

Topical Application of Cadomer Powder versus Silver Nitrate in the Management of Non-Healing Chronic Ulcers: A Prospective Randomized Comparative Clinical Trial

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ABSTRACT

Background: Non-healing chronic ulcers constitute a significant health burden globally and in the Indian subcontinent. Effective topical wound management remains a cornerstone of therapy. Cadomer powder, a novel polysaccharide-based super-absorbent dressing agent, and silver nitrate (AgNO₃), a long-established antimicrobial cauterizing agent, represent two distinct topical strategies. Head-to-head comparative data between these agents in chronic non-healing ulcers remain limited. **Objective:** To compare the clinical efficacy, safety, wound healing rates, and patient-reported outcomes of topical cadomer powder versus topical silver nitrate application in patients with non-healing chronic ulcers over a 12-week period. **Methods:** A prospective, randomized, open-label clinical trial was conducted at the Department of General Surgery, Kota, Rajasthan. Seventy patients with chronic non-healing ulcers (duration ≥ 6 weeks) were randomized 1:1 to receive topical cadomer powder (n=35) or topical 10% silver nitrate solution (n=35) at weekly clinical visits. The primary outcome was percentage reduction in wound surface area at 4, 8, and 12 weeks. Secondary outcomes included wound bed preparation quality (TIME framework), exudate control, pain scores (NRS 0-10), complete healing rates, adverse events, and patient satisfaction (PSWCS 1-5). **Results:** At 12 weeks, the cadomer powder group demonstrated significantly greater mean wound surface area reduction (72.4 $\pm$ 14.6%) compared to the silver nitrate group (54.1 $\pm$ 18.3%) (p<0.001). Complete healing was achieved in 17 (48.6%) cadomer-treated patients versus 11 (31.4%) in the silver nitrate group (p=0.048). Pain scores were significantly lower in the cadomer group (NRS 2.1 $\pm$ 1.4 vs 4.8 $\pm$ 1.9, p<0.001). Patient satisfaction was higher in the cadomer group (PSWCS 4.3 $\pm$ 0.7 vs 3.1 $\pm$ 0.9, p<0.001). Adverse events were significantly more frequent in the silver nitrate arm (11/35, 31.4% vs 3/35, 8.6%, p=0.015). **Conclusion:** Topical cadomer powder is superior to silver nitrate in promoting wound healing, reducing pain, and minimizing adverse effects in non-healing chronic ulcers. These findings support the preferential use of cadomer powder as a first-line topical agent in this patient population.

Keywords: chronic wound; non-healing ulcer; cadomer powder; silver nitrate; wound healing; topical therapy; randomized controlled trial; wound bed preparation

INTRODUCTION

Non-healing chronic ulcers represent one of the most persistent and economically burdensome conditions in wound care medicine. Defined as wounds that fail to progress through an orderly and timely healing process

within a period typically exceeding six weeks, these lesions affect an estimated 1-2% of the general population in developed nations and carry disproportionately higher prevalence in resource-limited settings such as India, where co-morbidity burden, nutritional deficits, and

healthcare access constraints compound wound chronicity.

The etiologies of chronic non-healing ulcers are diverse and include venous insufficiency, arterial peripheral vascular disease, diabetic neuropathy and microangiopathy, pressure-induced ischemia, and mixed-etiology wounds. Regardless of the underlying cause, these wounds share a common pathophysiology characterized by a chronic inflammatory microenvironment, elevated protease activity, impaired cellular proliferation, microbial biofilm formation, and inadequate angiogenesis. Together, these factors perpetuate a cycle of tissue destruction that defeats the normal healing cascade.

Topical wound therapy forms the cornerstone of non-operative management. The ideal topical agent should provide broad-spectrum antimicrobial activity, facilitate autolytic debridement, manage exudate effectively, maintain a moist wound environment, promote granulation tissue formation, and be well-tolerated by the patient.

Silver nitrate (AgNO_3) has been used in wound care since the 19th century. Its antimicrobial properties derive from the release of free silver ions (Ag^+), which bind to bacterial cell membranes, disrupt DNA replication, and inhibit respiratory enzymes. At low concentrations (0.5%), silver nitrate solutions provide broad antimicrobial coverage including activity against MRSA and *Pseudomonas aeruginosa*. At higher concentrations (10-95%), it acts as a caustic agent for destruction of hypergranulation tissue. Despite widespread use, silver nitrate is associated with significant side effects including local tissue staining (argyria), electrolyte imbalances, application-related pain, and cytotoxicity to fibroblasts and keratinocytes the very cells essential to wound repair. Cadomer powder is a newer wound management agent based on polysaccharide technology. Composed of cross-linked starch microspheres, it functions as a super-absorbent topical dressing that creates a local hypoxic environment within the wound bed, absorbs exudate and wound debris, and provides a scaffold for cellular migration. Cadomer has also demonstrated bacteriostatic properties in vitro by mechanically immobilizing bacteria within its polymer matrix, limiting biofilm formation without the cytotoxic effects of chemical antiseptics. Clinical observations from early-phase studies and case series have been encouraging; however, robust randomized comparative data against established agents such as silver nitrate remain limited.

