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Incidence and Infective Microorganism of Pin Tract Infection

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Original Article

ABSTRACT

***Background**: In Iraq, the external fixation is widely used for highly incident fractures caused by war, violent accidents or road traffic accidents. The road traffic accidents represented the main cause for fractures in Kurdistan region which needs reduction and holding by external fixator. The pin tract infection is the most common complication of external fixation for fractures.. **Objective**: To assess the incidence and commonest microorganisms causing pin tract infection in Sulaimani city. **Patients and Methods**: A retrospective cross sectional review that carried out in Sulaimani Hospitals (Sulaimani, Shar and Shoresh teaching hospitals) through duration period of ten years from first of February, 2010 to 31st of January, 2020 on 87 patients with bone fractures managed by external fixation. The diagnosis of pin tract infection was according to the clinical features, microscopial examination and radiological findings.. **Results**: The pin tract infection incidence of fractured patients was (34.9%). The infective microorganisms for pin tract infection were staphylococcus aureus (50%), staphylococcus epidermidis (36.7%) and E. Coli (13.3%). Checketts Otterburn classification of pin tract infection was classified into; G1 (36.7%), G2 (23.3%) and G3 (40%).. **Conclusion**: The incidence of pin tract infection among fractured patients after external fixation is (34.9%) that is within international range and the staphylococcus aureus is the commonest microorganism.*

***Keywords:** External fixation, Pin tract infection, Staphylococcus aureus*

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1. INTRODUCTION

The pin tract infections are the most common complications of external fixation. The exact definition of pin track infection is any infection occurs in the skin tract of any metallic implant used in orthopedics like Kirschner wires, traction pins and pins of external fixation[1]. The incidence of pin tract infection among fractures treated by Kirschner wires reached to 1.4%, [2] while incidence of pin tract infection among fractures treated by external fixation reached to 27.4%[3]. Additionally, the pin tract infections are associated with high risk of toxic shock syndrome and necrotizing fasciitis leading to high risk of limb amputation and death[4]. Although the necessity of external fixation in correction of congenital malformations, mobilizing stiff joints and non-union fractures, 1 the external fixation is accompanied with high morbidity rates specifically when fixation is prolonged [5].

A specific pathogenesis of pin tract infection is unknown till now. However, some authors stated that pin tract infection starts from outside to inside[6-8]. For that, the infection spread from soft tissue to bone leading to pin loose and affect the bone fixation [5]. Other theories for pin tract infection are fluid accumulation around the pin or instability of the external fixation pin which leads to pin loosening and infection[9]. The staphylococcus epidermidis, staphylococcus aureus and Escherichia coli are the main infective agents of external fixation pin tract infections[10]. Younger age of patients and longer duration of external fixation were found to be the common risk factors of pin tract infection [3].However, older age patients with clinical morbidities are more prone to pin tract infections[11]. Other factors affecting incidence of pin tract infections are type of fracture, fixator type, pin insertion technique and post-operative care[12]. Classification or grading of pin tract infections is depending on clinical symptoms like pain or erythema [13] or on purulent discharge and swelling [14] or on treatment response [15]. The Paley classification was firstly introduced at 1990 that classified complications following lengthening procedures according to the Ilizarov method into problems (resolved by non-surgical methods), obstacles (resolved by surgical methods) and complications (unresolved) [16].

The treatment of pin tract infection is commonly depending on Checketts–Otterburn PTI classification which categorized the infection into minor and major [17]. For minor cases, the treatment is concerned on improving infection site care and oral antibiotics with continuing the external fixation[18]. The pin site care includes disinfection solutions, cleansing methods,

dressing materials and frequent dressing changes [19]. For major cases, removing infected pins, intravenous antibiotics and curettage are used for severe cases[12]. In general, the acceptable treatment strategy is byre-fitting infected pins and wires better than removal or replacement and enhancing not removing of external fixation [12]. The prevention of pin tract infection should be taken in consideration before during planning of the external fixation by selecting better fixator pins and shorter duration of pin application [20]. Many authors found that prevention of pin tract infections are dependable on pin design, surgical technique, use of cleansing solutions, frequency of pin site cleaning, dressing type, showering, prophylactic antibiotics and other factors [21-27].

