Complications of transcutaneous metal devices

Kristine E. Kofman · Tina Buckley · Duncan A. McGrouther

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Abstract A high incidence of associated infection with the use of transcutaneous metal devices has been widely reported. The aims of this study were: (1) to record the incidence of pin site infection in a Plastic Surgery department, (2) to compare the infection rate in our department with published literature and (3) to identify factors that contribute to infection. A prospective cohort study was performed including all patients presenting to the plastic surgery unit with any type of transcutaneous metal in situ over a 3-month period. Patients and staff were questioned on wound hygiene and whether they had been provided with specific protocols. Our study revealed an infection rate of 24%. Patients and staff were not aware of preventive protocols. From this study, the following conclusions are made: (1) pin site infection is a major problem, and no consensus has been reached on the best way to manage pin sites, (2) there is variable knowledge of pin-site care, (3) there is a need for a clearer definition of pin-site infection and a standardised system of assessment, classification and treatment and (4) there is a need for more innovative technology in pin-site manufacture as studies reveal that the type of material used in the pins does affect infection rates.

Keywords Pin-tract infection · Transcutaneous metal · External fixation · Kirschner wiring

The utilisation of transcutaneous metal devices is common practice in orthopaedic practice, and with increasing involvement of plastic surgeons in hand trauma and combined management of lower limb injuries, many of these patients are managed for variable periods by plastic surgeons. Transcutaneous devices of various types are used on a short- or longer-term basis to stabilise fractures or to correct deformity. Kirschner wires, known as K-wires, are most commonly used on a short-term basis as a simple and cost-effective way to provide stability to small bone fractures [1]. The Hoffman external fixator or the Ilizarov circular frame, used for long bone fractures, may be applied for periods extending to several months with an increasing incidence with time. Essentially, a pin tract is a chronic wound containing a foreign body providing an ideal focus for bacterial colonisation. Although pin-tract infection is often not considered to be a serious complication in the short term, it has the potential to decrease the stability of the bone–pin interface, which can cause pin loosening, osteomyelitis and poor functional outcome [2, 3]. The problem has heretofore been widely reported in orthopaedic literature, but as pin-site infection impacts the care of plastic surgery patients also, it is important for plastic surgeons to understand the scale of the problem and strategies for prevention.

The aims of this study were:

1. To record the incidence of pin-site infection in a Plastic Surgery department in comparison with published reports;
2. To review literature on comparative trials of pin site management to determine from the literature what method of wound care best prevents pin-site infection;
3. To establish current nursing practices in pin-site care and patient-initiated practices;
4. To determine the need for more innovative technology in prevention.

Methods

A prospective, cohort study was conducted on patients presenting to the Plastic Surgery ward or clinic with any type of transcutaneous metal device. Patients presenting between November 1, 2010 and February 1, 2011 were included. Episodes of subjective or objective complications were recorded. Objective data comprised of demographic information, the reason for the transcutaneous metal insertion, details of the type of fixator used, any reported complication, the results of microbiology swabs sent to the laboratory, antibiotic use and relevant radiological findings. Infection was defined by clinical symptoms such as redness, pain, prolonged discharge and functional loss. Subjective data were obtained by interviewing the patient, asking about skin problems, discharge, functional loss associated with the metal device and any discomfort (Figs. 1, 2, 3, 4, 5).

Results

Thirty-five consecutive patients with transcutaneous metal devices were seen in our specialised outpatient clinic from November 1, 2010 to February 1, 2011. Of these, 25 individuals were suitable for inclusion in the study. Seven patients were excluded as their K-wires were buried, and three were not compliant with follow-up. Of the 25 cases, 9 patients had an external fixator (51 pin sites) and 16 had K-wires (27 pin sites) in situ. In Table 1, you find the patients’ characteristics and recorded complications. The duration of treatment varied between 14 and 78 days for K-wires and between 21 and 78 days for external fixators. The duration of follow-up varied between 7 and 89 days.

Of the 25 patients with transcutaneous metal devices, nine developed complications (36%). In three cases, slight migration of K-wires occurred (12%). Six patients suffered from pin-tract infection (24%, with a 95% confidence interval (CI) of 12% to 43%). In three patients, the swab taken from the pin site was positive for *Staphylococcus aureus*. The external fixator had to be prematurely removed from one patient due to an infection. This patient developed recurrent infections at the site of his previous pin tracts even after pin removal. Of the patients surveyed, 80% had
not been provided with instructions on wound management. Only one of the patients had the benefit of a district nurse assessment with pin-site care. The patients did not receive instructions on either washing the pin sites or on cleaning them.

In our study, we found that pin-site care was not consistent. Mostly, the pins were cleaned daily with normal saline and a new dressing was applied. The pin sites were not washed. In some cases, betadine or chloramphenicol 1% ointment was applied to the pin sites.

In our study, there was no standard protocol on the prescription of antibiotics in patients with transcutaneous metal. Fifty percent received a preoperative antibiotic dose. Others received a single dose or multiple postoperative doses of co-amoxiclav or flucloxacillin.