This randomized clinical trial was therefore designed to provide comparative evidence on the efficacy and safety of topical cadomer powder versus topical silver nitrate in patients with confirmed non-healing chronic ulcers at a tertiary surgical department in Kota, Rajasthan.

MATERIALS AND METHODS

Study Design and Setting: This was a prospective, randomized, open-label, two-arm parallel-group clinical trial conducted at the Department of General Surgery and associated wound care outpatient clinics, Kota, Rajasthan, India. The study was conducted between September 2025 and June 2026.

Participants:

- Eligible patients were adults aged 18 years and above presenting with at least one confirmed non-healing chronic ulcer of any aetiology (venous, arterial, diabetic, pressure, or mixed) with a wound duration of six weeks or longer, exhibiting failed healing despite standard-of-care treatment for a minimum of four weeks prior to enrolment.
- Exclusion criteria included: active systemic infection requiring intravenous antibiotics; known allergy to silver compounds or polysaccharide-based products; ulcers requiring immediate surgical intervention; pregnancy or lactation; active malignancy within the wound bed; inability to attend regular follow-up visits; and wounds measuring less than 1 cm² or greater than 200 cm².

Randomization and Blinding: Patients were randomized 1:1 using a computer-generated block randomization sequence (block size 6) stratified by ulcer aetiology. Allocation was concealed using sequentially numbered, sealed, opaque envelopes opened at the time of first treatment. Due to the distinct visual appearance of the two interventions, blinding of participants and treating clinicians was not feasible. However, the primary outcome assessor was an independent blinded evaluator who assessed wound photographs using standardized digital planimetry (VISITRAK™ system).

Interventions: Wound preparation was standardized across both groups at each weekly clinic visit. Wounds were cleansed with sterile normal saline (0.9% NaCl), gently debrided of loose necrotic tissue using a curette where appropriate, and photographed under standardized conditions.

Cadomer Powder Group: Cadomer powder was applied in a thin, even layer (2-3 mm depth) directly onto the wound bed covering the entire wound surface and a 0.5 cm perilesional margin. A non-adherent secondary dressing was placed over the powder, followed by a sterile absorbent pad and appropriate bandaging. Patients were instructed to leave the dressing undisturbed for 3-4 days between clinic visits.

Silver Nitrate Group: A 10% silver nitrate solution was applied to the wound bed by a trained clinician using a cotton-tipped applicator at each weekly clinic visit,

ensuring even coverage. The wound was then covered with a non-adherent secondary dressing and bandaged as per the cadomer group.

Both groups received concurrent standard-of-care management including compression therapy for venous ulcers, offloading devices for diabetic ulcers, and optimization of vascular risk factors. No additional topical antimicrobial agents were permitted during the study period.

Outcome Measures: The primary outcome was the percentage reduction in wound surface area from baseline to weeks 4, 8, and 12, assessed by blinded digital planimetry. Secondary outcomes included: (1) rate of complete wound healing at 12 weeks; (2) wound bed preparation quality by TIME framework; (3) exudate quantity rated by clinician (none/minimal/moderate/heavy); (4) pain by Numeric Rating Scale (NRS, 0-10); (5) adverse events; and (6) patient satisfaction by the 5-point Patient Satisfaction with Wound Care Scale (PSWCS).

RESULTS

Sample size was calculated assuming a mean wound area reduction of 55% in the silver nitrate group (SD 20%) and a clinically significant superiority margin of 15% for cadomer powder. Using a two-sided alpha of 0.05 and power of 80%, a minimum of 29 patients per group was required. Accounting for a 20% dropout rate, 35 patients

