



Effect of Safety Measures Precautions on Pin Tract Infection and Disability among Orthopedic Patients with External Fixation

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Abstract:

Background: External fixators are golden methods in controlling fractures however, a key drawback to its use is high incidence of pin-tract infection with estimated rates between 9 and 100%. **Aim of the study:** was to evaluate the effect of safety measures precautions on pin tract infection and disability among orthopedic patients with external fixation **Subjects and Methods:** **Research Design:** A quasi experimental design was utilized in this study. **Setting:** The study was conducted in orthopedic departments at Accidents hospital and Outpatient hospital at Zagazig University Hospitals. **Subjects:** Purposive sample of 40 orthopedic patients with external fixation divided into two groups each group consisted of 40 patients. **Tools of data collection:** four tools were utilized for data collection: patients' interviewing questionnaire, Checketts-Otterburn Grading System of pin site infection, Safety measures precautions, and ADLs-brief-disability-questionnaire. **Results:** revealed that more than half of patients aged below 30 years, more than three quarter were male, there was increase in patients' knowledge, self-care practice, and safety measures, there was decrease in infection, and disability rates post intervention and in follow up compared to pre intervention. There was a statistically highly significant difference in relation between adequate safety measures and medical diagnosis, there was statistically highly significant positive correlation between knowledge with (self-care practice and safety measure). while there were negative correlations between each of (knowledge, self-care practice and safety measures) with each of (infection, and disability). **Conclusion:** safety measures precautions significantly improved patients' knowledge, practice, pin tract infection, and disability among orthopedic patients with external fixation. **Recommendations:** safety measures should be included in routine nursing care and patient education.

Keywords: Pin Tract Infection, Orthopedic , Patients, External Fixation

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Introduction:

More than 500 million people are injured each year worldwide, with more than 25% sustaining an orthopedic injury. Many are hospitalized and require surgery. Orthopedic trauma surgery is associated with severe acute pain and infection rates. **(Edgley, et al., 2019)**. Orthopedic trauma can have a profound socioeconomic impact on patients, particularly within a year of injury including: ongoing pain, significant disability and lose employment due to injury **(Suroto, et al., 2021)**. External fixators are orthopedic devices that are used to stabilize fractured bones and correct their position and orientation with minimally invasive techniques, allowing the realignment of the bone segments without surgically exposing them **(Widanage, et al., 2023)**

The biological benefits of frame fixation are well documented; however, a key drawback to the use of percutaneous fixation is the incidence of pin-site infection (PSI) which is a common side effect of external fixation with estimated rates between 9 and 100%. It is therefore our duty as care providers to take steps to minimize infection, appropriately diagnose and rapidly treat PSIs when they develop. **(Shields, et al., 2022)**.

Pin tract infection in external fixation can lead to loosening, osteomyelitis and amputation it is possible to differentiate between minor and major infection. The first is limited to soft tissues, whereas the latter includes bone involvement **(Guerado, et al., 2019)**.

Disability is an activity limitation (resulting from an impairment) that creates difficulty in the performance, accomplishment, or completion of an activity in the manner or within the range considered normal for a human being therefore, orthopedic rehabilitation is essential process to improve the treatment outcome of various orthopedic disorders and disabilities, including fractures. **(Salah Uddin, 2019)**.

Significance of the study:

With the increasing numbers of fractures worldwide and the associated rates of external fixation devices as a vital option in fracture management. Orthopedic patients with external fixation devices need specialized education regarding complication management including pin tract infection and disability. The nursing care should be started at the preoperational period through providing advices on physical and mental preparation, complication monitoring, rehabilitation by promoting exercise, all are required after operation for patient safety without complications and well rehabilitation. **(Mandour, et al.,2022)**

Therefore, it is necessary to establish hospital-specific protocols as safety measures to reduce the risk of infection among the patients. This includes adequate education, and training for the patient. **(Aly, 2020)**.

Aim of the study:

The current study aimed to evaluate the effect of safety measures precautions on pin tract infection and disability among orthopedic patients with external fixation.

Research Hypothesis:

1. The level of knowledge and practice will be improved among orthopedic patients with external fixation after the implementation of safety measures precautions.
2. Pin tract infection rates will be decreased among orthopedic patients with external fixation after the implementation of safety measures precautions.
3. Disability rates will be decreased among orthopedic patients with external fixation after the implementation of safety measures precautions.

