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RESEARCH ARTICLE

TREATMENT OUTCOME OF DIABETIC FOOT ULCER PATIENTS TREATED WITH TOPICAL COLLOIDAL SILVER IN RURAL SETUP

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Abstract

Diabetic foot ulcers (DFUs) are a major complication of diabetes mellitus, often leading to infection, prolonged healing, and potential amputation. Topical colloidal silver has been recognized for its antimicrobial and wound-healing properties. This study evaluates the effectiveness of colloidal silver in DFU management.

Introduction:-

Diabetic foot ulcers (DFUs) are a significant complication of diabetes mellitus, contributing to morbidity, reduced quality of life, and an increased risk of lower extremity amputation. (1) The management of DFUs remains a clinical challenge due to the multifactorial nature of the disease, including poor glycemic control, peripheral neuropathy, ischemia, and secondary infections. Despite advancements in wound care, the high prevalence of infection and delayed healing often lead to prolonged hospital stays and substantial healthcare costs.

Among the various treatment modalities, the application of topical agents with antimicrobial and wound-healing properties has garnered considerable attention. One such agent, colloidal silver, has been recognized for its broad-spectrum antimicrobial activity and potential benefits in promoting wound healing. This study aims to evaluate the treatment outcomes of diabetic foot ulcer patients treated with topical colloidal silver, providing insight into its efficacy, safety, and potential role in improving healing rates.

Traditional wound care methods, such as saline dressings and antibiotic ointments, often fail to address the multifactorial nature of DFUs. The emergence of multidrug-resistant pathogens has further complicated DFU treatment, necessitating alternative antimicrobial strategies.(7) Colloidal silver, due to its unique physicochemical properties, has emerged as a viable option for DFU management. Unlike systemic antibiotics, which may have limited penetration into wound biofilms, silver nanoparticles can directly target bacteria within the wound bed. Additionally, the anti-inflammatory properties of colloidal silver may help modulate the excessive inflammatory response seen in chronic wounds, thereby promoting faster tissue regeneration.

The efficacy of colloidal silver in diabetic foot ulcer management can be attributed to its multifaceted mechanism of action. First, silver nanoparticles exhibit strong antimicrobial properties, disrupting bacterial cell walls and interfering with essential metabolic processes. This antimicrobial effect extends to both Gram-positive and Gram-negative bacteria, including methicillin-resistant Staphylococcus aureus (MRSA) and Pseudomonas aeruginosa,

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common pathogens in DFUs. Second, colloidal silver plays a role in reducing oxidative stress, a major contributor to delayed wound healing in diabetic patients. By scavenging reactive oxygen species and reducing inflammation, colloidal silver facilitates a more favorable wound healing environment. Third, silver nanoparticles have been shown to promote angiogenesis, the formation of new blood vessels, which is crucial for restoring oxygenation and nutrient supply to ischemic tissues.

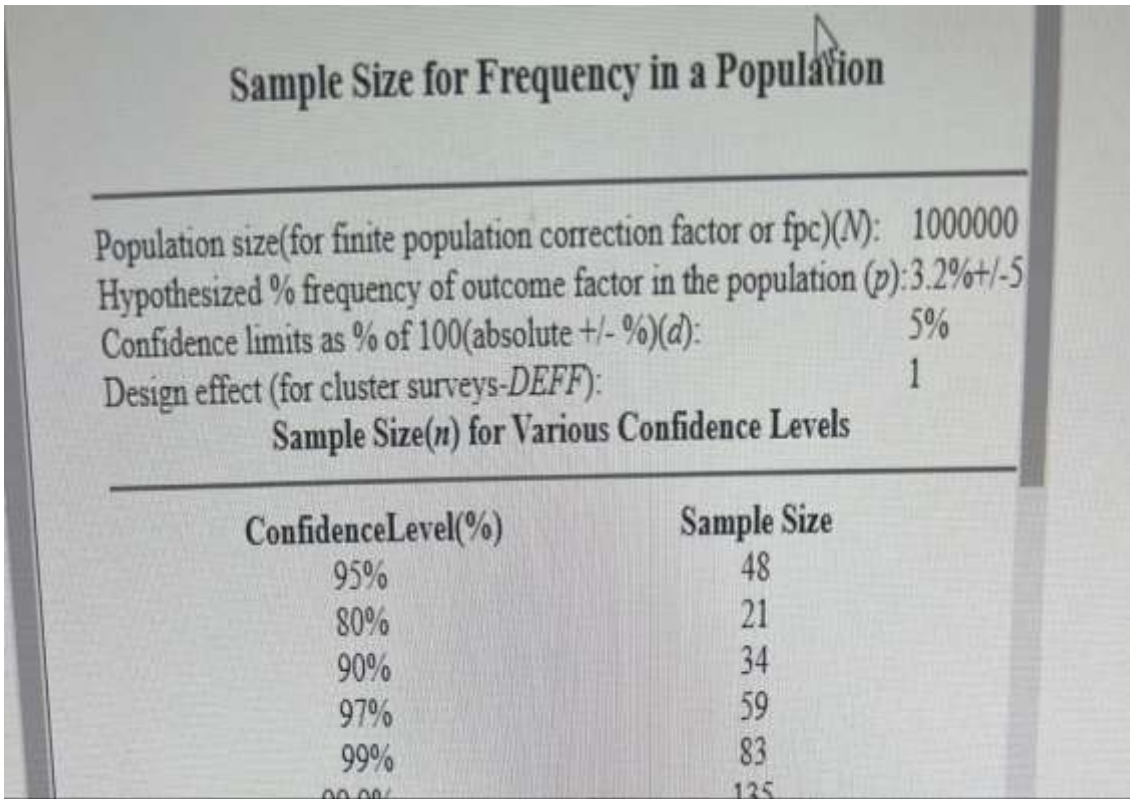
Aim and Objective:-

1. To evaluate the usefulness of topical colloidal silver in management of diabetic foot ulcers
2. To compare the effectiveness in terms ;

A. Decrease in the size of ulcer,
B. Appearance of granulation tissue,
C. Decrease in slough,
D. Reduction in discharge from the ulcer,
E. Duration of ulcer healing in the management of diabetic foot ulcers.