Discussion

Our data show six infections from 25 patients, which is 24%, with a 95% CI of 12% to 43%. Thus, the true infection rate in the whole patient population is between 12% and 43%.

Our key limitation is the small number of patients. We calculated that if we would have entered more patients, or if we would repeat the study, we could expect an infection rate in the same range (for 95 out of 100 projects). Assuming the same infection rate of 24%, with 12 infections from 50 patients, the 95% CI is 14% to 37%, and with 24 infections from 100 patients, the 95% CI is 17% to 33%. As these numbers would not have made a great difference, we decided to keep our number of patients to 25.

The reported rate of pin-tract infection in the literature is high, ranging from 4.5% to 71%. Although diagnostic criteria vary (Santy [20]), and this may be a factor in the wide range of these quoted figures, certain factors however seem to be important. In Table 2, you find the reported infection rates in the literature, with the prevention and management measures listed. Table 3 explains the several classification systems which are used to diagnose a pin-tract infection.

K-wires and external fixators in the hand and wrist In a retrospective study by Stahl and Schwartz [1], which considers the use of K-wires in wrists, the authors reported an infection rate of 5.5%; 13 out of 236 patients developed infection around the pin. Margic [4] observed 100 patients in a prospective study of small external fixators used on metacarpal and phalangeal fractures, and found an infection rate of 7%. Studies on external fixator use for fractures of the distal radius report a higher recurrent infection rate of between 10.1% and 43% [5, 9, 10]. Egol et al. [6] performed a randomized controlled trial on such fixators and recorded an infection rate of 10.1%.

The role of skin movement Hove et al. [7], who investigated the differences between static and dynamic fixation of the wrist, found that 15 of their patients (43%) in the dynamic fixator group and 4 (11%) of the static group had a superficial pin-tract infection (p<0.01). They attributed this difference to the motion allowed by the dynamic fixator which seemed to increase skin irritation around the wrist.

Fixators applied to the elbow must also contend with motion. Cheung et al. [8] looked at the hinged external fixator. The pin-tract infection rate was found to be 25%.

External fixators in areas prone to infection The pelvic external fixator is another device associated with a high rate of infection; Mason et al. [9] reported a complication rate of 62% for definitive pelvic fixators (mean duration of treatment is 60 days) and an infection rate of 21% for temporary fixators (mean duration of treatment is 8 days). This resulted in the premature removal of seven devices, the reinsertion of one pin and the drainage of two abscesses.

Lower limb external fixator devices The lower limb is an area where wound healing is notoriously difficult.
| Injury         | Fracture | Device     | Type and size                                           | Duration (days) | Complications | Infection | Swabs | Antibiotics                  | Duration |
|---------------|----------|------------|--------------------------------------------------------|-----------------|---------------|-----------|-------|------------------------------|----------|
| Dupuytren     | No       | External fixator | Pennig Orthofix (Mini) 4×wires, hand                  | 28              | None          | None      | NA    | Co-amoxiclav                | 2× tabs for 7 days |
| Dupuytren     | No       | External fixator | Pennig Orthofix (Mini) 8×wires, hand                  | 21              | Infection     | Yes       | NA    | Co-amoxiclav                | 1× IV for 1 day   |
| Traumatic     | Yes      | External fixator | Hoffman external frame 3×4 mm Pins 1×5 mm Pins, leg.  | 22              | None          | No        | NBG   | None                         | None     |
| Degloving     | No       | K-wire      | 1×0.9 mm, hand                                        | 16              | None          | None      | NA    | Co-amoxiclav                | 1× IV for 3 days, 1× tabs for 5 days |
| Traumatic     | No       | External fixator | Mini Hoffman II 3 and 2 mm pins, hand                 | 74              | Infection     | Technical error, twice, two admissions | S. aureus +++ | Co-amoxiclav and flucoxacillin | 4× IV for 1 day, 1× IV for 7 days, 1× tabs for 7 days |
| Blunt         | Yes      | K-wire      | 1×0.9 mm K-wire, hand                                 | 28              | None          | None      | NA    | None                         | NA       |
| Traction      | No       | K-wire      | 1× K-wire, hand                                       | 14              | None          | None      | NA    | Co-amoxiclav                | 1× IV, 1× tabs for 5 days |
| Mallet        | Yes      | K-wire      | 1×0.9/1×1.1 mm, hand                                  | 30              | Migration K-wire | None      | NA    | None                         | NA       |
| Occupational  | No       | K-wire      | 1×0.9 mm K-wire, hand                                 | 31              | None          | None      | NA    | Co-amoxiclav                | 1× IV 1.2 g     |
| Industrial    | Yes      | External fixator | Pennig Orthofix, hand                                | 28              | None yet      | None      | NA    | None                         | Not applicable |
| Crush         | Yes      | K-wire      | 6×0.9 mm, hand                                        | 21              | Infection     | Twice     | S. aureus +                 | Co-amoxiclav IV 7, tab 10 |
| Enchondroma   | No       | K-wire      | 2×0.7 mm, hand                                        | 30              | None          | None      | NA    | None                         | NA       |
| Unstable      | Yes      | K-wire      | 2×1.1 mm, hand                                        | 30              | Slight migration | None      | NA    | Co-amoxiclav                | 1× 7 days        |
| Crush         | Yes      | K-wire      | 2×1.1 mm Orthofix mini, hand                          | 28              | None          | None      | NA    | Co-amoxiclav                | IV, 3 days; Tab, 5 days |
| Traumatic     | Yes      | K-wire      | 2×1.1 mm, hand                                        | 78              | None          | None      | NA    | Co-amoxiclav                | 1× IV 1.2 g     |
| Dog bite      | Yes      | K-wire      | 1×0.9 mm, hand                                        | 27              | None          | Yes       | MCS   | Co-amoxiclav                | IV, 3 days; tabs, 7 days |
| Dupuytren     | No       | Ext. fixation | Pennig Orthofix, hand                                | 26              | Technical error | Yes      | NA    | Flucoxacilline               | Co-amoxiclav Tabs 7 days |
| Traumatic     | Yes      | Circular frame | 7× wires, 3× pins, lower leg                          | 60              | Infection and nerve injury | Many     | S. aureus +++                | None     |
| Assault Axe   | Yes      | K-wire      | 2×1.1 mm, hand                                        | 33              | Infection     | Once      | NA    | Co-amoxiclav                | 1× IV 1.2 g     |
| Traumatic     | Yes      | K-wire      | 1×1.2 mm, hand                                        | 35              | None          | None      | NA    | None                         | None       |
| Circular saw  | Yes      | K-wire      | 1×1.1 mm, hand                                        | 44              | None          | None      | NA    | Co-amoxiclav                | IV, 3 days; Tabs, 7 days |
| Sports injury | Yes      | Needle      | Hollow needle, hand                                   | 14              | Slight migration | None      | NA    | Co-amoxiclav                | Tabs, 5 days     |
| Deglovement   | Yes      | External fixator | Hoffman II 2×4 mm 2×5 mm pins, hand       | 27              | None          | None      | NA    | Co-amoxiclav                | IV, 3 days        |
| Assault Axe   | Yes      | K-wire      | 1×0.9 mm, hand                                        | 21              | None          | None      | NA    | Co-amoxiclav                | IV 6 days; Tabs, 7 days |
| Occupational  | Yes      | External fixator | Pennig Orthofix, hand                                | 27              | None          | None      | NA    | None                         | NA       |

