

Comparative study of nanocrystalline silver dressing with normal saline dressing in diabetic foot ulcer

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Conflicts of Interest: Nil

Abstract

Diabetic foot is defined as the presence of infection, ulceration, gangrene and/or destruction of deep tissues associated with neurologic abnormalities and various degrees of peripheral arterial disease (PAD) in the lower limb in patients with diabetes¹⁻².

Global prevalence of diabetes in 2003 was estimated to be 194 million. By 2030, this figure is predicted to rise to 366 million due to longer life expectancy and changing dietary habits. In fact, the prevalence is soaring in south India it may reach an astronomical figure of 13% to 18%³.

In India due to increase in diabetes cases and increased life expectancy i.e. Increase in geriatric population, foot complications are on the rise in diabetics. Amputations and ulcers that precede limb loss are largely preventable.

The number of admissions to hospital for foot related complications are increasing and limbs are amputated are

more than those lost in both world wars. This is of great socioeconomic importance as majority of them are in the prime earning age group and are poor³.

During the past few decades, we have gained considerable knowledge regarding anatomy, physiology, pathology, and management of diabetic foot ulcers. And various treatment modalities are discovered in the form of wound dressing like creams, ointments, solutions, negative suction vacuum dressing, foam dressing, and absorptive dressings.

An ideal diabetic wound management involves control of infection and prevention of tissue damage and promoting normal wound healing. Characteristics of an ideal dressing include- providing a moist environment, removal of excess exudate, prevention of desiccation, allowing gaseous exchange, impermeability to microorganisms, thermal insulation, prevention of particulate

contamination, non-toxicity to beneficial host cells, mechanical protection, non-traumatic, easy to use and cost effectiveness⁴.

Wound healing is a complex biological process influenced by several agents, which promote granulation tissue regeneration and contribute towards wound healing. Diabetic foot ulcers are the consequence of multiple factors including peripheral neuropathy, decreased blood supply, high plantar pressures leading to significant risk for morbidity, limb loss and mortality⁴. Hence this study was aimed to compare effectiveness of nano-crystalline silver dressing with normal saline dressing in diabetic foot ulcer.

Silver ion (Ag⁺), as a broad antimicrobial spectrum has been used for wound treatment since 69 B.C.⁵⁻⁹ Silver ions are highly reactive and affect multiple sites within bacterial cells, ultimately causing bacterial cell death by binding to the bacterial cell membranes and causing disruption of the bacterial cell wall and cell leakage, they also interfere with energy production, enzyme function and cell replication and thus are active against a broad range of bacteria, fungi and viruses. An ideal wound management involves control of infection and prevention of tissue damage and promoting normal wound healing. Hence, we conducted a comparative study between, most used wound care product in practice i.e., Normal saline and nano crystalline silver dressing. Normal saline has been effectively used over the years in the treatment of diabetic foot ulcers and other wounds and it is most used in the practice. Both are available in our hospital. Very few studies are conducted to compare efficacy of nano crystalline silver dressing which is a newer modality in the treatment of diabetic foot management, hence this study was aimed to compare effectiveness nano-

crystalline silver dressing with normal saline dressing in diabetic foot ulcer.

Materials and methods

The study will be done on 98 patients in ESI hospital Bangalore. The patients are randomly divided into 2 groups-study group and control group. Patients are made to understand and sign the informed consent form.

Study group(A)-received Nano crystalline silver dressing. Control group(B)-received once daily dressing with saline

Source of data

All patients irrespective of sex in department of General surgery in ESIC MC PGIMSR hospital Bangalore, admitted with diabetic foot ulcer between

January 2020 to June 2021

Method of collection of subjects

The prospective study (case control study) is intended to be carried out in 98 patients with diabetic foot ulcer in ESIC MC Bengaluru.

Inclusion criteria

1. Patients willing to give informed written consent for participation in the study.
2. All the patient irrespective of gender above 30 years of age who are diagnosed with diabetic ulcers.
3. All diabetic foot ulcer falling under Wagner grade 1 and 2.

Exclusion criteria

1. Patient not willing to give informed consent
2. Patient with known sensitivity to silver
3. Patient with osteomyelitis.
4. Malignant ulcers.
5. During radiation therapy
6. On patient undergoing MRI examination
7. Other clinically significant medical conditions that would impair wound healing including renal.

Hepatic, hematological, neurological and immunological diseases.

8. Patients receiving corticosteroids, immunosuppressive agents, radiation, or chemotherapy within one month prior to entry into study were also excluded.
9. All patient with Wagner grade 3 and above

Method of data collection

The included patients were subjected to:

1. Detailed clinical history
2. General Physical examination and local ulcer examination.
3. Investigations
 - A. Routine blood investigations- Complete blood count, renal function tests, blood sugars
 - B. Radiological- X ray wherever indicated
 - C. Swab Culture sensitivity(C/S) form ulcer on Day 1 in all patients, and subsequent C/S on variable days.
4. Informed Written Consent
5. Assessments were done on day 1,3,5,7,9,12,15,18,21.

