

COMPARATIVE STUDY ON HEALING POTENTIAL OF 0.01% SILVER NITRATE AND 1% POVIDONE IODINE OVER CHRONIC ULCER

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Abstract

Background: The economic burden of chronic nonhealing ulcers is enormous because of increasing aging population due to their inherent risk factors. Management of these ulcers pose significant challenge to healthcare professionals. **Materials and Methods:** This study was conducted at Coimbatore Medical College Hospital during March 2022 to September 2022 in the Department of General Surgery after appropriate ethical board clearance. Hundred consecutive patients were selected and they were divided into two equal groups. 0.01% Silver nitrate solution was used for topical dressing to one group of patients and 1% Povidone Iodine topical dressing in other group. The reduction in the size of the wound at the end 15th was assessed by an independent assessor blinded to the method of dressing. Presence of various risk factors were also evaluated among the two groups of participants. **Result:** Considering the gender, both the groups had similar participants with the mean age of patients in the study group is 47.3 and in control group 45.26 irrespective of gender. Presence of diabetes mellitus, systemic hypertension, coronary artery disease (CAD), smoking, alcohol intake and the presence of neuropathy were assessed among the two groups of participants. There was statistically significant reduction of 36.64% in raw area was noted in study group as compared to 18.55% in control group at the end of 15th day. 96% in the study group showed significant reduction in pus discharge compared to 22% in control group. 76% of wounds became fit for grafting and only 10% of wounds had positive culture at the end of 15 days in the silver nitrate dressing group. **Conclusion:** We found that the healing potential of silver nitrate 0.01% solution over chronic nonhealing ulcers is superior to 1% povidone iodine solution though some studies found in literature gives contrary evidence.

INTRODUCTION

Chronic nonhealing wounds are defined as wounds that have failed to proceed through an orderly and timely reparative process to produce anatomical and functional integrity over a period of 3 months. It is about two to three million people per year are at risk of developing diabetic ulcer in USA. Further about 60000 people per year develop chronic leg ulcers due to venous insufficiency and another one to three million people per year develop pressure ulcers secondary to immobility. These numbers are increasing in aging population and in patients who is having risk factors like atherosclerotic disease, diabetes mellitus and smoking.

This scenario pose significant challenge to health care professionals and burden on health care systems and economy. Patients with chronic wound also report reduced quality of life and social isolation. Presence of necrotic tissues, lack of healthy granulation, recurrent wound break down, increase in wound size and regression of normal healing implies chronic wound. Combination of adverse systemic and local factors such as malnutrition, aging, tissue hypoxia, diabetes, smoking, atherosclerosis, bacterial colonization and the presence of foreign body impair the normal healing process and contribute inadvertently to the pathogenesis of chronic wounds.

Aim of the Study

The aim is to determine whether silver ions increases the rate of healing in chronic non healing ulcers in comparison to povidone- iodine.

MATERIALS AND METHODS

This study was conducted at Coimbatore Medical College Hospital during March 2022 to September 2022 in the Department of General Surgery after appropriate ethical board clearance. Hundred consecutive patients were selected and enrolled using the following inclusion and exclusion criteria for the study with proper informed consent.

Inclusion Criteria

- Age group from 18 years to 65 years
- Wound of size from 3cm to 5cm with the depth not more than 3cms involving extremities without exposing underlying bone.
- Non healing infected wound with pus presenting for more than 6 weeks

Exclusion Criteria

- Clean surgical wounds and small acute wounds at low risk of infection
- Patient with poor nutritional status like Serum Albumin level less than 2gm/dl
- Patient with low Hemoglobin {less than 8g/dl}
- Diabetic patients with uncontrolled glycemic status
- Patient is under treatment with following drugs chemotherapeutic agents and steroids
- Conditions impairing oxygenation at wound site e.g. COPD, Heart Failure
- Obese patient (BMI more than 30)
- In patients with spreading infection or in patients with signs of septicemia
- Chronic ulcer with clinical and radiological finding suggestive of osteomyelitic changes
- Arterial ulcer with deep tissue involvement and gangrene formation
- Vasculitic disorders and associated ulceration e.g Buerger's disease
- Venous ulcers
- Patients treated entirely under outpatient department
- Pregnant women and children

- Malignancy
- Patients with any form of Nicotine abuse

Further they were divided into two equal groups after the debridement of their unhealthy wounds. 0.01% Silver nitrate solution was used for topical dressing on alternate days for about ten days to one group of patients. 1% Povidone Iodine topical dressing was used for another group of patients. The reduction in the size of the wound was assessed by computer algorithm due to variable shapes of the wound at the end of the 15 days. The formation of healthy granulation and fitness for grafting was also assessed at the end 15th by an independent assessor blinded to the method of dressing. Presence of Diabetes mellitus, Systemic Hypertension, Coronary Artery Disease (CAD), Smoking, Alcohol intake, Neuropathy and level of hemoglobin were assessed among the two groups of participants. Presence of slough, pus discharge and positive culture were also assessed.

