Clinical Article

Pin tract sepsis: Incidence with the use of circular fixators in a limb reconstruction unit

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Abstract

Background

Pin site-related problems remain one of the most common complications in the realm of limb reconstructive surgery. Several factors determine the integrity of the bone–pin interface, including the insertion technique, the mechanical forces applied through the frame and the selected pin site care protocol. Pin site complications can be catastrophic as they may lead to failure of the bone–pin interface and, possibly, osteomyelitis.

Methods

Between July 2008 and July 2011, 111 patients at our Limb Reconstruction Unit were treated with circular external fixators. These patients' records were reviewed with regard to pin site complications, treatment thereof and outcome.

Results

Eighty patients met the inclusion and exclusion criteria. Pin site infection was found in 21 patients (26.25%). One patient had a major infection, which required debridement of the pin tract. The remaining 20 cases were all minor infections that responded to local treatment and oral antibiotics.

Conclusion

Circular external fixation remains a safe treatment method, with the majority of pin site complications being of a minor nature that respond readily to local treatment and oral antibiotics.

Key words: Pin site, complications, external fixation

Introduction

External fixation, and in particular, circular external fixation, is an essential component of contemporary limb reconstructive surgery. Pin site infection is, however, often noted as a major complication, and may act as a deterrent against the utilisation of these techniques.[1,2]

The majority of pin site complications were of a minor nature and responded readily to local treatment and oral antibiotics

Table I: Checketts-Otterburn classification

Grade	Characteristics	Treatment
Minor infection		
1	Slight redness, little discharge	Improved pin site care
2	Redness of the skin, discharge, pain and tenderness in the soft tissue	Improved pin site care, oral antibiotics
3	Grade 2 but no improvement with oral antibiotics	Affected pin or pins resited and external fixation can be continued
Major infection		
4	Severe soft tissue infection involving several pins, sometimes with associated loosening of the pin	External fixation must be abandoned
5	Grade 4 but radiographic changes	External fixation must be abandoned
6	Infection after fixator removal. Pin track heals initially, but will subsequently break down and discharge in intervals. Radiographs show new bone formation and sometimes sequestra	Curettage of the pin tract

The incidence of pin site infection varies greatly, with the published figures ranging from 11.3% to 100%.[3-11] Mostafavi reported a 71% incidence of pin site infection in reconstructive surgery.[8] The high incidence of pin tract complications reported in limb reconstruction surgery may be related to the long periods of time spent in the external fixator and high demands placed on the bone–pin interface during bone transport and deformity correction.

In order to minimise the complications of pin loosening and sepsis, a protocol that includes attention to external fixator design and biomechanics,[3] intra-operative insertion technique[10] and post-operative care should be instituted.[5] The primary goal is to establish a stable bone–pin interface that will withstand the stresses transferred during the reconstruction period.[3,12]

In this article we report the incidence of pin tract complications encountered at our institution, using a pin tract protocol that is inexpensive, simple and effective.

Materials and methods

The study population consisted of all patients who were treated with circular external fixators in a three-year period from July 2008 to July 2011. Patients were included if they had completed treatment and the external fixator had been removed. Patients were excluded if the external fixator had not been applied at our institution, or the records were insufficient with regard to the required data.

The patients' charts were reviewed and information extracted regarding patient demographics, indications for circular fixation, type of fixator used, pin tract complications and treatment of these complications. Pin site infections were graded according to the Checketts and Otterburn classification[13] (*Table I*).

Results

The charts of 111 patients were reviewed. Eighty patients (59 males and 21 females) were included (*Table II*). The mean age was 37.7 years, ranging from 9 years to 66 years. The indications for the use of these external fixators are listed in *Table III*. The external fixators applied consisted of 41 Ilizarov fixators (Smith & Nephew, Memphis, TN), 20 Truelok fixators (Orthofix, Verona, Italy) and 19 Taylor Spatial Frame fixators (Smith & Nephew, Memphis, TN).

In 58 out of 80 patients (72.5%) no pin site complications occurred. The remaining 21 patients (26.25%) all had pin tract infection of at least one wire or half pin. Twenty of these infections were minor according to the Checketts-Otterburn classification, while the remaining infection was classified as major.