In Iraq, the external fixation is widely used for highly incident fractures caused by war, violent accidents or road traffic accidents [28]. The road traffic accidents represented the main cause for fractures in Kurdistan region which needs for external fixation [29]. Neglected pin site care, resistant antibiotics and poor planning for post-fixation care are the main reasons for higher incidence of pin tract infection in Kurdistan[30. 31]. For all of these reasons and scarcity of national literatures discussing this problem, we conduct this research to assess the incidence and commonest microorganisms causing pin tract infection in Sulaimani city.

2. PATIENTS and METHODS

A retrospective cross sectional review that carried out in Sulaimani Hospitals (Sulaimani, Shar, and Shoresh teaching hospitals) through duration period of ten years from first of February, 2010 to 31st of January, 2020. The study population was all patients with bone fractures managed by external fixation during study duration. Patients with bone fractures from all age groups, treated external fixation, infected gap non union bone, multi-fragment fractures and bone loss or bone defect were the inclusion criteria. Exclusion criteria were congenital bone conditions, fibular hemimelia, tibial hemimelia, cosmetic bone elongation and congenital psudo-arthrosis of tibia. The ethical considerations were implemented according Helsinki Declaration regarding ethical approval of Health authorities; an ethical approval was taken from Kurdistan Board Ethical Committee and confidentiality of data. A convenient sample of 87 patients with bone fractures managed by external fixation was selected after eligibility to inclusion and exclusion criteria.

Data collected either directly from the patients or from their saved medical records in

Sulaimani Hospitals in a data collection sheet (Questionnaire) included the following data; demographic characteristics of patients , fracture characteristics (bone types and diagnosis), treatment characteristics of fractured patients (procedure, type of external fixation and complications) and pin tract infection incidence and characteristics (pin tract infection incidence, infective microorganism and Checketts Otterburn classification). The diagnosis of pin tract infection was done to the clinical features, microscopial examination and radiological findings, while, the classification of fractured patients was implemented according to Checketts Otterburn criteria[20].

Age of patients categorized into five groups (<20 years, 20-29 years, 30-39 years, 40-49 years and ≥55 years) and ranged from 14 years to 65 years. The diseased bones were tibia, femur, humerus and foot bones. The procedures were bone transport or fibula protibia or arthrodiastasis. The types of external fixations were Hybrid external fixation or conventional external fixation. The external fixation surgical operation was done and the complications were also assessed. The micromicroorganism culturing of pin tract infection was implemented at Laboratories of Sulamini Hospitals. Follow up of fractured patients for at least one month postoperatively. Methods to reduce pin tract infection: correct drilling and insertion of wire/pin to reduce pin tract infection, they inserted in the save zone to avoid ligament and tendon to prevent inflammation loosening and then infection, the wire was drilled and the pin inserted manually and slowly without using drill and continuous cooling with normal saline to prevent thermo necrosis which will lead to infection, meticulous skin incision and releasing soft tissue at the insertion site to prevent injury and loosing which complicated by infection. We avoided area of open injury or wound area to prevent pin tract infection. Data were analyzed using the Statistical Package of Social Sciences (SPSS) version 22 software for windows. Chi-square and Fishers exact tests were applied for analyzing categorical variables accordingly. Level of significance (P. value) was regarded statistically significant when it was 0.05 or less..

3. RESULTS

Eighty seven fractured patients were enrolled with mean age of (30 years) and range of 14-65 years; 19.5% of patients were at age group of less than 20 years, 40.2% of them were at age group 20-29 years, 16.1% of them were at age group 30-39 years, 10.3% of them were at age group 40-49 years and 13.8% of them were at age of 50 years and more. The male to female ratio was 2.5:1.0, (**Table 1**), The diseased bones of studied patients were commonly distributed as followings; tibia (54%), femur (23%), humerus (21.9%) and foot fracture (1.2%). Traumatic bone defect represented 77% of fractures and gap non-union represented 23% of fractures. (**Table 2**). The procedure of treatment used was mainly bone transport (96.6%), followed by fibula protibia (2.3%) and arthrodiastasis (1.1%). The external fixation types used were mostly Hybrid external fixation (82.8%) and conventional external fixation (17.2%). The postoperative complications according to paley classification encountered in 26.4% of fractured patients; problem was reported in 60.9% of complicated patients and obstacle in 39.1% of them. (**Table 3**). The incidence of pin tract infection for fractured patients was (34.9%). The infective microorganisms for pin tract infection were staphylococcus aureus (50%), staphylococcus epidermidis (36.7%) and E. Coli (13.3%). Checketts Otterburn classification of pin tract infection was classified into; G1 (36.7%), G2 (23.3%) and G3 (40%). (**Table 4**). No significant differences were observed between patients with pin tract infection and patients with no pin tract infection regarding age ($p=0.1$) and gender ($p=0.8$). (**Table 5**). There was a highly significant association between femoral fractures and higher incidence of pin tract infection ($p<0.001$), 73.7% of femoral fractures had pin tract infection. A highly significant association was observed between infected gap non-union fractures and higher incidence of pin tract infection ($p<0.001$), 70% of infected gap non-union fractures had pin tract infection. (**Table 6**). There was a significant association between fibula protibia procedure and pin tract infection ($p=0.05$). No significant differences were observed between patients with pin tract infection and patients with no pin tract infection regarding type of external fixation ($p=0.4$) and complication types ($p=0.2$). A highly significant association was observed between presence of postoperative complications and higher incidence of pin tract infection ($p<0.001$), 90.9% of postoperatively complicated patients had pin tract infection. (**Table 7**).

