Effect of Chlorhexidine Solution on Reducing Pin Site Infection among Patient with External Fixation

Walaa Ali Abed-El gawad Ali (1), Inshrah Roshdy Mohammed (2), Hend Elham Mohammed (3), Eman Fadl Abd El khalik (4).

1. Demonstrator of Medical-Surgical Nursing, Faculty of Nursing - Minia University.
2. Professor of Medical Surgical Nursing, Faculty of Nursing – Minia University.
3. Assistant Professor of Medical-Surgical Nursing, Faculty of Nursing - Minia University
4. Assistant Professor of Medical-Surgical Nursing, Faculty of Nursing - Minia University

Abstract

Background: Pin site infections are a common complication of external fixation that places a significant burden on the patient and healthcare system. **The aim of the study:** this study aimed to evaluate the effect of using chlorhexidine solution on reducing pin site infection among patient with external fixation. **Research design**: Quasi experimental research design was utilized to fulfill the purpose of this study. **Subjects**: Purposive sample composed of sixty (30 study and 30 control) male& female patients **Setting**: The current study was carried out in Orthopedic department, **Tools**: Three tools were utilized to collect data, **The first tool**: Structured interview Scio demographic and medical data questionnaire. **The second tool**: Grading of pin site infection. **The third tool:** Bacterial wound investigation sheet. **Results**:, It was the same percentage between studied sample regard overall score of infection criteria in two weeks, but control subjects have a progressive increase at 6th week reaching 90% among them were had pin site infection criteria while the study subjects recorded that only a 17%. In the same weeks There are no statistical significance difference between studied sample regard infection criteria at 3rd and 4th week while there highly statistical significance difference between them at 5th and 6th week P value= < 0.05. **Conclusion**: The study findings concluded that sterile dressing and using of chlorhexidine as alternative cleansing agent among study group who underwent external fixation was a positive effect on pin-site infections as compared to the control group. **Recommendation**: Hospitals should recommend using chlorhexidine solution as a cleansing agent for patients who underwent external fixation. Periodic training and educational programs about using chlorhexidine solution during dressing for prevention of pin site infection should be developed for the health team members especially the nursing staff.

Key Words: , Chlorhexidine. External Fixation,:, Infection and Pin site

Introduction

A bone fracture is a medical condition in which there is a partial or complete break in the continuity of the bone. The bone may fracture into many fragments in more severe circumstances. A pathologic fracture is one that results from a medical condition that weakens the bones, such as osteoporosis, osteopenia, bone cancer, or osteogenesis imperfecta, rather than from a high force impact or stress injury **(Burr et al., 2019)**

There are many alternatives for treating fractures, including medicinal intervention (closed reduction), surgical intervention (open reduction), and joint replacement on a partial or whole basis. Different levels of pain brought on by muscular spasms are felt by patients with fractures **(DeWit et al., 2016; Lazevnick, 2018)** Fractures fixation has two major types "external and internal". An external fixator is a metallic device made of metal pins that are inserted into the bone and connected to external rods that stabilize the fracture as it heals. External fixation is indicated in simple fractures, complex fractures with extensive soft tissue damage, the correction of congenital bony defects, nonunion or mal-union, and limb lengthening **(Korobeinikov et al., 2019).**

External fixation is a technique used to manage musculoskeletal conditions such as complex fractures or limb deformity. External fixator devices are applied using a surgical procedure whereby pins and/or wires are inserted through the skin into the bone. The pins and wires are then secured using a system of clamps, connectors or circular rings to create a scaffold system. The sites where the pins or wires enter the skin are commonly referred to as pin sites) (**Tarkin et al., 2022).**

Treatment for orthopedic conditions such osteomyelitis, limb deformity, and high-energy injuries frequently involves the use of Ilizarov external fixation technology. Patients typically receive treatment with an external fixator for six to eighteen months or longer. However, postoperative symptoms may appear throughout the healing phase as pin-site infection has become one of the most prevalent, with a range of 0.5% to 100 **(Guo et al., 2020).**

The burden of pin site infections, a common side effect of external fixation, on patients and the healthcare system is significant because they call for more clinic visits throughout a patient's course of therapy, may require additional care like antibiotics and surgery, and most importantly, may compromise patient outcomes should osteomyelitis or instability arise from pin loosening **(Kazmers et al., 2016).**

Even though pin site infections are a complication, they can nevertheless have serious consequences that could jeopardize the treatment's objectives and raise patient morbidity. These include frame instability, pin loosening (with loss of fixation), loss of alignment, etc. Osteomyelitis, infection of the joint or fracture site, and worsening pain that restricts patient function **(Laubscher et al., 2022).**

Pin-tract infections could be managed by different methods of pin site care that have been described as dry dressing changes, pin cleansing with spirit, hydrogen peroxide or saline solution. Steps of pin site care include: obtaining

specimen for culture and sensitivity, increasing frequency of local cleansing, protecting pin with dressing and starting oral antibiotics, changing antibiotics to intravenous antibiotics then removing the pin **(Kortor et al., 2021)**.