The minor infections were subdivided into one grade 1, 15 grade 2 and four grade 3 infections. The grade 1 infection resolved with meticulous pin site care without any further intervention. All the grade 2 infections responded to local pin site care and a course of oral antibiotics. All four grade 3 infections were managed with removal of the offending wire which led to resolution of the infection. One wire was resited elsewhere as we felt that frame stability could be compromised by the removal of the infected wire.

Table II: Patient details

Patient	Age	Gender	Fixator	Indication	Time in frame (Weeks)	Pin tract sepsis	Checketts & Otterburn Grade	Treatment
J.J.	27	M	Ilizarov	Bone transport tibia	104	Yes	3	Wire removed
P.M	39	F	Ilizarov	Bone transport tibia	36	Yes	2	Oral antibiotics
T.D.	27	M	Ilizarov	Bone transport tibia	34	No	-	-
T.T.	40	M	Truelok	Bone transport tibia	65	No	-	-
S.P.	25	M	Truelok	Bone transport tibia	11	No	-	-
P.M.	44	M	Ilizarov	Bone transport tibia	29	Yes	2	Oral antibiotics
N.S.	9	F	Truelok	Bone transport tibia	12	No	-	-
P.S.	27	F	Truelok	Bi-Masquelet tibia	36	No	-	-
B.M.	49	M	Truelok	Bi-Masquelet tibia	24	No	-	-
A.H.	26	M	Ilizarov	Bi-Masquelet tibia	29	No	-	-
T.J.	34	M	Ilizarov	Non-union tibia	6	No	-	-
H.H.	50	F	Truelok	Non-union tibia	18	No	-	-
N.M.	21	F	Ilizarov	Non-union tibia	24	No	-	-
S.D	25	M	Truelok	Non-union tibia	25	Yes	2	Oral antibiotics
B.G.	55	M	Truelok	Non-union tibia	22	No	-	-
N.N.	57	F	Truelok	Infected non-union tibia	28	No	-	-
T.N.	24	M	Truelok	Complex fracture tibia	50	No	-	-
M.L.	23	M	Truelok	Complex fracture tibia	19	No	-	-
P.S.	27	F	Truelok	Complex fracture tibia	36	No	-	-
L.G.	44	M	Ilizarov	Complex fracture tibia	50	No	-	-
M.M.	40	M	Ilizarov	Complex fracture tibia	4	No	-	-
M.L.	30	M	Truelok	Complex fracture tibia	12	No	-	-
S.M.	18	M	Ilizarov	Complex fracture tibia	50	No	-	-
P.S.	50	M	Ilizarov	Complex fracture tibia	26	No	-	-
S.M.	59	M	Ilizarov	Complex fracture humerus	16	No	-	-
D.N.	36	F	Truelok	Tumour resection tibia	54	Yes	3	Wire removed and resited
M.M.	26	M	Ilizarov	Chronic osteitis tibia	38	No	-	-
M.M.	26	M	Ilizarov	Chronic osteitis tibia	38	No	-	-
S.M.	23	M	Ilizarov	Periarticular fracture tibia	9	No	-	-
R.M.	43	F	Ilizarov	Periarticular fracture tibia	12	No	-	-
M.S.	35	M	Ilizarov	Periarticular fracture tibia	8	No	-	-
M.L.	14	M	Ilizarov	Periarticular fracture tibia	11	No	-	-
X.X.	38	M	Ilizarov	Periarticular fracture tibia	36	No	-	-

