The effect of HIV infection on the incidence and severity of circular external fixator pin track sepsis: a retrospective comparative study of 229 patients

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Abstract Pin track sepsis is a common complication of circular external fixation. HIV status has been implicated as an independent risk factor for the development of pin track infection and has been cited as a reason not to attempt complex limb reconstruction in HIV-positive patients. This retrospective review of patients treated with circular external fixators looked at the incidence of pin track sepsis in HIV-positive, HIV-negative and patients whose HIV status was unknown. The records of 229 patients, 40 of whom were HIV-positive, were reviewed. The overall incidence of pin track sepsis was 22.7 %. HIV infection did not affect the incidence of pin track sepsis ($p = 0.9$). The severity of pin track sepsis was not influenced by HIV status ($p = 0.9$) or CD4 count ($p = 0.2$). With the employment of meticulous pin insertion techniques and an effective postoperative pin track care protocol, circular external fixation can be used safely in HIV-positive individuals.

Keywords HIV • Pin track sepsis • Complication • Ilizarov • Circular external fixator

Introduction

External fixation, and circular external fixation in particular, has evolved as an indispensable component of contemporary trauma and limb reconstruction surgery. Owing to its minimally invasive nature, circular fixators are being used increasingly in the management of skeletal trauma. Injuries associated with soft tissue compromise, such as periartricular fractures of the tibia, circular fixation has been shown to decrease the incidence of deep infection [1–6]. Its use is well established in the reconstruction of post-traumatic, post-infective bone defects and congenital deformities. This treatment modality is, however, associated with its own set of complications of which the most frequent is pin track sepsis with the reported incidences ranging from 11.3 to 100 % [4, 7–15].

Pin track sepsis is often the first clinical manifestation of a vicious cycle of pin loosening and sustained pin site infection. It is a misconception that pin track sepsis result in pin loosening; pin loosening is more often the inciting event that leads to pin site infection [14, 16–19]. Failure of the pin–bone interface can have catastrophic consequences and may lead to failure of the reconstruction and, ultimately, limb ablation in some. A meticulous approach to pin and wire insertion combined with a structured protocol of pin site care has been shown to decrease the incidence of pin track sepsis [4, 20, 21]. Certain patient factors may, however, influence the incidence and severity of pin track sepsis. Poor diabetic control and HIV infection have both been implicated as independent risk factors for the development of pin track infection [7, 15, 22–24].

HIV infection was previously considered to be a relative contraindication for the use of external fixators. A recent study from Malawi investigating the use of monolateral external fixators in tibial trauma found an increased incidence and severity of pin track sepsis in HIV-positive patients [22–24]. This study is cited frequently against limb reconstruction with external fixation in HIV-positive patients. The use of circular fixators, in particular, has been avoided in HIV-positive patients due to the prolonged periods of treatment required.
South Africa has the highest incidence of HIV infection in the world. The 2011 National Antenatal Sentinel Survey reported a national prevalence of 17.3%, with areas like KwaZulu-Natal approaching 25% [25]. The majority of these patients are between 20 and 50 years old. South Africa also has one of the highest incidences of road traffic accidents in the world, affecting mostly young adults [26, 27]. The HIV pandemic in South Africa, combined with the high incidence of trauma, has resulted in many HIV-positive patients requiring treatment for complex trauma or a need for post-traumatic limb reconstruction. Of note is that the overall fracture prevalence is increased in HIV-positive compared to HIV-negative patients [28–30].

This retrospective review aims to compare the rate and severity of pin track sepsis in HIV-positive and HIV-negative patients treated with circular external fixators. The research proposal was reviewed and approved by the local ethics committee. An extensive literature review revealed this current study to be the largest yet to compare the incidence of pin track sepsis in HIV-positive and HIV-negative patients. It is currently also the only study investigating the effect of HIV infection on the incidence and severity of pin track sepsis with the use of circular external fixators.

Materials and methods

The study population consisted of all patients who were treated with circular external fixators at our institution between July 2008 and December 2012. Patients were included if they had completed treatment and had the external fixator removed. Patients were excluded if the external fixator was not applied at our institution or if the records were insufficient for the required data.

All patients were offered voluntary HIV counseling and testing. The CD4 count of all HIV-positive patients was measured. Patients with CD4 counts below 350 cells/mm³ were started on highly active antiretroviral therapy (HAART) in accordance with South African national antiretroviral treatment guidelines.

The fixator design and application followed the general principles as outlined by Catagni with the emphasis on construction of a stable frame configuration [31–36]. Particular attention was paid to atraumatic pin and wire insertion. Recognized anatomical safe zones were used and insertion was carried out with as little heat and energy transfer as possible [31, 36, 37]. Postoperative pin track care followed the protocol previously set out by Ferreira and Marais [21]. Outpatient follow-up was scheduled at two to four weekly intervals until frame removal. At every clinic visit, the progress was assessed and any complications, including pin track sepsis, were documented. Pin site

Table 1 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 |

infections were graded according the Checketts and Otterburn classification (Table 1) [38].