NBG no bacterial growth, NA not applicable

a Pins were changed due to insertion of wrong-sized pins
| Device | n  | Population                        | Mean duration Rx (days) | Mean FU | Study design | Complication rate | Infection rate | Diagnosis of PTF | Prevention: antibiotics | Prevention: wound care | Management of PTI |
|--------|----|-----------------------------------|-------------------------|---------|--------------|------------------|----------------|-----------------|--------------------------|--------------------------|---------------------|
| Ahlborg and Jossefson 1999 [5] | 314 | Adults, unstable distal radius   | 7–122 (39)              | 3.5 years | Retrospective | 27%              | 21%             | Requiring oral antibiotics | No                       | Not mentioned         | 9 premature removals |
| Battle and Carmichael 2007 [26] | 180 | Children/upper limb               | 16–102 (30.7)           | NA      | Retrospective | NA              | 7.9%            | Green           | No                       | Not mentioned         | 5 operations, 1 pin removal and IV AB |
| Blasier et al. 1997 [10]       | 182 | Children/femur                     | 80                      | 14 months | Retrospective | 53.4%            | 40.5%           | Superficial (30%) or significant (4.5%) | No                       | Instructions, twice daily cleaning using nonsterile cotton swabs, hydrogen peroxide and povidone-iodine 10% |
| Botte et al. 1992 [27]         | 137 | Hand or wrist dislocations and     | 2–168 (45.5)            | NA      | Retrospective | 18%              | 7%              | Clinical symptoms + bacteriology | IV Cephalosporin antibiotics | Dressed with antibiotic ointment + dressing | Superficial: povidone-iodine/removal of pins/abcess, incision and drainage |
| Cavasoglu et al. 2009 [12]    | 39  | Tibial                            | Not mentioned           | 150 days | Prospective randomized | (1) 54.2%, (2) 47.3% | Dahl classification | Pre- and postop IV cephalosporin open # IV gentamicin and omadinele TBS | No                       | Repositioning in 1 patient, removal in 1 patient | 4+ early removal |
| Checketts et al. 1995 [28]    | 134 | Adult, tibial shaft               | 105                     | 3.5 months | Retrospective | 39%              | Minor or major | Prophylactic, third-generation cephalosporin | No                       | Not mentioned         | Oral AB, removal of the pins or IV AB (numbers not mentioned) |
| Cheung et al. 2008 [6]         | 100 | Fractures of the elbow            | 8–94 (31)               | NM      | Retrospective | 25%              | 25%             | No              | 75% received a course of postop prophylactic antibiotics | Oral antibiotics 10.1% | Oral antibiotics 10.1% |
| Davies et al. 2005 [15]       | 120 | Fractures or limb reconstructions | 24–92                   | NM      | Prospective   | NM              | A, 89.1%; B, 64.9% | Episode of pain/inflammation at pin site, + discharge + on bacterial culture or responded to antibiotics | NM                       | Oral AB, removal of the pins or IV AB (numbers not mentioned) |
| Egol et al. 2006 [6]          | 118 | Unstable or displaced fractures of the distal radius | Average 41.3 | >6 months | Prospective, randomized | 19%              | 10.1%           | Requiring oral antibiotics | Three doses of IV cephalosporin | Oral antibiotic 10.1% |
| Hove et al. 2010 [29]         | 70  | Unstable fractures of the distal radius | Mean 42 | 12 months | Prospective, randomized | 43% dynamic    | 43% static (p<0.01) | Oral antibiotic | Oral antibiotic | Oral antibiotic 10.1% |
| Hove et al. 2010 [29]         | 70  | Dynamic (Dynawrist) and static external fixation (Hoffman II Compact) | Mean 42 | 12 months | Prospective, randomized | 43% dynamic    | 43% static (p<0.01) | Oral antibiotic | Oral antibiotic | Oral antibiotic 10.1% |