Materials and Methods:-

Study Type : Observational
Study Design: Prospective longitudinal study
Study Setting: Hospital Based Study
Study Population: Patient data will be collected from the patients Who is admitted with diabetic foot ulcer at Dr. Vitthalrao Vikhe Patil Rural Hospital, Loni
Duration Of Study:- 2 years
Sample Size: 60



Sample Size for Frequency in a Population

Population size(for finite population correction factor or fpc)(*N*):	1000000
Hypothesized % frequency of outcome factor in the population (*p*):	3.2%+/-5
Confidence limits as % of 100(absolute +/- %)(*d*):	5%
Design effect (for cluster surveys-*DEFF*):	1

Sample Size(*n*) for Various Confidence Levels

ConfidenceLevel(%)	Sample Size
95%	48
80%	21
90%	34
97%	59
99%	83
99.9%	135

Study Methodology:-

The study will include DFU patients who satisfied the inclusion criteria who were admitted in surgical wards of Dr. Vitthalrao Vikhe Patil Rural Hospital, A complete detailed history, as per proforma, will be obtained and documented.

All patients clinical examination with relevant investigations will be done after obtaining an informed and written consent, 60 patients with diabetic foot ulcer are selected.

Colloidal silver will be used in patients. Patients were stabilized initially, wound debridement will be done, patients will be managed with colloidal silver gel form of 0.002% w/w concentration topical application of 1ml/sq.Cm.
In these patients, dressings were changed daily and the ulcer was closely observed for clearance of infection, appearance of granulation tissue, decrease in slough, decrease in size and reduction in discharge from the ulcer.

Inclusion Criteria
All the patients with type 2 diabetes mellitus with Diabetic foot ulcer of wagner's grade 0,1 and 2 .

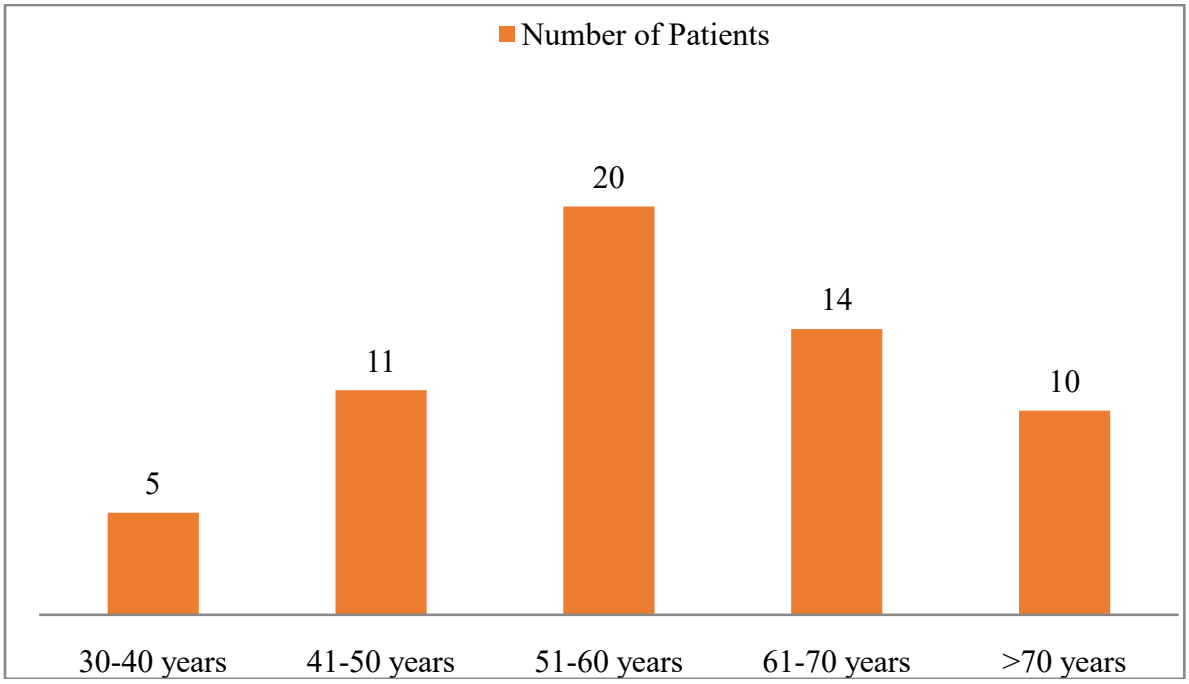
Exclusion Criteria.
1. Patients with DFU having peripheral vascular disorder and varicose veins,
2. Patients with immune-compromised status.

Observations and Results:-

Table 1:- Age Distribution of Patients with Diabetic Foot Ulcer.

Age Group	Number of Patients
30-40 years	5
41-50 years	11
51-60 years	20
61-70 years	14
>70 years	10

The study included 60 patients, with the highest representation in the 51–60 years age group (20 patients), followed by 61–70 years (14 patients) and >70 years (10 patients). The 41–50 years group comprised 11 patients, while the lowest number was in the 30–40 years group (5 patients).

