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Does pin tract infection after external fixator limits its advantage as a cost-effective solution for open fractures in low-middle income countries, a prospective cohort study

Faaiz Ali Shah

Mian Amjad Ali

Vickash Kumar

Waqar Alam

Obada Hussein Hasan
Aga Khan University, obada.husseinali@aku.edu

RESEARCH ARTICLE

Does pin tract infection after external fixator limits its advantage as a cost-effective solution for open fractures in low-middle income countries, a prospective cohort study

Faaiz Ali Shah,[1] Mian Amjad Ali,[2] Vickash Kumar,[3] Waqar Alam,[4] Obada Hasan[5]

Abstract

Objectives: To determine the frequency of pin tract infection in external fixator tibia and its effects on the definite fracture fixation and bone healing.

Methods: The prospective study was conducted at Lady Reading Hospital, Peshawar, Pakistan, from August 2017 to July 2018, and comprised patients regardless of age and gender with open fracture tibia Gustillo-Anderson type II and type IIIA. Pin tract infection was assessed following the application of locally made external fixation of tibia open fractures. Follow-up was done fortnightly till soft tissue healing, removal of external fixator and definite fracture healing. Pin tract infection was classified and treated according to the Checketts-Otterburn classification system. SPSS 20 was used for data analysis.

Results: Of the 117 patients, 95(81%) were males and 22(19%) were females with an overall mean age of 24.7±9.35 years. Pin tract infection was documented in 28(23.9%) patients. Minor and major pin tract infections were reported in 27(96.4%) and 1(3.5%) patient respectively. Soft tissues healed in 27(96.4%) cases.

Conclusion: External fixator for initial stabilisation of open tibial fractures in all patients is recommended.

Keywords: External fixator, Tibia fracture, Pin tract infection. (JPMA 69: S-41; 2019)

Introduction

Fracture of the tibial shaft is one of the commonest long bone to fracture[1] with an annual incidence of 3.4/10 open tibial fractures in the general population.[2] Due to the subcutaneous location of tibia, direct control of fracture reduction, simple, quick and easy application of the implant and early postoperative mobility of the patient, external fixation is the treatment of choice in open fracture tibia.[3] Pin tract infection (PTI) is unfortunately considered a universal complication of this device,[4] and incidence ranging from 6.6% to 56.6% have been reported.[5,6] PTI is defined as redness, warmth or discharge around the schanz screws of the external fixator, causing increasing pain, pin loosing or positive culture of discharge around the pins.[7] PTI can lead to serious complications of deep tissue infection and osteomyelitis in about 4% patients and which can results in severe pain, use of excessive medications, prolonged immobilisation and pin loosing.[8,9] Infected pins are removed and exchanged or external fixator abandoned in cases not responding to local care and antibiotics.[8]

Many patients with open tibial fractures regularly report at our facility and majority of them are initially temporarily stabilised with locally made external fixators which are economically feasible for low-income patients. Once the soft tissues are healed, definitive fracture fixation is carried out. But no study on this issue has been done till now in our setup. The current study was planned to determine the frequency of PTI in external fixator tibia and its effects on the definite fracture fixation and bone healing.

Patients and Methods

The prospective study was conducted at Lady Reading Hospital, Peshawar, Pakistan, from August 2017 to July 2018, and comprised patients regardless of age and gender with

[1,2]Department Of Orthopaedics, Lady Reading Hospital Peshawar, [3]South City Hospital Karachi, [4]District Headquarter Hospital Temargara Lower Dir KPK, [5]Department of Surgery, Section of Orthopaedics, The Aga Khan University Hospital, Karachi Pakistan.

Correspondence: Obada Hasan. e-mail: Obada.husseinali@aku.edu

open fracture tibia Gustillo-Anderson type II and type IIIA. Protocol was developed before starting the study, and the sample size was calculated using World Health Organisation (WHO) formula[10] with confidence level of 95% and margin of error 9%. Non-probability convenience sampling was used, and approval was obtained from the institutional review committee. Also, informed consent was taken from either the patients or their guardians. The work has been reported in line with the Strengthening the Reporting of Cohort Studies in Surgery (STROCSS) criteria.[11]

Open fractures tibia received after 24 hours, fractures with intra-articular extension, bilateral tibial fractures, open fractures with bone loss, segmental fractures, associated pelvic and acetabulum fractures, ipsilateral open femur fracture requiring external fixator and patients operated for external fixator tibia in other hospitals were excluded from the study. All patients were assessed and resuscitated according to the Advanced Trauma Life Support (ATLS) protocol.[12] All patients were assessed by the on-call orthopaedic resident and the case was then discussed with the consultant on duty. Radiographs of the affected extremity were taken. Associated head, chest and abdominal injuries were looked for and treated accordingly. Patients were given one dose of a second-generation intravenous (IV) antibiotics and anti-tetanus toxoid.