Subjects and methods:

Research Design:

A quasi experimental design was utilized in this study.

Study Setting:

Orthopedic departments at Accidents hospital and Outpatient hospital at Zagazig University Hospitals

Subjects:

Purposive sample of 40 orthopedic patients with external fixation divided into two groups. Each group consisted of 40 patients: pre-safety measures precautions group and post-safety measures precautions group.

Tools of data collection:

Four tools were used to collect the necessary data

Tool I - Patients' interviewing questionnaire:

It involved the following three parts to cover the following data:

Part 1: for the assessment of patients' demographic characteristics

Part 2: to assess patients' knowledge about self-care and external fixation

The scoring system

Each correct answer =one (1) and incorrect answer and don't know=zero (0).

Unsatisfactory level of knowledge: for those who had score % < 60% of the maximum score.

Satisfactory level of knowledge: for those who had score % \geq 60% of the maximum score.

Part 3: Patient's self-care practice checklist: questions to assess patients' self-care practice.

Scoring System:

score 1 was given if the patient correctly did the practice and score 0 if not.

Unsatisfactory level of practice: for those who had score % < 60% of the maximum score.

Satisfactory level of practice: for those who had score % \geq 60% of the maximum score.

Tool II: Checketts-Otterburns Grading System to determine degree of infection.

score 1 was given if the patient had infection and score 0 if not

Tool III: safety measures precautions: developed by researcher after reviewing literature

The scoring system

Score 1 was given if the patient answer was Yes and score 0 if answer was No.

Inadequate level: for those who had score % < 60% of the maximum score.

Adequate level: for those who had score % \geq 60% of the maximum score.

Tool IV: Assess the disability level using ADLs-brief-disability-questionnaire

Scoring system:

Each item was scored based on a 4-point Likert scale, ranging from (0) without any difficulties to (3) unable to perform. Total mean scores were calculated. A total mean score of 2.25 or higher was considered as disable while a score less than 2.25 was considered as able

Administrative and Ethical Consideration:

A permission was taken from the dean of the faculty of Nursing, from the manager of Zagazig University Hospitals and from the head of orthopedic department, participants oral permission was taken after full explanation of the aim of the study. The researcher assured maintaining anonymity and confidentiality of the participants.

Pilot study:

A pilot study for tools of data collection was carried out on four patients within selected criteria in order to test for clarity, relevance, comprehensiveness, understandable, feasible, applicability and ease for implementation. The

results of the data obtained from the pilot study helped in modification of the tools.

Field work:

Implementation phase for data collection started as following: The selection of patients, the collection of data, and the implementation of the safety measures lasted over a period of 11 months, began from June 2022 to the end of April 2023. The questionnaire was designed by the researcher. Data used was collected three days per week in the morning and afternoon where the safety measures were implemented, from 10:00am to 1:00pm. patients were grouped; each group included 4-5 patient. Each interview took approximately 30 minutes in each theoretical session and 45 minutes in each practical session. The data was collected in a simplified Arabic language. The safety measures consisted of 18 sessions; one third of the sessions (6) were theoretical, and two thirds (12) were practical.

Assessment phase:

The program was constructed on the assessment of patients' knowledge and practice before implementation of the program. The assessment was performed before the implementation of program by interviewing each patient to assess their knowledge by using tools.

Planning Phase:

Based on the results obtained from the pilot study and assessment phase as well as reviewing the related literature, the safety measures were planned and designed by the researcher. Detected needs, requirements and deficiencies were translated into aim and

objectives of the program and set in the form of the booklet that was prepared by the researcher.

Teaching methods were selected to suit teaching in small groups in a form of lectures and group discussion.

Teaching materials were prepared as booklet (handout), brochures, videos and colored posters that covered theoretical and practical information.

Implementation phase:

The program was implemented through eighteen sessions in which the patients were given the program in groups. The length of each session varied according to the content of the session and the patient's responses and it ranged from 30-45 minutes.

Evaluation Phase:

Evaluation was done immediately post safety measures implementation and 1 month follow up. The evaluation was done to assess patient's knowledge, practice, pin site infection and disability through comparing the results of the pre, post, and follow up tests to assess the continuous effect of safety measures.