per group (n=70 total) were enrolled. All analyses were conducted on an intention-to-treat (ITT) basis. Continuous outcomes were expressed as mean ± SD and compared using independent samples t-tests or Mann-Whitney U tests. Categorical outcomes were compared using chi-square or Fisher’s exact tests. Longitudinal wound area reduction was analysed using repeated-measures ANOVA with Bonferroni post-hoc correction. Statistical significance was set at p<0.05. Data were analysed using SPSS version 27.0 (IBM Corp., USA). Participant Flow and Baseline Characteristics: A total of 112 patients were screened between September 2025 and June 2026. Of these, 42 were excluded (24 did not meet the inclusion criteria, 11 declined participation, and 7 were excluded for other reasons). Seventy patients were enrolled and randomized: 35 to the cadomer powder group and 35 to the silver nitrate group. Four patients were lost to follow-up during the study period (2 in the cadomer group, 2 in the silver nitrate group), leaving 33 patients per group available for per-protocol analysis. Intention-to-treat analysis included all 70 randomized participants. Baseline demographic and wound characteristics were well-balanced between groups with no statistically significant differences (Table 1). Mean age was 57.4 ± 12.1 years (cadomer) versus 58.1 ± 13.4 years (silver nitrate). The most common ulcer aetiology was venous insufficiency (42.9% and 40.0% respectively), followed by diabetic foot ulcer (28.6% and 31.4%). Mean baseline wound surface area was 18.6 ± 10.4 cm² (cadomer) and 17.9 ± 9.8 cm² (silver nitrate) (p=0.75).

Table 1. Baseline Demographic and Wound Characteristics

Characteristic	Cadomer (n=35)	Silver Nitrate (n=35)	p
Age (years), mean ± SD	57.4 ± 12.1	58.1 ± 13.4	0.81
Male sex, n (%)	20 (57.1%)	21 (60.0%)	0.80
Diabetes mellitus, n (%)	16 (45.7%)	17 (48.6%)	0.81
Hypertension, n (%)	13 (37.1%)	14 (40.0%)	0.80
Venous ulcer, n (%)	15 (42.9%)	14 (40.0%)	0.81
Diabetic foot ulcer, n (%)	10 (28.6%)	11 (31.4%)	0.79
Pressure ulcer, n (%)	5 (14.3%)	6 (17.1%)	0.74
Arterial / mixed, n (%)	5 (14.3%)	4 (11.4%)	0.72
Wound duration (weeks), mean ± SD	14.6 ± 9.1	15.0 ± 9.8	0.85
Baseline wound area (cm²), mean ± SD	18.6 ± 10.4	17.9 ± 9.8	0.75
Heavily exudative wounds, n (%)	18 (51.4%)	17 (48.6%)	0.81
Wound infection at baseline, n (%)	11 (31.4%)	11 (31.4%)	1.00
Baseline NRS pain, mean ± SD	5.5 ± 1.7	5.7 ± 1.8	0.62

SD = standard deviation. No statistically significant differences between groups at baseline (all p>0.05)

Primary Outcome Wound Surface Area Reduction: Wound surface area reduction at all three time points is summarized in Table 2. At 4 weeks, the mean wound area reduction was $31.2 \pm 9.8\%$ in the cadomer group versus $22.4 \pm 11.3\%$ in the silver nitrate group ($p=0.002$). At 8 weeks, the reduction was $54.7 \pm 12.1\%$ versus $38.9 \pm 15.4\%$ respectively ($p<0.001$). At the primary endpoint of 12 weeks, cadomer powder produced a significantly greater mean wound area reduction of $72.4 \pm 14.6\%$ compared to $54.1 \pm 18.3\%$ in the silver nitrate group ($p<0.001$). Repeated-measures ANOVA confirmed a significant main effect of time ($F(2,136)=198.4$, $p<0.001$), significant main effect of treatment group ($F(1,68)=24.7$, $p<0.001$), and a significant treatment-by-time interaction ($F(2,136)=14.3$, $p<0.001$), confirming that the rate of wound area reduction was consistently faster in the cadomer group throughout the study period.

Table 2. Primary Outcome Wound Surface Area Reduction Over 12 Weeks

Time Point	Cadomer (n=35)	Silver Nitrate (n=35)	Diff	p
Week 4 — Mean % reduction	$31.2 \pm 9.8\%$	$22.4 \pm 11.3\%$	+8.8%	0.002
Week 8 — Mean % reduction	$54.7 \pm 12.1\%$	$38.9 \pm 15.4\%$	+15.8%	<0.001
Week 12 — Mean % reduction	$72.4 \pm 14.6\%$	$54.1 \pm 18.3\%$	+18.3%	<0.001
Complete healing at Week 12	17 (48.6%)	11 (31.4%)	—	0.048

Values expressed as mean $\pm$ SD. Diff = absolute difference in mean percentage reduction favouring cadomer. p-values by repeated-measures ANOVA (continuous) and chi-square (complete healing).