A retrospective review was undertaken and the variables recorded included patient demographics, HIV status, CD4 count and use of antiretroviral medication, indications for circular fixation, type of external fixator used, pin track complications and treatment of these complications. Results were analyzed using the independent t test, one-way ANOVA test and the Kruskal–Wallis H test to ascertain whether HIV infection had any effect on the incidence or severity on pin track sepsis.

Results

The records of 274 patients were reviewed. Forty-five patients were excluded because the external fixators had not yet been removed. Therefore, 229 patients (163 males and 66 females) were included: The mean age was 34.5 years (standard deviation ± 15.4, range 6–71 years); mean time in external fixation was 22.9 weeks (SD ± 14.7, range 6–104 weeks).

The external fixators applied consisted of 71 Ilizarov fixators (Smith and Nephew, Memphis, TN), 91 Truelok fixators (Orthofix, Verona, Italy), 65 Taylor Spatial Frames (Smith and Nephew, Memphis, TN) and two TL-Hex fixators (Orthofix, Verona, Italy) (Table 2). The indications for the use of the external fixators are listed in Table 3.
The patients were divided into groups according to their HIV status. A third group was made up of patients who refused HIV testing and designated as the unknown group. The HIV-positive group consisted of 40 (17.5 %) patients. The mean age was 37.2 years (SD ± 10.2, range 8–56 years). Time in the external fixator averaged 26 weeks (SD ± 16.6, range 6–77 weeks). The HIV-negative group consisted of 168 (73.4 %) patients. The mean age was 33.2 (SD ± 16.5, range 6–71 years) and time in external fixation averaged 33.2 weeks (SD ± 16.5, range 6–71 weeks). The group whose HIV status was unknown consisted of 21 (9.2 %) patients. Their mean age was 39.7 years (SD ± 13.1, range 17–59 years) and time in external fixation averaged 18.9 weeks (SD ± 10.2, range 7–50 weeks). There was no statistically significant difference between the three groups in terms of age (p = 0.09) or time in the external fixator (p = 0.18).

Pin track infection occurred in 52 (22.7 %) out of 229 patients. In the subgroups, nine (22.5 %) patients in the HIV-positive group (n = 40), 38 (22.6 %) patients in the HIV-negative group (n = 168) and five (23.8 %) patients in the unknown group (n = 21) developed pin track sepsis. Checketts and Otterburn grades for the three groups are shown in Fig. 1. There was no statistically significant difference in the incidence of pin track sepsis between the three groups (p = 0.94). Furthermore, the three groups had no statistically significant differences in terms of severity of pin track sepsis (p = 0.9).

A subgroup analysis of the HIV-positive patients (n = 40) was undertaken. Mean CD4 count was 347.4 cells/mm3 (D ± 162.4, range 82–682 cells/mm3) and 25 (62.5 %) patients were receiving HAART. Our data showed that CD4 count had no influence on either the incidence (p = 0.57) or severity (p = 0.21) of pin track sepsis in the HIV-positive group.

Discussion

Pin track sepsis remains a common complication with the use of external fixators [7, 15]. Quoted incidences range from 11.3 to 100 % [9–13]. Mostafavi reported a 71 % incidence of pin site infection in reconstructive surgery [11].

The use of meticulous pin insertion techniques and the implementation of an evidence-based pin track care protocol can reduce the incidence of pin track sepsis with circular external fixation in reconstructive surgery to approximately 25 % [4]. Our results compare favorably to previously published figures with an overall pin track sepsis incidence of 22.7 % (52 out of 229) observed in this series.

Several factors have been implicated in the development of pin track sepsis [4, 21]. They include frame design and biomechanics, pin and wire insertion techniques, point of commencement of pin track care and the specific care protocol employed [7, 8, 12, 13, 40]. Strategies to reduce pin track sepsis should include measures aimed at optimization of these factors. Some non-modifiable risk factors have also been associated with pin site infection. These include diabetes mellitus and HIV infection [7, 15, 22–24].

