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Efficacy of copper-impregnated wound dressing for wound healing in repeat cesarean section: A randomized controlled trial

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ABSTRACT

Background: Surgical site infection (SSI) is a frequent complication following cesarean section and contributes substantially to maternal morbidity. With increasing cesarean delivery rates and limited resources in public hospitals, there is a pressing need for cost-effective infection-prevention strategies. Copper, with intrinsic antimicrobial properties, has emerged as a promising adjunct in wound care. **Aims and Objectives:** The aim of this study was to evaluate the efficacy and safety of copper-impregnated wound dressings compared with standard gauze dressings in women undergoing repeat cesarean section, specifically assessing wound healing using the Redness, Edema, Ecchymosis, Discharge, and Approximation (REEDA) score, SSI incidence, hospital stay, and adverse effects. **Materials and Methods:** A randomized controlled trial was conducted at a tertiary-care government hospital, enrolling 100 women undergoing repeat cesarean section (50 copper dressing; 50 standard gauze). Samples of copper dressings were provided free of cost by MedCu Technologies. Baseline characteristics, comorbidities, and operative variables were comparable. Wound healing was assessed using the REEDA score on post-operative Days 7, 10 and 30. Additional outcomes included SSI incidence, readmission, resuturing, adverse reactions, and hospital stay. Data were analyzed using the Statistical Package for the Social Sciences version 20.0, with $P<0.05$ considered significant. **Results:** The copper group showed significantly lower REEDA scores on Days 7, 10 and 30 ($P<0.001$). SSI occurred in 8% versus 20% of controls ($P=0.08$), with fewer readmissions (0% vs. 6%). Mean hospital stay was shorter (6.12 ± 4.97 vs. 8.64 ± 6.93 days, $P=0.006$). No adverse reactions were reported. **Conclusion:** Copper-impregnated dressings improved wound healing, reduced SSI trend, and shortened hospital stay, suggesting a safe, cost-effective alternative warranting larger multi-centric evaluation.

Key words: Copper-impregnated wound dressings; Surgical site infection; Repeat cesarean section; Wound healing; Redness, edema, ecchymosis, discharge, approximation score

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INTRODUCTION

Surgical site infection (SSI) is one of the most frequent post-operative complications after cesarean delivery and remains a leading cause of maternal morbidity, particularly in resource-limited settings. Given the high incidence of 23% to 38%[1] of SSIs associated with cesarean sections in India, along with the rising prevalence of these procedures, there is a critical need for cost-effective, accessible interventions to improve post-operative outcomes. Copper

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Table 1: Baseline characteristics of study participants (n=100)

Variable	Copper-impregnated group (n=50)	Control group (n=50)	P-value
Age (years, mean±SD)	28.08±4.19	28.14±5.48	0.951
BMI (kg/m², mean±SD)	22.78±2.98	23.23±3.75	0.381
Mean family income (Rs)	24,780±7,115.06	22,880±6,723.82	>0.05
Booking status (Booked/unbooked)	76%/24%	54%/46%	0.021**
Gestational age (weeks, mean±SD)	37.74±1.70	37.91±1.98	0.381
Elective repeat LSCS (%)	18%	14%	0.585
Previous LSCS (1/2)	80%/20%	88%/12%	—
Indication of cesarean (Maternal/fetal)	68%/32%	56%/44%	0.216
Comorbidities present (%)	Anemia (22%), diabetes (2%), hypertension (6%), obesity (4%), and hypothyroidism (6%)	Anemia (18%), diabetes (6%), hypertension (10%), obesity (6%), and hypothyroidism (6%)	0.841
Mean duration of surgery (min)	70.60±16.34	72.40±11.35	0.158
Type of anesthesia (Spinal/General)	98%	92%	0.362
NICU admission (%)	18%	22%	0.803
Most common NICU cause (Respiratory distress)	12%	10%	—
Mean birth weight (kg)	2.68±0.59	2.68±0.60	0.973

SD: Standard deviation, LSCS: Lower-segment cesarean section, NICU: Neonatal intensive care unit, BMI: Body mass index

is a trace element with well-established antimicrobial and wound-healing properties. It acts by generating reactive oxygen species, disrupting bacterial membranes, and modulating angiogenesis and collagen synthesis. Laboratory and clinical studies have demonstrated the broad-spectrum antimicrobial activity of copper against Gram-positive and Gram-negative organisms, including multidrug-resistant strains.[2] This study evaluated the efficacy of copper-impregnated wound dressings specifically in patients undergoing repeat cesarean sections, a population at heightened risk for complications due to repeated surgical interventions.

Aim

To study efficacy of copper impregnated wound dressings for wound healing in repeat caesarean delivery.