The role of the orthopedic nurse specialist includes identifying patients' concerns and responding to their expectations about care. The nurse specialist is able to expertly support patients through a period of change and adjustment, helping reduce the risk that they will not accept the frame and/or not adhere to treatment. Actively involving patients in care planning and evaluation contributes to a holistic, patient-centered approach where care is individualized **(Coventry et al., 2017).**

Nurses play an important role for patients undergoing external fixator application. Preoperatively; the nurse should carefully assess the patients' condition, diagnostic test results should be reviewed the night before surgery, prepare skin under aseptic condition, remove hair around the operative site and administer preoperative medication as prescribed **(Sayed et al., 2019)**

Postoperatively; the nurses do routine postoperative care in addition to specific care to the affected side. Which include; observing vital signs, administering postoperative medications as ordered, elevating the limb, inspecting pin site for signs and symptoms of infection and provide care for wound. Before discharge; the nurses educate patients about signs and symptoms of infection, restrictions needed to protect the affected limb, pin site care, activity of daily living, medications and follow up visits **(Sayed et al., 2019)**

The nurse notifies the physician if signs of infection are present or if the pins or clamps seem loose. The nurse encourages isometric and active exercises as tolerated. When the swelling subsides, the nurse helps the patient become mobile within the prescribed weight-bearing limits (non–weight bearing to full weight bearing). Adherence to weight-bearing instructions minimizes the chance of loosening of the pins when stress is applied to the bone–pin interface (**Artuso et al., 2019**).

Significance of the study

Pin site infection is a prevalent complication associated with external skeletal fixation devices, but its reported incidence varies widely **(Iliadis, et al., 2022).** With better wound care, most pin site infections can be properly treated, but if they are not, they can spread to deeper tissues and cause treatment failure owing to fixation loosening or osteomyelitis **(Bue, Bjarnason, Rölfing, Larsen, & Petruskevicius, 2021).** Rates for pin tract infections range from 6% to 96.6%, depending on the research population, type of external fixation, and reporting procedures. Importantly, deep tissue infections or osteomyelitis may occur in 4% of patients **(Liu et al., 2021).**

Giving patients and their carers a handout outlining the pin site care regimen is an efficient strategy to reduce site pen infection, prevent it from happening in the first place, and provide high-quality care **(Kazmers, Fragomen *et al.*, 2016)**. The current study's researcher hypothesized that implementing a consistent care regimen for pin sites will decrease their infection's severity, length of stay, cost, and rising comorbidities. The nurses' failure to follow a pin site care protocol while performing pin site dressing may have contributed to the high rate of patients with external fixes or trends who had pin site infections, according to the researchers' extensive observations in the orthopedic department.

Treatment for surgical site infections (SSIs) is becoming more expensive. It is anticipated that utilizing evidence-based tactics, almost half of SSIs can be avoided **(Ceroni et al., 2016)**.

Aim of the study

To evaluate the effect of using chlorhexidine solution on reducing pin site infection among patient with external fixation.

Research hypotheses

Pain site grading infection for study group will reduced when using of chlorhexidine solution in dressing than control group

Research Design;

Quasi experimental research design was utilized to fulfill the purpose of this study.

Subjects

Purposive sample composed of sixty patients with external fixation. Study subject will be divided by randomization equally (n = 30) as study and control groups, and will be selected according to certain inclusive and exclusive criteria. The sample size was selected according to the following equation **(Gravetter et al., 2020).**

Description:

N = required sample size

t = confidence level at 95 % (standard value of 1.960)

p = estimated prevalence of orthopedic department at Minia University Hospital 2018 (0.04)

m = margin of error at 5 % (standard value of 0.050)

$$\mathbf{N} = \frac{t^2 \times p(1-p)}{m^2}$$

$$\mathbf{N} = \frac{(1.96)^2 \times 0.04(1-0.04)}{0.05^2} \quad \mathbf{N = 59}$$

Inclusion criteria:

1- Adult patient who participate in the study
2- post-operative patient with external fixation
3- Deferent type of fracture (distal radius fractures, tibia fractures, femur fractures).

Exclusion criteria: Patients will be excluded if:

1- Who not able to comprehend.
2- Diabetic patients
3- Malnourished patient (under body weight BMI < 18 kg/m^2).

Setting

The current study was carried out in Orthopedic department at Minia University Hospital, it is located on the 2nd and 3rd floor, Building (A) that consists of (6) rooms that contain (20-22 beds) three rooms for male patients that contain (13 beds) and three for female patients that contain (7-9 beds).

Study Duration:

The total data collection was collected over a period of eighteen months. December 2018 to May 2019 and from January 2020 to December 2021.

Tools of data collection

Three tools were be collected by the researcher after reviewed by extensive literature such as **Paul & Williams (2016), Hinkle & Cheever (2018), Honan (2018),** see appendix B, as the following:-

First Tool: structured interview and medical data questionnaire:

It includes two parts:-

- **1st part**; covers socio- demographic data of the patients as:

(Age, education, type of care giver, and place of residence...etc.)

2nd part: medical data such as (type of fracture bone, pin site complication, infection control measure in department, patient and weight …… etc.)

Second tool: Grading of pin site infection:

It was developed by **SantyTomlinson et al., (2019)** to assess five features (pain, redness, discharge, swelling and general symptoms).

Scoring system

Each feature was categorized with sub-features to be either calm (0), irritated (1), or infected (2). The score for each one of the 5 features was obtained by calculating the mean so, the score is a continuous number and ranges from 0 to 2. For better clarity of data presentation, each score was multiplied by 5 with corresponding categorization is: (0) for calm, (> 0 and ≤ 5) for irritated, or (> 5 and up to 10) for infected.

To determine the character of each pin site (calm, or irritated, or infected), the sum of mean scores of the five features was divided by 5, so, the total score is also a continuous number and ranges from 0 to 10 with the same corresponding categorization as preview.

Third tool; Bacterial wound investigation sheet;

the researcher was collected bacterial wound investigation sheet which done as doctor order after the first 48hr post operatively and after six weeks from patient discharge. The result of this sheet was categorized as positive bacterial result or negative bacterial result.

Validity and Reliability:

Tools Validity:

To determine the degree to which study tools actually assess what they were intended to test, content validity was conducted. A panel of five specialists in the field of medical-surgical nursing, including one from Minia University's faculty of nursing, three from Assuit University's faculty of nursing, and one from Ain-Shams University's faculty of nursing, evaluated the present research instruments. Every jury member (100%) concurred that the existing research tools were reliable and pertinent to the study's objectives.

