An Analysis of Pin Track Infections

Christopher Iobst, MD
Nemours Children’s Hospital
Orlando, FL
Disclosures

• Speaker’s Bureau for Smith and Nephew
Introduction

• Stability and health of the pin-skin/pin-bone interface critical in external fixation
• Breakdown at the pin-skin/pin-bone interface creates pin track infections
• Pin track infections are an anticipated nuisance of using external fixation
Introduction

• Despite pin track infections being ubiquitous in external fixation the data is limited and poor quality

• Can find references stating range of pin track infections is anywhere between 0% and 100%

• Examine the external fixation literature since 1980 to determine a more refined understanding of pin track infections
Methods

• PubMed search for “external fixation”
  – 9620 articles found
  – Search limits created
    • Custom range of dates (01/01/1980 – 06/30/2014)
    • Human only
    • English only
  – 5493 articles found
Methods

• Exclusion criteria
  – External fixation of axial skeleton (cranium/pelvis/spine)
  – Case reports (minimum 5 patients)
  – Unable to access journal article from Nemours online library
  – Results had to report pin track infections as number of patients affected (not by individual pin/wire)
Methods

• Data points extracted:
  – Year of publication
  – Number of patients
  – Average age of patients
  – Reason for external fixation (trauma, lengthening, deformity, etc.)
  – Fixation per segment (two points or more than two points)
  – Body part (distal radius, femur, humerus, tibia, etc.)
  – Hydroxy-apatite coated pins versus non-coated pins
  – Duration of external fixation
  – Type of fixator (circular versus uni-planar)
  – Number of patients with documented pin track infections
Results

• Each year (1980-2014) represented by at least one article

• 150 total articles reviewed (6130 patients)
  – 1980s = 31 articles (1295 patients)
  – 1990s = 34 articles (1631 patients)
  – 2000s = 48 articles (1583 patients)
  – 2010s = 37 articles (1621 patients)
Results

• Total = 6130 patients with 1684 pin track infections

• Overall Pin track infection rate = 27.4%
Results

• Adult patients:
  – Pin track infection rate = 23%  (964/4222)

• Pediatric patients:
  – Pin track infection rate = 38%  (706/1851)
Results

• Age
  – Under 18 years old = 38%  (717/1893)
  – 18-39 years old = 27%  (556/2082)
  – 40-64 years old = 23%  (309/1329)
  – Over 65 years old = 8%  (31/389)
Results

• Patient Etiology
  – Trauma:
    • 24% Pin track infection rate (986/4161)
  – Deformity:
    • 29% Pin track infection rate (348/1199)
  – Lengthening:
    • 46% Pin track infection rate (239/512)
Results

• Duration of time in frame
  – 42 days or less = 19.6% (191/972)
  – 43 to 90 days = 24.2% (475/1956)
  – 91 to 150 days = 27.2% (498/1828)
  – More than 150 days = 37.8% (440/1161)
  – More than 180 days = 47.8% (335/700)
Affect of Duration on Pin Track Infection Rate

![Graph showing the effect of duration on Pin Track Infection Rate. The x-axis represents different duration periods: <42 days, 43-90 days, 91-150 days, >150 days, >180 days. The y-axis represents PTI Rate. The graph illustrates an increasing trend in PTI Rate with increasing duration.](image-url)
Results

- Location of frame pin track infection rate:
  - Tibia = 33% (754/2278)
  - Distal radius = 12% (139/1122)
  - Femur = 22% (245/1099)
  - Humerus = 23% (53/228)
  - Upper extremity = 14% (213/1511)
  - Lower extremity = 31% (1285/4155)
Results

• Distal radius: 48% six weeks duration or less

• All distal radius frames removed within 67 days

• Only 3% Femur frames and 12% Tibial frames removed with < 67 days duration
Results

• Pin type
  – Hydroxyapatite (HA) coated = 29.5% (71/240)
  – Non HA coated = 25.9% (1457/5609)
Results

• Frame Type
  – Circular: 29.5% pin track infection rate (457/1545)
  – Uni-planar: 22.9% pin track infection rate (937/4089)
Results

- Trauma
- Deformity
- Lengthening

Types:
- Circular
- Uni-planar
Results

- **1980s**: Pin track infection rate = 23.2%
  - (1295 patients with 301 infections)
- **1990s**: Pin track infection rate = 25.9%
  - (1631 patients with 424 infections)
- **2000s**: Pin track infection rate = 36.1%
  - (1583 patients with 573 infections)
- **2010s**: Pin track infection rate = 23.8%
  - (1621 patients with 386 infections)
Results

The graph shows the distribution of fractures in different bones (Distal Radius, Femur, Tibia) across different decades (1980s, 1990s, 2000s, 2010s).
Results

• Only two points of fixation per segment
  – 21.5% infection rate  (566/2629)