Furthermore (**Figures 1-7**) demonstrate the sequel of a twenty eight years old man, with

chronic Osteomyelitis of left tibia for the last 20 years as a complication of fracture and tight bandaging causing 11 cm infected gap non-union and outcomes of corrections

Table 1. Demographic characteristics of fractured patients.

Variable	No.	%
Age at diagnosis (year)		
<20 years	17	19.5
20-29 years	35	40.2
30-39 years	14	16.1
40-49 years	9	10.3
≥50 years	12	13.8
Mean (SD*)	30.0 ±13.8	-
Gender		
Male	62	71.3
Female	25	28.7
Total	**87**	**100.0**
SD: standard deviation of mean		

Table 2. Fractures characteristics

Variable	No.	%
Diseased bones		
Tibia	47	54.0
Femur	20	23.0
Humerus	19	21.9
Foot	1	1.1
Diagnosis		
Traumatic bone defect	67	77.0
Gap non-union	20	23.0
Total	**87**	**100.0**

Table 3. Treatment characteristics of fractured patients.

Variable	No.	%
Procedure		
Bone transport	84	96.6
Fibula protibia	2	2.3
Arthrodiastasis	1	1.1
Type of external fixation		
Hybrid	72	82.8
Conventional external	15	17.2
Complications		
Yes	23	26.4
No	64	73.6
Complication types according to paley classification		
Problem	14	60.9
Obstacle	9	39.1
Total	**87**	**100.0**

Table 4. In tract infection incidence

Variable	No.	%
Pin tract infection		
Yes	30	34.9
No	56	65.1
Infective microorganisms		
S. Aureus	15	50.0
S. *Epidermidis*	11	36.7
E. Coli	4	13.3
Checketts Otter burn classification		
G1	11	36.7
G2	7	23.3
G3	12	40.0
Total	**87**	**100.0**

Table 5. Distribution of fractured patients' demographic characteristics according to incidence of pin tract infection

Variable	Pin tract infection				P
	Yes		No		
	No.	%	No.	%	
Age					0.1 NS
<20 years	2	12.5	14	87.5	
20-29 years	16	45.7	19	54.3	
30-39 years	5	35.7	9	64.3	
40-49 years	2	22.2	7	77.8	
≥50 years	5	41.7	7	58.3	
Gender					0.8 NS
Male	21	34.4	40	65.6	
Female	9	36.0	16	64.0	

NS=Not significant.

Table 6. Distribution of fractures characteristics according to incidence of pin tract infection in different bones.

Variable	Pin tract infection				P
	Yes		No		
	No.	%	No.	%	
Diseased bone					**<0.001** S
Tibia	13	27.7	34	72.3	
Femur	14	73.7	5	26.3	
Humerus	2	10.5	17	89.5	
Foot	1	100.0	0	-	
Diagnosis					**<0.001** S
Traumatic bone defect	16	24.2	50	75.8	
Gap non-union	14	70.0	6	30.0	

Table 7. Distribution of treatment characteristics according to incidence of pin tract infection.