Surgery was done under general or spinal anaesthesia. Wound was washed with 3 to 9 litres of normal saline and extensive debridement of the wound was done. Fracture was reduced directly through the wound or indirectly without opening the fracture site when extensive comminution was present on X-ray. A locally made Arbeitsgemeinschaft für Osteosynthesefragen (AO) external fixator (ESMECO) with at least 4 Schanz screws. The standard technique[13] of external fixator application was adopted in all cases. No tourniquet was used. Appropriate size Schanz screws were used (6mm diameter in adults and 4.5mm in children). In every case the screw diameter was <33% of the diameter of the bone. All cases were done by a qualified orthopaedic surgeon or an orthopaedic trainee with minimum 3 years of experience in handling such cases and under supervision.

The wound was left open or partially closed depending upon the degree of contamination and coverage of the bone. The affected limb was elevated for 24 hours. Patients were discharged on the 2nd post-op day. Only those patients were retained who needed further debridement, wound closure or additional fracture fixation. A uniform protocol of Kazmers[13] for pin tract care was started from the second post-op day. Each pin site was cleaned with sterile gauze soaked in a mixture of solution containing hydrogen per oxide and normal saline in 1:1 ratio daily. After cleaning, each pin site was covered with dry sterile gauze. On the 4th post-op day, the leg, the frame and the pin site were washed with water and soap, dried with a towel, and the pin site was covered with sterile dry gauze. Non-weight bearing with crutches was allowed. Patients of PTI were advised dressing twice daily, restricted weight bearing and elevation of the affected limb. Pin tract discharge was sent to laboratory for culture and sensitivity in cases of major PTI not resolving with pin site care protocols. Antibiotics were started accordingly. In case of resistant PTI with multiple loose pins, the external fixator was removed and alternative treatment option was adopted.

Patients were followed during admission and after discharge on a fortnightly basis till soft tissue healing (8th week). Contact numbers and addresses of all the patients were noted and hospital contact number was given and they were advised to contact earlier than scheduled visit if PTI signs and symptoms were noted. On each scheduled visit, wound condition of the limb was inspected and assessed by the primary consultant followed by detailed assessment of the radiographs for fracture alignment and healing. Pin tracts were inspected and infection, if present, was graded and treated with Checketts-Otterburn classification[14] of PTI of external fixator (Table 1). The effects of pin site infection on outcome of external fixator was documented as either infection treated and definitive implant applied or pin

Table-1: Checketts-Otterburn classification of pin tract infection of external fixator.

Grade	Characteristics	Treatment
	Minor infection	
I	Slight redness and little discharge	Improved pin site care
II	Redness of the skin, discharge, pain and tenderness in the soft tissue	Improved pin site care and oral antibiotics
III	Grade II but no improvement with oral antibiotics	Affected pin or pins re-sited and external fixator can be continued
	Major infection	
IV	Severe soft tissue infection involving several pins, sometimes with associated loosening of the pin	External fixation must be abandoned
V	Grade IV but radiographic changes	External fixator must be abandoned
VI	Infection after fixator removal. Pin track heals initially, but will subsequently break down and discharge in intervals. Radiographs show new bone formation and sometimes sequestrums.	Curettage of the pin tract

loosening requiring removal of external fixator and conversion to other treatment modality.

Data collected was analysed using SPSS 20. Mean ± standard deviation (SD) was calculated for continuous variables like age and time since injury. Frequency and percentages were calculated for categorical variables like gender and fracture side.

Results

Of the 117 patients, 95(81%) were males and 22(19%) were females with an overall mean age of 24.7±9.35 years. Paediatric patients were 14(11.9%) with a mean age of 6.07±2.05 years. Cause of injury in each case was noted (Table 2). Overall, 68(58.1%) patients were received in hospital within 6 hours of sustaining the fractures, while 49(42%) were received within 6-12 hours. Depending upon the fracture site and geometry, external fixator was applied in uniplanar configuration in 85(72.6%) patients, proximal triangular in 18(15.3%), distal triangular across ankle in 9(7.6%) and bilateral uniplanar across ankle in 5(4.2%) patients.