Objectives

Primary objective: To compare wound healing by REEDA (Redness, Edema, Ecchymosis, Discharge, Approximation) score on post-op day 7, day 10 and day 30 in copper impregnated wound dressing group and conventional dressing group.

Secondary objectives

1. To compare incidence of surgical site infections between copper impregnated wound dressing and conventional dressing group.
2. To study the side effects of copper impregnated wound dressing in caesarean wound healing such as erythema, itching, edema, etc.
3. To compare length of hospital stay, readmission rates and resuturing rates in both the groups.
4. To compare associated comorbidities in both the groups.

MATERIALS AND METHODS

Study design and setting

A randomized controlled trial was conducted at the tertiary care hospital of Delhi. Institutional Ethics Committee approval and informed consent were obtained.

Participants

All pregnant women with period of gestation more than 28 weeks undergoing repeat cesarean delivery either elective or emergency were eligible. Exclusion criteria included patients with hepatitis B, C, human immunodeficiency virus or syphilis, any dermatological condition around surgical site, patients allergic to copper or Wilson's disease or any acute febrile illness.

Intervention

Participants were randomly assigned to Group A (n=50, copper-impregnated dressing) and Group B (n=50, standard sterile gauze dressing). Dressings were applied immediately postoperatively, and wound healing was assessed on Day 7, 10, and 30.

Outcomes and measurements

Primary outcome was wound healing assessed by Redness, Edema, Ecchymosis, Discharge, and Approximation (REEDA) score on Days 7, 10, and 30 postoperatively. Secondary outcomes included SSI incidence, readmission/resuturing rates, adverse events, and duration of hospital stay.

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences version 20.0. Continuous variables were compared using t-test or Mann–Whitney U-test and categorical variables using Chi-square or Fisher's exact test. $P<0.05$ was considered statistically significant.

RESULTS

Baseline characteristics were comparable between groups (Table 1). Copper-impregnated dressings showed significantly lower REEDA scores from Day 7 onward (Day 7: 2.69±1.81 vs. 4.00±1.82, P<0.001; Day 10: 1.84±2.26 vs. 3.28±2.52, P<0.001; and Day 30: 0.57±0.96 vs. 1.24±1.00, P<0.001) (Figure 1).

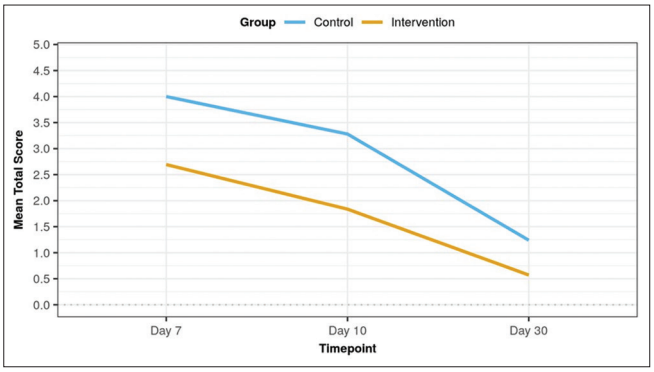

Figure 1: Comparison of redness, edema, ecchymosis, discharge, and approximation score over time

SSI occurred in 8% of the copper group versus 20% in controls (P=0.084) (Table 2), with fewer readmissions (0% vs. 6%) and significantly shorter hospital stay (6.12±4.97 vs. 8.64±6.93 days, P=0.006). Ten superficial SSIs were observed (2 copper group, 8 control) and four deep SSIs (2 in each copper and control group). Common isolates included *Escherichia coli*, *Citrobacter freundii*, Methicillin-resistant *Staphylococcus aureus* (MRSA), Methicillin-susceptible *S. aureus*, *Acinetobacter baumannii*, and *Enterococcus*, (Table 3) with antibiotic sensitivity being imipenem and linezolid (30% each) (Table 4). All the cases were sensitive to imipenem. Three out 4 (6%) in cases needed resuturing on Days 13, 16, and 25 while 7 out of 10 (14%) in controls

Table 2: Comparison of SSI between both the groups

Classification of SSI	Group			Fisher's exact test	
	Control (%)	Intervention (%)	Total (%)	χ^2	P-value
Superficial	8 (80.0)	2 (50.0)	10 (71.4)	1.260	0.520
Deep	2 (20.0)	2 (50.0)	4 (28.6)		
Total	10 (100.0)	4 (100.0)	14 (100.0)		

