcium alginate (₹500 vs. ₹50; p < 0.01).
Conclusion: Calcium alginate dressings demonstrated superior wound healing and reduced postoperative pain compared to chlorhexidine gauze dressings. However, their significantly higher cost may limit their use in resource-constrained rural settings.
Keywords: Calcium alginate. Donor site wound. Split-thickness skin graft.

INTRODUCTION

Split-thickness skin grafting (STSG) is one of the most frequently employed reconstructive procedures in general and plastic surgery, widely used to cover large wounds, burns, traumatic skin loss, and chronic ulcers. The success of this technique relies not only on the secure integration of the graft to the recipient site but also on the optimal healing of the donor site, from where the graft is harvested. Donor sites essentially represent controlled wounds created by the surgical procedure and typically heal through re-epithelialization from dermal appendages. However, the donor site wound is often more painful than the graft site itself due to exposure of sensory nerve endings, and improper management can result in delayed healing, infection, and patient discomfort.[1]

Over the decades, numerous dressing materials and wound care techniques have been explored for donor site management, yet no universally accepted gold standard exists. The primary goals of donor site wound care are to provide a moist healing environment, reduce pain, prevent infection, minimize trauma during dressing changes, and ensure rapid re-epithelialization. Dressings are generally classified into three categories: open, semi-open, and closed methods. The closed method, wherein the donor site is covered with a dressing until re-epithelialization occurs, has gained popularity for its ability to maintain moisture and protect the wound environment.[2]

Historically, paraffin gauze has been considered a standard donor site dressing. Although it is cheap and readily available, paraffin gauze frequently adheres to wounds, causing trauma and pain during dressing changes. To overcome these limitations, chlorhexidine impregnated paraffin gauze has been widely adopted due to its antibacterial properties against Gram-positive and Gram-negative organisms, including MRSA. Chlorhexidine works by binding to bacterial cell walls, altering osmotic balance, and inducing leakage of intracellular contents. However, disadvantages remain, such as adherence to epithelializing tissue, risk of maceration from exudate accumulation, and trauma on removal.[3]

In recent years, calcium alginate dressings have emerged as promising alternatives. Derived from brown seaweed, alginates are naturally occurring polysaccharides capable of absorbing large amounts of wound exudate. When in contact with moisture, they form a hydrophilic gel that maintains a moist environment conducive to epithelial migration. Additionally, calcium alginate dressings exhibit intrinsic hemostatic properties due to calcium ion release, which accelerates clotting at the donor site. These properties render alginate dressings particularly beneficial for donor sites, which are often exudative and prone to bleeding. Unlike gauze-based dressings, alginates are non-adherent, thus reducing pain and trauma during removal and minimizing disruption of newly formed epithelial tissue.[4]

Several comparative studies have evaluated modern dressings such as alginates, foams, hydrocolloids, and films against traditional gauze-based dressings. Evidence suggests that alginate dressings reduce pain, improve patient comfort, and may accelerate wound healing. Study found significantly shorter re-epithelialization times, reduced pain, and less soakage with calcium alginate compared to paraffin gauze. However, higher costs of alginate dressings limit their widespread adoption, especially in resource-limited rural settings.[5]

Aim: To compare the efficiency of calcium alginate dressings and chlorhexidine gauze dressings in the management of split-thickness skin graft donor site wounds in a rural general hospital.

Objectives

1. To assess and compare wound healing outcomes in donor sites dressed with calcium alginate versus chlorhexidine gauze.
2. To evaluate and compare postoperative pain at donor sites managed with calcium alginate versus chlorhexidine gauze.
3. To analyze the cost-effectiveness of calcium alginate dressings compared to chlorhexidine gauze dressings.

MATERIALS AND METHODS

Source of Data: All patients undergoing split-thickness skin grafting (STSG) in the Department of Surgery of a Rural General Hospital were considered. Eligible participants were enrolled after informed consent.

Study Design: A prospective, observational comparative study.

Study Location: Department of General Surgery, Rural General Hospital.

Study Duration: Two years (2020-2022).