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Patient	Age	Gender	Fixator	Indication	Time in frame (Weeks)	Pin tract sepsis	Checketts & Otterburn Grade	Treatment
X.B.	29	M	Ilizarov	Periarticular fracture tibia	18	No	-	-
M.M.	34	M	Ilizarov	Periarticular fracture tibia	19	No	-	-
A.N.	40	F	Ilizarov	Periarticular fracture tibia	20	Yes	2	Oral antibiotics
M.N.	57	M	Ilizarov	Periarticular fracture tibia	17	Yes	2	Oral antibiotics
E.M.	59	F	Ilizarov	Periarticular fracture tibia	28	No	-	-
S.N.	19	M	Ilizarov	Periarticular fracture tibia	23	No	-	-
N.N.	56	F	Ilizarov	Periarticular fracture tibia	26	Yes	2	Oral antibiotics
N.T.	42	M	Ilizarov	Periarticular fracture tibia	20	Yes	2	Oral antibiotics
F.M.	37	M	Ilizarov	Periarticular fracture tibia	20	No	-	-
N.M.	21	F	Ilizarov	Periarticular fracture tibia	16	No	-	-
D.N.	41	F	Ilizarov	Periarticular fracture tibia	17	No	-	-
P.M.	66	M	Ilizarov	Periarticular fracture tibia	14	No	-	-
M.K.	40	M	Truelok	Periarticular fracture tibia	14	Yes	2	Oral antibiotics
L.M.	50	M	Ilizarov	Periarticular fracture tibia	12	Yes	3	Wire removed
B.N.	27	M	Ilizarov	Periarticular fracture tibia	16	No	-	-
S.K.	59	M	Ilizarov	Periarticular fracture tibia	10	No	-	-
T.M.	41	F	Truelok	Periarticular fracture tibia	21	No	-	-
M.N.	46	M	Ilizarov	Periarticular fracture tibia	20	No	-	-
S.D.	33	M	Ilizarov	Periarticular fracture tibia	13	No	-	-
A.N.	43	F	Ilizarov	Periarticular fracture tibia	9	No	-	-
S.Z.	57	M	Truelok	Periarticular fracture tibia	13	No	-	-
S.Z.	57	M	Truelok	Periarticular fracture tibia	13	No	-	-
A.M.	45	M	Ilizarov	Periarticular fracture tibia	19	Yes	3	Wire removed
M.S.	36	M	Ilizarov	Periarticular fracture tibia	15	No	-	-
T.N.	24	M	Truelok	Periarticular fracture tibia	50	No	-	-
T.S.	53	F	Ilizarov	Periarticular fracture tibia	10	No	-	-
P.C.	54	M	Ilizarov	Periarticular fracture tibia	32	No	-	-
M.X.	40	M	Truelok	Periarticular fracture tibia	16	No	-	-
H.G.	48	F	TSF	Deformity correction tibia	7	No	-	-
K.S.	32	F	TSF	Deformity correction knee	22	Yes	2	Oral antibiotics
T.M.	29	M	TSF	Deformity correction tibia	32	No	-	-
J.K.	43	F	TSF	Deformity correction tibia	50	Yes	2	Oral antibiotics
S.S.	30	M	TSF	Deformity correction tibia	16	No	-	-
N.F.	58	M	TSF	Deformity correction tibia	16	No	-	-
J.K.	53	M	TSF	Deformity correction tibia	14	Yes	1	Pin site care

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In 58 out of 80 patients (72.5%) no pin site complications occurred

Patient	Age	Gender	Fixator	Indication	Time in frame (Weeks)	Pin tract sepsis	Checketts & Otterburn Grade	Treatment
B.K.	57	M	TSF	Deformity correction tibia	33	No	-	-
S.Z.	23	M	TSF	Deformity correction tibia	15	No	-	-
T.L.	46	M	TSF	Deformity correction tibia	39	Yes	2	Oral antibiotics
F.Z	25	F	TSF	Deformity correction tibia	26	No	-	-
M.M.	15	M	TSF	Deformity correction tibia	12	Yes	2	Oral antibiotics
L.C.	14	M	TSF	Deformity correction tibia	14	Yes	6	Pin site debridement
K.G.	45	M	TSF	Deformity correction tibia	24	No	-	-
B.K.	57	M	TSF	Deformity correction tibia	36	Yes	2	Oral antibiotics
B.K.	57	M	TSF	Deformity correction tibia	18	Yes	2	Oral antibiotics
V.J.	53	M	TSF	Deformity correction tibia	12	No	-	-
T.Z.	35	M	TSF	Deformity correction tibia	12	No	-	-
T.K.	14	M	TSF	Deformity correction tibia	10	Yes	2	Oral antibiotics

Every effort should be made to avoid or at least minimise the occurrence and severity of pin site infections

Table III: Circular external fixator indications

Indications	Fixator used (Number of cases)		
	Ilizarov	Truelok	Taylor Spatial Frame
Bone transport	4	3	
Bi-Masquelet	1	2	
Non-union tibia	2	4	
Periarticular fracture tibia	28	6	
Tumour resection tibia		1	
Chronic osteomyelitis tibia	3		
Complex fracture tibia	2	4	
Complex fracture humerus	1		
Deformity correction tibia			18
Deformity correction knee			1

The patient who developed a major infection was classified as a Checketts-Otterburn grade 6 infection. This infection occurred at the end of the treatment period after union was achieved, and the external fixators were abandoned without the need for additional stabilisation. This patient presented for follow-up 2 weeks after frame removal, and had a non-healing pin site. Radiographs revealed a small sequestrum in the pin tract that required debridement of the tract in theatre and subsequently healed without incidence.