RESULTS

Considering the gender, the study group has 22 male and 28 female while the control group has 21 male and 29 female. The mean age of patients in the study group is 47.3 and control group 45.26 irrespective of gender. Presence of diabetes mellitus, systemic hypertension, coronary artery disease (CAD), smoking, alcohol intake and the presence of neuropathy were assessed among the two groups of participants [Table 1]. Further the mean value of hemoglobin was 10.58 in silver nitrate dressing (study) group and 11.04 in povidone iodine (control) group.

The reduction of surface area of ulcer was measured using computer algorithm due to variable shapes of wounds at the end of 15th day. There was statistically significant reduction of 36.64% in raw area was noted in study group as compared to 18.55% reduction in control group [Table 2]. Further more than 50% reduction in pus discharge achieved in 48 out of 50 patients (96%) in the study group where as in control group only in 11 out of 50 (22%) achieved more than 50% reduction in pus.

Table 1: Prevalence of comorbid status

Sl.no	Comorbidity	Silver nitrate dressing	Povidone iodine dressing
1	Diabetes melitus	35(70.0%)	21(42.0%)
2	Systemic hypertension	22(44.0%)	19(38.0%)
3	Smoking	12(24.0%)	17(34.0%)
4	Coronary artery disease	12(24.0%)	7(14.0%)
5	Alcohol intake	16(32.0%)	18(36.0%)
6	Neuropathy	13(26.0%)	7(14.0%)

Table 2: Percentage reduction of ulcer area

Type of dressing	N	Mean	Sd	P value
Silver nitrate dressing	50	36.64	5.090	.005*
Povidone iodine dressing	50	18.55	9.190	

*. Statistically Significant ($P < 0.05$)

Only 5 (10%) wounds had positive culture growth at the end of 15 days in the silver nitrate dressing group when compared to 36 wounds (72%) in povidone iodine group. 38 wounds (76%) became fit for grafting when treated with silver nitrate compared to only 14 (28%) wounds in povidone iodine group.

DISCUSSION

Silver either in metallic or in ion form is known to be a broad-spectrum antibiotic with antiseptic, antimicrobial, anti-inflammatory and prohealing properties. Since ancient times silver was used for disinfecting water and liquids. The first report on silver nitrate was published from Rome in 69 BC and first information about medical use of silver nitrate began from Gabor (702 -705 AD). In 1520 Paracelsus used silver nitrate for wound management. Between 1700 and 1800, it was used to manage leg ulcers, venereal diseases and acne. In 19th century silver nitrate solution was used for burns care. In 1884 German obstetrician Crede applied 1% silver nitrate eye drops for newborns to prevent gonorrheal infection. The first Chief of Surgery at Johns Hopkins, William Halsted used silver wire sutures for hernia repair. He also founded silver foil as an effective method of controlling postoperative infections in surgical wounds.^[5-8]

Though the topical silver was used as an antimicrobial agent in wound management for so many years its use was restricted as the form of silver available for dressing was difficult to apply. Recently, wide range of wound dressing that contain elemental silver or silver releasing compound have been developed that are easier to apply. These dressings provide sustained availability of silver on wound surface and they have overcome problems associated with ancient silver preparations. Silver dressing are easier to apply with less frequent dressing changes, maintains moist environment on wound surface and promote autolytic debridement.^[9,10]

Silver ions are highly reactive and affect multiple sites within bacterial cells finally causing bacterial cell death. They bind to bacterial cell wall causing disruption of the bacterial cell wall and cell leakage. Silver ions transported into the cell disrupt cell function by binding to proteins and also affect the energy production, enzyme functions and replication of cells. Silver ions are active against a broad range of bacteria, fungi and viruses, including many antibiotic-resistant bacteria, such as methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant *Enterococci* (VRE). Topical agents have multiple sites of antimicrobial action on target cells therefore they have lower risk of bacterial resistance. As a result, topical antiseptics have the potential to play an important role in controlling bioburden in wounds while limiting exposure to antibiotics and thereby reducing the risk of development of further antibiotic resistance.^[11-18]