Tools Reliability:

Reliability was done for the first tool were tested for internal consistency by using Cronbach's' alpha test that indicated strong and good reliable tools were 0.822 respectively.

Pilot study

The feasibility, objectivity, and application of the data collection tool were examined in a pilot study on 10% (6 patients) of the total sample. On the basis of the pilot study's findings, the researcher made no adjustments. These patients were a part of the investigation.

Ethical Consideration;

The Minia University Hospital Director, the Dean of the Faculty, the Director of the Orthopedic Department, and the Six-member Ethical Committee of the Nursing Faculty all gave their official approval for the study to go forward. The subjects' involvement in this study was voluntary, they were told of its goals, methods, advantages, nature, and follow-up, and they were free to leave at any time without giving a reason.

Subjects gave their verbal and written consent after being informed that the information they provided would not be used in any additional research without their consent once again. Through the coding of all data and the protection of the acquired data, the confidentiality and anonymity of each subject were guaranteed.

Study procedure.

There are three phases' to the field work or procedure included preparatory, implementation, and evaluation.

Preparatory phase: To locate the most recent, pertinent studies on the research subject from around the world, books, periodicals, and the internet were sifted through. The infrastructure of the proposed study was evaluated using patients undergoing external fixation prototyping test. A pilot research was also conducted. Oral consent was obtained from participants, the investigator was given permission to carry out the study by the director of the orthopedic department at Minia University, and the study was approved by the dean of the nursing faculty and the ethics committee. A jury committee examined the created tools and performed validity and reliability tests on the tools.

Implementation phase: As soon as patients were admitted to the orthopaedic department, researchers started gathering tools. The study group was chosen by the researchers after the control group. The eighteen-month data collection cycle started in December 2018 and lasted until May 2019 and January 2020, respectively.

First, information was gathered using the first instrument (appendix B) for the control group. This process took around 10-15 minutes per patient every day. Then, after the researchers had finished gathering data from the control group, he would begin doing the same with the study group.

Every patient was given the opportunity to ask any question in order to clear up any misunderstandings, and the researchers collected the first tool (1st part, 2nd part) appendix B from the study group within 10 to 15 minutes immediately following surgery, depending on the patients' tolerance. On average, there were around 1:2 patients every day. The researcher then demonstrates how to properly take care of the study group's pin sites using chlorhexidine solution to them once daily from the time the patient is discharged from the hospital until that point.

The study group receive a brochure in Arabic language **appendix E** which having pictures to remember them ensure there understanding and competency for demonstration of procedure at home once daily for six weeks

after discharge. After a thorough examination of relevant literature, the researchers designed it **(Perry et al., 2015).** It consisted of 20 steps such as (Apply an apron after washing hands with liquid soap and water. Prepare the tools for the procedure on a spotless surface, etc.). Appendix B in English language which was implemented by researcher for study group also it was taught for care giver for study group to apply it at home for their patient the researcher ensure that care giver was became competence this procedure before patient discharge.

The researcher after that used second tool from study group to assess and collection Grading of pin site infection from second days postoperatively until patient discharge and follow up by care giver via telephone interview the researchers collected third tool bacterial wound investigation sheet from study group which done as doctor order after the first 48hr post operatively and after six weeks from patient discharge. The result of this sheet was categorized as positive bacterial result or negative bacterial result. Finally, after finishing data collection from the study group the researcher gave health education about pin site care and brochure in Arabic language **appendix E** for control group.

Evaluation phase: the researchers evaluated control group about second tool **appendix B** (Grading of pin site infection) within 48 hours post-operative, then evaluated weekly for 6 weeks from discharge. The researchers evaluated control group about third tool (bacterial wound investigation sheet) after 48 hours and then after 6 weeks.

The researchers evaluated study group about second tool **appendix B** within 48 hours post-operative to assess the effect of the chlorhexidine solution, then evaluated weekly for 6 weeks from discharge. The researchers evaluated study group about third tool after 48 hours and then after 6 weeks.

Statistical analysis of data

Means and standard deviations as a measure of dispersion were used in descriptive statistics to summarise, tabulate, and show the data. The data were statistically analysed using SPSS, an IBM (25) statistical package for the social sciences, which includes the test of significance described in common statistical texts.

Qualitative data were expressed as number and/or percentage. For quantitative data, comparison between two variables was done using student's t-test. For qualitative data, comparison between in two independent groups was done using Chi square test (or fisher test in case of less than 5 cases). Adjusted multiple linear regression (crude model and multivariate model) was done to show the magnitude of comparative results. Probability (P-value) is the degree of significance, less than 0.05 was considered significant.