Variable	Pin tract infection				P
	Yes		No		
	No.	%	No.	%	
Procedure					**0.05** S
Bone transport	27	32.5	56	67.5	
Fibula protibia	2	100.0	0	0.0	
Arthrodiastasis	1	100.0	0	0.0	
Type of external fixation					0.4 NS
Hybrid external fixation	26	36.6	45	63.4	
Conventional ex-fix	4	26.7	11	73.3	
Complications					**<0.001** S
Yes	20	90.9	2	9.1	
No	10	15.6	54	84.4	
Complication types according to paley classification					0.2 NS
Problem	11	84.6	2	15.4	
Obstacle	9	100.0	0	-	

NS=Not significant, S=Significant., S: significant

Figure 1. Twenty eight years old man, with chronic Osteomyelitis of left tibia for the last 20 years as a complication of fracture and tight bandaging causing 11 cm infected gap non-union.

Figure 2. Plain radiograph ,A.P. & Lat. views , multiple sequestrate gap in the tibia & ankylosed ankle.

Figure 3. Same patient with Ilizarov frame; the middle block for compression of Fibula-Pro-Tibia, while proximal and distal blocks for correction of tibial bowing and elongation

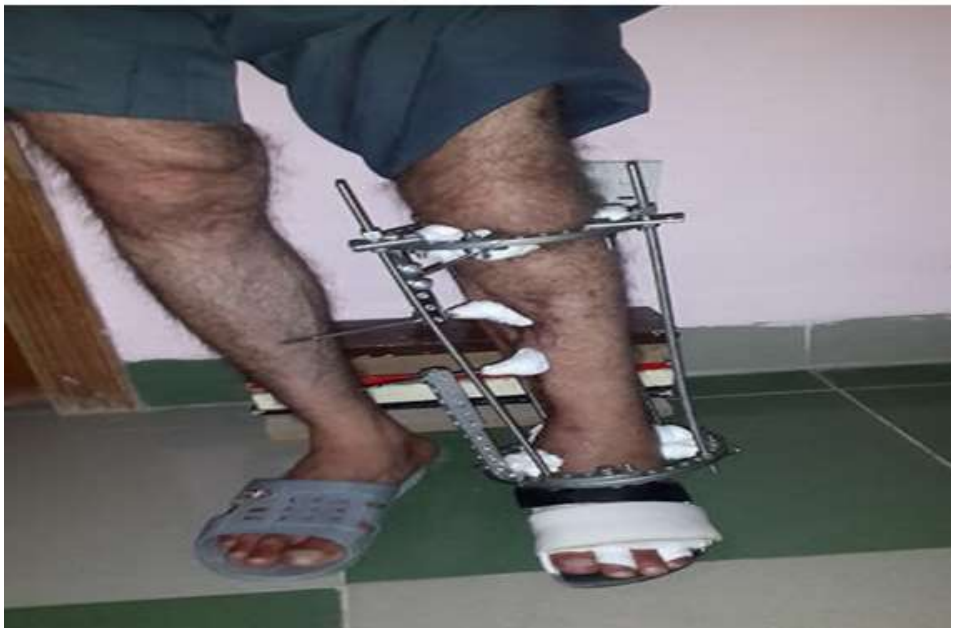

Figure 4. The same patient achieved pin tract infection obstacle according to the D. paley classification which was treated by removing middle block of the ilizarov frame and remaining the proximal and distal rings with good stability.

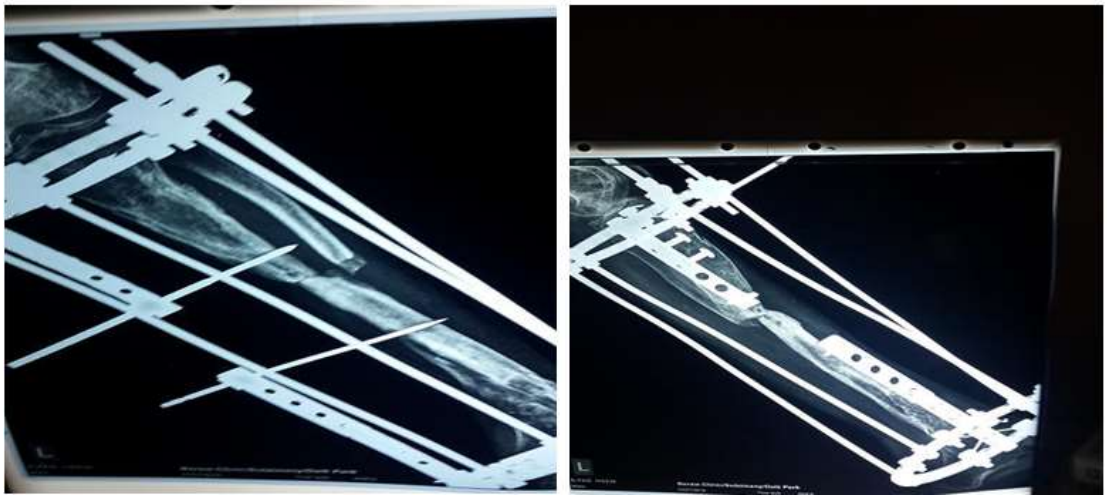

Figure 5. Plain radiograph A.P and lateral views , well corticalised distraction sites hypertrophied distal fragment of fibula.