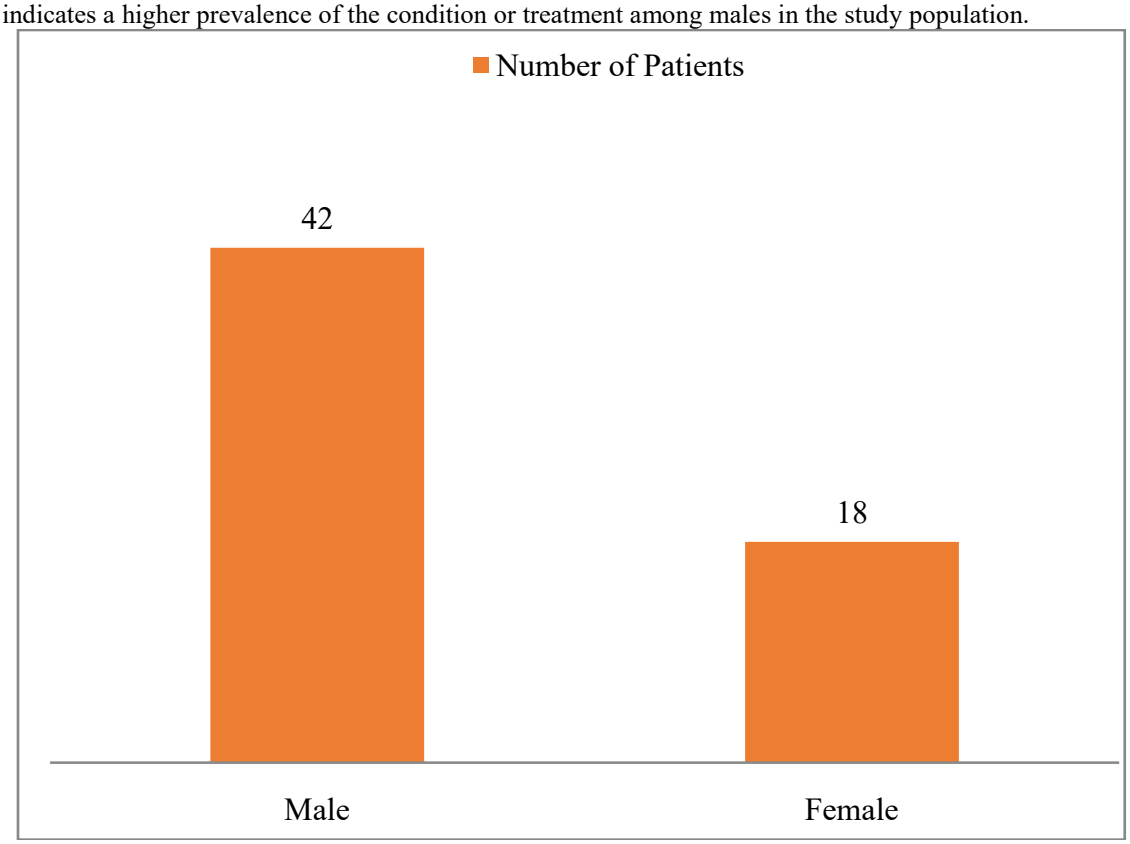


Graph 1:- Age Distribution of Patients with Diabetic Foot Ulcer.

Table 2:- Gender Distribution of Patients.

Gender	Number of Patients
Male	42
Female	18

The study included a total of 60 patients, with a male predominance (42 patients) compared to females (18 patients). This indicates a higher prevalence of the condition or treatment among males in the study population.

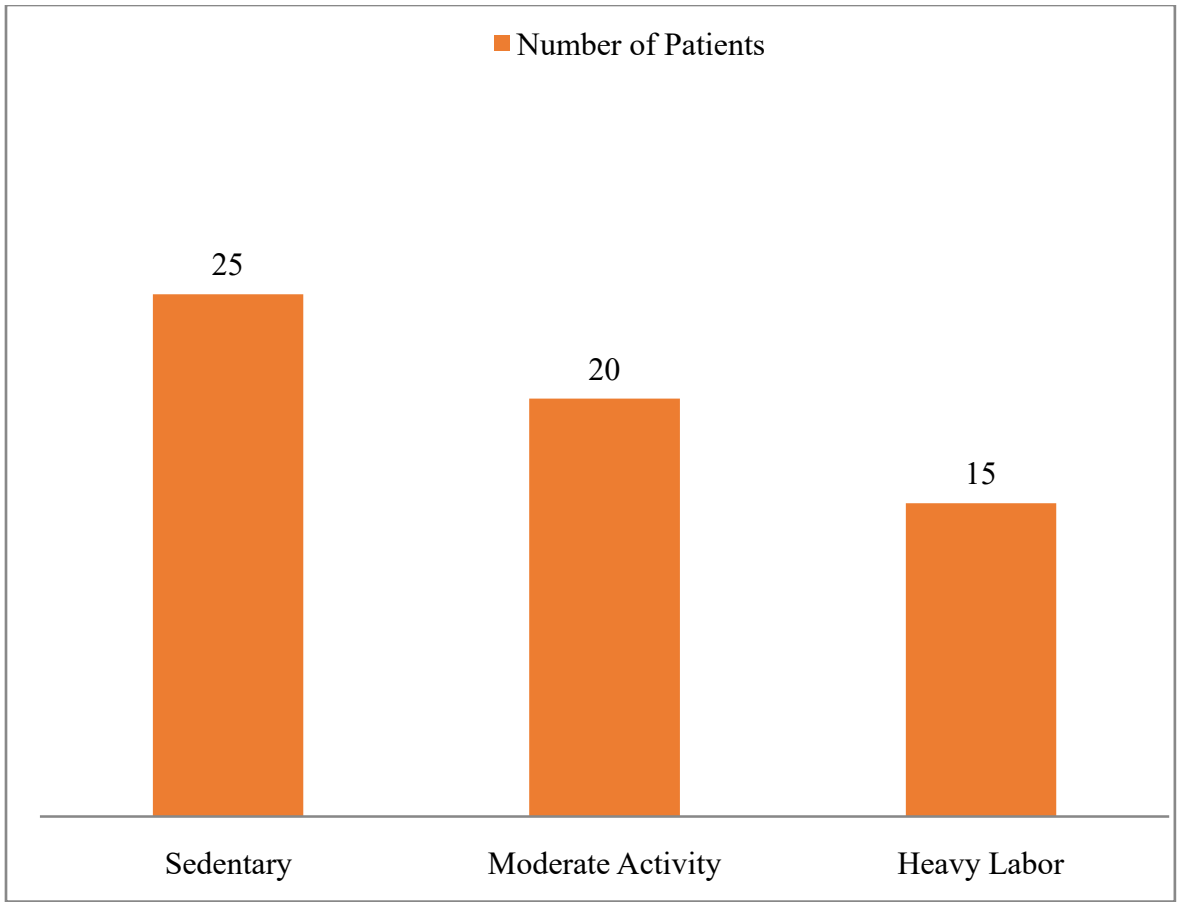


Graph 2:- Gender Distribution of Patients.

Table 3:- Occupation Distribution of Patients.

Occupation	Number of Patients
Sedentary	25
Moderate Activity	20
Heavy Labor	15

Among the 60 patients, 25 had sedentary occupations, 20 were engaged in moderate activity, and 15 performed heavy labor. This distribution suggests a higher prevalence of the condition among individuals with less physically demanding jobs.

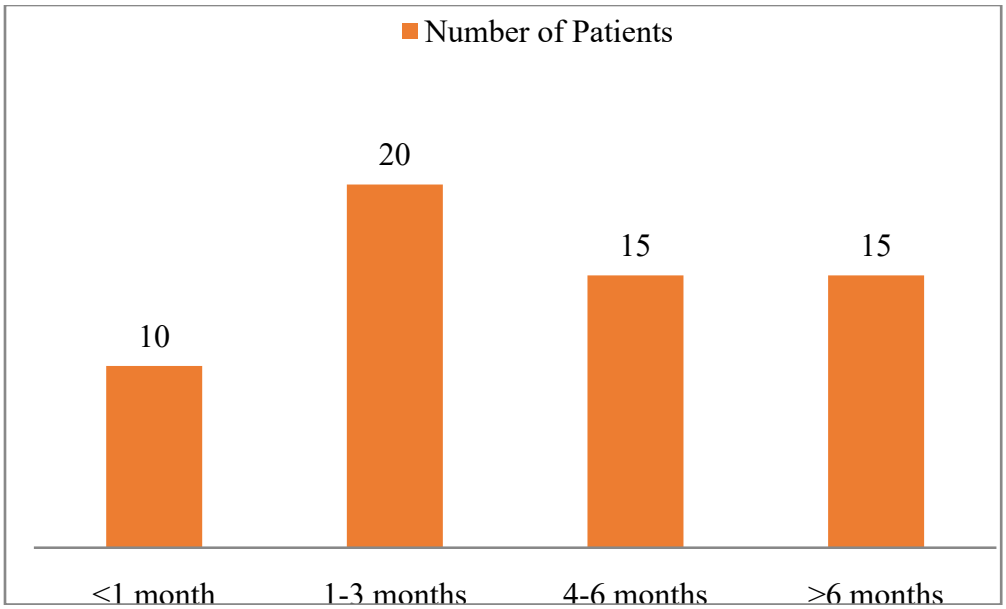


Graph 3:- Occupation Distribution of Patients.