• More than two points of fixation per segment
  – 30.5% infection rate  (651/2131)
Results

- Trauma
- Deformity
- Lengthening

- Two points fixation
- Greater than two points fixation
Results

- Two points of fixation
- More than two points of fixation

- Distal Radius
- Femur
- Humerus
- Tibia
Results

- Two points of fixation
- More than two points of fixation

Bar chart showing the distribution of fixation points for two time intervals: less than 42 days and more than 150 days.
Discussion

• Overall pin track infection rate since 1980 = 27.4%

(1684/6130 patients)
Discussion

• Pediatric patients 1.7X more likely to develop a pin track infection than an adult patient

• Pin track infection rate appears to steadily decrease with increasing age
Discussion

• Direct correlation between duration of external fixator time and the risk in pin track infection

• As time in frame increases the pin track infection risk increases

• Dramatically starts to increase after 150 days
Discussion

• Underlying etiology for frame affects pin track infection rate

• Lengthening approximately 2X risk compared to deformity correction and trauma patients

• Likely related to duration
Discussion

• Location of frame affects pin track infection rate
  – Lower extremity 2.2X more likely than upper extremity to have pin track infection
  – Tibia>Humerus>Femur>Distal radius
  – Tibia 2.75X more likely than distal radius
Discussion

• Hydroxy-apatite coated pins did not appear to improve pin track infection rate

• Circular frames have higher pin track infection rate than uni-planar frames
  – Duration
  – Location
  – Etiology
Discussion

• Most at risk patient:

Pediatric patient undergoing prolonged tibial lengthening with a circular frame using more than 3 points of fixation per segment
Conclusion

27.4%
References 1980-1989

1981 Edge External Fixation for complicated tibial fractures
1982 Court-Brown Experience with the Sukhtian-Hughes external fixation system
1983 Coppola Use of the Hoffman external fixator in the treatment of femoral fractures
1983 Velazco Hoffman fixation for tibial fractures
1983 Cooney External fixation of distal radius fractures
1983 Larsson Open tibial shaft fractures
1983 Karlstrom External fixation of severe open tibial fractures with the Hoffman frame
1983 Stephens Femoral and tibial lengthening
1983 Tolo External skeletal fixation in children's fractures
1983 Hedley External fixation as a secondary procedure
1984 Dabezies Fractures of the femoral shaft treated by external fixation with the Wagner device
1984 Green External fixation for the uninfected angulated nonunion of the tibia
1985 Vaughan Treatment of unstable fractures of the distal radius by external fixation
1985 Court-Brown Hughes external fixator in treatment of tibial fractures
1986 Behrens External fixation of the tibia
1986 Foster Update on external fixators in the treatment of wrist fractures
1987 Kristiansen External fixation of displaced fractures of the proximal humerus
1987 Jenkins External fixation of Colles' fractures
1987 Clyburn Dynamic external fixation for comminuted intra-articular fractures of the distal end of the radius
1987 McCoy External fixation in contemporary fracture management
1987 Alonso Use of the AO/ASIF external fixator in children
1987 Rand Failed total knee arthroplasty treated by arthrodesis of the knee using the Ace-Fischer apparatus
1988 Edwards Severe open tibial fractures 1989 Paterson Lower limb lengthening by a modified Wagner technique
1989 Maurer Infection after intramedullary nailing of severe open tibial fractures initially treated with external fixation
1989 Kongsholm Plaster cast versus external fixation for unstable intraarticular Colles' fractures
1989 Holbrook Treatment of open fractures of the tibial shart: Ender nailing versus external fixation
1989 Grill Correction of complicated extremity deformities by external fixation
1989 Howard External fixation or plaster for severely displaced comminuted Colles' fractures
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1989 Nagano Shoulder arthrodesis by external fixation
References 1990-1999