Various Assessment Tools were used to compare wound healing between NCS and NS groups based on:

- A. Decrease in pus discharge
- B. Appearance of Granulation tissue
- C. Wound size

Antibiotic coverage was given for all patients, in some patient's intravenous antibiotics was followed by oral antibiotics.

Methodology

All diabetic foot ulcer patients attending the surgery clinic during the study period, diagnosed with Diabetes mellitus according to criteria laid down by the American Diabetes Association Criteria are included in the study. A total of 98 attending the clinic agreed to be a part of the study.

These are equally divided into two groups (49 each) - the Study group and Control group.

1. Study group are treated with nanocrystalline silver ion dressings which need to be changed every 2-3 days
2. In the control group Normal saline soaked gauzes are used which is changed daily.

Ulcers are to be treated until the wound get closed spontaneously or the wound showed healthy granulation and was able to be grafted or secondarily sutured or until completion of the 56 days (8 weeks) of assessment whichever was earlier. Each patient received supportive and conventional care of the wound throughout the study. Blood sugar was controlled by insulin and oral hypoglycemic. All patients are administered broad spectrum systemic antibiotics. Based on previous literature we hypothesized that the proportion of complete responder among the nano crystalline dressing and normal saline dressing was found to be 65% and 35% respectively.

We calculated sample size with 80% power and 95% confidence interval and ratio of case to control as 1:1 calculated using www.openepi.com

The estimated sample size for the study is 98 in which 49 are control and 49 are cases The data will be analyzed for the descriptive and inferential statistics for the descriptive analysis to calculate mean, Standard deviation and proportion for the inferential statistics we shall apply chi square test to test a test of significance if p value <0.05 considered as significant

Statistical analysis

Data will be analyzed for descriptive and inferential statistics, so for descriptive statistics we calculate mean standard deviation range and proportion. For inferential statistics the continuous variable is converted to

categorical-variable, based on cut-off and chi-square test is applied to test the significance, A p value of <0.05 shall be considered as significant, we calculate sensitivity specificity, negative predictive value and positive predictive value

Results

The numbers of patients studied were 98 and are divided into two group, nano silver dressing group and conventional dressing with normal saline group of 49 each. The present study includes 98 Patients with Diabetic foot ulcers admitted at ESIC MC AND PGIMSR in Department of General surgery, satisfying the inclusion criteria and randomized into two groups. Group A included patients in whom Nano crystalline silver (NCS) was used and Group B included patients in whom Normal saline (NS) was used. The Efficacy of Nano crystalline versus Normal saline in treating diabetic foot ulcers was studied. There were no toxicity or hypersensitivity reactions to either group reported in our study. The following observations have been made in the study.

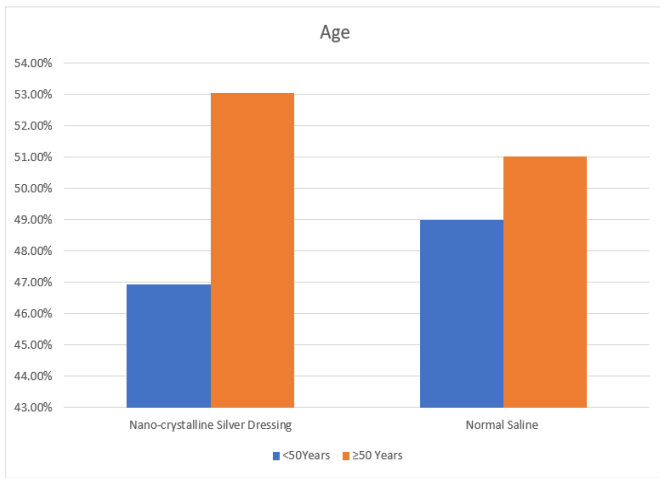
Both groups were matched in terms of

- 1) Age wise distribution
- 2) Sex distribution
- 3) Severity of pain
- 4) Pus discharge
- 5) Surrounding tissue
- 6) Mean difference between the age group
- 7)Wound healing parameter
- 8)wound size formation
- 9) Complete cure
- 10) Estimated mean time to complete cure
- 11) duration of hospital stays
- 12) Graft taken up in percentage

Table 1: Age Distribution of the study participants

Out of 98 study participant, 47 were aged <50years of age i,e 46.70% (including both NCS and NS Group) among them 23(46.94%) were NCS group and 24 (48.98%)were normal saline group and 51 were aged >50 years i,e 53.30%.chi square test applied for both the group with p value of 0.009 which is statistically significant in both the age group.