One patient developed a hypersensitivity reaction to the alcoholic solution of chlorhexidine. The reaction was resolved by diluting the cleaning solution to half strength and continuing pin site care.

Discussion

Pin tract infection is a very common finding,[1-11] and the potential complications can be catastrophic. These complications could ultimately lead to failure of the bone–pin interface and chronic osteomyelitis. Because of this, every effort should be made to avoid or at least minimise the occurrence and severity of pin site infections.

Instability of the external fixator–pin–bone construct leads to pin loosening and infection.[3] This infection then further contributes to the deterioration of the bone–pin interface. It is a common misconception that pin loosening results from pin tract infection, when in actual fact pin loosening is often the initiating event that leads to pin tract sepsis.

For this reason, the external fixator construct is vital in the prevention of pin site complications.[3] The overall stability of the external fixator construct is not only a function of the fixator itself, but involves a complex interplay of the geometrical and mechanical properties of the fixator, as well as the properties of the surrounding tissues and fracture pattern.[14] There also appears to be a race between the gradually increasing loading capacity of healing bone and failure of the bone–pin interface.[15] For this reason it is important to keep the fracture configuration in mind when deciding on which external fixator to use.

An unstable fixator not only provides an unsuitable environment for bone healing but also causes excessive movement at the fixator–pin-bone interface, leading to pin site irritation and infection.[3,16] Parameswaran found that the type of fixator had an effect on the incidence of pin site infection, with monolateral and hybrid fixators showing a much higher incidence when compared to ring fixators.[3] Consequently, the fixator design should always be kept in mind when embarking on limb reconstruction that will require prolonged periods of external fixation.

It is important to note that every strategy that aims to reduce pin tract infection should begin in the operating theatre.[10] We strongly advocate this approach, and recommend that every effort is made to ensure that pin and wire insertion is as atraumatic as possible, thereby minimising the iatrogenic damage to skin, soft tissue and bone.

The aim is to have pin sites heal around the wires or pins, much like a pierced earring insertion site heals.[17] We therefore recommend careful planning of any incision to ensure a snug fit of the skin around the pin, while avoiding any skin tension. These incisions should be as small as possible in order to facilitate rapid healing of the skin around the pin or wire and thereby creating a bone–pin interface that is sealed from the external environment.

The soft tissue envelope should be considered carefully during wire and pin insertion. Subcutaneous bone surfaces are preferable, while areas with considerable soft tissue bulk or tendons should be avoided as far as possible, as soft tissue movement around a wire or pin leads to an increased risk for infection.[2,18,19] Any muscle compartment that is traversed should be placed under stretch during wire insertion in order to prevent transfixing muscles in a shortened position.[2] Furthermore, wires should not be drilled through the soft tissues. Wires should rather be pushed onto the near cortex then drilled through the bone, and finally advanced through the distal soft tissues by tapping the wire with a mallet[5] (*Figure 1*). This procedure has the added advantage of decreasing the amount of heat generated through friction between the spinning wire and the bone.

The anterior tibial crest should be avoided at all cost, as drilling through the thick cortical bone can generate excessive heat that could lead to thermal necrosis of the surrounding bone, ring sequestra and pin loosening.[2]

Pre-drilling should always be performed for half-pin insertion, even when using self-drilling pins.[2,5] Drilling should be done under continuous cold saline irrigation and in a metronomic (stop-start) fashion to ensure proper cooling of the drill bit.[2,10] After drilling the pilot hole, it must be irrigated to remove the bone swarf that might act as sequestra and prevent optimal bone–pin fixation.[10] We recommend the use of a 20 ml syringe filled with cold saline together with small feeding tube in order to flush the pilot hole (*Figure 2*).