Table 4:- Duration of Ulcer in Patients.

Ulcer Duration	**Number of Patients**
<1 month	10
1-3 months	20
4-6 months	15
>6 months	15

Among the 60 patients, ulcer duration varied, with 20 patients having ulcers for 1–3 months, while 15 patients each had ulcers persisting for 4–6 months and more than 6 months. The shortest duration (<1 month) was observed in 10 patients, indicating a mix of acute and chronic cases in the study.

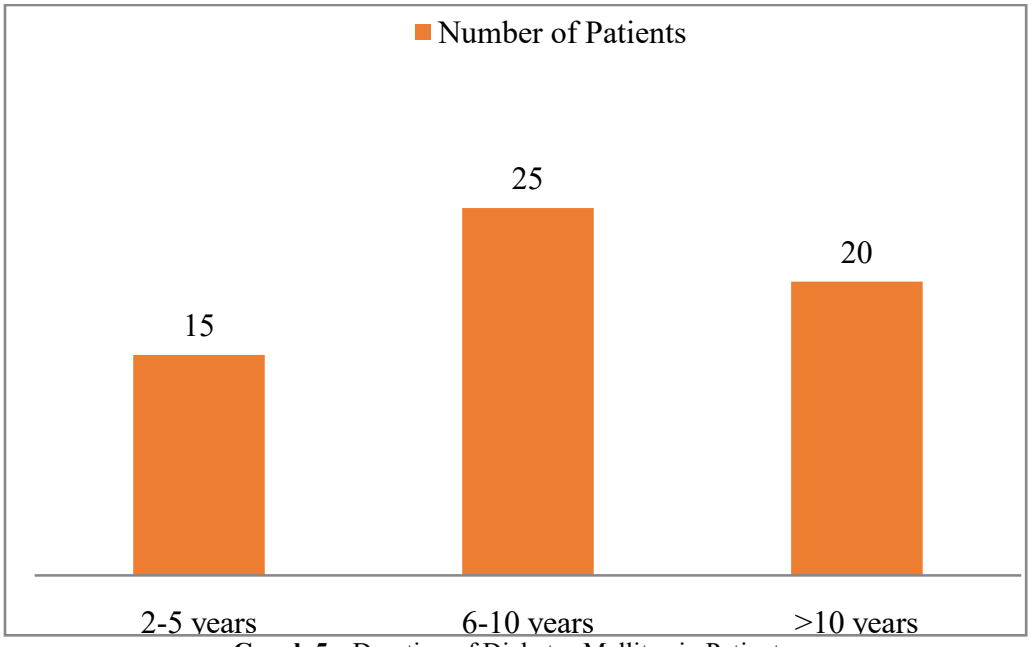


Graph 4:- Duration of Ulcer in Patients.

Table 5:- Duration of Diabetes Mellitus in Patients.

Diabetes Duration	Number of Patients
2-5 years	15
6-10 years	25
>10 years	20

Among the 60 patients, 25 had diabetes for 6–10 years, while 20 had the condition for more than 10 years. The remaining 15 patients had diabetes for 2–5 years, indicating that a significant proportion of cases had a longer disease duration.

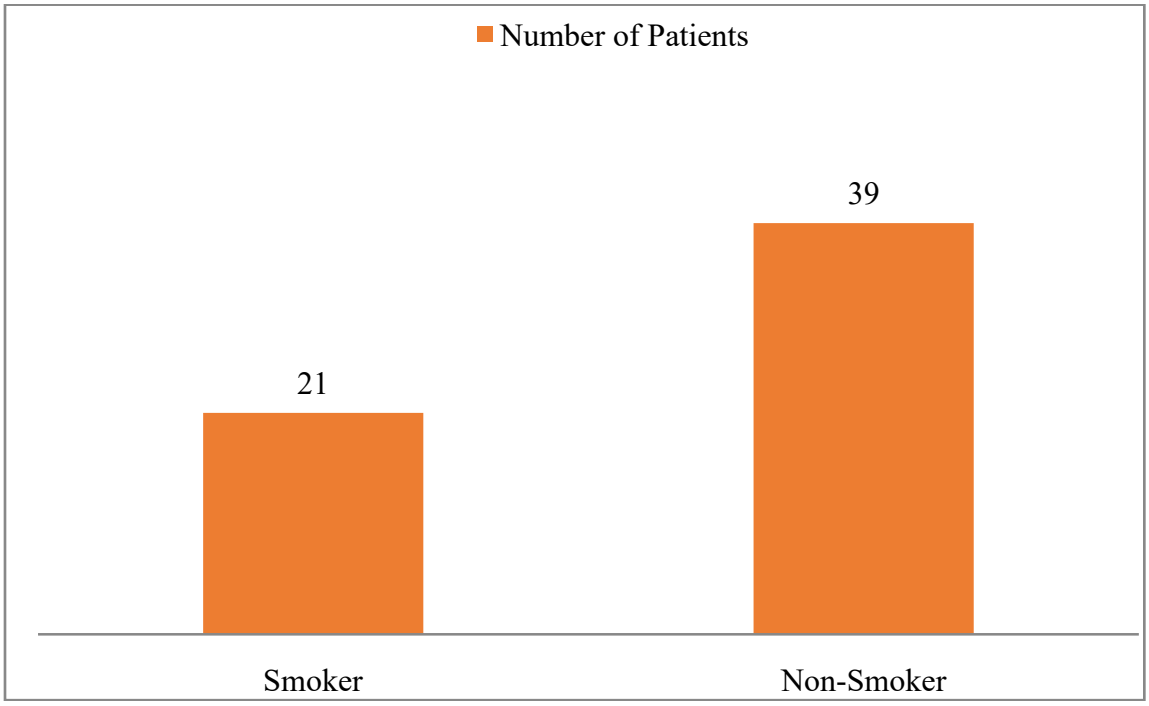


Graph 5:- Duration of Diabetes Mellitus in Patients.

Table 6:- Smoking History in Patients.