Content validity & reliability:

- **For validity assurance purposes,** Content validity was used for the modified tools and the designed booklet to determine whether the tools covered the aim or not. It developed by a jury of five experts from faculty of Nursing, Zagazig University.
- Reliability of tools was done by using Cronbach's Alpha test to measure the internal consistency for the components of tools.

Statistical analysis:

All data were collected, tabulated and statistically analyzed using SPSS 20.0 for windows. Mc nemar test or marginal homogeneity was used to compare between two dependent groups of categorical data. Wilcoxon signed ranks test was used to compare between two dependent groups of non- normally distributed variables. Percent of categorical variables were compared using Chi-square test or Fisher's exact test when appropriate. Spearman correlation coefficient was calculated to assess relationship between study variables, (+) sign indicate direct correlation & (-) sign indicate inverse correlation. Multiple linear regression (step-wise) was also used to predict factors which affect disability scores.

Results:

Table (1) showed that more than half of the patients (55%) aged below 30 years with mean \pm SD 34.25 ± 13.06 years. Most of studied patients (85%) were male. As regards marital status half of the patients (50%) were married. More than half of the patients (62.5%) were educated. Furthermore, slightly more than half of studied patients were employed (52.5%). Additionally, most of the patients (90%) lived in rural area.

Table (2). Clarified that patients' total knowledge increased post intervention and in follow up compared to pre intervention with satisfactory knowledge score (92.5%, 82.5, 12.5) respectively. Also, it showed that there was a highly statistical significance difference between pre and post intervention with P. value 0.001.

Table (3): Revealed that there was increase in satisfactory patients' self-care practice post intervention (90.0%) and follow up (80.0%) compared to pre intervention (2.5%). Also, it showed a highly statistically significant differences in patients' self-care practice pre and post intervention with P. value 0.001.

Table (4) Revealed that there was decrease in second, fourth, fifth and six degrees of infection among orthopedic patients with external fixation in post intervention and follow up compared to pre intervention. Also, it showed that there was a highly statistically significant differences in the first, and third degree of infection pre and post intervention with P. value was 0.001, it is also illustrated a significant difference in second degree of infection in post-intervention and follow up phase with P. value <0.05. With total score ($1.25 \pm 0.98, 1.00 \pm 0.55, 1.025 \pm 0.76$) in pre, post and follow up phase.

Table (5) Revealed that there was a decrease in disable score among orthopedic patients with external fixation in pre intervention, follow up and post intervention phase (12.5%, 5.0%, 2.5%,) respectively, and increase in ability score from (87.5%) pre intervention phase to (97.5%) and (95.0%) in post intervention and follow up phase.

Table (6) Revealed that there was statistically highly significant positive correlation between knowledge, self-care practice and safety measure with (p 0.793 and 0.839) respectively. it also showed that

there was a highly statistically significant positive correlation between self-care practice and safety measure with p value 0.742. an inverse correlation was found between infection and (knowledge, self-care practice, and safety measures) another inverse correlation was found between disability and (knowledge, self-care practice, and safety measures).

Discussion:

Regarding demographic characteristics, results of the present study revealed that more than half of the patients aged below 30 years old, this result may be regarded to the fact that this age group spent most of their time out of homes. Also, they characterized by high level of activity and therefore they are vulnerable to risky behaviors and accidents. The finding of the present study is supported by **Sayed et al., (2019)** in study about "Effect of Nursing Management on Pin Site Infection Among Incidence Patients with External Fixators" at traumatology department at Assiut University Hospital, they found that the greater part of patients' age ranged between 18-30 years' old

The finding of the present study disagrees with **Abbas & Awadelseid, (2020)** in study about "Outcome of Pin Tract Care in Sudanese Patients Treated with Ilizarov" conducted in north Khartoum hospital, they found that the greater part of patients' age ranged between 32.5 years.

Regarding the patients' sex: Most of studied patients were male this finding agrees with **Morsy et al, (2021)** who found in the

study “Effectiveness of Nursing Guidelines Regarding Self- Care Strategies for Patients with External Skeletal Fixation” that males were more prevalent than female this may be due to males more involved in outdoors activity and more vulnerable to accidents due to their nature of work.