AGE CAT		Nanocrystalline Silver Dressing	Normal Saline	Total	Chi Square	P-value
<50Years	Number	23	24	47	1.556	0.009
	Percent	46.94%	48.98%	46.70%		
≥50 Years	Number	26	25	51		
	Percent	53.06%	51.02%	53.30%		
Total	Number	49	49	98		
	Percent	100.00%	100.00%	100.00%		

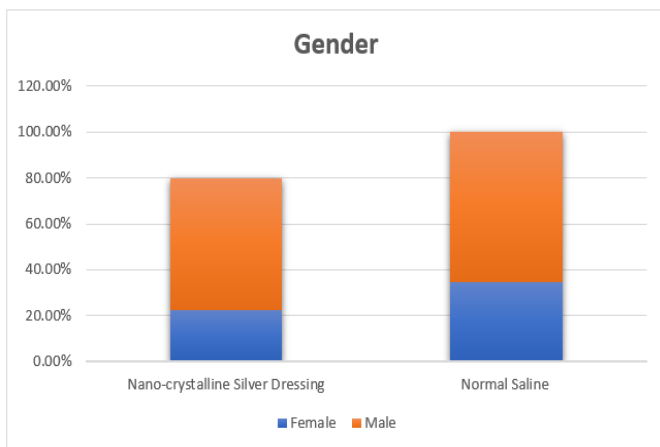


Graph 1

Table 2: Gender Distribution of the study participants

Out of 98 study group, 28 were female in which 11(22.45%) belonging to NCS group and 17(34.69%) were NS Group. And 60 were male in which 28(57.14%) belonging to NCS group and 32(65.31%) were NS group. Chi square test was applied to both the group with p value <0.001 which is statistically significant.

		Nano-crystalline Silver Dressing	Normal Saline	Chi square	P-value
Female	Count	11	17	15.74	<0.001
	% of Total	22.45%	34.69%		
Male	Count	28	32		
	% of Total	57.14%	65.31%		
Total	Count	49	49		
	% of Total	100.00%	100.00%		

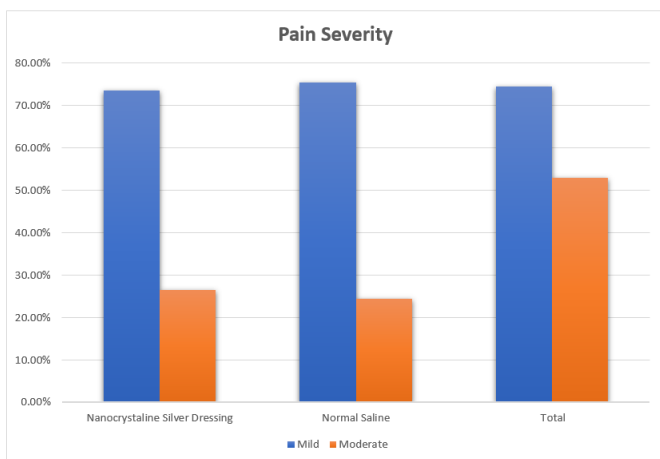


Graph 2

Table 3: Pain classification distribution of the study participants

Out of 98 total 73 cases (74.49%) reported mild pain in which 36(73.47%) were NCS group and 37(75.51%) NS group. And 26 reported moderate pain (53.06%) in which 13(26.53%) were NCS and 12(24.49%) NS dressing, chi square test applied to both the group with p value of 0.874 which is statistically not significant. Adequate analgesia provided in both groups during the study

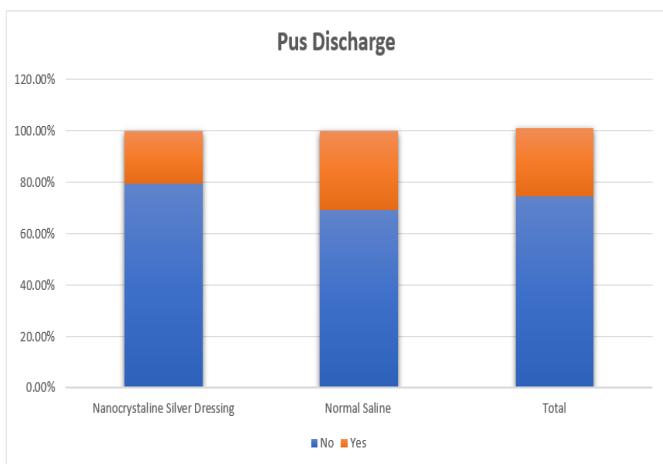
		Nanocrystalline Silver Dressing	Normal Saline	Total	Chi square	P-value
Mild	Count	36	37	73	0.684	0.874
	% of Total	73.47%	75.51%	74.49%		
Moderate	Count	13	12	26		
	% of Total	26.53%	24.49%	53.06%		
Total	Count	49	49	98		
	% of Total	100.00%	100.00%	100.00%		