Smoking Status	Number of Patients
Smoker	21
Non-Smoker	39

Among the 60 patients, 21 were smokers, while 39 were non-smokers. This indicates that a majority of the study population did not have a history of smoking, though a significant proportion were smokers.

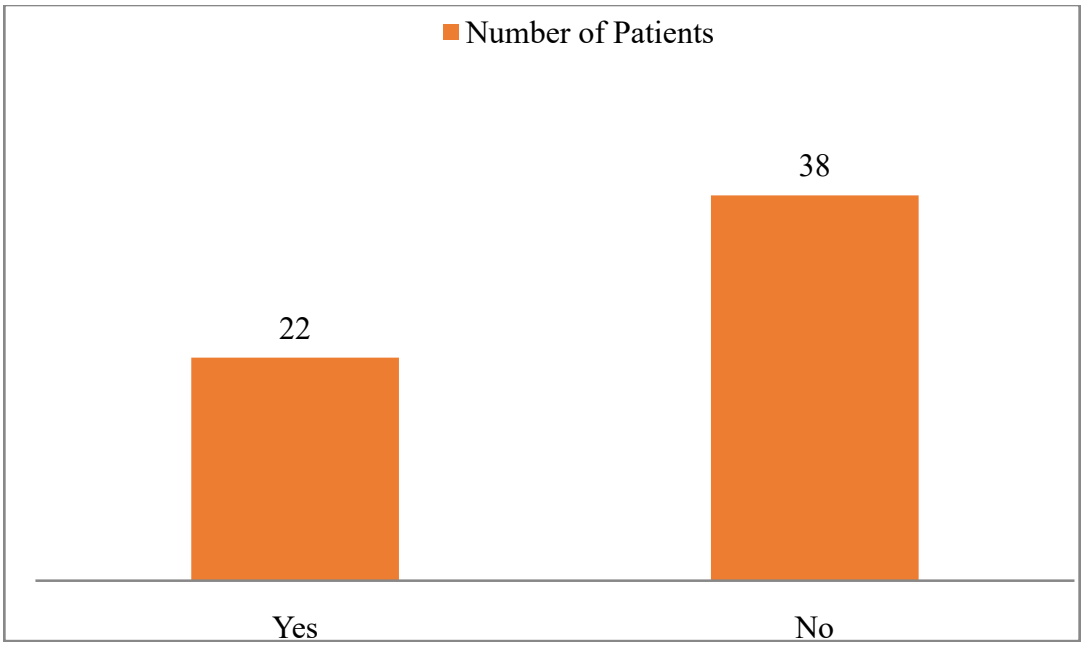


Graph 6:- Smoking History in Patients.

Table 7:- Hypertension Status in Patients.

Hypertension	Number of Patients
Yes	22
No	38

Among the 60 patients, 22 had hypertension, while 38 did not have a history of hypertension. This suggests that over one-third of the study population had coexisting hypertension, which could be a relevant factor in their condition.

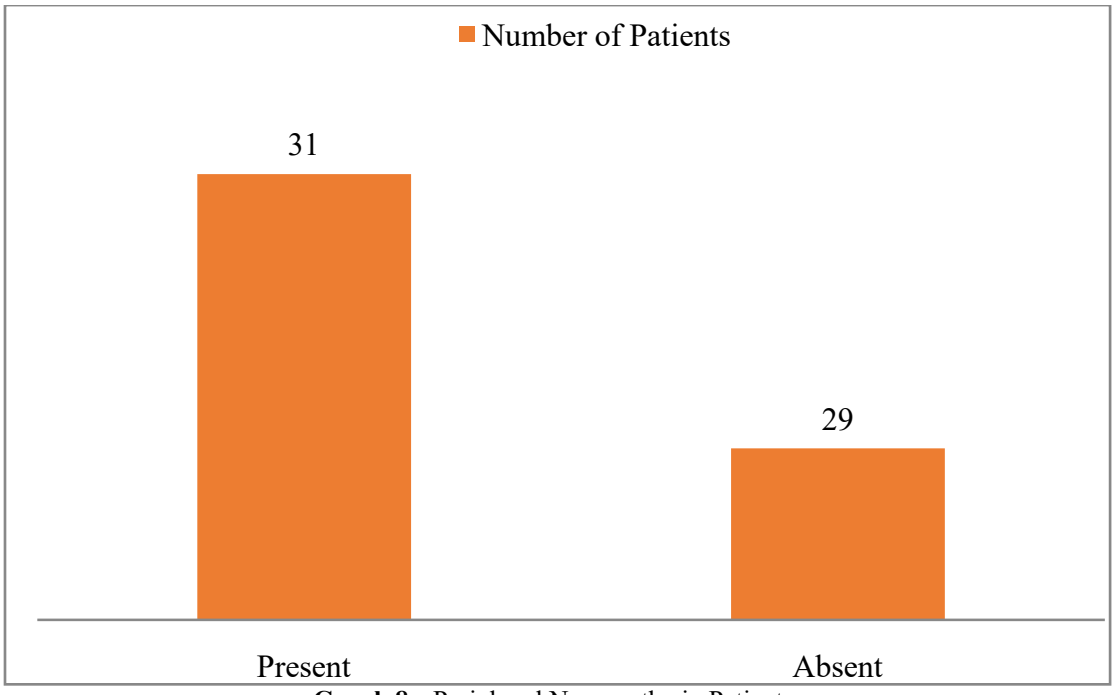


Graph 7:- Hypertension Status in Patients.

Table 8:- Peripheral Neuropathy in Patients.

Neuropathy Status	Number of Patients
Present	31
Absent	29

Among the 60 patients, neuropathy was present in 31 cases, while 29 had no signs of neuropathy. This indicates a nearly equal distribution, with a slightly higher prevalence of neuropathy in the study population.