Sample Size: A total of 62 patients were included, divided into two groups:

- **Group A:** Donor site dressed with calcium alginate dressing (n = 31)
- **Group B:** Donor site dressed with chlorhexidine gauze dressing (n = 31)

Sample size was calculated using previous data on mean pain scores and wound healing outcomes, with $\alpha = 0.05$ and power = 90%, considering a 10% loss to follow-up.

Inclusion Criteria

1. Patients aged 18-60 years.
2. Donor site wound size < 10% of total body surface area.

Exclusion Criteria

1. Known allergy to chlorhexidine gauze or calcium alginate dressing.
2. Pregnant or lactating women.
3. Patients with uncontrolled diabetes mellitus (HbA1c > 7).

Procedure and Methodology: Preoperative assessment included complete history, clinical examination, and relevant investigations. Patients were counselled, and informed written consent was obtained. STSG was harvested from the thigh using a modified Humby's knife under standard aseptic precautions. Donor site was immediately dressed with either calcium alginate or chlorhexidine gauze as per random group allocation. Dressings were left in situ until the first postoperative visit (14-16 days). Pain assessment was performed using the Visual Analogue Scale (VAS) on day 1, day 5, and day 14.

Wound healing was documented by clinical examination, standardized wound photography, and wound healing scores. Any signs of infection (erythema, pus discharge, foul odour) were recorded. All patients received standard postoperative care including antibiotics, analgesics, and supportive therapy.

Sample Processing: Each donor site was inspected during follow-up. Data on wound healing, infection status, pain scores, and costs were entered in structured proformas.

Data Collection: Data was collected prospectively at baseline (day of surgery), postoperative day 5, and postoperative day 14-16. Outcomes were documented with photographs and entered into master charts.

Statistical Methods: Data was entered in Microsoft Excel and analyzed using SPSS v26. Quantitative variables (age, wound healing score) were presented as mean ± SD and compared using Student's t-test. Categorical variables (infection rates, gender distribution) were expressed as frequency and percentage, analyzed with Chi-square or Fisher's exact test. Ordinal data (pain scores) were analyzed using the Mann-Whitney U test. A p-value < 0.05 was considered statistically significant.

RESULTS

[Table 1] presents the baseline profile of patients included in the study. The mean age of participants was 34.84 ± 13.29 years in the calcium alginate group and 36.06 ± 13.56 years in the chlorhexidine group, with no significant difference (p = 0.72). Gender distribution was also comparable, with 58.1% males in the calcium alginate group and 45.2% in the chlorhexidine group (p = 0.44). Comorbidities such as diabetes (19.4% vs. 25.8%), immunocompromised state (9.7% vs. 6.5%), and obesity (29.0% vs. 19.4%) were evenly distributed across groups without statistical significance. The anterior thigh was the most common donor site in both groups (61.3% vs. 71.0%, p = 0.71). These findings suggest that both groups were demographically and clinically comparable at baseline, minimizing the risk of confounding.

Table 1: Baseline profile of study groups (n=62)

Variable	Group A (Calcium alginate, n=31)	Group B (Chlorhexidine, n=31)	Test statistic	95% CI of Difference	p-value
Age (years), Mean ± SD	34.84 ± 13.29	36.06 ± 13.56	t = -0.36	-6.84 to 4.40	0.72
Gender (Male), n (%)	18 (58.1%)	14 (45.2%)	χ^2 = 0.59	-	0.44
Diabetes, n (%)	6 (19.4%)	8 (25.8%)	χ^2 = 0.49	-	0.48
Immunocompromised, n (%)	3 (9.7%)	2 (6.5%)	Fisher's Exact	-	1.00
Obesity, n (%)	9 (29.0%)	6 (19.4%)	χ^2 = 1.02	-	0.31
Donor site - Anterior thigh, n (%)	19 (61.3%)	22 (71.0%)	χ^2 = 0.69	-	0.71

Table 2: Wound healing outcomes at donor sites

Outcome	Group A (Calcium alginate)	Group B (Chlorhexidine)	Test statistic	95% CI of Difference	p-value
Wound infection, n (%)	1 (3.2%)	3 (9.7%)	Fisher's Exact	-	0.301
Mean wound healing score (Day 14), Mean ± SD	6.08 ± 2.14	7.74 ± 2.44	t = -2.21	-3.16 to -0.16	0.03*
Healing category - Excellent (≤5), n (%)	15 (48.4%)	5 (16.1%)	χ^2 = 9.5	-	<0.01*
Healing category - Poor (>10), n (%)	1 (3.2%)	5 (16.1%)	χ^2 = 4.3	-	<0.05*