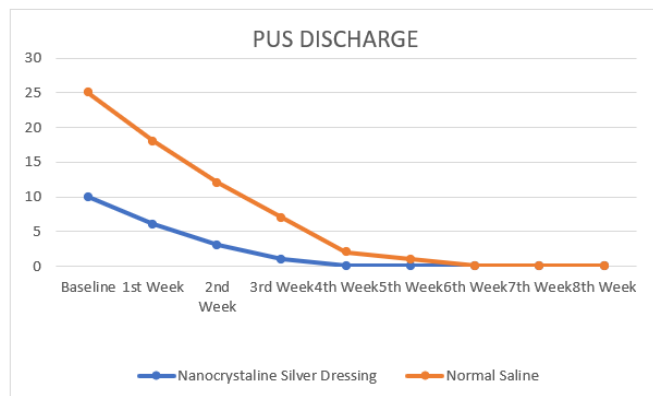
Graph 3

Table 4: Pus discharge distribution of the study participants Chi square Test, Sig. 2 tailed, p<0.05

			Nanocrystalline Silver Dressing	Normal Saline	Total	Chi square	P-value
Pus Discharge	No	Count	39	34	73	1.751	0.661
		% of Total	79.59%	69.39%	74.49%		
	Yes	Count	10	15	26		
		% of Total	20.41%	30.61%	26.53%		
	Total	Count	49	49	98		
		% of Total	100.00%	100.00%	100.00%		



3rd Week	1	6
4th Week	0	2
5th Week	0	1
6th Week	0	0
7th Week	0	0
8th Week	0	0



Graph 4

Pus Discharge In follow up

Pus discharge	Nanocrystalline Silver Dressing	Normal Saline
Baseline	10	15
1st Week	6	12
2nd Week	3	9

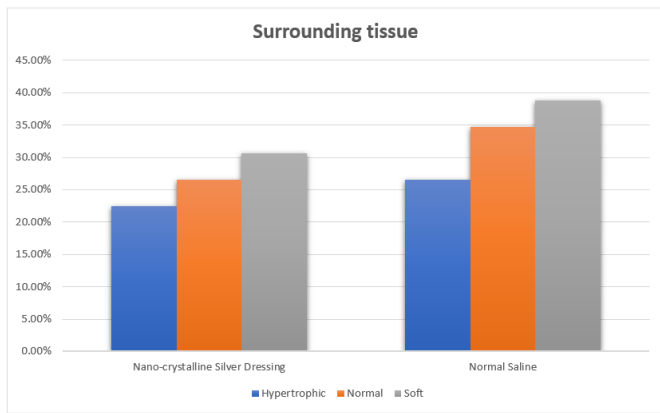
Graph 5

Table 5: Surrounding tissue condition

Out of 98 patients, 24 had hypertrophic surrounding tissue in which 11 were NCS and 13 were NS, 30 had normal surrounding tissue in which 13 were NCS and 17 were NS and 34 had soft surrounding tissue in which 15 were NCS and 19 were NS.

Chi square test was applied with p value 0.097 which is statistically not significant.

		Nanocrystalline Silver Dressing	Normal Saline	Total	Chi square	P-value
Hypertrophic	Count	11	13	24	2.576	0.097
	% of Total	22.45%	26.53%	24.49%		
Normal	Count	13	17	30		
	% of Total	26.53%	34.69%	30.61%		
Soft	Count	15	19	34		
	% of Total	30.61%	38.78%	34.69%		
Total	Count	49	49	98		
	% of Total	100.00%	100.00%	100.00%		



Graph 6

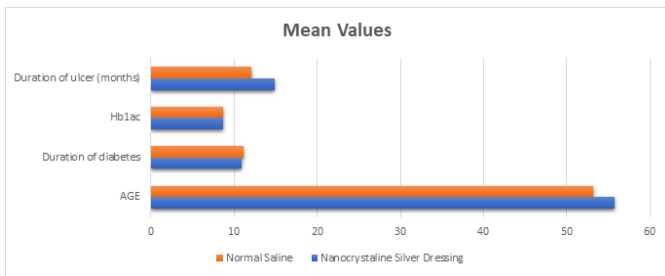
Table 6: Mean Difference between the Groups

Out of 49 patients in NCS group mean age group of patients was 55.75 ± 10 and with NS group mean age group 53.17 ± 9.3 . Duration of diabetes in years 10.92 (mean value) with ± 5.4 in NCS group and mean value of 11.15 ± 3.7 in normal saline group.

HbA1c level 8.72 ± 2.2 in NCS group and 8.66 ± 0.31 in NS group.