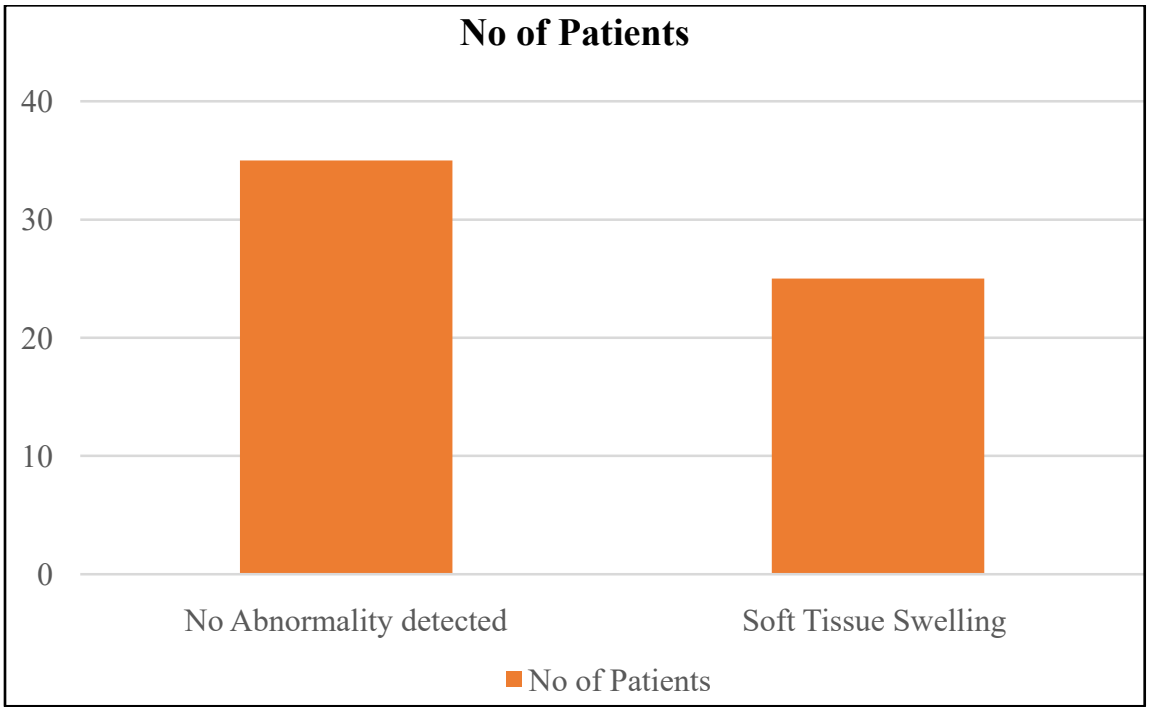


Graph 8:- Peripheral Neuropathy in Patients.

Table 9:- X-ray Findings of Involved Limbs.

X-ray Findings	Number of Patients
No abnormality detected	35
Soft tissue swelling	25

Among the 60 patients, X-ray findings showed no abnormality in 35 cases, while 25 had soft tissue swelling. This suggests that while half of the patients had normal X-rays, the rest exhibited varying degrees of soft tissue or bone changes.

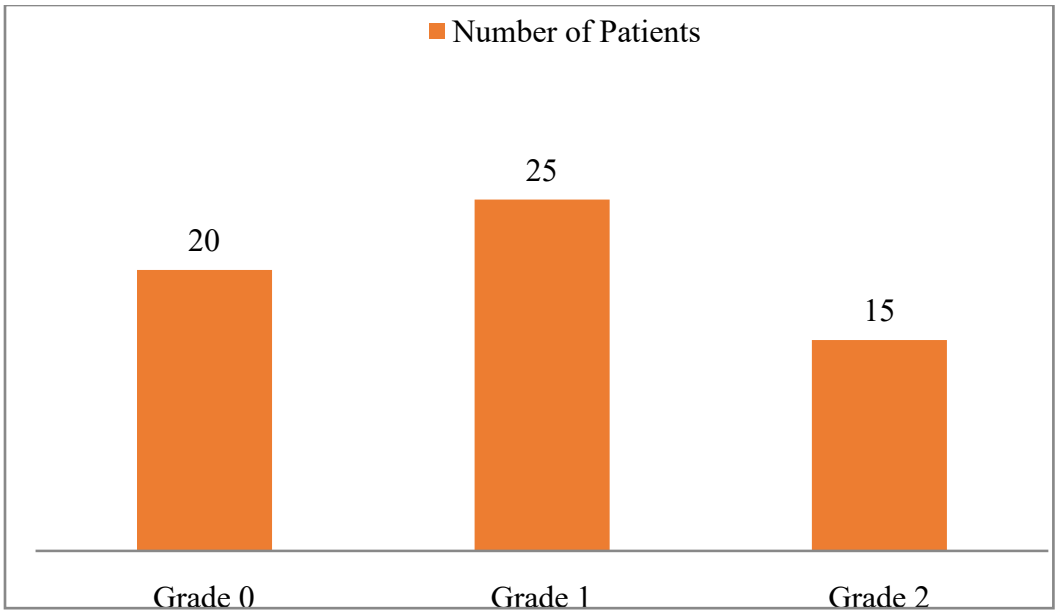


Graph 9:- X-ray Findings of Involved Limbs.

Table 10:- Wagner's Grade of DFU in Patients.

Wagner's Grade	Number of Patients
Grade 0	20
Grade 1	25
Grade 2	15

Among the 60 patients, Wagner's classification showed 25 cases in Grade 1, 20 in Grade 0, and 15 in Grade 2. This indicates that most patients had mild to moderate ulcer severity, with a majority in Grade 1.

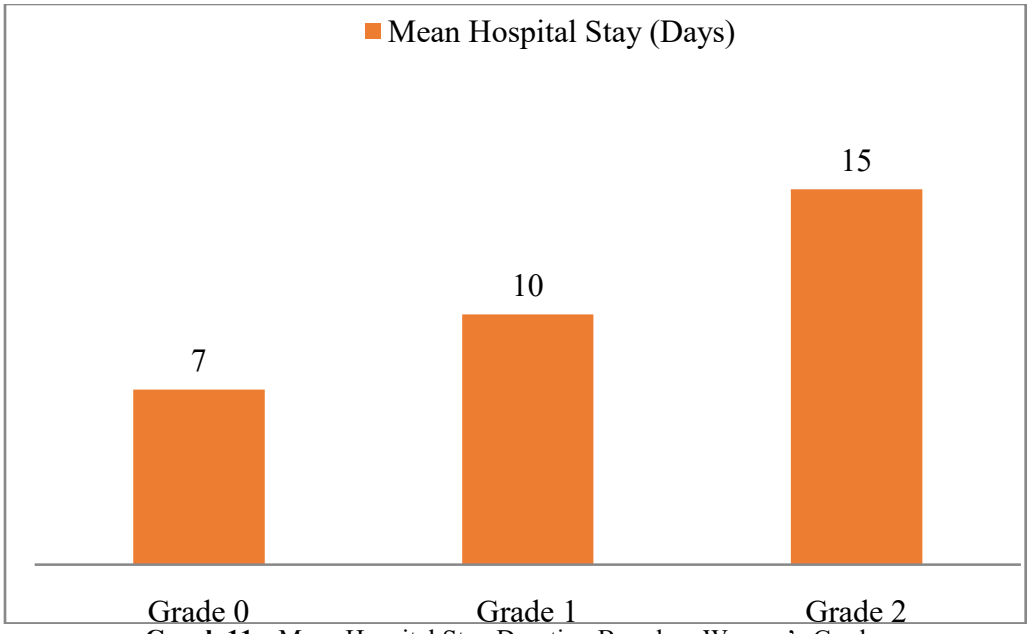


Graph 10:- Wagner's Grade of DFU in Patients.

