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Microbiological Profile of Pin Tract Infections due to External Fixators

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ABSTRACT

Introduction: Pin tract infections are complications associated with external fixators. Proper diagnosis and treatment can prevent further complications related to the infection. There are limited numbers of studies on this infection and thus treatment is usually based on individual's experience. Therefore, this study was undertaken to have a better understanding of pin tract infections and to help us establish a treatment protocol in the hospital.

Aim: To determine the incidence of pin tract infections among all patients who have external fixators, to identify the causative agents and study their antibiotic sensitivity pattern.

Materials and Methods: The present study was a cross-sectional study which was conducted in a tertiary hospital for patients who had external fixators. After obtaining ethical clearance and informed consent from the patient, all patients were monitored and if there was clinical suspicion of infection, discharge/pus was collected from the infection site and processed in the microbiology laboratory as per standard laboratory protocol to isolate and identify the causative agent. Antimicrobial susceptibility using Kirby Bauer's disc diffusion method. Statistical analysis was done by using Microsoft excel 2010.

Results: It was found that out of the 30 patients included in the study, six patients showed clinical evidence of pin tract infections with male preponderance. The most common isolate was *Acinetobacter baumanii* followed by *Pseudomonas aeruginosa*, *Citrobacter koseri* with variable antibiotic susceptibility pattern.

Conclusion: Pin tract infection occurred in 20% of the patients. Early diagnosis and treatment prevents complications which further reduces the cost of treatment and the number of days of hospital stay.

Keywords: *Acinetobacter baumanii*, Antibiotic sensitivity, Pin fixation techniques

INTRODUCTION

External fixation is a method of skeletal fixation, where percutaneous pins and wires are placed in the bone and connected to an external frame [1]. External fixators are used to stabilise fractures or as interventions in limb lengthening procedures and reconstructive surgeries [2]. External fixators are associated with a number of complications such as non-union, malunion, delayed union, loss of fixation as well as infections.

Incidence of pin tract infections ranges from 11 to 100% and the studies have reported *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Pseudomonas aeruginosa* and *Streptococcus* species as the causative agents [2]. There is limited literature and no clear consensus regarding the diagnosis, classification or treatment protocol of pin tract infections [3]. The risk factors associated with pin tract infections are increased duration of fixation of pin, inappropriate placement of pin [3,4], engaging a single cortex of a bone, increased soft tissue motion, increased thickness of soft tissue over the bone, inadequate postoperative follow-up care, less stability of fracture site, poor plan and construction of the external fixator frame, poor skin hygiene, prior skin infection have been attributed as risk factor for pin tract infection.

Infections associated with various external fixators are collectively called pin tract infections and is the most common complication associated with external fixators. If not identified and treated in time, it causes further complications such as loss of stability of pin-bone interface, non-union or chronic osteomyelitis leading to delayed fracture healing and/or loss of bone stability or it can also lead to deep tissue infection requiring surgical intervention [5]. Furthermore, there are no studies on pin tract infections in this tertiary care hospital. Therefore, the present study was undertaken to determine the incidence of pin tract infections, causative agents and their antimicrobial resistance pattern in a tertiary care hospital.

MATERIALS AND METHODS

The present study was a cross-sectional study which was conducted in Departments of Microbiology and Orthopaedics at RL Jalappa Hospital and Research Centre, a tertiary hospital in Southern Karnataka, India from April 2016 to May 2016. Ethical clearance was obtained from the Institutional Ethical Committee before starting the study (DMC/KLR/IEC/88/2018-19). Informed consent was taken and the patient's details were collected in a predesigned proforma.

Inclusion criteria: Patients who underwent external fixation with AO external fixators, Ilizarov rings, Jess fixators and K-wires for fracture stabilisation or for limb lengthening were included in the study.

Exclusion criteria: Patients in whom the external fixator was applied in a different hospital or fractures which were fixed internally were not included in this study.

Sample size calculation: A sample size of 30 was calculated using free EPI software with 95% confidence interval, 5% type 1 error and 50% prevalence based on pilot study which was conducted in the hospital.