In a randomized controlled multicenter study by Jorgensen et al the effect of a sustained silver release foam dressing in critically colonized venous leg ulcers with delayed wound healing was evaluated. After 4 weeks there was significantly greater reduction in dressing soakage, maceration and ulcer area were observed in study group.^[3]

Daxesh Patel et al in their prospective observational study evaluated the effects of silver based dressing materials in 50 cases of diabetic foot ulcers on the basis of discharge from the wound, healing rate, appearance of the granulation tissue and wound culture. Only three patients out of 50 cases studied showed persistent purulent discharge, absent granulation tissue, positive wound culture. Hence they concluded that silver based dressing reduces the discharge from wound and promotes wound healing more effectively.^[2]

Lo SF et al conducted systematic review of silver releasing dressings in the management of infected chronic wounds. This systematic review of literature was conducted by using CINAHL, PUBMED, COCHRANE and MEDLINE databases. This review confirms the use of silver dressings in chronic infected wounds appear more effective and better tolerated by patients.^[11,12]

Trial C et al conducted a randomized controlled trial to assess the antimicrobial effectiveness of new ionic silver alginate wound dressings. 42 patients with locally infected chronic wounds or acute wounds were enrolled in this open label, prospective, controlled randomized trial which showed the regression of local signs of infection, local tolerance, acceptability and usefulness were found better with silver dressings.^[17]

Meaume S et al evaluated the effect of silver releasing hydro alginate dressing in chronic wounds with signs of local infection. In this randomized open labelled multicentric comparative study, 51 patients subjected to silver releasing hydroalginate dressing and 48 patients were allotted to have a pure calcium alginate dressing as control group. This study suggests that the use of silver releasing dressing in the management of wound at high risk of infection have favorable wound prognosis.^[13] In 2007 Kim et al demonstrated growth inhibitory effect of silver nitrate on *E.coli* and *Staph aureus*.^[4]

Seigel HJ et al. compared negative pressure dressing with or without silver in wounds involving pelvis and extremities. They examined 42 cases with massive tissue loss more than 200cm² (in which 26 cases treated with vacuum alone and 16 cases by vacuum with silver dressing). Average hospitalization days in vacuum only group was 33 days compared to 14 days in vacuum with silver dressing group. Operative debridement numbers were almost twice less in vacuum with silver dressing group when comparing vacuum only group.^[15]

Landsdown conducted a sequential microbiological examination of wound swabs from seven patients with chronic wounds with various types of silver

compound dressings and they found in all the cases bacterial bioburden is reduced.^[7]

Our study was done as a prospective randomized controlled comparative study during March 2022 to September 2022 in the Department of General Surgery, Coimbatore Medical College Hospital after appropriate ethical board clearance to compare the efficacy of 0.01% of silver nitrate dressing to conventional 1% Povidone iodine dressing in the management of chronic non healing ulcers. Hundred consecutive patients were selected and enrolled using pre-approved inclusion and exclusion criteria for the study with proper informed consent. They were divided into study and control group containing 50 patients each. Control group was treated with conventional 1% Povidone iodine dressing and the study group was treated with 0.01% Silver nitrate dressing for a period of 15 days.

In contrary to above studies Carter MJ concluded silver-impregnated dressings improve the short-term healing of wounds and ulcers, long-term effects remain unclear.^[1] Similarly Storm-Versloot MN showed that there is insufficient evidence to establish whether silver-containing dressings or topical agents promote wound healing or prevent wound infection.^[16]

Mean age in study population is 47.30 years and in control group is 45.26 years. In our study group 70 percent of patients with non-healing ulcer had diabetes mellitus as risk factor compared to 42 percent patients in control group had the same risk factor. 44% of study group were hypertensive while 38% in control group were hypertensive. Coronary artery disease was prevalent in 24% of study group and 14% of control group. 24 % and 32% were in the study group and 34 % & 36 % in control group were smokers and alcoholics respectively.

Final wound surface area was measured and reduction in the wound area of both groups were compared. Slough and wound discharge were significantly reduced in 96% of study group patients and 76% of wound in this group became fit for grafting treated with silver nitrate dressing.

CONCLUSION

To summate we found that the healing potential of silver nitrate 0.01% solution over chronic nonhealing ulcers is superior to 1% povidone iodine solution. Since some studies found in literature gives contrary evidence researchers are intrigued to do further research to validate their claim.

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