PTI was documented in 28(23.9%) patients. Of them, 22(75.5%) were males, including 4(18.18%) children, and 6(21.4%) were female patients. Among the patients with PTI, 7(25%) were diabetics and 11(39.2%) were smokers. The pin site infection was of minor type in 27(96.4%) of these patients. Minor grade I pin tract infection was reported in 23(82.1%) patients and resolved with pin site care. Grade II infection was documented in 4(14.2%) patients, and the discharge was sent to laboratory for culture and sensitivity. There was no growth in 3(75%) patients and staphylococcal aureus in 1(25%) patient which was sensitive to most of the commonly used oral antibiotics. Grade II infection in patients was successfully treated with pin site care and oral antibiotics with external fixator in place. External fixator was removed after soft tissue healing and plating was done in 13(46.4%) patients and interlocking nails in 8(28.5%) patients, while 6(21.4%) patients, including 4(66.6%) children, achieved union in external fixator.

Only 1(3.5%) patient developed major PTI of Grade IV. It was a distal tibial triangular fixator applied for Gustillo Anderson type IIIA fracture. Culture and sensitivity of pin site discharge reported staphylococcal aureus and sensitivity to only linezolid and vancomycin. Since multiple Schanz screws had pin site infection and were loose, external fixators were removed before the scheduled time at 6th week. Backslab was given and regular debridement and dressing of pin site with antibiotic cover was continued till infection was cleared clinically and serologically, and interlocking nails was done as definitive treatment.

The total number of infected Schanz screws was 41 in 28(24%) patients. Distal tibial Schanz screw was the most frequently infected screw in 22(53.6%) patients followed by proximal tibial in 10(24.3%), calcanium 7(17%) and diaphyseal 2(4.8%). Overall, 18(64.2%) had one Schanz screw infected. Two screws had pin tract infection in 7(25%) patients, while the maximum number of infected Schanz screws per patient was three in 3(10.7%) patients.

The mean duration of external fixator retention was 4.4 weeks (range: 3.2-8 weeks). Besides, 89(76%) patients had no PTI and in 71(79.7%) of them external fixator was removed at 4th week post-op after soft tissues healing, and other treatment modality (interlocking nail, plating) was done. Also, in 22(78.5%) patients with PTI, the external fixators were retained for 6 weeks or more till soft tissues healed.

Only in 6(21.4%) patients, PTI was noted in the 4th week post-op. With the exception of 1(3.5%) patient who developed PTI, the infection didn't influence definite fracture fixation in other patients. No osteomyelitis was reported.

Table-2: Injury profile of patients.

S.No	Patient demographic feature	Number of patients	Percentage
1	Right tibia fracture	75	64.1%
2	Left tibia fracture	42	35.8%
3	Motor vehicle accident	63	53.8%
4	Gun shot injury	38	22.4
5	Fall from height	9	7.6%
6	Heavy object falling on the limb	7	5.9%
7	Gustillo Anderson type IIIA	75	64.1%
8	Gustillo Anderson type II	42	35.8%

Discussion

We noted pin site infection in 23.9% patients. Comparing our results with other national and international studies (Table 3) there is a large discrepancy. This can be explained

Table-3: Frequency of pin tract infection in different studies.

S.No	Author	Year of Study	Frequency of pin tract infection
1	Iobst CA[16]	2016	24%
2	Piwani M[6]	2015	6.6%
3	Khan TB[5]	2012	56.6%
4	Hussain S[18]	2011	25%
5	Beltsios M[17]	2009	27.7%
6	Present study	2018	23.9%

by the fact that no consensus has been achieved globally till now regarding a uniform definition, classification and pathogenesis of PTI.[13,15] Secondly, differences exist in techniques of application of external fixator, protocol for pin tract care, population demographics and duration of study.[16] Thirdly, pin site infection rate is considered per patient in some studies and per individual pin in others.[13] Furthermore, in almost all local studies, external fixator was continued as a definitive treatment for fracture fixation rather than a temporary device for soft tissue healing. This results in prolonged duration of external fixator application and subsequently higher frequencies of PTI and complications.