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- 1991 Thakur   Open tibial fractures
- 1991 Jakim   External fixation for intra-articular fractures of the distal radius
- 1991 Roumen  Unstable Colles’ fractures in elderly patients
- 1991 Dhal   External fixation of intertrochanteric fractures of the femur
- 1991 Tucker  Management of unstable open and closed tibial fractures using the Ilizarov method
- 1991 Proubasta  Rolando’s fracture of the first metacarpal
- 1991 Bell   The use of the Ilizarov technique in the correction of limb deformities associated with skeletal dysplasia
- 1992 Velazquez  Complications of use of the Ilizarov technique in the correction of limb deformities in children
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- 1993 Marsh  Chronic infected tibial nonunions with bone loss
- 1993 Sommerkamp  Dynamic external fixation of unstable fractures of the distal part of the radius
- 1993 Kanel  Unilateral external fixation for corrective osteotomies in patients with hypophosphatemic rickets
- 1993 Marsh  External fixation and limited internal fixation for complex fractures of the tibial plateau
- 1993 Price  Dynamic axial external fixation in the surgical treatment of tibia vara
- 1993 Stanitski  Results of femoral lengthening using the Ilizarov technique
- 1993 Marshall  Use of an articulated external fixator for fractures of the tibial plafond
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- 1994 Pritchett  External fixation or closed medullary pinning for unstable Colles’ fractures
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- 1996 Stanitski  Management of late onset tibia vara in the obese patient by using circular external fixation
- 1996 Bar-On  External fixation or flexible intramedullary nails for femoral shaft fractures in children
- 1996 Stanitski  Correction of proximal Tibial Deformities in Adolescents with the T-Garches external fixator
- 1996 Hosny  The treatment of infected non-union of the tibia by compression-distraction techniques using the Ilizarov external fixator
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- 1997 Geiger  External fixation in proximal tibial osteotomy
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- 2001 Arazhi Ilizarov external fixation for severely comminuted supracondylar and intercondylar fractures of the distal femur
- 2002 Kato Callotasis lengthening in patients with 2002 brachymetacarpia
- 2002 Delp analysis deformity correction using the Taylor spatial frame
- 2003 Kubiak with open fractures treated by external fixation
- 2006 Freedman The Ilizarov method for the treatment of resistant clubfoot
- 2004 El Hayek External fixators in the treatment of fractures in children
- 2005 Ring Hinged elbow external fixation for severe elbow contracture
- 2004 Wong Gait patterns after fracture of the femoral shaft in children managed by external fixation or early hip spica cast
- 2005 Catagni Cosmetic bilateral leg lengthening
- 2005 Carmichael Rates of refracture associated with external fixation in 2005 osteoarthritis of the elbow external fixation for severe elbow contracture
- 2006 Kato Operative treatment of tibial fractures in children
- 2005 Moroni Dynamic hip screw compared with external fixation for treatment of osteoporotic perprosthetic fractures
- 2005 Handelsman The role of the small AO external fixator in supracondylar femoral fractures
- 2006 Kashani The role of external fixation in the treatment of proximal thigh and hip fractures
- 2006 Antoci Multiaxial external fixation for correction of tibial malunion and nonunion with six axis correction and external fixation in distal radial fractures
- 2006 sleds and ulnar osteotomy
- 2006 Egol locking palmar plating for unstable distal radius fractures in the elderly
- 2009 McCarthy Pedestal fixation system
- 2008 pandya Correction of Blount's disease by a multi-axial external fixation system
- 2009 Kim Tibial lengthening using a reamed type intramedullary nail and an Ilizarov external fixator
- 2009 Kocaoglu Fixator-assisted acute femoral deformity correction and consecutive lengthening over an intramedullary nail
- 2009 Monga Closed reduction and external fixation for displaced proximal humeral fractures
- 2009 W-Dahl No clinical benefits using a new design of pins for external fixation
- 2009 Clarke Treatment of Blount Disease
- 2009 fixation correction of tibial fractures using the Taylor Spatial Frame
- 2009 Kaoqoglu Reconstruction with callus distraction for nonunion with bone osteomyelitis of the femur
- 2007 McCarthy External fixation and centralization versus external fixation in children and adults using the Taylor Spatial Frame
- 2008 Myers External fixation of high-energy tibia fractures
- 2007 Erdem Lengthening of short bones by distraction osteogenesis
- 2007 Zhang Reconstruction with callus distraction for nonunion with bone osteomyelitis of the femur
- 2007 Albright Lateral external fixation - a new surgical technique for unreducible supracondylar humeral fractures in children
- 2007 Sung Reuse of external fixation components
- 2007 Yildiz Correction of simple and complex pediatric deformities using the Taylor Spatial Frame
- 2007 Angel Fixator-assisted acute femoral deformity correction and consecutive lengthening over an intramedullary nail
- 2009 Eidelman Lengthening of short bones by distraction
- 2009 York Alendronate improves screw fixation in osteoporotic bone
- 2007 Naqui Pin tract infection during limb lengthening using external fixation
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- 2009 McCarthy Pediatric Deformity Correction using a MAC fixator
- 2006 Catholic Reconstruction of segmental bone defects due to chronic osteomyelitis with use of an external fixator and an intramedullary nail
- 2006 Egol Treatment of external fixation pins about the wrist
- 2007 Norrish Pin-track infection in HIV-positive and HIV-negative patients with open fractures treated by external fixation
- 2008 Kocaoglu Treatment of osteoporotic fractures of the distal femur with use of an external fixator and an intramedullary nail
- 2004 Wong Gait patterns after fracture of the femoral shaft in children
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<table>
<thead>
<tr>
<th>Year</th>
<th>Author(s)</th>
<th>Title</th>
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<tr>
<td>2010</td>
<td>Haddad</td>