Duration of ulcer was 14.85 ± 7.6 months in NCS group and 12.103 ± 8.3 months in NS group

		Mean	Std. Deviation	Std. Error Mean	T-test	P-value
AGE	Nanocrystalline Silver Dressing	55.75	10.451	1.165	1.754	0.545
	Normal Saline	53.17	9.337	1.125		
Duration of diabetes	Nanocrystalline Silver Dressing	10.92	5.477	0.752	1.125	0.34
	Normal Saline	11.15	3.746	0.789		
Hb1ac	Nanocrystalline Silver Dressing	8.72	2.211	0.0427	1.074	0.711
	Normal Saline	8.66	0.3189	0.0438		
Duration of ulcer (months)	Nanocrystalline Silver Dressing	14.858	7.6989	1.0575	1.746	0.069
	Normal Saline	12.103	8.3082	1.1412		



Graph 7

Table 7: Wound healing parameters between the study groups

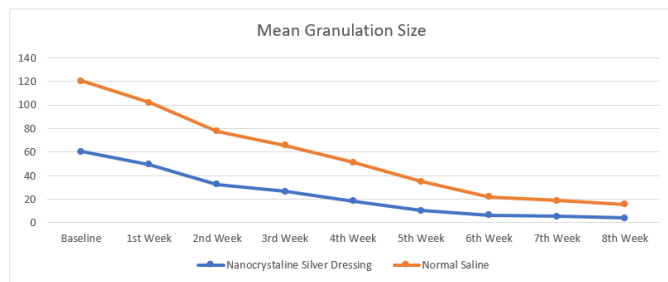
	Group	Mean	Std. Deviation	Mean Percentage difference
Baseline	Nanocrystalline Silver Dressing	60.47	10.74	0.00
	Normal Saline	59.71	9.23	0.00
1st Week	Nanocrystalline Silver Dressing	49.55	8.79	18.06
	Normal Saline	52.47	10.98	12.13
2nd Week	Nanocrystalline Silver Dressing	32.47	4.50	34.47
	Normal Saline	45.33	3.38	13.61
3rd Week	Nanocrystalline Silver Dressing	26.45	3.91	18.54
	Normal Saline	39.41	3.09	13.06
4th Week	Nanocrystalline Silver Dressing	18.64	3.23	29.53
	Normal Saline	32.44	2.93	17.69
5th Week	Nanocrystalline Silver Dressing	10.44	2.86	43.99
	Normal Saline	24.67	2.85	23.95
6th Week	Nanocrystalline Silver Dressing	6.54	2.64	37.36
	Normal Saline	15.47	2.51	37.29
7th Week	Nanocrystalline Silver Dressing	5.44	2.64	16.82
	Normal Saline	13.44	2.51	13.12
8th Week	Nanocrystalline Silver Dressing	4.22	2.64	22.43
	Normal Saline	11.5	2.51	14.43

Table 8: wound size (cm²/day)

Independent t test, Sig. 2 tailed, p<0.05

There is statistically significant difference between the granulation tissues formation rate between the Nanocrystalline Silver Dressing and Normal Saline. The Size of the baseline wound is one of the important variables for the rate of healing. For the ulcers <40cm², the difference of rate of healing was not significant, while for ≥40 cm², the rate of healing among Nanocrystalline Silver Dressing was significantly higher (6.21cm²/day) as compared to normal saline (4.20cm²/day). (p<0.001)

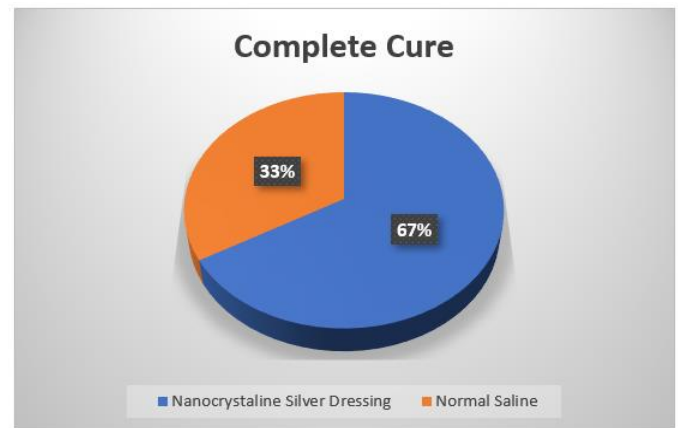
Wound size q (cm ² /day)	Nanocrystalline Silver Dressing	Normal Saline	T test	P-value
Mean rate	4.2±3.22	2.61±4.17	16.114	0.003
<40	3.47±3.11	2.24±3.22	2.143	0.06
≥40	6.21±8.14	4.20±4.07	10.449	<0.001