HIV infection has prompted many orthopedic and trauma surgeons to avoid the use of circular external fixators for the purpose of limb reconstruction in HIV-positive patients. Norrish and Harrison published the first data comparing pin track infection with the use of monolateral

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**Table 2** External fixators applied

|                  | HIV+ | HIV− | Unknown | Total |
|------------------|------|------|---------|-------|
| Ilizarov         | 14   | 44   | 13      | 71    |
| Truelok          | 21   | 65   | 5       | 91    |
| Taylor Spatial Frame | 5   | 57   | 3       | 65    |
| TL-Hex           | 0    | 2    | 0       | 2     |
| Total            | 40   | 168  | 21      | 229   |

**Table 3** Circular external fixator indications

| Indications             | HIV+ | HIV− | Unknown |
|-------------------------|------|------|---------|
| Complex trauma          | 7    | 21   | 3       |
| Periarticular fracture  | 17   | 50   | 12      |
| Non-union               | 5    | 25   | 2       |
| Bone transport          | 1    | 7    | 1       |
| Bone defect             | 2    | 3    |         |
| Limb lengthening        | 1    |      |         |
| Chronic osteomyelitis   | 3    | 5    |         |
| Deformity correction    | 5    | 56   | 3       |
| Total                   | 40   | 168  | 21      |
external fixators in HIV-positive and HIV-negative patients [22, 24, 39]. They reported on 13 HIV-positive and 34 HIV-negative patients and found significantly more infections requiring pharmaceutical or surgical intervention in the HIV-positive group. Our results differ in that we could show no correlation between the incidence or severity of pin track sepsis and HIV status. Our results do correlate with the findings of no correlation between CD4 count and the severity of pin track infection in HIV-positive patients. The low patient numbers and wide CD4 range could explain the apparent lack of relationship and more research is required.

In conclusion, while pin track sepsis is a common complication with the use of circular external fixators, we did not find that the incidence or severity of pin track sepsis was influenced by HIV infection or degree of immune compromise. This finding should not preclude the use of circular external fixators for complex trauma and limb reconstruction in HIV-positive individuals.

Conflict of interest The authors declare that they have no conflict of interest and no financial support was received for this study.

Ethical standards The study was authorized by the local ethics committee and performed in accordance with the Ethical standards of the 1964 Declaration of Helsinki as revised in 2000.