SSI: Surgical site infection

Table 3: Comparison of organism isolated between both the groups

Organism isolated	Group			Fisher's exact test	
	Control (%)	Intervention	Total	χ^2	P-value
No organism	2 (20.0)	2 (50.0)	4 (28.6)	5.83	0.730
Escherichia coli	2 (20.0)	1 (25.0)	3 (21.4)		
MRSA	3 (30.0)	0 (0.0)	3 (21.4)		
Acinetobacter baumanni	1 (10.0)	0 (0.0)	1 (7.1)		
Citrobacter freundii	0 (0.0)	1 (25.0)	1 (7.1)		
Enterococcus	1 (10.0)	0 (0.0)	1 (7.1)		
MSSA	1 (10.0)	0 (0.0)	1 (7.1)		
Total	10 (100.0)	4 (100.0)	14 (100.0)		

MRSA: Methicillin-resistant *Staphylococcus aureus*, MSSA: Methicillin-susceptible *Staphylococcus aureus*

Table 4: Comparison of antibiotic sensitivity between both the groups

Antibiotic sensitivity	Group			Fisher's exact test	
	Control	Intervention	Total	χ^2	P-value
Imipenem	1 (12.5)	2 (100.0)	3 (30.0)	5.833	0.800
Linezolid	3 (37.5)	0 (0.0)	3 (30.0)		
Cotrimoxazole	1 (12.5)	0 (0.0)	1 (10.0)		
Gentamicin	1 (12.5)	0 (0.0)	1 (10.0)		
Meropenem	1 (12.5)	0 (0.0)	1 (10.0)		
Tazopip	1 (12.5)	0 (0.0)	1 (10.0)		
Total	8 (100.0)	2 (100.0)	10 (100.0)		

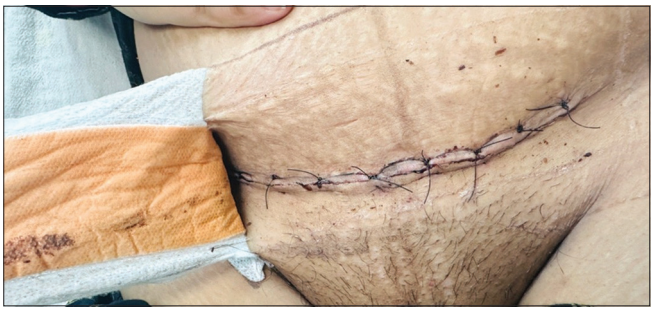

Figure 2: Copper-impregnated wound dressing removal on Day 7

needed resuturing. No adverse reactions or rejections were reported.

DISCUSSION

This randomized controlled trial evaluated the efficacy and safety of copper-impregnated wound dressings compared with standard gauze in women undergoing repeat cesarean section. The copper group demonstrated significantly lower REEDA scores from Day 7 onward (Figure 2) indicating faster wound healing, and a clinically relevant reduction in SSI incidence (8% vs. 20%), although this difference did not reach statistical significance. Mean hospital stay was also significantly shorter in the copper group, suggesting earlier recovery and potential resource savings.

The findings are consistent with previous reports by Arendsen et al.[3] and Melamed et al.,[4] who noted accelerated healing and lower infection rates with copper dressings, and by Wijetunge et al.,[5] who found comparable or superior results to silver dressings. These results highlight copper as a simple, low-cost, and locally applicable adjunct for post-operative wound care, particularly relevant in public hospitals and low-resource settings.

Limitations of the study

Limitations include the single-center design and modest sample size, which may limit external validity and the ability to detect smaller differences in secondary outcomes. Blinding was not feasible due to visible differences between dressings, introducing potential observer bias. Future multicentric studies with larger cohorts and cost-effectiveness analyses are warranted to strengthen the evidence base.

CONCLUSION

These findings suggest that copper-impregnated dressings not only promote faster healing and earlier discharge but also may additionally help reduce colonization or infection with resistant organisms such as MRSA. The absence of reported adverse effects further supports copper dressings as a safe, practical, and clinically relevant adjunct for post-operative wound care following repeat cesarean delivery.

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Strengths of the study

The study's strengths include its randomized controlled design ensuring baseline comparability, specific focus on repeat cesarean deliveries – a subgroup at higher surgical risk – and comprehensive outcome assessment covering wound healing, SSI, adverse events, and hospital stay. By addressing an under-researched population, this work contributes meaningful clinical data to existing literature, particularly from a resource-limited Indian context.

Ethics approval

The study was approved by the Institutional Ethics Committee of the Hospital, Delhi, India. Written informed consent was obtained from all participants.

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SA- Literature survey, prepared first draft of manuscript, implementation of study protocol, data collection, data analysis, manuscript preparation and submission of article; **RS-** Concept, design, clinical protocol, manuscript preparation, editing, and manuscript revision; **RA-** Review manuscript; **NG-** Review manuscript.

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