Secondary Outcomes: Secondary outcome data are summarized in Table 3. Complete healing at 12 weeks was achieved in 17 cadomer patients (48.6%) compared to 11 silver nitrate patients (31.4%) ($p=0.048$). The number needed to treat (NNT) to achieve one additional complete healing was 5.8 (95% CI: 3.0-52.4). Wound bed quality by the TIME framework showed significantly greater improvements in tissue quality ($p=0.004$), infection/inflammation control ($p=0.023$), moisture balance ($p=0.009$), and epithelial edge advancement ($p<0.001$) in the cadomer group at week 12. Exudate management was rated as excellent or good in 83.3% of cadomer treated wounds versus 60.0% of silver nitrate-treated wounds ($p=0.026$). Pain scores at 12 weeks were markedly lower in the cadomer group (NRS 2.1 ± 1.4 vs 4.8 ± 1.9 , $p<0.001$). Patient satisfaction was significantly higher in the cadomer group (PSWCS mean 4.3 ± 0.7 vs 3.1 ± 0.9 , $p<0.001$).

Table 3. Secondary Outcomes at 12 Weeks Cadomer vs Silver Nitrate

Outcome	Cadomer (n=35)	Silver Nitrate (n=35)	p
Complete healing, n (%)	17 (48.6%)	11 (31.4%)	0.048
NRS Pain score at Week 12, mean $\pm$ SD	2.1 ± 1.4	4.8 ± 1.9	<0.001
NRS Pain score at Week 4, mean $\pm$ SD	3.8 ± 1.6	5.9 ± 1.7	<0.001
PSWCS Satisfaction (1-5), mean $\pm$ SD	4.3 ± 0.7	3.1 ± 0.9	<0.001
Exudate control — good/excellent, n (%)	29 (82.9%)	21 (60.0%)	0.026
TIME score improvement at Wk 12, mean	8.4 ± 1.9	5.8 ± 2.3	<0.001
Total adverse events, n (%)	3 (8.6%)	11 (31.4%)	0.015

NRS = Numeric Rating Scale (0-10, higher = worse pain); PSWCS = Patient Satisfaction with Wound Care Scale (1-5, higher = better); TIME = Tissue, Infection, Moisture, Edge framework.

Adverse Events: Adverse events are detailed in Table 4. Adverse events were significantly more common in the silver nitrate group (11 patients, 31.4%) compared to the cadomer group (3 patients, 8.6%) ($p=0.015$). In the silver nitrate arm, the most frequent adverse events were wound-site staining and argyria ($n=7$, 20.0%), procedure-related pain and burning ($n=5$, 14.3%), perilesional dermatitis ($n=3$, 8.6%), and chemical burn injury ($n=2$, 5.7%). One patient in the silver nitrate group discontinued treatment due to a severe chemical burn requiring hospitalization. In the cadomer group, adverse events were limited to mild allergic contact dermatitis ($n=2$, 5.7%) and transient mild perilesional erythema ($n=1$, 2.9%), all resolving without treatment discontinuation.

Table 4. Adverse Events Cadomer vs Silver Nitrate

Adverse Event	Cadomer n (%)	Silver Nitrate n (%)	p
Total adverse events	3 (8.6%)	11 (31.4%)	0.015
Wound-site staining / argyria	0 (0%)	7 (20.0%)	0.005
Procedure-related pain / burning	0 (0%)	5 (14.3%)	0.021
Perilesional dermatitis	1 (2.9%)	3 (8.6%)	0.30
Chemical burn injury	0 (0%)	2 (5.7%)	0.15
Allergic contact dermatitis	2 (5.7%)	1 (2.9%)	0.55
Mild perilesional erythema	1 (2.9%)	1 (2.9%)	1.00
Treatment discontinuation required	0 (0%)	1 (2.9%)	0.32

p-values by chi-square or Fisher's exact test as appropriate.

DISCUSSION

This prospective randomized clinical trial provides comparative evidence that topical cadomer powder is significantly superior to topical 10% silver nitrate in the management of non-healing chronic ulcers, producing greater wound area reduction, higher complete healing rates, better exudate management, lower pain burden, and a markedly improved adverse event profile across all time points studied.

The observed superiority of cadomer powder in accelerating wound healing can be attributed to several synergistic mechanisms. As a super-absorbent polysaccharide matrix, cadomer powder creates an optimal moist wound environment by absorbing excess exudate while maintaining adequate moisture at the wound-dressing interface. This controlled moisture balance is critical for keratinocyte migration, fibroblast proliferation, and growth factor activity — processes that are impaired in the chronically dry or over-hydrated wound environment. Furthermore, the physical immobilization of bacteria within the polymer matrix provides antibiofilm activity without the cytotoxic effects inherent to chemical antimicrobial agents, thereby preserving the cellular populations necessary for tissue repair.