On the other hand, this finding disagreed with **Xing et al. (2020)** who made a study about “Factors influencing self-care in outpatients with external fixation” in China, who reported that more than half of patients were females.

Related to marital status, the present study revealed that half of the studied patients were married. this may be related to most of patients' age ranged from 20 -60 years and patients in this age are expected to be married but the elevated costs of marriage may delay it for some men. The result agrees with **El-Shishtawy & Mohamed (2022)** in their study “Effect of Self-Management Protocol on Dietary Adherence for Patients with Kidney Stones undergoing Shock Wave Lithotripsy Technique” performed at Urology Outpatient at Zagazig University Hospital.

Regarding educational level, the present study revealed that more than half of the patients were educated this result was incongruent with **Xing et al., (2020)** who found that more than half of patients' had an education level of junior high school or lower this may be due to the fact that education became of great concern in current days. In contrast with this finding **Khorais, et al.,**

(2018) showed that nearly a third of the studied patients were illiterate.

Concerning occupation, it was observed that more than half of studied patients' were employed this agrees with **Badr et al, (2021)** in the study “Effect of safety measures educational program on the incidence of infection, satisfaction, and anxiety level among orthopedic patients with external fixation” who showed manual workers represented more than half of the studied patients this may be due to the nature of the work which lead them to be more liable to accidents and fractures.

Additionally, most of the patients lived in rural area this agrees with **Mohamed et al., (2020)** in the study "Nurses Performance Regarding Orthopedic Patients with External Fixation at Zagazig University Hospitals" they found that half of studied sample lived in rural area this may be due to decrease obligation of traffic laws in rural areas thus increasing incidence of accidents and fractures.

As regards to patients' knowledge, the current study results delineated that satisfactory patients' knowledge increased post intervention and follow up phase compared to pre intervention this agrees with **Abdelhady et al (2022)** in the study “Effect of Implementing Nursing Care Guidelines on Nurses' Knowledge for orthopedic patients undergoing External Fixation” conducted in orthopedic departments of Kafrelsheikh University Hospital this indicates patients' need to learn more about their condition.

The result of the current study agrees with **Elhapashy et al (2021)** in the study “Effect of structured teaching program among patients with lower limb fracture regarding self-care of casted limb” performed in the Orthopedic Department at Mansoura University Hospital. who found a statistically significant difference with the improvement of the level of knowledge pre- and post-structured teaching program about self-care among patients.

This difference in pre-test and post-test knowledge scores of respondents indicates that the teaching program was effective in improving the knowledge score regarding external fixation among orthopedic patients. Hence, the research hypothesis was accepted.

As regards to patients’ practice, the current study results revealed that there was increase in satisfactory patients’ self-care practice post intervention and follow up compared to pre intervention similar findings were reported by **Abouelala et al (2023)** who reported increase in practices scores which included wound care, neurovascular assessment of the lower extremities, practicing exercises in post and follow-up phase after implementation of the self-management protocol.

About "Wound care" and "Assessing wound site," it was noted that there was increase in satisfactory patients’ self-care practice post intervention and follow up compared to pre intervention this disagrees with (**Said et al 2020**) who conducted a

study about "Nurses` safety practices provided for patients undergoing external fixation surgeries” conducted at the inpatient orthopedic wards and the operating theaters of EL-Hadra Orthopedic and Traumatology University Hospital Alexandria, Egypt who found those safety measures were done unsafely by nearly two-thirds of the study sample.

Regarding infection there was decrease in second, fourth, fifth and six degrees of infection among orthopedic patients with external fixation in post intervention and follow up compared to pre intervention. This improvement of pin site infection attributed to positive consequence of implementation of educational program which emphasized on important knowledge and practices about pin site care. This result disagrees with **Badr et al, (2021)** who found that most of patients had no infection. Regarding patients’ knowledge about Signs of inflammation which indicate infection there was increase in post and follow up phase compared to pre intervention with a highly statistical significance difference between pre and post intervention this results are in the same line with (**Konda, 2020**) in her study “Effectiveness Of Information Booklet On Prevention Of Pin Site Infection” in India who found that the majority of studied sample have inadequate knowledge regarding prevention of pin site infection and after administering the information booklet most of them had adequate knowledge.