Results

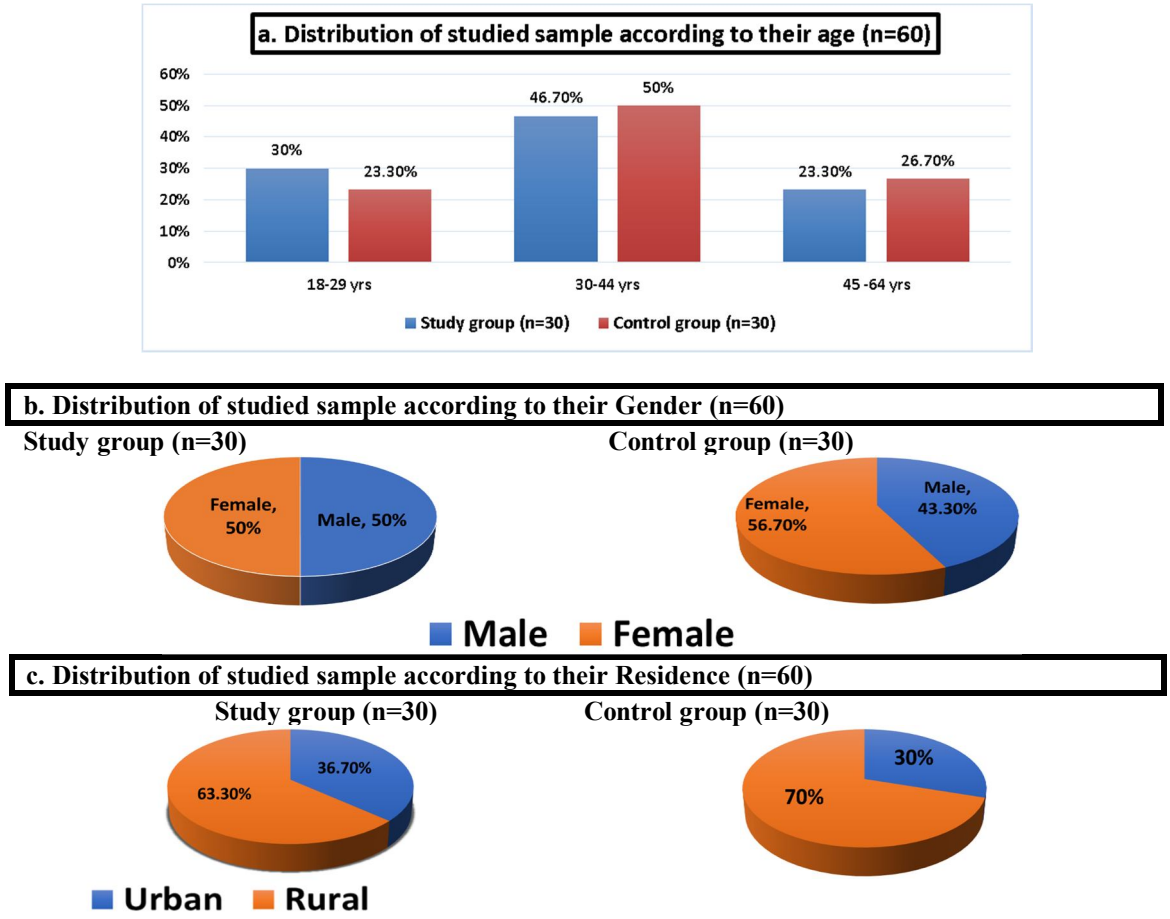

Figure (1): Distribution of studied sample according to their Age, Gender and Residence (n=60)

Figure (1) A,B,C reflects that the subjects aged 30-44 years represents 46.7% and 50% of in the study group and control group, respectively. More than half of the control group were female (56.7%) while the female was equal to male in the study group (50%). Related to residence, subjects lived in rural were 36.7% and 30% of in the study group and control group, respectively. There are no statistical significance differences. Between both group

Table (1). Sociodemographic characteristics of the studied sample (n= 60):

Sociodemographic characteristics	Study group (n=30) N (%)	Control group (n=30) N (%)	Sig. test	P- value
Level of education				
Illiterate	2(6.7%)	3(10%)	fisher =1.264	0.935 NS
Read and write	6(20%)	5(16.7%)		
Elementary	17(56.7%)	17(50%)		
Secondary	3(10%)	3(10%)		
University	2 (6.7%)	4(13%)		
Care givers				
Relatives	23(76.7%)	20(66.7%)	X^2=0.739	0.390 NS
None relatives	7(23.3%)	10(33.3%)		

*** *P*-value is significant. NS: *P*-value is not significant.**

Table 1: reflected that more than half of the studied sample had elementary education(50%)) and the lowest percentage of them was illiterate. (6.7%) The majority of study group were cared by their relatives.