In cases where half pins are required, we routinely use hydroxyapatite-coated pins, and in our unit we have completely abandoned the use of uncoated pins. Hydroxyapatite-coated pins show increased fixation strength when compared to uncoated pins, as is evident from extraction torque forces that are higher than insertion torque forces and 90 times higher than conventional uncoated pins.[9,20-22] This improved fixation translates into lower rates of osteolysis, lower incidence of pin loosening and decreased pin site infection when compared to uncoated pins.[9,11,21-29]

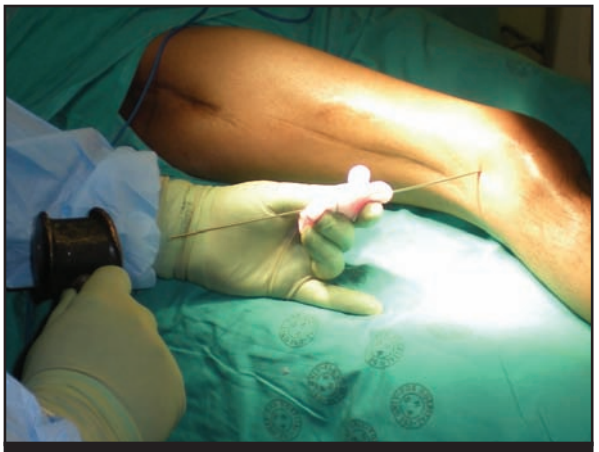

Figure 1

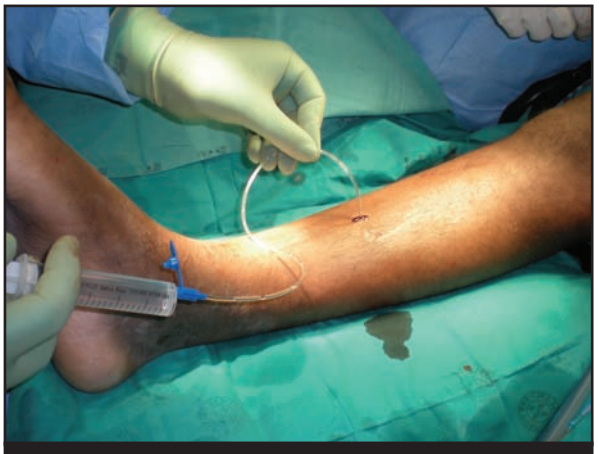

Figure 2

As far as possible a non-touch technique, for insertion of wires and half pins, must be used.[10] Half pins are never touched prior to insertion, and wires are handled and manipulated with chlorhexidine-soaked swabs (*Figure 3*).

Peri-operative care consists of dressing the pin sites with an alcoholic solution of chlorhexidine-soaked swab immediately after each wire or pin is inserted. These dressings are held in place with a small amount of pressure to prevent skin tenting and haematoma formation.[10,30] We generally use the rubber of a 20 ml syringe plunger in order to keep slight pressure on our dressing (*Figure 4*). These dressings are then changed at the end of the procedure if they are blood stained. Finally fluffed gauze is packed between the soft tissue and frame, and the whole extremity and external fixator is covered with a sterile dressing (*Figure 5*), which is left in place for the first 7 to 10 days post-operatively.[31]

Pin tract care is initiated following removal of the post-operative dressings at day 7 to 10 after the surgery.[31] No consensus exists regarding the optimal care of pin sites, and a myriad of pin site protocols have been advocated.[5] Protocols range from a nihilistic approach, advocating no active pin care,[32] to intensive regimens involving twice-daily cleaning, dressing and oral antibiotics for the entire duration of the external fixator.[3]

Pin tract care at our institution consists of twice-daily cleaning of the pin–skin interface with an alcoholic solution of chlorhexidine and clean gauze.[3,4,19] Chlorhexidine has been shown to have improved benefit when compared to normal saline in terms of pin site infection.[33] We advocate pin sites to be left uncovered after cleaning, and that dry, absorptive dressings only be considered in the presence of an exudate.[5] Twice-daily pin site care is continued for the entire duration of the external fixator. This extended period of pin tract cleaning, combined with a meticulous insertion technique, could explain why we encountered so few grade 1 infections in our study, as pin tract care is the suggested treatment for grade 1 infections.

Once the pin sites have healed, patients are allowed to have a daily shower, providing that the limb and external fixator is dried thoroughly thereafter. We do not recommend swimming, and swimming in dams or the ocean is definitely not allowed.