Study Procedure

All patients included in the study were monitored for signs and symptoms of infection such as erythema, pain, tenderness and/or discharge from the contact site. If there was clinical suspicion of infection, discharge from the infection site was collected on two swabs and immediately transported to the microbiology laboratory. On receipt in the microbiology laboratory, one swab was used to prepare direct smears followed by Gram staining and the second swab was inoculated on 5% sheep blood agar and MacConkey agar and incubated at 37°C. The following morning, the plates were examined for growth. If there was no growth, the plates were incubated for another 24 hours. If any growth was seen, it was identified based on colony morphology, bacterial morphology on gram stain and biochemical reactions as per standard laboratory methods [6,7].

Antibiotic susceptibility testing was done as per Clinical Laboratory Standards Institute (CLSI 2016) guidelines with modified Kirby Bauer's disc diffusion method using Mueller Hinton medium. The antibiotic tested were ampicillin (10 μg), amikacin (30 μg), amoxycillin-clavulanic acid (20 μg/10 μg), ceftazidime (30 μg), cefotaxime (30 μg), ceftriaxone (30 μg), chloramphenicol (30 μg), ciprofloxacin (5 μg), ertapenem (10 μg), gentamycin (10 μg), imipenem (10 μg), levofloxacin (5 μg), piperacillin (100 μg), piperacillin-tazobactam (100 μg/30 μg), tetracycline (30 μg), tobramycin (10 μg), and trimethoprim-sulfamethoxazole (1.25 μg/23.75 μg) [8]. The antibiotic discs were procured from Himedia, Mumbai, Maharashtra, India.

STATISTICAL ANALYSIS

All the data was entered and analysed in Microsoft Excel 2010 and expressed as percentages.

RESULTS

A total of 30 patients who had external fixators within the study period of two months were reviewed. There were 27 (90%) male and 3 (10%) female patients. Male to female ratio was 9:1. Age of patients ranged from 16 to 60 years with a mean of 37 years.

Age (years)	Male n (%)	Female n (%)
11-20	3 (10)	1 (3)
21-30	7 (23)	1 (3)
31-40	6 (20)	--
41-50	6 (20)	1 (3)
51-60	4 (12)	--
>60	1 (3)	--
Total	27 (90)	3 (10)

[Table/Fig-1]: Age and gender distribution of patients (N=30).

Age and gender distribution of patients is depicted in [Table/Fig-1]. The symptoms observed in the patients were pain, discharge and fever [Table/Fig-2]. The external fixators used included AO external fixators, Ilizarov rings, Jess fixators and K-wires. The bone more frequently requiring external fixation in the present study were the tibia (2), femur (1), humerus (1), ulna (1) and pelvis (1). The most common risk factor associated was increased thickness of soft tissue over the bone (4) and increased soft tissue motion (2).

Among the 30 patients included in the study, 6 (20%) patients showed clinical evidence of pin tract infections [Table/Fig-2]. The frequency of infection was more among the males (17%) compared to females (3%). Positive cultures were obtained from all the six samples. *Acinetobacter baumanii* was the most common causative agent followed by *Pseudomonas aeruginosa*, *Citrobacter koseri*, *Enterobacter* species and *Klebsiella pneumoniae*. The isolated organisms exhibited varied pattern of antimicrobial susceptibility as shown in [Table/Fig-3]. Among the isolates of *Acinetobacter baumanii*, one isolate was sensitive to amikacin, gentamycin, tobramycin, ciprofloxacin, levofloxacin, tetracycline and cotrimoxazole. Both the isolates were resistant to β-lactam group and β-lactam-β-lactamase inhibitor drugs like piperacillin, ceftazidime, imipenem and piperacillin/tazobactam. *Pseudomonas aeruginosa* was sensitive to all the drugs tested. *Enterobacter* species and *Citrobacter koseri* were sensitive to tetracycline, imipenem and ertapenem as shown in [Table/Fig-3].

Out of six infected patients, one patient had osteomyelitis. In this case, the pin was removed and antibiotic therapy was followed. The patient responded to the treatment. The remaining five were simple infections involving the soft tissues. All these cases were treated with antibiotics as per sensitivity pattern and responded to the treatment [Table/Fig-2].