We observed that the longer the external fixator was retained, the higher were the chances of PTI. External fixator for 6 weeks or more was associated with 78.5% PTI than 21.4% of patients developing PTI at 4th week. We are supported by other studies in this regard.[17,18] A study[18] reported PTI 19.6% in fixators retained for 42 days than 47.8% in those over 180 days. It also reported that hydroxy appetite (HA)-coated Schanz screws had an infection rate of 29.5% and non-HA-coated screws had 25.9%. Unfortunately we could not analyse PTI in HA-coated screws. The study,[18] also documented PTI decade-wise globally and pointed out that in 1980s it was 23.2%, in 1990s 25.9% and in 2000 it was 36.1%. It also noted a higher frequency of PTI in paediatric patients. The reasons, according to the study,[18] were inability of children to care for the pins themselves and extra mobility and sports activity made the pins more prone to contamination and early loosening. We reported PTI in only 4 of the 14 children with external fixators. All were minor grade I infection and were completely resolved with pin site care. We also noted a difference in infection rate of Schanz screws in different locations. Schanz screws inserted in periarticular locations like distal tibial and by proximal tibial Schanz screw were the most frequently infected (53.6% and 24.3% respectively). A study[17] reported similar findings and suggested increased motion of soft tissues around the joint as possible explanation for increased frequency of PTI in these locations.

The worst consequence of PTI is osteomyelitis which has been reported in 1-4%.[8,19] But we did not note any osteomyelitis. The possible reasons can be shorter duration of external fixator, strict regular follow-up, early recognition of PTI and prompt treatment.

We used external fixator as a temporary device for stabilising open tibial fractures till soft tissue healing. External fixator for prolonged duration and as a definitive treatment option has a number of reported complications.[6,20] These include frame loosening in about 12.5% and delayed union in 10-38.3%,[20] malunion in 3.3-21.7% 6 and non-union in 3.3-40%.[16]

Prevention is always better than cure. To prevent PTI, planning should start in the operation theatre, with the selection of an appropriate external fixator.[15] The pin-bone interface must be optimally stabilised.[4,8] The standard technique of insertion of Schanz screws can decrease the chances of PTI. Sharp drill bit with low-velocity drilling taking care of soft tissues and insertion of Schanz pin manually with hand chuck is recommended.[13] The use of tourniquet while applying external fixator is not recommended[21] as it would prevent "cooling" of the bone by blood, causing heat necrosis of bone and post-tourniquet haematoma formation, hence, increased chances of PTI. Although no uniform pin tract protocol has been agreed upon, it is suggested that if any signs of infection is noted at pin site areas then the frequency of care should be intensified.[15] Antibiotic prophylaxis for PTI in open fractures is lacking evidence.[22] We used locally made AO external fixator in all of our cases. This external fixator is readily available, easy and quick to apply and economically feasible for low-income patients compared to foreign made external fixators or ring fixators which are expensive, difficult to apply and time-consuming. This external fixtor is biomechanically excellent as we have not noted any breakage or failure of its component in our study. Furthermore pin tract care with hydrogen peroxide and normal saline is easy to apply and readily afforded by poor patients.

Our study questions the common clinical dilemma of PTI after external fixator and whether it limits its advantage as a cost-effective primary solution for tibia open fracture in our developing-country setting. The prospective nature of the study allowed us to detect and manage PTIs early, preventing their catastrophic effect on bone healing or osteomyelitis.

The sample size of our study, however, was relatively small to derive strong associations. The lack of standardised protocol for pin tract classification and care is also a potential limitation of the study. Further research, including randomised clinical trials, should be done to study the differences between temporary and definitive fixation and evaluation of different variables, like frequency

of pin tract cleaning, dressing and antiseptic solutions, smoking and diabetes in positive cases of PTI to establish firm guidelines.

We recommend external fixator for open fractures tibia, especially in low-income patients. However, the longer the external fixator is retained, the greater are the chances of PTI. Early recognition of PTI by the patient as well as the operating surgeon is essential for the initiation of prompt treatment and prevention of complications. Pamphlet distribution to patients with external fixator, advising pin tract care, maybe useful for pin tract care at home.

Conclusion

Pin tract infection is common after external fixator tibia. Majority of PTI was of minor grade, and resolved with pin tract care and antibiotics without affecting the definitive fracture fixation and bone healing.

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