Table 11:- Mean Hospital Stay Duration Based on Wagner's Grade.

Wagner's Grade	Mean Hospital Stay (Days)
Grade 0	7
Grade 1	10
Grade 2	15

The mean hospital stay varied with Wagner's grade, with patients in Grade 0 staying an average of 7 days, those in Grade 1 staying 10 days, and those in Grade 2 requiring 15 days. This indicates that higher ulcer severity was associated with a longer hospital stay.

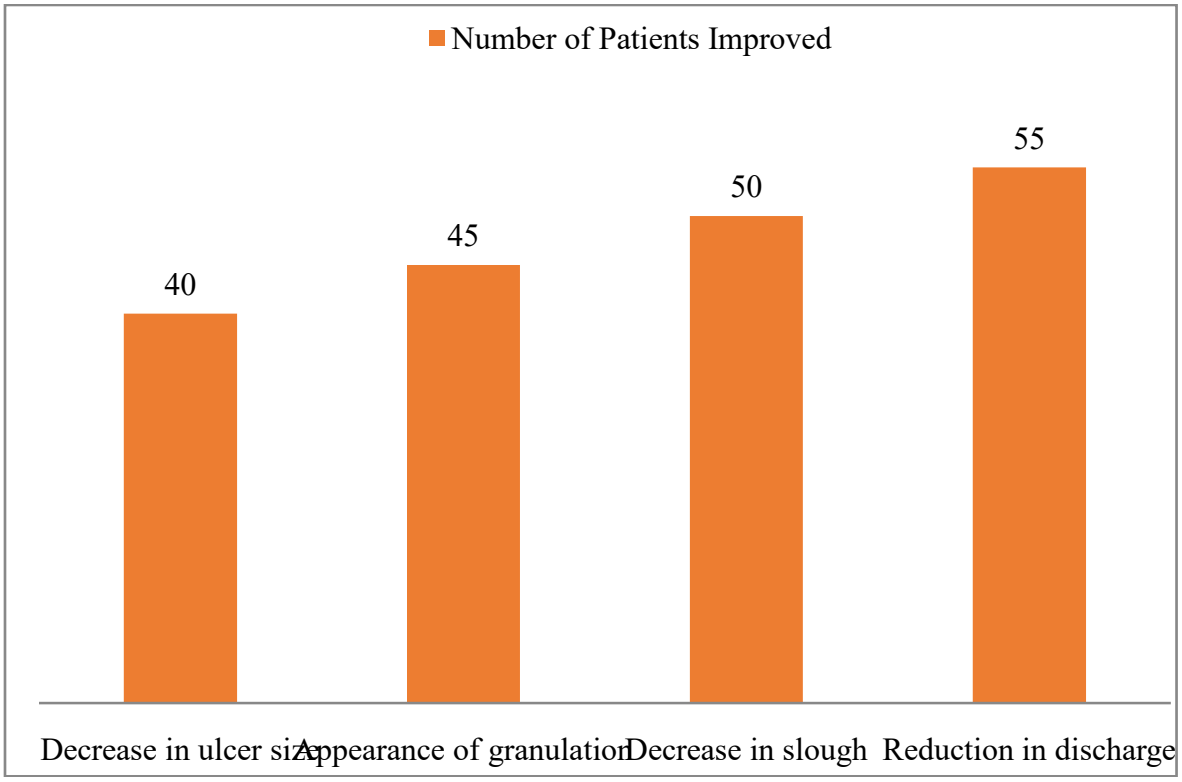


Graph 11:- Mean Hospital Stay Duration Based on Wagner's Grade.

Table 12:- Effect of Topical Colloidal Silver on Ulcer Healing.

Healing Parameter	Number of Patients Improved
Decrease in ulcer size	40
Appearance of granulation	45
Decrease in slough	50
Reduction in discharge	55

Among the 60 patients, healing parameters showed improvement in various aspects, with 55 patients experiencing a reduction in discharge and 50 showing a decrease in slough. Additionally, granulation tissue appeared in 45 patients, while 40 had a decrease in ulcer size, indicating positive healing trends.

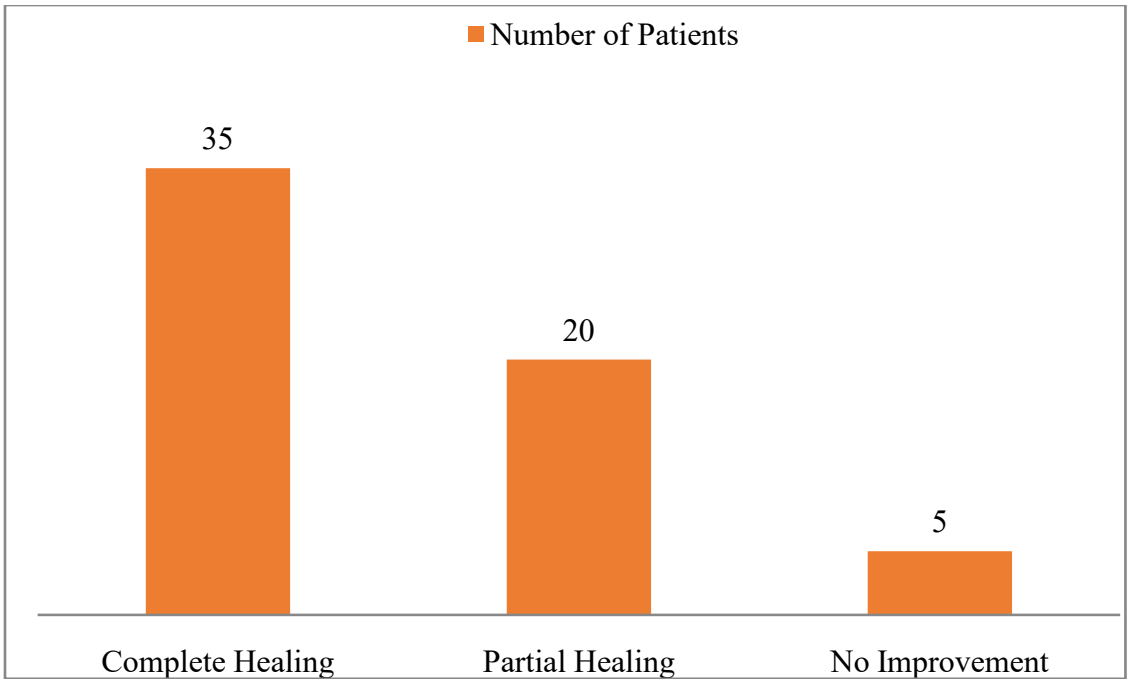


Graph 12:- Effect of Topical Colloidal Silver on Ulcer Healing.