The result of the current study is in contrast with **Hossny, et al., (2020)** in their study “Nursing performance associated with providing complete preventive nursing care and its relation with incidence of pin site infection: turn the lens inside” conducted in the trauma department of Assiut University Hospital who noted that grade (I) happened in about fifth of the studied patients, while grades I, II, and III were developed in about fifth of the control group following the provision of preventive nursing care.

Encinas-Ullán et al (2020) in the study “The use of external fixation in the emergency department: applications, common errors, complications and their treatment” reported that pin infection is the most common complication, which occurs in thirty of cases and recommend a daily treatment with a disinfectant and providing education to patients regarding pin care to prevent infections.

Meanwhile, **Liu et al (2021)** in the study “Risk factors of pin tract infection during bone transport using unilateral external fixator in the treatment of bone defects” conducted in, Verona, Italy stated that occupation, gender, living environment (non-urban), smoking, and diabetes were the top five significant risk factors for pin tract infection (PTI).

Regarding to disability the present study revealed that there was a decrease in disable score among orthopedic patients with external fixation in pre intervention, follow up and post intervention phase with

increase in ability score, this is a normal result to increase patients’ knowledge and practice regarding dealing with external fixation. In the same context **Briguglio (2021)** in the study “The Burdens of Orthopedic Patients and the Value of the HEPAS Approach (Healthy Eating, Physical Activity, and Sleep Hygiene)” emphasized that the cornerstones of health promotion, prevention and recovery of musculoskeletal disorders include food, nutrition education, the promotion of an active lifestyle all these factors decrease the risk of long-term disability promote nourishment, movement, rest and considered to be the primary needs for a person’s quality of life.

In the same line **Mahmoud & Omran (2022)** in the study “Effect of Evidence Based Practices Guidelines on Immobilized Orthopedic Patients' Outcome regarding Pressure Ulcers” conducted at Benha University Hospital's orthopedics unit mentioned that preventative interventions such as skin care, diet, mobility, and position modification should be done effectively as mobility and exercise are two of the most significant predictors for developing complications.

Gadallah & El Miedany (2022) in the study “Operative secondary prevention of fragility fractures: national clinical standards for fracture liaison service in Egypt—an initiative by the Egyptian Academy of Bone Health” mentioned that fractures have a significant negative

impact on the patients' functional abilities as well as health-related quality of life. Fractures are also associated with high rates of morbidity and mortality whilst fracture occurrence can be a life-changing experience at the individual's level, with significant negative impact on the persons' mobility causing social isolation and possibly depression.

The result of the current study shows that there was a statistically significant relation between patients' ability level and duration of external fixation this disagree with **Sherrington et al (2020)** in the study "Exercise to reduce mobility disability and prevent falls after fall-related leg or pelvic fracture: restore randomized controlled trial) performed in Australia who found that no statistically significant intervention impacts on disability.

The result of present study revealed that there was statistically highly significant positive correlation between knowledge, self-care practice and safety measure. it also shows statistically highly significant positive correlation between self-care practice and safety measure this finding was in the same line with the study done by **Gethin et al. (2020)** entitled "Evidence for person-centered care in chronic wound care: A systematic review and recommendations for practice" they found that significant improvements were reported in patient knowledge, pain and self-care behaviors. In that context **Elhapashy et al (2021)** mentioned that there

were significant associations between patients' knowledge regarding self-care and their demographic characteristics. The result of the present study illustrates that there was an inverse correlation between infection and (knowledge, self-care practice and safety measure) this also agrees with **Sayed, et al., (2019)**, who indicated that negative correlations had been established between pin site infection and patients' knowledge, indicating that the percentage of pin site infection decreases as patient knowledge increases.

Conclusion:

Based on the finding of the present study it can be concluded that the safety measures precautions significantly improved patients' knowledge, practice, pin tract infection and disability

Recommendations:

In the light of the findings of the current study, the following are recommended:

- The educational intervention and safety measures should be included in routine nursing care and patient education as a protocol before and after external fixation surgery.
- Increase patients' awareness about the importance of pin site care and periodic check up to prevent developing any complications which can effect on their quality of life.