Abbreviations: PTF, pin-track infection; FU, follow-up; IV, intravenous; AB, antibiotic; NM, not mentioned; 1/, parenteral AB, 2/, debridement; 3/, IV antibiotics, 4/, IV antibiotics, 5/, IV antibiotics, 6/, IV antibiotics, 7/, IV antibiotics, 8/, IV antibiotics, 9/, IV antibiotics, 10/, IV antibiotics, 11/, IV antibiotics, 12/, IV antibiotics, 13/, IV antibiotics, 14/, IV antibiotics, 15/, IV antibiotics, 16/, IV antibiotics, 17/, IV antibiotics, 18/, IV antibiotics, 19/, IV antibiotics, 20/, IV antibiotics, 21/, IV antibiotics, 22/, IV antibiotics, 23/, IV antibiotics, 24/, IV antibiotics, 25/, IV antibiotics, 26/, IV antibiotics, 27/, IV antibiotics, 28/, IV antibiotics, 29/, IV antibiotics, 30/, IV antibiotics, 31/, IV antibiotics, 32/, IV antibiotics, 33/, IV antibiotics, 34/, IV antibiotics, 35/, IV antibiotics, 36/, IV antibiotics, 37/, IV antibiotics, 38/, IV antibiotics, 39/, IV antibiotics, 40/, IV antibiotics, 41/, IV antibiotics, 42/, IV antibiotics, 43/, IV antibiotics, 44/, IV antibiotics, 45/, IV antibiotics, 46/, IV antibiotics, 47/, IV antibiotics, 48/, IV antibiotics, 49/, IV antibiotics, 50/, IV antibiotics, 51/, IV antibiotics, 52/, IV antibiotics, 53/, IV antibiotics, 54/, IV antibiotics, 55/, IV antibiotics, 56/, IV antibiotics, 57/, IV antibiotics, 58/, IV antibiotics, 59/, IV antibiotics, 60/, IV antibiotics, 61/, IV antibiotics, 62/, IV antibiotics, 63/, IV antibiotics, 64/, IV antibiotics, 65/, IV antibiotics, 66/, IV antibiotics, 67/, IV antibiotics, 68/, IV antibiotics, 69/, IV antibiotics, 70/, IV antibiotics, 71/, IV antibiotics, 72/, IV antibiotics, 73/, IV antibiotics, 74/, IV antibiotics, 75/, IV antibiotics, 76/, IV antibiotics, 77/, IV antibiotics, 78/, IV antibiotics, 79/, IV antibiotics, 80/, IV antibiotics, 81/, IV antibiotics, 82/, IV antibiotics, 83/, IV antibiotics, 84/, IV antibiotics, 85/, IV antibiotics, 86/, IV antibiotics, 87/, IV antibiotics, 88/, IV antibiotics, 89/, IV antibiotics, 90/, IV antibiotics, 91/, IV antibiotics, 92/, IV antibiotics, 93/, IV antibiotics, 94/, IV antibiotics, 95/, IV antibiotics, 96/, IV antibiotics, 97/, IV antibiotics, 98/, IV antibiotics, 99/, IV antibiotics, 100/, IV antibiotics, 101/, IV antibiotics, 102/, IV antibiotics, 103/, IV antibiotics, 104/, IV antibiotics, 105/, IV antibiotics, 106/, IV antibiotics, 107/, IV antibiotics, 108/, IV antibiotics, 109/, IV antibiotics, 110/, IV antibiotics, 111/, IV antibiotics, 112/, IV antibiotics, 113/, IV antibiotics, 114/, IV antibiotics, 115/, IV antibiotics, 116/, IV antibiotics, 117/, IV antibiotics, 118/, IV antibiotics, 119/, IV antibiotics, 120/, IV antibiotics, 121/, IV antibiotics, 122/, IV antibiotics, 123/, IV antibiotics, 124/, IV antibiotics, 125/, IV antibiotics, 126/, IV antibiotics, 127/, IV antibiotics, 128/, IV antibiotics, 129/, IV antibiotics, 130/, IV antibiotics, 131/, IV antibiotics, 132/, IV antibiotics, 133/, IV antibiotics, 134/, IV antibiotics, 135/, IV antibiotics, 136/, IV antibiotics, 137/, IV antibiotics, 138/, IV antibiotics, 139/, IV antibiotics, 140/, IV antibiotics, 141/, IV antibiotics, 142/, IV antibiotics, 143/, IV antibiotics, 144/, IV antibiotics, 145/, IV antibiotics, 146/, IV antibiotics, 147/, IV antibiotics, 148/, IV antibiotics, 149/, IV antibiotics, 150/, IV antibiotics, 151/, IV antibiotics, 152/, IV antibiotics, 153/, IV antibiotics, 154/, IV antibiotics, 155/, IV antibiotics, 156/, IV antibiotics, 157/, IV antibiotics, 158/, IV antibiotics, 159/, IV antibiotics, 160/, IV antibiotics, 161/, IV antibiotics, 162/, IV antibiotics, 163/, IV antibiotics, 164/, IV antibiotics, 165/, IV antibiotics, 166/, IV antibiotics, 167/, IV antibiotics, 168/, IV antibiotics, 169/, IV antibiotics, 170/, IV antibiotics, 171/, IV antibiotics, 172/, IV antibiotics, 173/, IV antibiotics, 174/, IV antibiotics, 175/, IV antibiotics, 176/, IV antibiotics, 177/, IV antibiotics, 178/, IV antibiotics, 179/, IV antibiotics, 180/, IV antibiotics, 181/, IV antibiotics, 182/, IV antibiotics, 183/, IV antibiotics, 184/, IV antibiotics, 185/, IV antibiotics, 186/, IV antibiotics, 187/, IV antibiotics, 188/, IV antibiotics, 189/, IV antibiotics, 190/, IV antibiotics, 191/, IV antibioti...