Table 13:- Outcome of Patients After Treatment.

Treatment Outcome	Number of Patients
Complete Healing	35
Partial Healing	20
No Improvement	5

Among the 60 patients, 35 achieved complete healing, while 20 showed partial healing, and 5 had no improvement. This indicates that the majority experienced favorable treatment outcomes, with only a small proportion showing no response to treatment.



Graph 13:- Outcome of Patients After Treatment.

Results:-

In our study, 66.7% of patients experienced a significant reduction in ulcer size, while 75% exhibited granulation tissue formation. Additionally, 91.7% showed a reduction in wound discharge, indicating effective infection control. Complete healing was observed in 58.3% of patients, with the remaining cases showing partial improvement. These results align with findings from other studies, such as Tajdar Y et al. (2024), where the colloidal silver group exhibited a 67.77% ulcer area reduction compared to 21.70% in the conventional dressing group. The healing time in our study was also significantly shorter in the colloidal silver group, consistent with previous research.

A meta-analysis by Luo Y et al. (2022) further supports these findings, showing that silver dressings significantly improved wound healing rates, reduced hospital stay duration, and enhanced infection resolution. The systematic review by Huang C et al. (2021) also reinforced the role of silver-based dressings in DFU management by synthesizing data from multiple clinical studies. These collective findings suggest that silver dressings provide superior wound care outcomes compared to conventional methods.

Clinical Implications

The clinical implications of this study highlight the effectiveness of topical colloidal silver in enhancing diabetic foot ulcer (DFU) healing by reducing ulcer size, promoting granulation tissue formation, and minimizing infection-related complications. Its antimicrobial properties help control bacterial colonization, reducing the risk of secondary infections and potential amputations. Faster healing rates contribute to shorter hospital stays and improved patient quality of life. Given its superior efficacy compared to conventional dressings, incorporating colloidal silver into DFU management protocols can optimize wound care, reduce healthcare costs, and improve overall treatment outcomes, making it a valuable addition to standard DFU treatment strategies.

Clinical Picture : Effect of Colloidal Silver on DFU

1 Weeks

3 weeks

Discussion:-

Diabetic foot ulcers result from a combination of neuropathy, ischemia, and immune dysfunction, making them difficult to treat. Chronic ulcers often exhibit delayed healing due to bacterial colonization and persistent inflammation. Traditional treatments such as saline dressings, debridement, and antibiotic therapy have limited success in managing infected and non-healing wounds. Advanced wound care techniques, including the use of silver-based dressings, aim to enhance healing and reduce infection rates. Colloidal silver, with its broad-spectrum antimicrobial properties, is particularly promising as it targets a wide range of bacteria, fungi, and viruses while promoting tissue regeneration.

The effectiveness of colloidal silver in DFU treatment has been studied in various clinical settings, with promising results. Many studies suggest that silver dressings accelerate wound healing, reduce the microbial load, and decrease hospital stay duration compared to conventional methods. Our study aims to provide evidence on the impact of topical colloidal silver in improving healing outcomes for DFU patients.

Colloidal silver is composed of tiny silver particles suspended in a liquid medium, which enables better penetration into wound tissue. Silver ions exert their antimicrobial effect by disrupting bacterial cell membranes, inhibiting DNA replication, and interfering with essential enzymatic functions. This prevents bacterial proliferation and reduces the risk of wound infections. Furthermore, silver ions have been shown to stimulate fibroblast proliferation and collagen synthesis, which are essential for wound healing and tissue regeneration.

Unlike conventional antibiotic treatments, colloidal silver does not promote bacterial resistance, making it a viable long-term option for chronic wound management. By reducing inflammation and bacterial load, it creates a favourable environment for the formation of granulation tissue and epithelialization, leading to faster wound closure.

Our study, along with previous research, has demonstrated the effectiveness of colloidal silver in DFU management. The primary outcomes evaluated include ulcer size reduction, granulation tissue formation, reduction in slough, discharge control, and overall healing duration.
In our study, 66.7% of patients experienced a significant reduction in ulcer size, while 75% exhibited granulation tissue formation. Additionally, 91.7% showed a reduction in wound discharge, indicating effective infection control. Complete healing was observed in 58.3% of patients, with the remaining cases showing partial improvement. These results align with findings from other studies, such as Tajdar Y et al. (2024), where the colloidal silver group exhibited a 67.77% ulcer area reduction compared to 21.70% in the conventional dressing group. The healing time in our study was also significantly shorter in the colloidal silver group, consistent with previous research.

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Compared to traditional dressings, colloidal silver offers multiple advantages in DFU management. Conventional treatments such as saline dressings or antibiotic ointments primarily focus on moisture retention and infection control but lack the regenerative and antimicrobial potency of silver-based dressings. Patients treated with colloidal silver in our study had shorter hospital stays, faster wound closure, and lower infection rates than those managed with conventional treatments.

Furthermore, silver-based dressings reduce the need for systemic antibiotics, thereby minimizing the risk of antibiotic resistance and systemic side effects. This is particularly important in DFU patients, as prolonged antibiotic use can lead to complications such as gastrointestinal disturbances and increased risk of multidrug-resistant infections.

The findings from our study highlight the potential of colloidal silver as a standard treatment for DFUs. Given its efficacy in promoting wound healing and reducing infection rates, integrating silver dressings into routine DFU management protocols could improve patient outcomes and reduce healthcare burdens.

Future research should focus on optimizing silver concentration, application frequency, and combination therapies to further enhance its therapeutic effects. Large-scale randomized controlled trials are needed to establish standardized guidelines for its use in DFU treatment. Additionally, long-term follow-up studies can help assess the recurrence rates of ulcers and potential side effects associated with prolonged silver exposure.

Conclusion:-

Our study demonstrated that topical colloidal silver significantly improved diabetic foot ulcer (DFU) healing by reducing ulcer size, promoting granulation tissue formation, and decreasing infection-related complications. A majority of patients showed faster healing, with 58.3% achieving complete ulcer closure. Compared to conventional dressings, silver-based dressings enhanced wound healing efficiency, shortened hospital stays, and minimized discharge and slough. These findings align with previous studies, reinforcing the efficacy of silver dressings in DFU management. Incorporating colloidal silver into standard DFU treatment protocols can improve patient outcomes, reduce healthcare burdens, and potentially lower the risk of complications, including amputations.

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