[Table 2] highlights wound healing outcomes. The incidence of wound infection was lower in the calcium alginate group (3.2%) compared to the chlorhexidine group (9.7%), though this was not statistically significant (p = 0.301). The mean wound healing score on day 14 was significantly better in the calcium alginate group (6.08 ± 2.14) than in the chlorhexidine group (7.74 ± 2.44; p = 0.03). Moreover, excellent healing (score ≤ 5) was achieved in 48.4% of calcium alginate cases versus only 16.1% of chlorhexidine cases (p < 0.01). Conversely, poor healing (score > 10) was observed in 16.1% of chlorhexidine cases compared to just 3.2% in the calcium alginate group (p < 0.05). These results clearly demonstrate superior healing outcomes with calcium alginate dressings.

Table 3: Postoperative pain at donor site (VAS scores)

Time point	Group A (Calcium alginate, Mean ± SD)	Group B (Chlorhexidine, Mean ± SD)	Test statistic	95% CI of Difference	p-value
Day 1	6.13 ± 1.41	5.84 ± 1.27	t = 0.85	-0.38 to 0.96	0.397
Day 5	2.01 ± 1.01	2.55 ± 1.00	t = -2.64	-0.95 to -0.13	0.011*
Day 14	0.68 ± 0.65	1.48 ± 1.36	t = -3.05	-1.33 to -0.27	<0.01*

[Table 3] summarizes postoperative pain outcomes based on VAS scores. On day 1, pain levels were comparable between the two groups (6.13 ± 1.41 vs. 5.84 ± 1.27; p = 0.397). By day 5, however, patients with calcium alginate dressings reported significantly less pain (2.01 ± 1.01 vs. 2.55 ± 1.00; p = 0.011). This trend persisted at day 14, where pain scores were markedly lower in the calcium alginate group (0.68 ± 0.65) compared to the chlorhexidine group (1.48 ± 1.36; p < 0.01). These findings suggest that calcium alginate not only aids wound healing but also offers better patient comfort through reduced postoperative pain.

Table 4: Cost-effectiveness of dressings

Group	Median Cost (₹)	Range (₹)	Test statistic	95% CI of Difference	p-value
Calcium alginate	500	500-500	Mann-Whitney U	-	<0.01*
Chlorhexidine	50	50-50	-	-	-

[Table 4] evaluates the cost-effectiveness of both dressings. The median cost of treatment with calcium alginate was ₹500, whereas chlorhexidine gauze cost only ₹50. The difference was statistically significant (p < 0.01), indicating that while calcium alginate provided superior healing and pain relief, it incurred a substantially higher financial burden compared to chlorhexidine.

DISCUSSION

Baseline comparability [Table 1]. Both groups were well matched at entry: age, sex, diabetes, immune status, obesity, and donor-site location showed no statistically significant imbalances (all p > 0.30). Such balance reduces confounding and supports attribution of downstream differences to the dressing itself. Prior systematic reviews of donor-site dressings emphasize that comparability at baseline is essential when interpreting healing and pain outcomes; Üstün GG et al (2020),[6] specifically flagged heterogeneity from baseline imbalances as a threat to validity in earlier trials of "modern" versus gauze dressings. Thomas' overview of alginates likewise notes that patient factors (age, comorbidity, anatomical site) influence re-epithelialization trajectories and must be evenly distributed for fair comparisons.

Healing outcomes [Table 2]. Cohort demonstrated superior healing with calcium alginate, with a significantly lower (better) day-14 wound-healing score (mean difference -1.66; 95% CI -3.16 to -0.16; p = 0.03) and a higher proportion achieving "excellent" healing (48.4% vs 16.1%; p < 0.01). The direction of effect mirrors multiple studies comparing alginates to traditional tulle/paraffin gauze. In a prospective controlled trial, a greater proportion of alginate-dressed donor sites were completely healed by day 10 than paraffin-gauze sites (21/30 vs 7/21; p < 0.05). Kus KJ et al (2020),[7] similarly reported faster re-epithelialization with alginate (7-10 days) than with paraffin gauze (10-14 days), alongside less soakage and easier removal.