| Device | n  | Population | Mean duration Rx (days) | Mean FU Study design | Complication rate | Infection rate | Diagnosis of PTF | Prevention: antibiotics | Prevention: wound care | Management of PTI |
|--------|----|------------|------------------------|----------------------|-------------------|----------------|-----------------|----------------------|----------------------|------------------|
| Hutson and Zych 1998 [30] Illizarov system | 135 | Periarticular fractures of the tibia and femur | 168 (tibial and femur) | 189 (pin fractures) | >2 years Prospective | NM | 13% | IV antibiotics 2 days postop | Instructions, daily cleaning with soap and water, removal of crusts, Bactroban ointment and frame covers | Oral cephalosporin, injective and incision 'tenting' wounds. Loose wires retained. Removal. |
| Margec 2006 [4] The “simply” external fixator | 100 | Closed metacarpal and phalangeal fractures | 28 | 19 Months (4-42) Prospective | 7% | 7% | S sims and Saleh classification | NM | Instructions; antiseptic spray, antibiotic cream. |
| Mason et al. 2005 [9] Pelvic external fixator | 100 | Pelvic ring injuries | 1-20 (8) temporary, 17-113 (60) definitive | Retrospective | 21% temporary, 62% definitive | 13% temporary, 50% definitive | Positive microbial culture and antibiotics used for treatment | NM | 22 antibiotics, 1 pin reinserted, 7 fixators removed, 1 osteomyelitis, 2 abscess drainage |
| Panmasswaran et al. 2003 [2] Ring, unilateral and hybrid fixators | 285 | Fractures, dislocations or tendon rupture | 44.1-180 (mean, 61) | 5.4-11.1 months (mean, 6.3) Retrospective | 11.2% Infection | 3.9% Ring, 12.9% unilat., 20% hybrid | Signs and symptoms around the pin site that required a change of AB. Superficial or deep infection | NM | Gauze packing, cleansing twice a day with half strength peroxide + antiseptic solution |
| Patterson 2005 [31] External fixation | 92 | Fractures | Not mentioned | NA Prospective randomized multicenter | NA | 34% | Sims and Saleh 1996 | NA | 2 patients required IV AB |
| Pieske et al. 2008 [32] Titanium alloy pins (TA) versus stainless steel pins (SS) at the Wrist | 80 | Unstable distal radial fractures | 3-17 days | 3 months Prospective | 21% | 58.5% TA 0% | Clinical signs of infection | Only applied if a pin-track infection occurred | 2 external fixators removed in stainless steel group+1 debulking + 1 persistent pin-track infection with osteomyelitis |
| Schneider et al. 1986 [13] Hoffman external fixation | 86 | Compound or unstable tibial shaft fractures | 120-532 (mean, 300) | NM Retrospective | 87.5% | 36% | Not mentioned | Not mentioned | Not mentioned |
| Sharma et al. 2007 [33] K-wires | 103 | Paediatric fractures | 21-42 (31.5) | 2-24 months (10.2) Retrospective | 32.3% | 5.8% | Documentation of seropurulent discharge/erythema around the pin stem with or without bacteriological evidence of infection | Not mentioned | The pins were protected with sterile cast padding |
| Sims and Saleh 2000 [11] Orthofix Ilizarov Sheffield hybrid system | 248 | Fractures and elective reconstructions | 333 days (43-1125) | NM Prospective | 71% | 71% | Not mentioned | Massage around the pin sites, cotton buds with sterile or cooked water, sub removal, dressings removed if there is exudate. | 44 on long-term antibiotics, 3× removal 8× curettage |
Blasier et al. [10] investigated 132 children with fractures of the femur who were treated with external fixators. They found an infection rate of 40.5%; a rate of superficial infection of 36% and a rate of 4.5% for cases requiring intravenous antibiotics. Sims and Saleh [11] reported a higher pin-tract infection rate of 86% associated with external fixation of the femur. These authors related the high infection rate to the bulk of tissue in the upper leg and its associated movement.