Pin tract sepsis may either start as cellulitis around a pin or a localised form of osteitis. Most cases are secondary to *Staphylococcus aureus* infection,[9,10] and antibiotic treatment should be directed at this microorganism.[2,7,32] In our series 95.2% of the infections were minor. This compares well with other studies which have reported figures ranging between 75% and 94% for minor infections.[2,5,7,9,10]

Patients who present with Checketts-Otterburn grade 2 infections are treated with a course of oral cloxacillin for seven days. If response to this treatment is inadequate the offending pin or wire is removed or exchanged. We encountered four (5.0%) patients with grade 3 infections and all three of these patients underwent removal of the infected wire or pin.

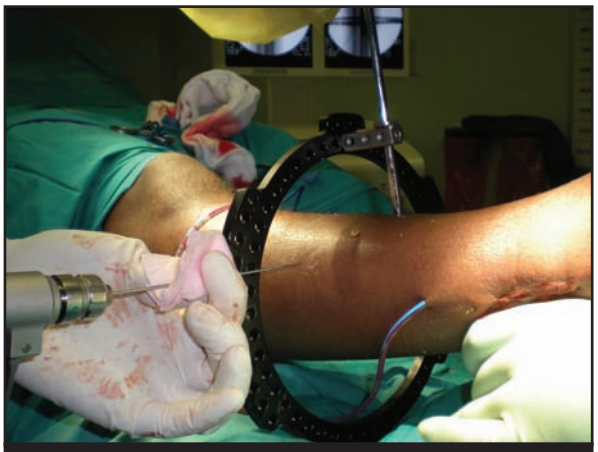

Figure 3

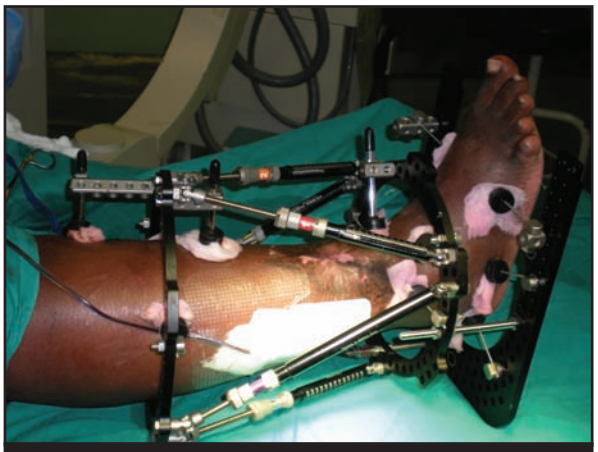

Figure 4

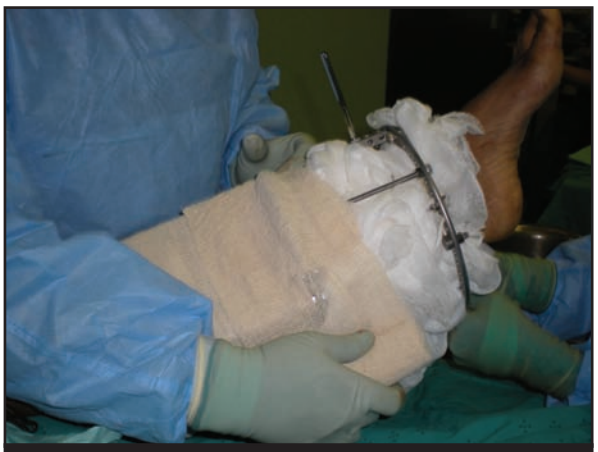

Figure 5

Pin tract care at our institution consists of twice-daily cleaning of the pin–skin interface with an alcoholic solution of chlorhexidine and clean gauze

Major infections are treated with removal of the external fixator. In our series only one (1.25%) patient required removal of his external fixator due to a major infection. This patient presented with a non-healing pin site 2 weeks after external fixator removal. He was subsequently admitted and treated with debridement of the pin tract utilising the Versajet Hydrosurgery system (Smith & Nephew, Memphis, TN).[2] After excision of the edges, the wound was closed, and healing occurred without any further complications.

Limitations of this paper include the retrospective nature of the review and the fact that the external fixators were almost exclusively used for tibial applications. We concede that external fixators used in other anatomic locations might not display similar results.

Conclusion

Although pin tract infection is frequently found in relation to circular external fixation, the majority of these are of a minor nature and respond well to local treatment and systemic antibiotics. Furthermore, a standardised pin site protocol, encompassing insertion, peri- and post-operative care as well as removal would limit the incidence of major infections and treatment failures.

The content of this article is the sole work of the author. No benefits of any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article. The research has been approved by an ethical committee.

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