Graph 8

Table 9: Number of complete cures

Group	Total N	Complete cure	Censored	Percent
			N	Percent
Nanocrystalline Silver Dressing	330	54	276	83.64%
Normal Saline	330	27	303	91.82%
Overall	660	81	579	87.73%

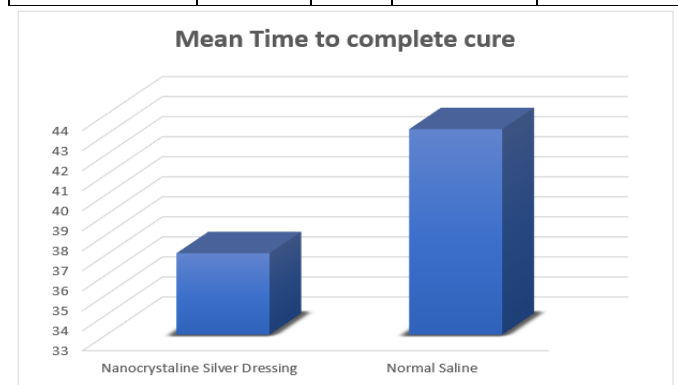


Graph 9

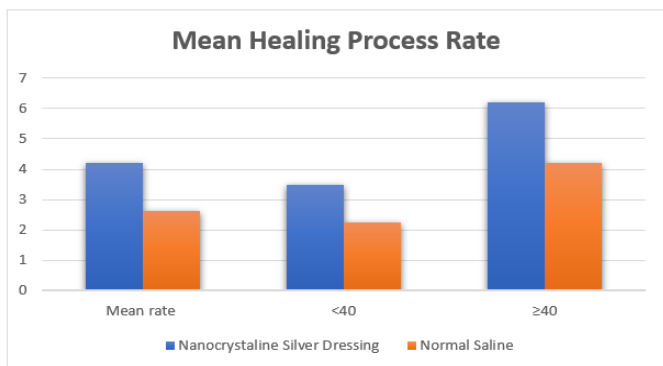
Table 10: Estimated Mean time to complete cure

Estimated Mean time to complete cure of ulcer was lower in Nanocrystalline Silver Dressing (37.06 days) as compared to the Normal Saline (43.25 days).

Group	Estimated Mean time to complete cure			
	Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Nanocrystalline Silver Dressing	37.061	0.145	10.423	49.319
Normal Saline	43.255	0.112	11.036	54.274



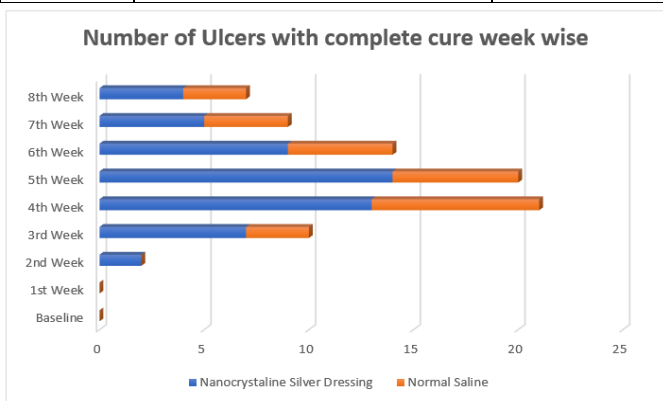
Graph 10



Graph 11

Table 11: Number of Complete Cure of Patients in Each Group with Each Follow Up

	Nanocrystalline Dressing	Silver	Normal Saline
Baseline	0		0
1st Week	0		0
2nd Week	2		0
3rd Week	7		3
4th Week	13		8
5th Week	14		6
6th Week	9		5
7th Week	5		4
8th Week	4		3



Graph 12

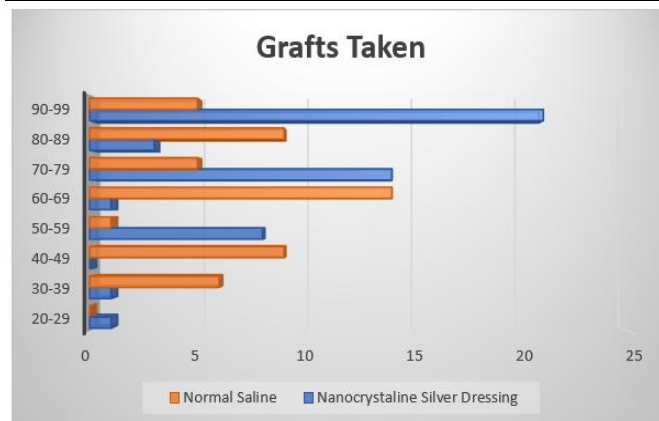
Number of Complete Cure of Patients in Each Group with Each Follow Up