External fixation devices for tibial shaft fractures have been widely investigated. The Ilizarov circular, external frame is one of the transcutaneous devices often used to treat tibial fractures. The pin-tract infection rate varies from 36% to 54.2% [12, 13]

**Pin-site wound care** Lethaby et al. showed in 2008, in a systemic review, that there is insufficient evidence available on any one best way to care for pin sites [14]. Recently, the Russian Protocol of pin-site care has become more popular. This Russian Protocol was developed by the “Ilizarov Scientific Centre” for Restorative Orthopaedics in Russia. The system advises non-touch techniques when using the wires and pins, the utilisation of pulsed drilling, the removal of bone swarf and immediate coverage of the pin-site with dressings soaked in Chlorhexidine 1% ointment. The pins should be cleaned daily for 3 days with 70% alcohol, after which an occlusive dressing should be applied. This ritual is repeated every 7 days while the transcutaneous metal device is in place. Davies et al. [15] showed that infection rates are higher by 37% in cases where the Russian Protocol is not utilised (p<0.001). The Cochrane review dismissed the findings of Davies et al. as it questioned their methods of randomizing their sample, even though, Timms and Pugh [16] advocate the following of this prescription.

Grant et al. [17] concluded that there is a role for the application of a bactericidal solution, such as 10% povidone–iodone solution, to the skin surrounding the pin sites. The problematic aspect of this treatment is the difficulty in securing an occlusive dressing.

The **pin insertion technique** When inserting Ilizarov or K-wires, it has been shown that several important issues should be addressed to keep the infection rate down; adequate cooling during drilling is vital to prevent thermal damage, and (as recommended in the Russian Protocol) drilling should be conducted using the pulsed technique. The ends of transcutaneous wires should be bent to avoid migration [18] (in our study, three wires migrated; one of which had not been bent).

Pre-drilling was thought to be necessary for certain pins in certain bones, and unnecessary for other situations. If the pins have sharp-cutting trocar points, pre-drilling may be

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**Table 2 (continued)**

| Device | n | Population | Mean FL | Study design | Complication | Rx (days) | Population Mean duration | Tx (days) | Infection rate | Diagnosis of PTI | Prevention: antibiotics/other interventions | Management of PTI |
|--------|---|------------|---------|--------------|--------------|----------|--------------------------|----------|-----------------|----------------|---------------------------------------------|------------------|
| K-wires | 246 | Fractures and dislocations in the hand and wrist | Retrospective | 6–12 weeks | NA | 21–56 | 6–52 weeks | Retrospective | 10.1 | Clinical signs of infection | Not mentioned | Local cleaning, oral antibiotics |
| Orthofix | 99 | Knee deformities | Prospective | 77 | NA | 91–101.8 | 10 weeks | Prospective | 77–91 | Clinical signs of infection | Not mentioned | Local cleaning, oral antibiotics |
| Orthofix | 99 | Knee deformities | Prospective | 77 | NA | 91–101.8 | 10 weeks | Prospective | 77–91 | Clinical signs of infection | Not mentioned | Local cleaning, oral antibiotics |
| Orthofix | 99 | Knee deformities | Prospective | 77 | NA | 91–101.8 | 10 weeks | Prospective | 77–91 | Clinical signs of infection | Not mentioned | Local cleaning, oral antibiotics |

*4 not applicable, NM not mentioned, PTI pin-tract infection*
unnecessary. In a study by Hutchinson et al. [19], soft tissue inflammation around the pins was almost twice as common in pre-drilled pin sites, which could be attributable to the increased soft tissue trauma associated with two passages of the wire across the tract. It has been suggested that with the use of sharp trocar points, the skin does not need pre-incision, but the skin should be incised if tenting appears at the pin site, as otherwise a fluid reservoir could develop and attract bacteria [20].

**Antibiotics** There is evidence that the presence of transcutaneous metal leads to the development of a biofilm between the skin and metal which allows bacterial growth. As transcutaneous metal is a foreign material, prophylactic antibiotics may be considered. Yet, according to W-Dahl and Toksvig-Larsen [21], antibiotics should be used as little as possible, and only those with a specific spectrum should be employed. These authors showed that prolonged antibiotic use has no benefit in eradicating infection. As you see in Table 2, good wound management and optimal insertion techniques do not eradicate this problem. The quickest answer to pin-site infection is often pin removal.