Notably, not all comparators favour alginate. Bache SE et al (2024),[8] found no significant difference in healing time when alginate was paired with a polyurethane film versus paraffin gauze, although the semi-occlusive film required more dressing changes and had leakage issues. Souza SC et al (2023),[9] also observed similar time to epithelialization between alginate and polyurethane film, but more frequent changes with the film and less leakage with alginate. Taken together, data align with trials that pit alginate directly against gauze and suggest a practical healing advantage for alginates in exudative donor sites, consistent with the moist-healing paradigm originating from Winter's seminal work.

Infection [Table 2]. Infections were infrequent and statistically comparable (3.2% vs 9.7%; p = 0.301). This is congruent with literature indicating that alginates do not possess strong intrinsic antimicrobial activity, but their fluid-handling characteristics help maintain an optimal moist environment without promoting infection when standard perioperative care is followed. Trials comparing alginate to gauze have reported low, similar infection rates under clean surgical conditions.

Pain outcomes [Table 3]. Pain was similar on day 1 but significantly lower with alginate by day 5 and day 14 (p = 0.011 and p < 0.01, respectively). This pattern is biologically plausible: alginates gel on contact with exudate, are non-adherent, and typically require fewer, less traumatic removals-mechanisms repeatedly linked to lower donor-site pain in comparative studies. Stoica AE et al (2020),[10] documented reduced pain and easier, less painful removal with alginate relative to paraffin gauze. Although Shi SS et al (2020),[11] did not detect significant pain differences when alginate was combined with a polyurethane film, that regimen necessitated more changes (potentially offsetting comfort gains). findings thus dovetail with studies where alginate is compared directly to gauze rather than to other modern occlusives.

Cost [Table 4]. Median material cost was ₹500 for alginate versus ₹50 for chlorhexidine gauze (p < 0.01)-a tenfold difference. Cost data in the literature are mixed and context dependent. Ho TT et al (2024),[12] reported lower overall treatment costs for paraffin gauze over semi-occlusive dressings, driven by unit price and change frequency. Conversely, some authors argue that faster re-epithelialization and fewer painful, disruptive changes with alginates may reduce indirect costs (nursing time, additional consumables, patient discomfort), particularly in highly exudative donor sites. In rural hospitals, the incremental material cost remains a real constraint. dataset suggests a clinical benefit (better healing categories, less pain) at a higher direct dressing cost; whether this is “cost-effective” locally will hinge on valuing pain reduction, fewer rescue dressings/analgesics, and any impact on clinic revisits.

CONCLUSION

The present study compared the outcomes of calcium alginate dressings with chlorhexidine gauze dressings for the management of split-thickness skin graft donor site wounds in a rural general hospital setting. Both groups were comparable in baseline demographic and clinical characteristics. Calcium alginate dressings were found to provide significantly better wound healing outcomes, with a higher proportion of patients achieving excellent healing and lower mean wound healing scores at two weeks. Postoperative pain was also significantly lower in the calcium alginate group on postoperative days 5 and 14, highlighting the atraumatic and non-adherent properties of alginate dressings. Although infection rates were low and comparable between groups, the cost of calcium alginate dressings was substantially higher compared to chlorhexidine gauze.

Overall, calcium alginate dressing offers superior wound healing and patient comfort, albeit at a higher material cost. In rural healthcare settings, where affordability is an important consideration, the choice of dressing should be guided by balancing clinical benefits with economic feasibility.

Limitations

1. The study was conducted in a single rural general hospital, limiting the generalizability of the findings to other healthcare settings.
2. The sample size was relatively small (n=62), which may limit the statistical power to detect rare complications such as infections or adverse reactions.
3. The study did not include long-term follow-up to assess scar quality, cosmetic outcomes, or functional sequelae of donor site healing.
4. Blinding of patients and healthcare staff was not possible due to the visible nature of the dressings, introducing the possibility of observer bias.
5. Cost analysis was restricted to the direct cost of dressing material and did not account for indirect costs such as nursing time, frequency of dressing changes, or patient satisfaction.

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