Table 12: Duration of Hospital stay

Duration (days)	Nanocrystalline Silver Dressing	Normal Saline	Total	P-value
Mean	34.4 ±	43.4 ±	-	0.004
Duration Stay	6.9	3.6		

Table 13: Grafts take up %

Grafts take up %	Nanocrystalline Dressing	Silver	Normal Saline
20-29	1		0
30-39	1		6
40-49	0		9
50-59	8		1
60-69	1		14
70-79	14		5
80-89	3		9
90-99	21		5



Graph 13

Clinical Photograph



Figure 1: Nano crystalline silver dressing



Nano crystalline silver dressing



Normal saline



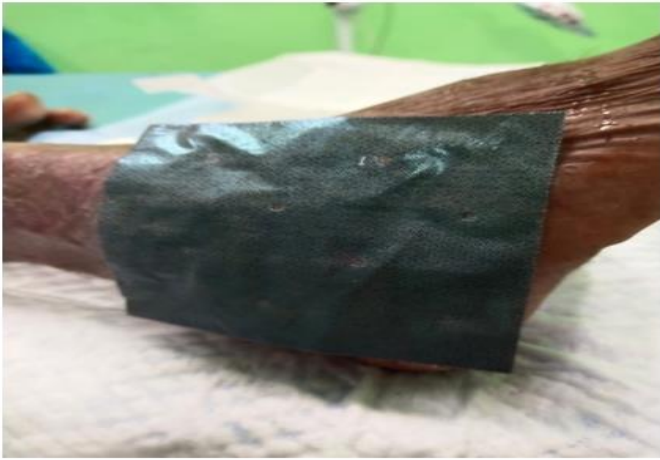
Case 2 Day1

Case 1 On Day1



Nano crystalline silver dressing

3rd week



2nd week



Nano crystalline silver dressing



4th week



Nano crystalline silver dressing



Case 3 –patient no 16

Day1



End of 2nd week



Case 4 – patient no 25

Nano crystalline dressing on day1



Case 5 – patient no 40



Day on 21



On day 21



Day 14



Day 28



Discussion

Diabetes has a wide spectrum of complications which can be attributed to persistent hyperglycaemia but, it is not the only one, as it cannot explain presence or absence of complications of diabetes, despite good glycaemia control. Long standing diabetes increases the risk of developing foot ulcers⁵⁹. The chronic pain and disability impose a big threat to patient's quality of life along with the financial burden due to prolonged treatment. More than 70% required surgical intervention and in more than 40% there is a toe or foot amputation⁶⁰. An aggressive approach to the wound management can save the limb in many cases. Patient education, good glycaemia control, offloading, debridement, infection control and adequate perfusion are mandatory in the management of diabetic foot ulcerations. Selection of an appropriate dressing with timely replacement can expedite the healing. Various modes of treatment and wound dressings are used but still treatment failure rate is very high and many patients still end up with limb amputations. Nanotechnology using silver ions offers greater antimicrobial property. The smaller silver particles produced are lesser toxic to human tissue cells due to increased surface area to volume ratios⁶¹⁻⁶². Silver has efficacy against wide spectrum of bacteria, virus and fungal infections⁶³. silver nano compounds attracted recently as silver nano particles may enter into the cell via pinocytosis and endocytosis. Entry into the cell is followed by damage to deoxyribonucleic acid (DNA) and bacterial proteins that eventually resulting in bacterial death⁶⁴. One parts per million (ppm) silver is sufficient to achieve bactericidal action. Nano crystalline technology appears to give the highest, sustained release of silver to a wound without clear risk of toxicity⁶⁵. Silver

nano particles can release Ag⁺ ions at a greater rate than bulk silver, by virtue of their large surface area⁶⁷.

The early disappearance of discharge and slough and the early appearance of granulation tissue point towards a quicker healing in diabetic foot ulcers in study groups using nanocrystalline silver as compared to conventional normal saline soaked dressings. The results drawn could be attributed to the potent and rapid antibacterial activity of nanocrystalline silver as shown by Wright J et al., Yin H et al., Voight D et al.,⁶⁸⁻⁷⁰.

The most common mode of wound closure in the study group was spontaneous closure, which was in concordance with Lee PY et al⁷¹. The silver ions promote a faster wound contraction due to accelerated proliferation and differentiation of fibroblasts into myofibroblasts⁷². This was followed by Split Thickness Skin Graft. The failure rates were low in the study group as only in 2 patient wounds did not close and only 1 patient underwent below knee amputation. However, failure rates were high in control group with wound not getting closed in 8 patients and 3 patients undergoing below knee amputation.