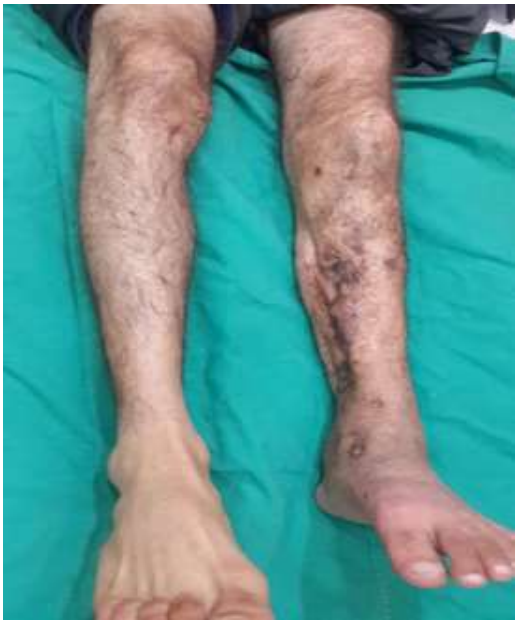

Figure 6. The same patient after removal of the Ilizarov frame .

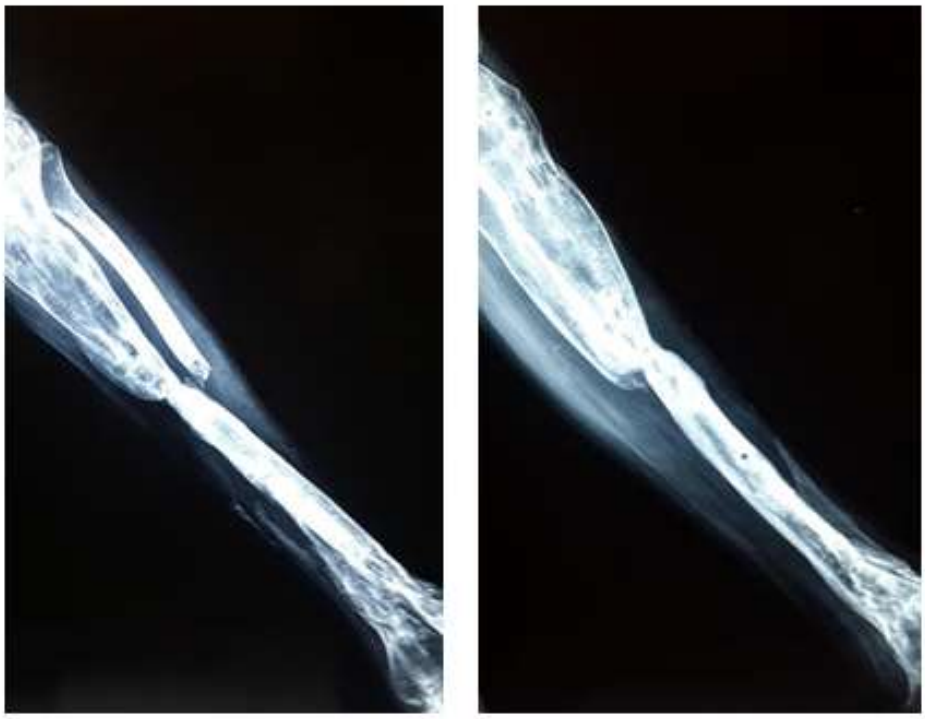

Figure 7. Plain radiograph A.P and Lateral views, union between hypertrophied distal fragment of fibula with proximal fragment of the tibia & fibula after removal of the Ilizarov frame

4. DISCUSSION

The pin tract infection is the main postoperative complication of skeleton fractures external fixation [32]. The common poor outcome of these pin tract infections is lowering the pin-bone construct stability. For that, the pin tract infection represented the most common clinical challenge facing the surgeon, especially for patients with priority of limb lengthening or deformity correction [33].