Table 1: Frequency and Percentage Distribution of Demographic Characteristics of Orthopedic Patients with External Fixation (n=40).

Demographic Characteristics	No.	%
Age (years)		
20-<30	22	55.0
30-<40	4	10.0
>40	14	35.0
Mean \pm SD		34.25 \pm 13.06
Gender		
Male	34	85.0
Female	6	15.0
Marital status		
Married	20	50.0
Not married	20	50.0
Academic qualification		
Educated	25	62.5
uneducated	15	37.5
Job		
Works	21	52.5
does not work	19	47.5
Residence		
Urban	4	10.0
Rural	36	90.0

Table (2): Frequency and Percentage Distribution of Total Knowledge Score about External Fixation as Reported by Orthopedic Patients with External Fixation Throughout Study Phases (n=40).

Knowledge score	Pre		Post		Follow up		MC p ¹	MC p ²
	No	%	No	%	No	%		
Unsatisfactory	35	87.5	3	7.5	7	17.5	0.001**	0.219
Satisfactory	5	12.5	37	92.5	33	82.5		
Mean \pm SD	2.67 \pm 3.11		18.05 \pm 4.94		16.92 \pm 7.31			

MC: Mcnemar test, non-significant ($p>0.05$), **: statistically highly significant ($p<0.001$), p¹: for comparison between pre-intervention and post-intervention, p²: for comparison between post-intervention and follow up phase.

Table (3): Frequency and Percentage Distribution of Total Self-Care Practice Score as Reported by Orthopedic Patients with External Fixation Throughout Study Phases (n=40).

Practice score	Pre		Post		Follow up		MC p1	MC p2
	No	%	No	%	No	%		
Unsatisfactory	39	97.5	4	10.0	8	20.0	0.001**	0.219
Satisfactory	1	2.5	36	90.0	32	80.0		
Mean ± SD	11.55±5.32		29.72±8.05		27.80±9.47			

MC: McNemar test, non-significant ($p>0.05$), **: statistically highly significant ($p<0.001$), p¹: for comparison between pre-intervention and post-intervention, p²: for comparison between post-intervention and follow up phase.

Table (4): Frequency and Percentage Distribution of Orthopedic Patients with External Fixation regarding Degree of Infection throughout study phases (n=40).

Degree of infection	Pre		Post		Follow up		MC p1	MC p2
	No	%	No	%	No	%		
First	6	15	20	50.0	22	55.0	0.001**	0.096
Second	17	42.5	13	32.5	7	17.5	0.454	0.012*
Third	2	5	2	5.0	3	7.5	0.001**	0.99
Fourth	7	17.5	2	5.0	5	12.5	0.070	0.453
Fifth	3	7.5	1	2.5	1	2.5	0.99	0.99
Sixth	5	12.5	2	5.0	2	5.0	0.453	0.99
Total score (mean ±SD)	1.25 ±0.98		1.00 ±0.55		1.025± 0.76		W=1.225 P1=0.220	W=0.085- p2=0.933

MC: McNemar test, non-significant ($p>0.05$), *: significant ($p<0.05$), **: statistically highly significant ($p<0.001$), p¹: for comparison between pre-intervention and post-intervention, p²: for comparison between post-intervention and follow up phase.

Table (5): Frequency and Percentage Distribution of Orthopedic Patients with External Fixation Regarding Total Disability Score Throughout Study Phases (n=40).

Disability score	Pre		Post		Follow up		MC p1	MC p2
	No	%	No	%	No	%		
Able	35	87.5	39	97.5	38	95.0	0.219	0.99
Disable	5	12.5	1	2.5	2	5.0		

MC: McNemar test, non-significant ($p > 0.05$), p^1 : for comparison between pre-intervention and post-intervention, p^2 : for comparison between post-intervention and follow up phase.

Table (6) Correlation matrix between study variables

	knowledge	Self-care practice	Safety measure	Infection
Self-care practice(r)	0.793 **			
Safety measure(r)	0.839 **	0.742**		
Infection (r)	-0.017	-0.105	-0.026	
Disability (r)	-0.242	-0.245	-0.186	0.049

Non-significant ($p > 0.05$), *: significant ($p < 0.05$), **: statistically highly significant ($p < 0.001$), r: correlation coefficient

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