It was observed that in study group 10 patients out of 15 (66.7%) were complete responders as compared to 5 (33.3%) patients in control group which was in concordance with the study of Wright JB et al.,⁷³. Sharma R et al., recorded a higher percentage of complete responders (84.6%) which could be attributed to the longer duration of treatment in their study (12 weeks), however they also supported the fact that nanocrystalline silver ions accelerate healing of wounds⁷⁴. The percentage decrease in wound area after 8 weeks of dressing in the study and control group was 83.42% and 66.66% which was comparable to the results of Sharma et al., (85.63% and 68.63% respectively)

An ionized nano-crystalline silver dressing was evaluated through an uncontrolled, prospective study 98 patients with a variety of diabetic wounds. Out of 98 study participant, 47 were aged <50years of age i.e 46.70% (including both NCS and NS Group) among them 23(46.94%) were NCS group and 24 (48.98%) were normal saline group and 51 were aged >50 years i.e 53.30%. chi square test applied for both the group with p value of 0.009 which is statistically significant in both the age group.

Out of 98 study group, 28 were female in which 11(22.45%) belonging to NCS group and 17(34.69%) were NS Group. And 60 were male in which 28(57.14%) belonging to NCS group and 32(65.31%) were NS group. Chi square test was applied to both the group with p value <0.001 which is statistically significant. out of 98 total 73 cases (74.49%) reported mild pain in which 36(73.47%) were NCS group and 37(75.51%) NS group. And 26 reported moderate pain (53.06%) in which 13(26.53%) were NCS and 12(24.49%) NS dressing, chi square test applied to both the group with p value of 0.874 which is statistically not significant. Adequate analgesia provided in both groups during the study.

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out of 49 patients in NCS group mean age group of patients was 55.75 ±10 and with NS group mean age group 53.17±9.3

Duration of diabetes in years 10.92(mean value) with \pm 5.4 in NCS group and mean value of 11.15 ± 3.7 in normal saline group.

HbA1C level 8.72 ± 2.2 in NCS group and 8.66 ± 0.31 in NS group.

Duration of ulcer was 14.85 ± 7.6 months in NCS group and 12.103 ± 8.3 months in NS group.

Independent t test, Sig. 2 tailed, $p < 0.05$. There is statistically significant difference between the granulation tissues formation rate between the Nanocrystalline Silver Dressing and Normal Saline. The Size of the baseline wound is one of the important variables for the rate of healing. For the ulcers $< 40 \text{cm}^2$, the difference of rate of healing was not significant, while for $\geq 40 \text{cm}^2$, the rate of healing among Nanocrystalline Silver Dressing was significantly higher ($6.21 \text{cm}^2/\text{day}$) as compared to normal saline ($4.20 \text{cm}^2/\text{day}$). ($p < 0.001$).

Estimated Mean time to complete cure of ulcer was lower in Nanocrystalline Silver Dressing (37.06 days) as compared to the Normal Saline (43.25 days). Complete responders are the patient whose wounds get closed spontaneously or the wound healthy granulation tissue and was able to be grafted or secondarily sutured or until completion of the 56 days which ever was earlier. On responders' patients has been treated with alternative method such as foam therapy and vac therapy as mentioned earlier.

The results showed a marked clinical improvement for the majority of wounds treated with the dressing⁶³ Previous study found that the use of silver foam dressings resulted in a greater reduction in wound size and more effective control of leakage and odor than did use of non-silver dressings. Another study concluded that infected diabetic foot ulcer could benefit from the antibacterial

effectiveness of silver nano crystalline. Our results were also consistent to those previous studies.

Conclusion

Diabetic foot ulcers are very common in India sub continental. Various dressing material, disinfectant solutions are used. we conducted prospective study in ESIC MC and PGIMS Bangalore with 98 patients belonging to Wagner grade I and II diabetic foot ulcer. Wound assessment done at regular intervals and various wound outcome variables were compared. In

a study of 98 patients, most patients were in mean age group of 55.75 years. There was rapid decrease in wound size in silver group compared to normal saline group at 2nd week and earlier appearance of granulation and epithelialization in nano crystalline group. There was shorter duration of hospital stay, earlier wound disinfection and a greater number of patients who underwent skin grafting in nano crystalline silver dressing group. The results were statistically significant and in favor of nano crystalline.

With above mentioned results authors would like to conclude that nano crystalline silver dressing is effective, safe for management of Diabetic foot ulcers of Wagner grade I and Grade II with good patient compliance.

In patients treated with nano crystalline silver dressing, comparatively we found that there was:

1. Decrease wound discharge
2. Earlier appearance of granulation tissue
3. Rapid decrease in wound size
4. Early wound disinfection
5. Shorter duration of hospitalization

This study confirms that nano crystalline with its antibacterial effects and moistening effects and is safe, non-irritant and has faster response in wound healing and gives better efficacy as compared to traditional normal

saline dressing for use as a topical application in wound care in management of diabetic foot ulcers.

Hence it is a good choice for management of diabetic ulcer

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