Organism isolated	Number (%)	Type of external fixator	Symptoms	Treatment
Acinetobacter species	2 (6.8)	CRIF with external fixator	Pain and discharge	Amikacin/Levofloxacin/Tetracycline
		Illizarov ring	Discharge	Amikacin/Levofloxacin/Tetracycline
Citrobacter koseri	1 (3.3)	External fixator	Fever, pain, discharge	Imipenem/Chloramphenicol
Enterobacter species	1 (3.3)	Illizarov ring	Discharge	Imipenem/Levofloxacin/Tetracycline
Pseudomonas aeruginosa	1 (3.3)	External fixation	Fever, discharge	Levofloxacin/Imipenem
Klebsiella pneumoniae	1 (3.3)	Illizarov ring	Fever, pain, discharge	Amikacin/Levofloxacin/Imipenem

[Table/Fig-2]: Showing the organisms isolated along with frequency, type of external fixator and treatment.
CRIF: Closed reduction internal fixation

Antibiotic tested	*Acinetobacter baumanii*, n=2 (%)	*Enterobacter* spp., n=1 (%)	*Citrobacter koseri*, n=1	*Pseudomonas aeruginosa*, n=1	*Klebsiella pneumoniae*, n=1
Amikacin	1 (50)	0 (0)	0 (0)	1 (100)	1 (100)
Ampicillin	NT	0 (0)	0 (0)	NT	0 (0)
Amoxycillin-Clavulanic acid	NT	0 (0)	0 (0)	NT	1 (100)
Cefotaxime	NT	0 (0)	0 (0)	NT	0 (0)
Ceftazidime	0 (0)	0 (0)	0 (0)	1 (100)	0 (0)
Ceftriaxone	NT	0 (0)	0 (0)	NT	0 (0)
Chloramphenicol	NT	0 (0)	1 (100)	NT	1 (100)
Ciprofloxacin	1 (50)	0 (0)	0 (0)	1 (100)	0 (0)
Ertapenem	NT	1 (100)	1 (100)	NT	1 (100)
Gentamicin	1 (50)	0 (0)	0 (0)	1 (100)	1 (100)
Imipenem	0 (0)	1 (100)	1 (100)	1 (100)	1 (100)
Levofloxacin	1 (50)	1 (100)	0 (0)	1 (100)	1 (100)
Piperacillin	0 (0)	0 (0)	0 (0)	1 (100)	0 (0)
Piperacillin-tazobactam	0 (0)	0 (0)	0 (0)	1 (100)	1 (100)
Tetracycline	1 (50)	1 (100)	1 (100)	NT	1 (100)
Tobramycin	1 (50)	0 (0)	0 (0)	1 (100)	1 (100)
Trimethoprim-sulfamethoxazole	1 (50)	0 (0)	0 (0)	1 (100)	1 (100)

[Table/Fig-3]: Antibiotic sensitivity pattern of the isolates with pin track infections.
NT: Not tested
Note: The number within the brackets denotes the number of organisms susceptible to the antibiotic. The number outside the bracket denotes the number of organisms resistant to the antibiotic

DISCUSSION

Pin tract infection is the most common complication of external fixation method of fracture treatment [9]. This complication can be catastrophic if not diagnosed and treated early. The complications can vary from decrease in stability of the pin–bone interface to severe osteomyelitis. There is no consensus on the precise definition of a pin site infection, but this frequent complication of external fixation is a cause of considerable cost and patient morbidity. In the present study, an attempt was made to study the common microorganisms responsible for pin tract infections and their antibiotic sensitivity pattern in a tertiary care hospital.

A total of 30 patients who had external fixators during the study period were followed-up. The incidence of pin tract infections was (20%) in the present study. Other studies have reported incidence ranging from (11%), and (87.7%) [10,11].

The commonest organism isolated in a similar study was *Staphylococcus aureus* followed by *E. coli.* Mahan J et al., reported 74.8% of screw tips culture positive at removal, with a higher rate of gram-positive bacteria which includes *Staphylococus aureus* and *Staphylococcus epidermidis* [12]. The organisms isolated in present study were *Acinetobacter baumanii*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Citrobacter koseri* and *Enterobacter* species which probably are hospital acquired. These isolates were found to be multidrug resistant strains.