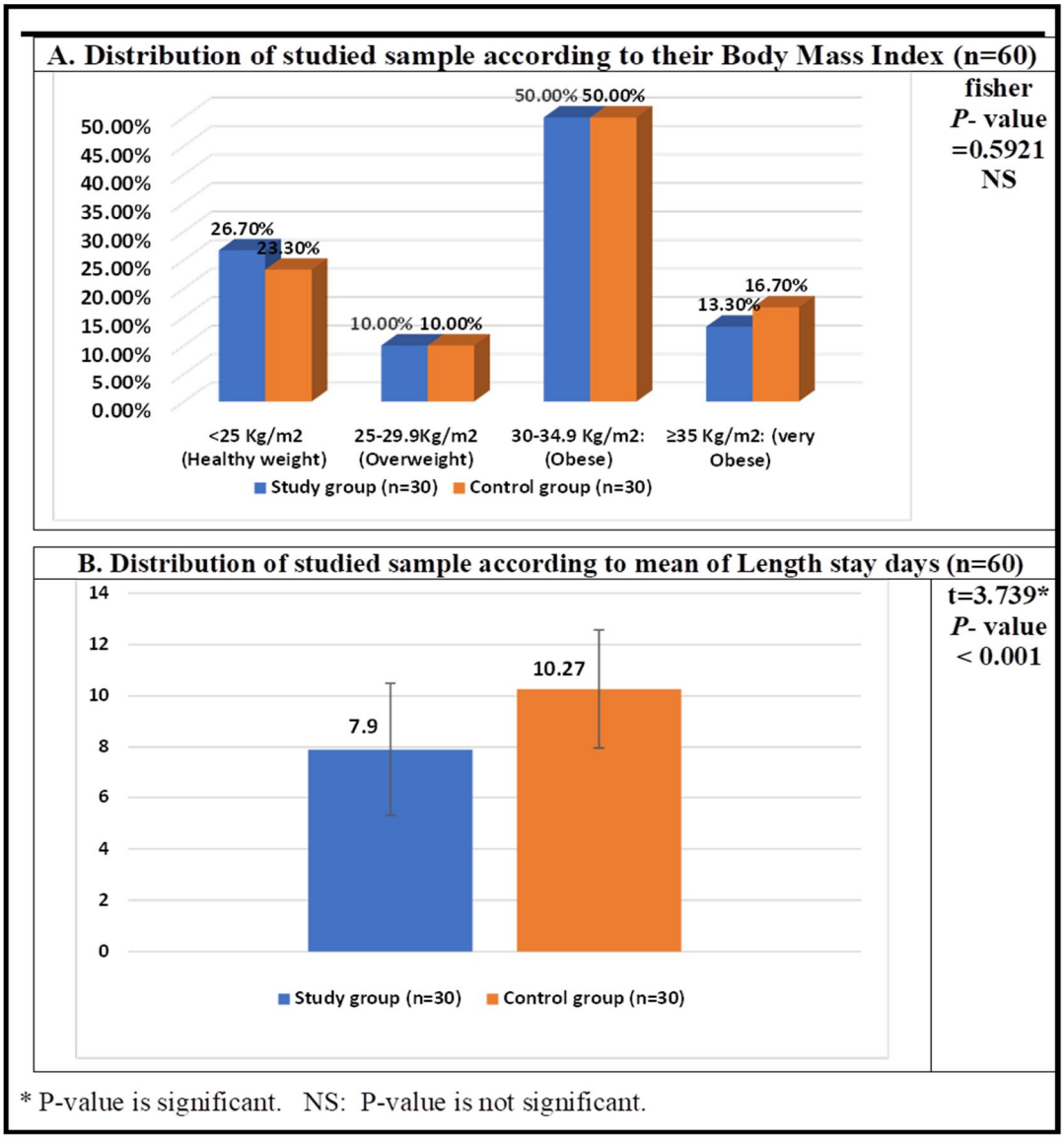

Figure (2): Distribution of studied sample according to their Body Mass Index, and mean of Length of stay days (n=60)

Figure (2) shows the study and control subjects mean average and stander deviation regard **Body mass index** the result found that they had 33.24±7.09 **Kg/m^2** and 32.77±5.23 **Kg/m^2** body mass index, respectively. Importantly, obese category (**30-34.9 Kg/m^2**) occupies half of both groups. Related to mean ± SD of length of stay were7.90 ±2.59 and10.17±2.69 in the study and control group, respectively with p-value < 0.001.

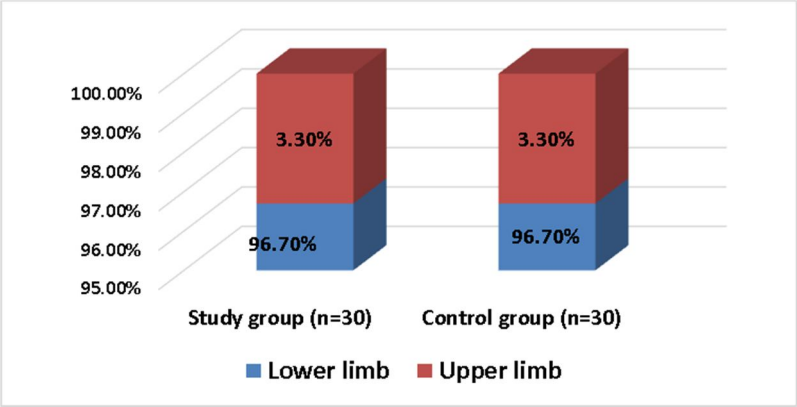

Figure (3): Distribution of studied sample according to their Type of Fracture

Figure (3) As fracture type, most of both groups were the same; the upper limb fractures were presented in only one subject in either study or control group, (3.3%) while lower limb fracture was reported in all other subjects (96.7%).

Table (2): Comparison between study and control subjects regarding mean average infection' scores across 6 weeks of the study after implementation of dressing:

	Study group (Mean± SD)	Control group (Mean± SD)	T	P-value
1st week	0	0	---	--
2nd week	0	0.40±1.30	1.682	**0.103**
3rd week	0.83±1.91	4.57±1.88*	7.676*	**< 0.001**
4th week	1.10±2.03	4.50 ±1.52*	7.398*	**< 0.001**
5th week	4.81±2.03	8.31±1.74*	7.170*	**< 0.001**
6th week	5.83±1.91	8.47±1.53*	5.909*	**< 0.001**

Significant level at P value < 0.05.

Table 2: As shows that, there were no infection criteria in both groups in the same in 1st week, but control subjects were started had 0.40±1.30 in the 2nd week and show a progressive increase over4.57±1.88 at 3rd week and got highest infection score in the 6th week reaching 8.47±1.53 in pin site infection criteria. Although, the study group recorded that infection score, were 4.81±2.03 at 5th week and reach to at 5.83±1.91 at 6th week. There was highly statistical significance difference between studied samples in the weeks 3rd to 6th weeks.

Table (3): Comparison between study and control subjects regard overall percentage distribution of infected criteria throughout 6 weeks' timeline:

	Study group		Control group		Fisher	P-value
	Not infected N (%)	Infected N (%)	Not infected N (%)	Infected N (%)		
1st week	30(100%)	0(0%)	30(100%)	0(0%)	--	--
2nd week	30(100%)	0(0%)	30(100%)	0(0%)	--	--
3rd week	30(100%)	0(0%)	28(93.3%)	2(6.7%)	0.4915	0.9217 NS
4th week	30(100%)	0(0%)	27(90%)	3(10%)	0.2373	0.9714 NS
5th week	25(83%)	5(17%)	4(13%)	26(86.7%)	< 0.001*	<0.001
6th week	25(83%)	5(17%)	3(10%)	27(90%)	< 0.001*	<0.001

*** *P*-value is significant. NS: *P*-value is not significant.**

Table 3 As shown, it was the same percentage between studied sample regard overall score of infection criteria in two weeks, but control subjects have a progressive increase at 6th week reaching 90% among them were had pin site infection criteria while the study subjects recorded that only a 17%. In the same weeks There are no statistical significance difference between studied sample regard infection criteria at 3rd and **4th** week while there highly statistical significance difference between them at **5th** and **6th** week ***P value*** $= < 0.05$.