Present study found pin tract incidence of fractured patients managed by external fixation in Sulaimani city was (34.9%). This incidence rate is lower than pin tract infection incidence rate of (59.1%) reported by Abalo et al [33] one year prospective study in Togo on 50 patients with 52 fractures. However, our study incidence rate is higher than results of Lobust and Liu systematic review study in USA [3] which found that incidence of pin tract infection among fractured patients managed by external fixation was (27.4%). According to our knowledge, this study is the first Iraqi study assessing specifically the incidence of pin tract infection. Recent Iraqi study on fifteen fractured patients managed by external fixation reported that two (13.3%) patients developed pin tract infection [34]. Many authors recorded the incidence of pin tract infection among fractured managed by external fixation with range of (0-100%) [35-41]. These differences in pin tract infection incidence rates might due to many factors such as patients factors, fractures factors, external fixator factors and surgeons experience in addition to factors related to health infrastructure. In many literatures, the main hypothesis in pathogenesis of pin tract infection stated that the infection develops from outside to the inside by soft tissue inflammation progressing to soft tissue infection that leading to bone infection regardless of pin stability [42, 43]. However, other literatures documented that pin tract infection is related to pin loosening [41, 44]. It was shown that common preventive measures were pin insertion manually by hand using on and off technique not by drilling addition to use gauze and normal saline to decrease thermonecrosis of bone and soft tissue The common infective microorganism for pin tract infection in current study was staphylococcus aureus (50%). This finding is similar to results of Kortor et al [45] retrospective study in Nigeria on 102 patients with open fractures treated by external fixation which found that thirty two patients (31.3%) had pin tract infection and the staphylococcus aureus was the common infective microorganism. The Checketts Otterburn classifications of pin tract infection in our study were G1 (36.7%), G2 (23.3%) and G3

(40%) that indicating minor pin tract infection cases. This finding is inconsistent with results of Ferreira et al [46] study in South Africa on 80 fractured patients managed by external fixator which found pin tract infection incidence of (26.25%) and reported one case of major pin tract infection (G6) and the others had minor infection. This inconsistency might be due to differences in quality care, surgeon experience and awareness of patients between different communities.

Current study showed a highly significant association between femoral fractures and higher incidence of pin tract infection ($p<0.001$). This finding is consistent with results of many literatures like Muragi et al [47] study in USA and Mohammed et al [48] study in Kenya which reported higher incidence of pin tract infection among patients with femoral fractures managed by external fixation. The main reasons for this finding are that femur is close to perneal region cause cross contamination from perianium (dieper) microorganism (E.coli) and poor higene. Our study revealed a highly significant association between gap non-union fractures and higher incidence of pin tract infection ($p<0.001$). This finding coincides with results of Singh et al [49] study in India on 27 patients with gap non-union of fractures had higher incidence rates of pin tract infection. The pin tract infection is directly related to gap non-union complication of external fixation for fractures especially for limb fractures [50].

In present study, there was a significant association between fibula protibia procedure and pin tract infection ($p=0.05$), two patients with fibula protibia procedure had pin tract infection. This finding is consistent with results of Said et al [51] study in Egypt which reported that main complications of fibula protibia procedure were the pin tract infection and non-union. Our study found a highly significant association between presence of postoperative complications and higher incidence of pin tract infection ($p<0.001$). This finding is similar to reports of Ceroni et al [20] study in Switzerland which stated that pin tract infection incidence is increased with higher co-morbidities following external fixation of fractures.

5. CONCLUSIONS

The incidence of pin tract infection among fractured patients after external fixation is (34.9%) that is within international range. The main infective microorganism responsible for pin tract infection is staphylococcus aureus. All cases with pin tract infection are

classified with minor infection according to Checketts Otterburn criteria. The common risk factors of pin tract infection are femoral fracture, gap non-union fracture, fibula protibia procedure and co-morbidities following external fixation. Our study urged the orthopedic surgeons to be aware for risk factors of pin tract infection and earlier management of infection and testing of tank water to detect E. coli because it's the source of this microorganism

Ethical Clearance: Ethical clearance and approval of the study are ascertained by the authors. All ethical issues and data collection were in accordance with the World Medical Association Declaration of Helsinki 2013 for ethical issues of researches involving humans. Data and privacy of patients were kept confidentially.

Conflict of interest: Authors declared none

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