The literature is limited with regard to prevention of pin site infection and there is no valid evidence to guide choice of dressing type, cleansing regimen, or other aspects of pin site infections and its care. Similar studies were done regarding the same. The rate of inflammation was (41.6%) and pin loosening was (22.9%) at the pin tract as reported by Mahan J et al., [12]. In the present study, the commonest complication was discharge from the site of infection which required frequent cleaning and antibiotics. Pin tract infection rate was (11.2%) in a study conducted by Parameswaran AD et al., [13].

Data on antibiotic susceptibility testing from isolates of pin tract infection is minimal. In the present study multidrug resistant pathogens were isolate which accounts for hospital acquired infections.

Limitation(s)

As the sample size was less, these findings should be extrapolated with caution. Further studies of similar kind with a larger sample size are necessary to establish diagnostic and therapeutic protocols for pin tract infections in our hospital.

CONCLUSION(S)

Pin tract infection occurred in (20%) of the patients. In view of increased emergence of drug resistance there is a need for diagnosing pin tract infections. Early detection and treatment reduce the economic burden on the patient and decreased hospital stay. Further improving the prognosis and outcome.

REFERENCES

[1] Sims M, Saleh M. External fixation- The incidence of pin site infection: A prospective audit. J Ortho Nur. 2000;4(2):59-63.

[2] Schalamon J, Petnahazy T, Herwig Ainoedhofer, Zwick BE, Singer G, Hoellwarth ME. Pin tract infection with external fixation of pediatric fractures. J Pediatr Surg. 2007;42(9):1584-87.

[3] Kazmers NH, Frogomen AT, Rozbruch R. Prevention of pin site infection in external fixation: A review of literature. Strat Traum Limb Recon. 2016;11(2):75-85.

[4] Ferraria N, Marias LC. Pin tract sepsis: Incidence with the use of circular fixators in a limb reconstruction unit. SA Orthopaedic Journal Autumn. 2012;11(1):40-48.

[5] Kortor JN, Kpela TM, Poopola SO. Pin-tract infections following external fixation of open fractures. J Med Trop. 2011;13(2):105-08

[6] Koneman EW, Allen SD, Janda WM, Schreckenberger PC, Winn WC. 'Introduction of Microbiology Part 1: The role of the microbiology laboratory in the diagnosis of infectious diseases: Guidelines to practice and management' Koneman's Colour Atlas and Textbook of Diagnostic Microbiology, 6th Ed; Baltimore Lippincott Williams and Wilkins. 2006:30-31.

[7] Overview of Bacterial Identification Methods and Strategies in: Forbes, BA, Sahm DF, Weissfeld AS (Eds). Bailey & Scott's Diagnostic Microbiology, 12th Ed. USA: Elsevier; 2007:216-47.

[8] Clinical Laboratory Standards Institute: Performance standards for antimicrobial susceptibility testing; 24th informational supplement, CLSI M100-S24, Vol. 34 No. 1. Wayne, PA: Clinical Laboratory Standards Institute; 2016.

[9] Antoci V, Ono CM, Raney EM. Pin tract infection during limb lengthening using external fixation. Am J Orthop. 2008;37(9):150-54.

[10] Trumpuz A, Zimmerli W. Diagnosis and treatment of infections associated with fracture fixation devices. Injury. 2006;37(Suppl 2):59-66.

[11] Mohammed RM, Atinga EO, Sitati FC, Gakuya EM. Pin tract infections after uniplanar external fixation of open fractures at a national, teaching and referral hospital. East Centr Afr J Surg. 2017;22(1):42-48.

[12] Mahan J, Seligson D, Henry SL, Hynes P, Dobbins J. Factors in pin tract infections. Orthopedics. 1991;14(3):305-08.

[13] Parameswaran AD, Roberts CS, Seligson D, Voor M. Pin tract infection with contemporary external fixation: How much of a problem. J Orthop Trauma. 2003;17(7):503-07.

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