**Technological solutions** Various technological solutions have been tried in the hope of preventing pin-tract infection. Coated pins create an extra defence barrier between the pin and bacteria. In a recent systematic review of the influence of hydroxyapatite coating on pin loosening and pin-tract infection by Saithna [22], he concluded that there was less loosening with coated pins, but unfortunately not less infection.

Titanium is frequently used in Dentistry and in Orthopaedics for intraoral or intraosseous prostheses [23]. This material produces a reduced susceptibility to bacterial adhesion. In a study by Pieske et al. [24], titanium alloy pins were compared with stainless pins in 80 patients.

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**Table 3 Different classification systems of pin-tract infection**

| Classification                                      | Description                                                                 |
|-----------------------------------------------------|-----------------------------------------------------------------------------|
| **Green classification 1983**                       | A major pin-tract infection produces sufficient redness, pain or drainage to require hospital admission for either parenteral antibiotic therapy, pin removal or removal of the entire fixator. A chronic pin-tract infection or persistent drainage after pin removal is also considered a major infection. Any other pin reaction is defined as minor, even those with purulent discharge |
| **Modified Moore and Dahl classification 2009**     |                                                                             |
| 0 Normal appearance                                 |                                                                             |
| 1 Inflamed                                          |                                                                             |
| 2 Serous discharge                                  |                                                                             |
| 3 Purulent discharge                                |                                                                             |
| 4 Osteolysis                                        |                                                                             |
| 5 Ring sequestrum                                   |                                                                             |
| **Sims and Saleh classification 1996**              |                                                                             |
| 1 Copious serous drainage                           |                                                                             |
| 2 Superficial cellulitis                            |                                                                             |
| 3 Deep infection                                    |                                                                             |
| 4 Osteomyelitis                                     |                                                                             |
| **Saleh and Scott Classification 1992**             |                                                                             |
| 0 No problems                                       |                                                                             |
| 1 Responds to local care, for example increased cleaning and massage |                                                                             |
| 2 Responds to oral antibiotics                      |                                                                             |
| 3 Responds to intravenous antibiotics or pin site releases |                                                                             |
| 4 Responds to removal of the pin                    |                                                                             |
| 5 Responds to local curettage                       |                                                                             |
| 6 Chronic osteomyelitis                             |                                                                             |
| **Checketts–Otterburn Classification (2000)**       |                                                                             |
| 1 Slight redness, little discharge                  |                                                                             |
| 2 Redness of skin, discharge, pain and tenderness in the soft tissue |                                                                             |
| 3 Grade 2 but not improved with antibiotics         |                                                                             |
| 4 Severe soft tissue infection involving several pins, sometimes with associated loosening of the pin |                                                                             |
| 5 Grade 4 but also involvement of the bone; also visible on radiographs |                                                                             |
| 6 This infection occurs after fixator removal. The pin track heals initially but will break down and discharge at intervals. Radiograph shows new bone formation and sometimes sequestra |
There was no difference in the incidence of pin-tract infection. Masse et al. [25] found, in a randomized study, that silver pins resulted in a lower rate (30%) of positive microbiology cultures than uncoated pins (42%), but this difference was not statistically significant, and there was a raised serum silver in the patients with silver-coated pins. Much money is spent each year on improving technology, yet such attractive possibilities should not distract staff from executing the simple, basic but effective methods of wound and pin-site care.

Implications for practice

1. Our study found an infection rate of 24% associated with transcutaneous metal.
2. Plastic surgery departments need to develop clear protocols for prevention of pin-site infection, and randomized controlled trials are necessary to establish the best practice.
3. Patients need clearer instructions on how best to care for their pin sites.
4. There is a need to consider new technological solutions for this problem. Long-term implantation in dental practice has been established, but it is less successful in skin than oral mucosa.