Table (4) Relation between percentage distribution results of pin site infection scale and positive wound culture results among studied sample at 6th week:

	Study group (n=30)		Control group (n=30)		*fisher's exact test*	*P*-value
	Not infected N (%)	Infected N (%)	Not infected N (%)	Infected N (%)		
Scale based Pin site infection	25(83%)	5(17%)	3(10%)	27(90%)	< 0.001*	<0.001
Diagnostic culture	25(83%)	5(17%)	3(10%)	27(90%)	< 0.001*	<0.001

*** *P*-value is significant**

This table shows that percentage distribution of both Scale Pin site infection and positive wound culture result were the same. There is a highly statistical significance correlation between pin site infection scale and the positive wound culture.

Discussion.

External fixation is mostly applied by orthopedic surgeon in damage control surgery. This method of fixation is used to span a close fracture or an open incision, but the most prevalent drawback of external fixators is pin tract infection (PTI) **(Shabir et al., 2019)**. One of the nursing concerns is to prevent infection at the sites of bone pins. Finding the most efficient technique to lower the number of pin site infection cases is necessary for nursing workers **(Tudu, 2019)**

From this concept this study aimed to evaluate the effect of using chlorhexidine solution on reducing pin site infection among patient with external fixation.

As regard to demographic characteristics among the studied subjects, the findings of the present study showed that around half of both group were had between thirty to forty-four years old. In the researchers' point of view, this is because most of the studied patients were at a reproductive age when they go out for their work and were more engaged in high-risk behaviors.

This finding was in agreement with **Makhdoom et al., (2020)** who reported that the mean age among study and control groups was (36.33 and 37.96) respectively. Also, this result come in accordance with **Khorais et al., (2018)** who report that the patients' mean age was thirty years.

The current study finding was opposite to the study conducted by **(Sayed et al., 2019)** they reported that about half of the studied patients ages ranged from eighteen to below thirty, with a mean ±SD (33.83±14.59).

Regarding the patient's gender and educational level, the present study showed that more than half of the control group were female while the female was equal to male in the study group, and the lowest percentage of them were illiterate and at university. . This may be due that female are at more risk for fracture due to hormonal changes and decrease in calcium level from multiple pregnancies. The current study's finding was compatible with the study conducted by **Rahşan et al., (2014)** who found that the majority were female and were primary school graduates.

These results were in contrast to a research by Sayed et al., (2019), who found that most of the patients were male and that around a third of them were illiterate.

The current study revealed that the majority of the studied sample had lived in rural area and according to the researcher opinion all rural residents work in construction and are at significant risk of fracture when carrying bricks and cement.

This study finding was in agreement with **(Mohammed et al., 2017)** who reported that more than two thirds of study participants were from rural areas. . Finding of the current study is explained by the researcher perspectives that, most of the govern orate in Upper Egypt is villages with a low degree of health care services

The present study revealed that most of the studied subjects had a lower limb fracture; this study finding was in line with that of **Mohammed et al., (2017)** who revealed that the most common diagnoses of patients recruited was open tibia-fibular fracture**.** This result comes in consistent with **Mohamady Mohamed et al., (2020)** who revealed that the most common diagnosis of patients recruited was an open tibia-fibular fracture.

The results of the current study showed that there was no statistically significant difference in the items of fracture type and body mass index between the two groups. This outcome is consistent with **Rahşan et al.'s (2014)** finding that there was no statistically significant change in fracture type and body mass index between groups.

Regarding body mass index and length of stay, the current study findings showed that obese category (**30-34.9 Kg/m^2**) occupies half of both groups. This may be the high increase in obesity all over the world and especially developing countries also obesity effects on mineralization process and calcium uptake in bones that put patients at more risk for fracture. This difference in morbid obesity prevalence rates among hospitalized patients between the two groups may partially reflect a higher prevalence of obesity globally than in Egypt. Additionally, the variance can be caused by various selection criteria used in the two researches. Related to mean ± SD of length of stay were 7.90 ±2.59 and 10.27±2.30 in the study and control group, respectively with p-value < 0.001. The researcher interpreted that the control group was more reliable for infection because betadine might progressively lose its efficacy over time if it is exposed to air. This is because a slow oxidation process could result from the solutions iodine reacting with airborne oxygen.

The current study's findings disagreed with this of the study conducted by **Rahşan et al., (2014)** who found that more than half of study participants had normal weight and a mean length of hospital stay of 9.55±1.66 (range: 8 to 10 days). No statistically significant difference was found between the two groups in terms length of hospital stay.

Regarding pin site infection score, the current study revealed that there were no infection criteria in both groups in the same in 1st week, but control subjects were started had 0.40±1.30 in the 2nd week and show a progressive increase over 4.57±1.88 at 3rd week and got highest infection score in the 6th week reaching 8.47±1.53 in pin site infection criteria. Although, the study group recorded that infection score, were 4.81±2.03 at 5th week and reach to at 5.83±1.91 at6th week. There was highly statistical significance difference between studied samples in the weeks 3rd to 6th weeks.

This was agreed with **Hossny et al., (2020)** who found that patients in the study group experienced only grade I pin site infection as compared with control group patients, as they experienced grades I, II, and III of pin site infection.