<td>External fixation for the treatment of intra-articular fractures of the distal radius</td>
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<td>2010</td>
<td>Giannicola</td>
<td>Open reduction and internal fixation combined with hinged external fixator in capitellum and trochlea fractures</td>
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<td>Kapoor</td>
<td>Capsuloligamentotaxis and definitive fixation by an ankle spanning Ilizarov fixator in high energy pilon fractures</td>
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<td>2010</td>
<td>Belloti</td>
<td>Treatment of reducible unstable fractures of the distal radius in adults</td>
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<td>2010</td>
<td>Blondel</td>
<td>Hexapodal external fixation in the management of children tibial fractures</td>
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<td>Hove</td>
<td>Dynamic compared with static external fixation of unstable fractures of the distal part of the radius</td>
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<td>2010</td>
<td>Ramseier</td>
<td>Femoral fractures in adolescents: a comparison of four methods of fixation</td>
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<td>Eidelman</td>
<td>Treatment of posttraumatic deformities in children and adolescents using the Taylor spatial frame</td>
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<td>2010</td>
<td>Pieske</td>
<td>Clinical benefit of hydroxyapatite-coated pins compared with stainless steel pins in external fixation at the wrist</td>
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<td>2011</td>
<td>Raju</td>
<td>Loss of correction in unstable comminuted distal radius fractures with external fixation and bone grafting</td>
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<td>2011</td>
<td>Vekris</td>
<td>Proximal screws placement in intertrochanteric fractures treated with external fixation</td>
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<td>External fixation for stable and unstable intertrochanteric fractures in patients older than 75 years of age</td>
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<td>Wani</td>
<td>Role of early Ilizarov ring fixator in the definitive management of type II, IIIA, and IIIB open tibial shaft fractures</td>
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<td>Babis</td>
<td>High energy tibial plateau fractures treated with hybrid external fixation</td>
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<td>Hydroxyapatite-coated pins versus titanium alloy pins in external fixation at the wrist</td>
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<td>Kocaoglu</td>
<td>Combined technique for the correction of lower limb deformities resulting from metabolic bone disease</td>
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<td>Guo</td>
<td>Tibial lengthening over an intramedullary nail in patients with short stature or leg length discrepancy</td>
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<td>2012</td>
<td>Monsell</td>
<td>High energy open tibial fractures in children</td>
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<td>2012</td>
<td>Refai</td>
<td>Does short term application of an Ilizarov Frame with transfixion pins correct relapsed clubfoot in children</td>
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<td>2012</td>
<td>Al-Sayyad</td>
<td>Taylor Spatial Frame in the treatment of upper extremity conditions</td>
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<td>2012</td>
<td>Basbozkurt</td>
<td>Ilizarov external fixation without removal of plate or screws</td>
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<td>2012</td>
<td>Marsland</td>
<td>Static monolateral external fixation for the Rolando fracture</td>
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<td>El-Sayed</td>
<td>Management of simple closed tibial shaft fractures using percutaneous lag screw fixation and Ilizarov external fixation in adults</td>
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<td>Foster</td>
<td>The treatment of complex tibial shaft fractures by the Ilizarov method</td>
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<td>Correction of residual clubfoot deformities in older children using the Taylor Spatial butt frame and midfoot Gigli saw osteotomy</td>
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<td>Hassan</td>
<td>The management of the neglected congenital foot deformity in the older child with the Taylor Spatial frame</td>
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<td>Pawar</td>
<td>Does humeral lengthening with a monolateral frame improve function</td>
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<td>External fixation of pediatric femoral shaft fractures</td>
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<td>Raskolnikov</td>
<td>The use of a multiplanar, multi-asix external fixator to achieve knee arthrodesis in a worst case scenario</td>
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<td>2013</td>
<td>Ruette</td>
<td>Humeral lengthening by distraction osteogenesis</td>
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<td>Erturk</td>
<td>Do additional intramedullary elastic nails improve the results of definitive treatment with external fixation of open tibia fractures</td>
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<td>Ramos</td>
<td>The Ilizarov external fixator - a useful alternative for the treatment of proximal tibial fractures</td>
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<td>Treatment of distal tibial fractures with the Ilizarov external fixator</td>
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<td>Malot</td>
<td>Role of hybrid monolateral fixators in managing humeral length and deformity correction</td>
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<td>2013</td>
<td>Kitoh</td>
<td>A comparative study of blade plate fixation and external fixation in osteotomies for slipped capital femoral epiphysis</td>
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<td>2013</td>
<td>Chen</td>
<td>Will the untreated ulnar styloid fracture influence the outcome of unstable distal radial fracture treated with external fixation</td>
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<tr>
<td>2014</td>
<td>Tafazal</td>
<td>Management of paediatric tibial fractures using two types of circular external fixator</td>
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