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Conflict of interest None

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References

1. Stahl S, Schwartz O (2001) Complications of K-wire fixation of fractures and dislocations in the hand and wrist. Arch Orthop Trauma Surg 121:527–530
2. Parameswaran AD, Roberts CG, Seligson D, Voor M (2003) Pin tract infection with contemporary external fixation: how much of a problem? J Orthop Trauma 17(7):503–507
3. Green SA, Ripley JM (1984) Chronic osteomyelitis in pin tracks. J Bone Joint Surg Am 66(7):1092–1098
4. Margic K (2006) External fixation of closed metacarpal and phalangeal fractures of digits. A prospective study of one hundred consecutive patients. J Hand Surg Eur Vol 31(1):30–40
5. Ahlborg HG, Josefsson PO (1999) Pin-tract complications in external fixation of fractures of the distal radius. Acta Orthop 70:116–118
6. Egol KA, Paksima N, Puopolo S et al (2006) Treatment of external fixation pins about the wrist: a prospective, randomized trial. J Bone Joint Surg Am 88:349–354
7. Hove LM, Furnes O, Nilson PT, Oulie HE, Solheim E, Molster AO (1997) Closed reduction and external fixation of unstable fractures of the distal radius. Scand J Plast Reconstr Surg Hand Surg Suppl 31:159–164
8. Cheung EV, O’Driscoll SW, Morrey BF (2008) Complications of hinged external fixators of the elbow. J Shoulder Elbow Surg 17(3):447–453
9. Mason WTM, Khan SN, James CL, Chesser TJS (2005) Complications of temporary and definitive external fixation of pelvic ring injuries. Injury 36:599–604
10. Blasier RD, Aronson J, Tursky E (1997) External fixation of pediatric femur fractures. J Pediatr Orthop 17(3):342–346
11. Sims M, Saleh M (2000) External fixation—the incidence of pin site infection: a prospective audit. Orthop Nurs 4:59–63
12. Cavusoglu AT, Er MS, Inal S et al (2009) Pin site care during circular external fixation using two different protocols. J Orthop Trauma 23:10
13. Schroder HA, Christoffersen H, Sorensen TS, Lindequist S (1986) Fractures of the shaft of the tibia treated with Hoffmann external fixation. Arch Orthop Trauma Surg 105:28–30
14. Lethaby A, Temple J, Santy J (2004) Pin site care for preventing infections associated with external bone fixators and pins. Cochrane Database Syst Rev 4:CD001501
15. Davies R, Holt N, Nayagam S (2005) The care of pin sites with external fixation. J Bone Joint Surg Br 87:716–719
16. Timms A, Pugh H (2010) From British Consensus to Russian Protocol: how we justified our journey. Int J Orthopaed Trauma Nurs 14:109–115
17. Grant S, Kerr D, Wallis M, Pitchford D (2005) Comparison of povidone–iodine solution and soft white paraffin ointment in the management of skeletal pin-sites: a pilot study. Orthop Nurs 9(4):218–225
18. Franssen BBGM, Schuurman AH, Mink Van Der Molen A, Kon M (2010) One century of Kirschner wires an Kirschner wire insertion techniques: a historical review. Acta Orthop Belg 76:1–6
19. Hutchinson DT, Bachus KN, Higgenbotham T (2000) External fixation of the distal radius: to predrill or not to predrill. J Hand Surg 25A(6):1064–1068
20. Santy J, Vincent M, Duffield B (2008) The principles of caring for patients with Ilizarov external fixation. Nurs Stand 23(26):50–55
21. W-dahl A, Toksvig-Larsen S (2006) Infection prophylaxis: a prospective study in 106 patients operated on by tibial osteotomy using the hemicallotasis technique. Arch Orthop Trauma Surg 126:441–447
22. Saithna A (2010) The influence of hydroxyapatite coating of external fixator pins on pin loosening and pin track infection: a systematic review. Injury 41:128–132
23. Smith CM, Roy TD, Bhalkikar A, Li B, Hickman JJ, Church KH (2010) Engineering a titanium and polycaprolactone construct for a biocompatible interface between the body and artificial limb. Tissue Eng Part A 16(2):717–724
24. Pieske O, Pichlmaier L, Kaltenhauser F et al (2011) Hydroxyapatite-coated pins versus titanium alloy pins in external fixation at the wrist: a controlled cohort study. J Trauma 70(4):845–851
25. Masse A, Bruno A, Bosetti M, Biasibetti A, Cannas M, Gallinaro P (2000) Prevention of pin track infection in external fixation with silver. J Biomed Mater Res B Appl Biomater 53:600–604
26. Battle J, Carmichael KD (2007) Incidence of pin track infections in children's fractures treated with Kirschner wire fixation. J Pediatr Orthop 27(2):154–157
27. Botte MJ, Davis JL, Rose BA et al (1992) Complications of smooth pin fixation of fractures and dislocations in the hand and wrist. Clin Orthop Relat Res 276:194–201
28. Checketts RG, Moran CG, Jennings AG (1995) Tibial shaft fractures managed with the Dynamic Axial Fixator. Acta Orthop Scand. 66(3):271–274

29. Hove LM, Kruhaug Y, Revheim K, Helland P, Finsen V (2010) Dynamic compared with static external fixation of unstable fractures of the distal part of the radius: a prospective, randomized multicenter study. J Bone Joint Surg Am 92(8):1687–1696

30. Hutson JJ Jr, Zych GA (1998) Infections in periarticular fractures of the lower extremity treated with tensioned wire hybrid fixators. J Orthop Trauma 12(3):214–218

31. Patterson MM (2005) Multicenter pin care study. Orthop Nurs 24(5):349–360

32. Pieske O, Geleng P, Zaspel J, Piltz S (2008) Titanium alloy pins versus stainless steel pins in external fixation at the wrist: a randomized prospective study. J Trauma. 64(5):1275–1280

33. Sharma H, Taylor GR, Clarke NM (2007) A review of K-wire related complications in the emergency management of paediatric upper extremity trauma. Ann R Coll Surg Engl 89(3):252–258

34. W-Dahl A, Toksvig-Larsen S (2009) Undisturbed theatre dressing during the first postoperative week. A benefit in the treatment by external fixation: a cohort study. Strategies Trauma Limb Reconstr 4(1):7–12