Also, **Makhdoom et al., (2020)** reported that considerably fewer patients who used Chlorhexidine as the washing agent experienced pin-site infections than those who used povidone-iodine or the control group (p=0.04). Additionally, the average number of days with a pin tract infection was considerably reduced in the chlorhexidine group compared to the povidone-iodine group (p=0.041).

In contrast, **Slater et al., (2021)** study about currently accepted theories for managing pin sites in external hexagonal frames who mentioned that chlorhexidine alone has been shown to be less effective and didn't lead to lower infection rates and he regarded that to the effect of using saline to encourage granulation and remove exudate or blood

The current study displayed that, it was the same percentage between studied sample regard overall score of infection criteria in two weeks, but control subjects have a progressive increase at 6th week reaching ninety percentage among them were had pin site infection criteria while the study subjects recorded that only a seventeen percentage in the same weeks. There were no statistical significance difference between studied sample regard infection criteria at 3rd and **4th** week while there highly statistical significance difference between them at **5th** and **6th week P value= < 0.05.** This may be due to control group take routine care so infection criteria

appeared quickly than study group also obesity is a great risk factor for infection and using betadine put them at risk for infection

The current study finding was similar to **Wu et al., (2018)** who found that in comparison to the chlorhexidine gluconate group, patients who got standard pin care had a considerably greater rate of pin tract infection.

The same as reported by **Privitera et al., (2017)** in comprehensive study and meta-analysis about chlorhexidine skin antisepsis versus iodine for surgical site infection prevention, they highlighted that numerous surgical operations benefit greatly from the prolonged activity of chlorhexidine gluconate, which is unaffected by body fluids.

Regarding number of patients who have Positive culture of infection, it was observed that **percentage distribution** of both Scale Pin site infection and positive **wound** culture result were the same. There is a highly statistical significance correlation between pin site infection scale and the **positive wound** culture.

It was agreed with **Amanti et al., (2017)** who found that 25% of the control group have a positive culture of infection.

Also, **Guo et al., (2020)** found that the infection rate of chlorhexidine group was lower than that of the other groups, with statistically significant differences.

Furthermore, **Kazmers et al., (2016)** who documented that the chlorhexidine solution outperformed the saline since the saline group frequently showed positive pin site cultures.

Conclusion:

The study findings concluded that sterile dressing and using of chlorhexidine as alternative cleansing agent among study group who underwent external fixation was a positive effect on pin-site infections as compared to the control group

Recommendations:

Recommendations related to nurses:

- Hospitals should recommend using chlorhexidine solution as a cleansing agent for patients who underwent external fixation.
- Periodic training and educational programs about using chlorhexidine solution during dressing for prevention of pin site infection should be developed for the health team members, especially the nursing staff.
- Provide the hospitals or Orthopedic departments' libraries with adequate advanced teaching aids regarding orthopedic nursing care in the form of textbooks or online websites that assist nursing staff to perform high-quality nursing practices.

Recommendations for the Patients:

- Preoperative teaching and training programs for patients about measures that can reduce postoperative pin site infection and care that can be done.

Recommendations for Further Researches:-

- Replication of the current study on a larger sample size to achieve generalizable results.
- Formulate a standard of perioperative care for patients with external fixation..

Limitations of the study

- Difficulties in availability of suitable place and materials to conduct the study.
- Non-cooperation from physicians and the nurses.
- Technically problem in CT scan in hospital.
- Pandemic covid19.

References

1. Amanti, A., Potalivo, G., Pelosi, F., Rende, R., & Cerulli, G. (2017). Randomized prospective study on the use of Eufiss in the prevention of infections in patients treated with external fixation. European journal of inflammation, 8(3), 189-192.
2. Artuso, M., Mas, V., Ilharreborde, B., Mazda, K., & Jehanno, P. (2019). External fixation: Role in decreasing postoperative complications of complex syndactyly release–A review of 18 patients. Orthopaedics & Traumatology: Surgery & Research, 105(6), 1187-1191.
3. Bue, M., Bjarnason, A. Ó., Rölfing, J. D., Larsen, K., & Petruskevicius, J. (2021). Prospective evaluation of pin site infections in 39 patients treated with external ring fixation. Journal of Bone and Joint Infection, 6(5), 135-140.
4. Burr, D. B., & Allen, M. R. (2019). Basic and applied bone biology: Academic Press.
5. Coventry, L. L., Pickles, S., Sin, M., Towell, A., Giles, M., Murray, K., &Twigg, D. E. (2017). Impact of the Orthopaedic Nurse Practitioner role on acute hospital length of stay and cost□savings for patients with hip fracture: A retrospective cohort study. Journal of advanced nursing, 73(11), 2652-2663.
6. Dewit, S. C., Stromberg, H., & Dallred, C. (2016). Medical-surgical nursing: Concepts & practice: Elsevier Health Sciences.disinfectants in preventing pin-site infection after using Ilizarov circular external fixators. European Journal of Inflammation, 18, 2058739220942647.
7. Gravetter, F. J., Wallnau, L. B., Forzano, L. A. B., & Witnauer, J. E. (2020). Essentials of statistics for the behavioral sciences. Cengage Learning.
8. Guo, X., Zhang, Y., Li, P., & Guo, J. (2020). Experimental study on the effects of different disinfectants in preventing pin-site infection after using Ilizarov circular external fixators. European journal of inflammation, 18, 2058739220942647.
9. Hinkle, J. L., & Cheever, K. H. (2018). Brunner and Suddarth's textbook of medical-surgical nursing. Wolterskluwerindia Pvt Ltd.
10. Honan, L. (2018). Focus on adult health: medical-surgical nursing. Lippincott Williams & Wilkins
11. Hossny, E. K., Elmagd, N. S. A., & Hussien, R. H. (2020). Nursing performance associated with providing complete preventive nursing care and its relation with incidence of pin site infection: turn the lens inside. Egyptian Nursing Journal, 17(2), 87.
12. Iliadis, A. D., Shields, D. W., Jamal, B., & Heidari, N. (2022). Current classifications of pin site infection and quality of reporting: a systematic review. Journal of Limb Lengthening & Reconstruction, 8(Suppl 1), S59-S68.
13. Kazmers, N. H., Fragomen, A. T., & Rozbruch, S. R. (2016). Prevention of pin site infection in external fixation: a review of the literature. Strategies in Trauma and Limb Reconstruction, 11(2), 75-85.
14. Khorais, A., Ebraheim, M., & Barakat, A. (2018). Self-care program: quality of life and satisfaction among