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References

1. Bone L, Stegemann P, McNamara K, Seibel R (1993) External fixation of severely comminuted and open tibial pilon fractures. Clin Orthop 292:101–107
2. Chin TYP, Bardana D, Bailey M, Williamson OD, Miller R, Edwards ER, Esser MP (2005) Functional outcome of tibial plateau fractures treated with the fine-wire fixator. Injury 36:1467–1475
3. Dendrinos GK, Kontos S, Katsenis D, Dalas A (1996) Treatment of high-energy tibial plateau fractures by the Ilizarov circular fixator. J Bone Joint Surg Br 78-B:710–717
4. Ferreira N, Marais LC (2012) Pin tract sepsis: incidence with the use of circular fixators in a limb reconstruction unit. SA Orthop J 11(1):10–18
5. Kapoor SK, Kataria H, Patra SR, Boruah T (2010) Capsuloligamentotaxis and definitive fixation by an ankle-spanning Ilizarov fixator in high-energy pilon fractures. J Bone Joint Surg Br 92-B:1100–1106
6. Kataria H, Sharma N, Kanojia RK (2007) Small wire external fixation for high-energy tibial plateau fractures. J Orthop Surg 15(2):137–143
7. Bibbo C, Brueggeeman J (2010) Prevention and management of complications arising from external fixation pin sites. J Foot Ankle Surg 49:87–92
8. Davies R, Holt N, Nayagam S (2005) The care of pin sites with external fixation. J Bone Joint Surg Br 87-B:716–719
9. Dejong ES, DeBerardino TM, Brooks DE, Nelson RJ, Campbell AA, Bottoni CR, Pasateri AE, Walton RS, Guymon CH, McMahan AT (2001) Antimicrobial efficacy of external fixator pins coated with a lipid stabilized hydroxyapatite/chlorhexidine complex to prevent pin tract infection in a goat model. J Trauma 50:1008–1014
10. Cavusoglu AT, Er MS, Inal S, Ozsoy MH, Dinkel MS, Sakogullari A (2009) Pin site care during circular external fixation using two different protocols. J Orthop Trauma 23:724–730
11. Mostafavi HR, Tornetta P III (1997) Open fractures of the humerus treated with external fixation. Clin Orthop Relat Res 337:187–197
12. Parameswaran AD, Roberts CS, Seligson D, Voor M (2003) Pin tract infection with contemporary external fixation: how much of a problem? J Orthop Trauma 17:503–507
13. Patterson MM (2005) Multicentre pin care study. Orthop Nurs 24(5):349–360
14. Piza G, Caja VL, Gonzalez- Veijo MZ, Navarro A (2004) Hydroxyapatite-coated external-fixation pins. The effect on pin loosening and pin-tract infection in leg lengthening for short stature. J Bone Joint Surg Br 86-B:892–897
15. Rogers LC, Bevilacqua NJ, Frykberg RG, Armstrong DG (2007) Predictors of postoperative complications of Ilizarov external ring fixators in the foot and ankle. J Foot Ankle Surg 46(5):372–375
16. Harding AK, Toksvig-Larsen S, Tagil M, W-Dahl A (2010) A single dose zolendronic acid enhances pin fixation in high tibial osteotomy using the hemicalotasis technique. A double-blind controlled randomized study in 46 patients. Bone 46:649–654
17. Moroni A, Heikkila J, Magyar G, Toksvig-Larsen S, Giannini S (2001) Fixation strength and pin tract infection of hydroxyapatite-coated tapered pins. Clin Orthop Relat Res 388:209–217
18. Moroni A, Aspengren P, Toksvig-Larsen S, Falzarano G, Giannini S (1998) Enhanced fixation with hydroxyapatite coated pins. Clin Orthop Relat Res 346:171–177
19. Moroni A, Cadossi M, Romagnoli M, Faldini C, Giannini S (2008) A biomechanical and histological analysis of standard versus hydroxyapatite-coated pins for external fixation. J Biomed Mater Res 86B:417–421
20. Antoci V, Ono CM, Antoci V Jr, Raney EM (2008) Pin-tract infection during limb lengthening using external fixation. Am J Orthop 37(9):E150–E154
21. Ferreira N, Marais LC (2012) Prevention and management of external fixator pin tract sepsis. Strat Traum Limb Recon 7:67–72. doi:10.1007/s11751-012-0139-2
22. Harrison WJ (2009) Open tibia fractures in HIV positive patients. Malawi Med J 21(4):174–175
23. Lubega N, Harrison WJ (2010) Orthopaedic and trauma surgery in HIV positive patients. Orthop Trauma 24(4):298–302
24. Norrish AR, Lewis CP, Harrison WJ (2007) Pin-track infection in HIV-positive and HIV-negative patients with open fractures treated by external fixation. J Bone Joint Surg 89B:790–793
25. The 2011 national antenatal sentinel HIV and Syphilis prevalence survey in South Africa. http://www.doh.gov.za/docs/presentations/2013/Antenatal_Sentinel_survey_Report2012_final.pdf
26. http://www.who.int/gho/road_safety/en/index.html
27. Global status report on road safety 2013.pdf http://www.who.int/violence_injury_prevention/road_safety_status/2013/en/index. html
28. Hansen AB, Gerstoft J, Kronborg G, Larsen CS, Pedersen C, Pedersen G, Oibel N (2012) Incidence of low and high-energy fractures in persons with and without HIV infection: a Danish population-based cohort study. AIDS 26(3):285–293. doi:10.1097/QAD.0b013e32834ed8a7
29. Shiau S, Broun EC, Arpadi SM, Yin MT (2013) Incident fractures in HIV-infected individuals: a systematic review and meta-
analysis. AIDS 27(12):1949–1957. doi: 10.1097/QAD.0b013e328361d241
30. Triant VA, Brown TT, Lee H, Grinspoon SK (2008) Fracture prevalence among human immunodeficiency virus (HIV)-infected versus non-HIV-infected patients in a large U.S. healthcare system. J Clin Endocrinol Metab 93:3499–3504. doi: 10.1210/jc.2008-0828
31. Catagni MA (2009) Treatment of fractures, nonunions, and bone loss of the tibia with the Ilizarov method, 5th edn. Il quadratino, Italy
32. Bronson DG, Samchukov ML, Birch JG, Browne RH, Ashman RB (1998) Stability of external circular fixation: a multi-variable biomechanical analysis. Clin Biomech 13:441–448
33. Fragomen AT, Rozbruch SR (2007) The mechanics of external fixation. HSSJ 3:13–29. doi: 10.1007/s11420-006-9025-0
34. Ilizarov GA (1990) Clinical application of the tension-stress effect for limb lengthening. Clin Orthop 250:8–26
35. Mullins MM, Davidson AW, Goodier D, Barry M (2003) The biomechanics of wire fixation in the Ilizarov system. Inj Int J Care Inj 34:155–157
36. Watson MA, Mathias KJ, Maffulli N (2000) External ring fixators: an overview. Proc Inst Mech Eng 214:459–470
37. Nayagam S (2007) Safe corridors in external fixation: the lower leg (tibia, fibula, hindfoot and forefoot). Strat Traum Limb Recon 2:105–110
38. Checketts RG, MacEachern AG, Otterburn M (2000) Pin track infection and the principles of pin site care. In: Goldberg A, De Bastiani A, Apley AG (eds) Orthofix external fixation in trauma and orthopaedics. Springer, Berlin, pp 97–103
39. Harrison WJ, Lewis CP, Lavy CBD (2004) Open fractures of the tibia in HIV positive patients: a prospective controlled single-blind study. Inj Int J Care Inj 35:852–856
40. Holmes SH, Brown SJ (2005) Skeletal pin site care. Orthop Nurs 24(2):99–107