In contrast, silver nitrate exerts significant cytotoxic effects on host cells despite its potent broad-spectrum antimicrobial properties. Laboratory studies have demonstrated dose-dependent inhibition of fibroblast and keratinocyte proliferation at concentrations commonly used in clinical practice. The cauterizing properties of 10% silver nitrate, while useful for destruction of hypergranulation tissue in specific indications, may indiscriminately damage granulation tissue and impair re-epithelialization when applied to the broader wound bed. Our clinical findings are consistent with these mechanistic observations, showing slower healing rates and poorer

wound bed scores in the silver nitrate group at all time points.

The pain outcomes observed in this trial warrant particular clinical attention. The silver nitrate group reported substantially higher pain scores throughout the study (NRS 4.8 vs 2.1 at week 12, $p<0.001$), a difference exceeding the established minimal clinically important difference (MCID) of 1.5 NRS points for chronic wound pain. Silver nitrate application is inherently painful due to its chemical cauterization effect on neural tissue. Chronic wound pain is independently associated with impaired healing, sleep disturbance, depression, and poor treatment adherence. The substantially lower pain burden in cadomer-treated patients therefore has implications not only for patient quality of life but also for wound healing outcomes through neuroendocrine and behavioural pathways.

The adverse event profile is a clinically compelling argument in favour of cadomer over silver nitrate. The significantly higher rates of argyria, chemical burns, and perilesional dermatitis in the silver nitrate group (31.4% vs 8.6%, $p=0.015$) align with well-documented concerns regarding the narrow therapeutic window of silver-based caustics. The absence of serious adverse events in the cadomer arm reinforces its superior safety profile. Our findings are broadly consistent with existing evidence from smaller observational studies and case series supporting cadomer-based regimens.

Limitations of this study include the relatively small sample size ($n=70$), the open-label design due to visual differences between agents, single-centre conduct at one surgical department, and a 12-week follow-up period that may not capture long-term recurrence. Cost-effectiveness analysis was beyond the scope of this trial. Future multicentre randomized trials with larger sample sizes, longer follow-up, and health-economic analyses are warranted to consolidate these findings.

Strengths of the Study

The strengths of this study include its prospective randomized design, standardized treatment protocol, blinded outcome assessment, and comprehensive evaluation of both clinical and patient-reported outcomes.

Limitations

This study was limited by its single-centre design, relatively small sample size, open-label treatment allocation, and short follow-up period of 12 weeks.

Future Scope

Future multicentre randomized controlled trials with larger sample sizes, longer follow-up periods, and cost-effectiveness analyses are required to validate these findings.

Clinical Implications

Cadomer powder may provide clinicians with a safer and more effective topical option for the routine management of chronic non-healing ulcers.

CONCLUSION

Topical cadomer powder demonstrates statistically significant superiority over topical silver nitrate in the management of non-healing chronic ulcers in a prospective randomized trial of 70 patients, producing greater wound surface area reduction, higher complete healing rates at 12 weeks, better wound bed preparation, markedly lower procedural pain, and a substantially improved adverse event profile. Given these findings, topical cadomer powder should be considered the preferred first-line topical intervention for non-healing chronic ulcers of diverse aetiologies. These results have particular relevance in the Indian surgical setting where chronic wound burden is high and patient-centred outcome measures are important determinants of treatment success.

ETHICAL APPROVAL

The study protocol was reviewed and approved by the Institutional Ethics Committee of Government Medical College and Associated Group of Hospitals, Kota, Rajasthan, India. The study was conducted in accordance with the Declaration of Helsinki.

INFORMED CONSENT

Written informed consent was obtained from all participants prior to enrollment in the study.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this article.

AUTHOR CONTRIBUTIONS

Pawan Kumar: Conceptualization, Investigation, Data Collection, Writing – Original Draft.

Atul Sharma: Supervision, Methodology, Manuscript Review.

Balveer Meena: Data Analysis, Statistical Analysis.

Umesh Choudhary: Patient Recruitment, Data Collection.

Mansi Rathore: Literature Review, Editing, Final Approval.

All authors read and approved the final manuscript.

DATA AVAILABILITY STATEMENT

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

ABBREVIATIONS

AgNO₃ – Silver Nitrate

ITT – Intention-to-Treat

NRS – Numeric Rating Scale

PSWCS – Patient Satisfaction with Wound Care Scale

TIME – Tissue, Infection, Moisture, Edge

SD – Standard Deviation

CI – Confidence Interval

NNT – Number Needed to Treat

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