patients with external skeletal fixation. IOSR Journal of Nursing and Health Science, 7(4), 71-83.
15. Korobeinikov, A., & Popkov, D. (2019). Use of external fixation for juxta-articular fractures in children. Injury, 50, S87-S94. .
16. Kortor, J. N., Kpela, T. M., & Poopola, S. O. (2021). Pin-Tract Infections Following External Fixation of Open Fractures. Journal of Medicine in the Tropics, 13(2), 105-108.
17. Laubscher, M., Nieuwoudt, L., & Marais, L. C. (2022). Effect of frame and fixation factors on the incidence of pin site infections in circular external fixation of the tibia: A systematic review of comparative studies. Journal of Limb Lengthening & Reconstruction, 8(3), 24.
18. Lazevnick, A. E. (2018). Precisionism in the Long 1920s. Princeton University,
19. Liu, K., Abulaiti, A., Liu, Y., Cai, F., Ren, P., & Yusufu, A. (2021). Risk factors of pin tract infection during bone transport using unilateral external fixator in the treatment of bone defects. BMC surgery, 21, 1-9.
20. Makhdoom, A., Baloch, R. A., AHMED, T., HASSAN, J., FARAZ, M., JOKHIO, L. D., & Ahmed, M. (2020). The Role of Chlorhexidine in the Prevention of Pin Tract Infection as Compared to Povidone-Iodine in Patients Managed by Ilizarov Circular Fixator.
21. Mohammed, R., Atinga, E., Sitati, F., & Gakuya, E. (2017). Pin tract infection after uniplanar external fixation of open fractures at a national, teaching and referral hospital. East and Central African Journal of Surgery, 22(1), 42-48.
22. Paul, P., Day, R. A., & Williams, B. (Eds.). (2016). Brunner & Suddarth's Canadian textbook of medical-surgical nursing. Wolters Kluwer.
23. Perry, A. G., Potter, P. A., & Ostendorf, W. (2015). Nursing Interventions & Clinical Skills-E-Book, 7th edition, chapter 17. Traction, Cast, and immobilization devices. Elsevier Health Sciences. pp: 459-68.
24. Privitera, G. P., Costa, A. L., Brusaferro, S., Chirletti, P., Crosasso, P., Massimetti, G., Nespoli, A., Petrosillo, N., Pittiruti, M., & Scoppettuolo, G. (2017). Skin antisepsis with chlorhexidine versus iodine for the prevention of surgical site infection: a systematic review and meta-analysis. American journal of infection control, 45(2), 180-189.
25. Rahsan, C., Korkmaz, F. D., & Sevki, S. (2014). Effects of two different solutions used in pin site care on the development of infection. Acta Orthopaedica et Traumatologica Turcica, 48(1), 80-85.
26. Santy-Tomlinson, J., Jomeen, J., & Ersser, S. J. (2019). Patient-reported symptoms of 'calm','irritated'and 'infected'skeletal external fixator pin site wound states; a cross-sectional study. International Journal of Orthopaedic and Trauma Nursing, 33, 44-51.
27. Santy□Tomlinson, J., Vincent, M., Glossop, N., Jomeen, J., & Pearcey, P. (2011). Calm, irritated or infected? The experience of the inflammatory states and symptoms of pin site infection and irritation during external fixation: a grounded theory study. Journal of clinical nursing, 20(21□22), 3163-3173.
28. Sayed, M. A. E., Mohammed, M. A., Mostafa, K. M., & Desouky, A. A. (2019). Effect of nursing management on pin site infection among incidence patients with external fixators. Assiut Scientific Nursing Journal, 7(16), 148-156.
29. Shabir, M., Afridi, H. U., Inam, M., Ali, M. A., & Shah, F. (2019). Comparison of 1% Silver Sulphadiazine and Chlorhexidine Dressing Combined Versus 5% Chlorhexidine Dressing Alone in Preventing Pin Tract Infection in External Fixators. Journal of Pakistan Orthopaedic Association, 31(03), 122-126.
30. Slater, G., & Mathen, L. (2021). Current Thinking in Pin-Site Management in External Hexagonal Frames. J Orthop Study Sports Med, 1(1), 1-9.
31. Tarkin, I. S., Murawski, C. D., &Mittwede, P. N. (2022).Temporizing Care of Acute Traumatic Foot and Ankle Injuries. Orthopedic Clinics, 53(1), 95-103.
32. Tudu, L. M. (2019). Betadine Dressing Versus Surgical Spirit Dressing in Prevention of Pin Site Infection among the Patients with External Skeletal Fixators. International Journal of Nursing Care, 7(1), 30.
33. Wu, S. C., Crews, R. T., Zelen, C., Wrobel, J. S., & Armstrong, D. G. (2018). Use of chlorhexidine□ impregnated patch at pin site to reduce local morbidity: the ChIPPS Pilot Trial. International wound journal, 5(3), 416-422