Pin site care for preventing infections associated with external bone fixators and pins (Review)

Temple J, Santy J

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ABSTRACT

Background
Metal pins are used to apply skeletal traction or external fixation devices in the management of orthopaedic fractures. These pins protrude through the skin and are therefore described as ‘percutaneous’ and much has been written on the management of the associated skin wound. The way in which percutaneous pins are treated may affect the incidence of pin site infection. Recommendations for care are not necessarily evidence based. This review set out to summarise the research evidence on the effect of pin site care on infection rates.

Objectives
To assess the effect on infection rates of different methods of cleansing and dressing orthopaedic percutaneous pin sites.

Search strategy
The following electronic databases were searched: Medline (from 1966), the Cochrane Central Register of Controlled Trials (2003 issue 1) and the Wounds Group Specialised Trials Register (March 2003). In addition reference lists of review articles and relevant trials were also searched and some handsearching undertaken.

Selection criteria
All randomised controlled trials (RCTs) in people comparing the effect on infection rates of different methods of cleansing or dressing orthopaedic percutaneous pin sites were evaluated.

Data collection and analysis
Two reviewers independently assessed the citations retrieved by the search strategies for reports of relevant RCTs.

Main results
Only one trial was eligible for inclusion in the review. Henry (1996) compared cleansing with 0.9% saline, cleansing with 70% alcohol and no cleansing and found significantly fewer infections in pin sites which had not been cleansed.

Authors’ conclusions
There is very little evidence as to which pin site care regimen best reduces infection rates. Clearly there is a need for large RCTs to determine the best method of pin site management.

PLAIN LANGUAGE SUMMARY

No strong evidence about insertion, care and removal techniques for pins used for attaching traction or other fixation devices into broken arms and legs

Metal pins are sometimes used to apply traction or other external fixation devices into broken arms or legs. These pins pierce through the skin. The way they are inserted, cared for and removed may affect the frequency of infection. Different solutions are used for
cleaning around pins, scabs may or may not be removed and massage might be used to drain fluids around the pin. There are different kinds of pins, loosening regimes and removal techniques. However, the review of trials found that there is little strong evidence to show which pin care techniques have the best outcomes.

**BACKGROUND**

External fixation is a process by which pins or wires are inserted into bone fragments through small incisions in the skin and then held together with an external clamp or framework. This means of treating fractures was proposed by Malgaigne in 1853 (cited Sisk 1983) as an alternative to immobilisation in plaster cast, traction or internal fixation.

Percutaneous orthopaedic pins are metal rods or wires used to apply either skeletal traction or support an external fixator device in the management of orthopaedic fractures or surgical procedures. They penetrate the skin, adjacent muscle and soft tissue and then enter bone and may penetrate through to the other side of a limb. Skeletal traction using a Steinmann pin does not totally immobilise bone fragments but allows a force to be applied to a limb, holding it in a suitable position and thus allowing fracture healing to occur. The early advocates of external fixation, experienced considerable problems. The skin entry points, known as pin sites, frequently became infected and reported infection rates range between 1% for major infections to 80% for minor infections (Green 1983). Infection is undesirable as it can lead to failure of fixation with consequent loss of alignment of the fracture. It can also lead to osteomyelitis and systemic infection, which may be both costly and difficult to treat. Therefore, external fixation was frequently criticised during the ensuing century (Sisk 1983) but its advantages, namely early mobilisation, axial loading of the fracture (along the normal line of load for the limb), easy observation of the limb and access to the skin for wound care, have led to its continued use and development (Behren 1988).

External fixation is now an established treatment modality and is extensively used to treat fractures either alone or in combination with internal fixation (where screws and plates are used to hold bone fragments together beneath a surgical wound), traction or plaster cast (Blasier 1997).

There is no uniformly accepted definition of pin site infection; this contributes to the difficulty when comparing rates. Green 1983 suggested that major infections were those with wound, redness, discharge or pus. Many of these required hospitalisation for antibiotics, pin removal or removal of the whole fixator. The threat of infection remains a constraint to the use of external fixators.

It has been proposed that effective insertion techniques and subsequent nursing care of pin sites will reduce the frequency of pin site infections, loosening of fixation and osteomyelitis (Kroll 1973; Sisk 1983; Green 1984). Many different regimens for pin site care have been described. These include regular cleansing with solutions such as hydrogen peroxide (Jones-Walton 1991), 0.9% normal saline or cooled boiled water (Sims 1996). At the Kurgan Ilizarov Institute in Russia a very specific dressing regimen of 70% alcohol and 0.2% chlorhexidine, is prescribed immediately post operatively. In this regime pins are never left uncovered and care is carried out by hospital personnel on a weekly basis (Grant 1992). However there is no consensus on the optimal frequency of pin site care, which ranges from daily (Tolo 1983) to weekly (Ahlborg 1999) or even fortnightly (Grant 1992). Other uncertainties include whether scabs around the pin sites should be removed, and whether massage to promote drainage of exudate should be practiced (Gordon 2000; McKenzie 1999; Sims 1996).

Wissing 1988 and Mahan 1991 emphasised that a number of factors including the surgical technique used to apply the fixator, might affect infection rates and might be more important than any local care. Experimental studies have shown the benefit in terms of either reduced pin loosening or pin site infection, from silver-coated (Collinge 1994), tobramycin-impregnated (Voos 1999) or hydroxyapatite coated pins (Moroni 1998).

A number of articles have been written on various aspects of external fixation, in particular comparing the outcomes of the treatments. However most of these are either animal research, patient outcomes from case series or descriptive studies. As it is unclear which care regimen is the most effective, a systematic review of the evidence is justified.

**OBJECTIVES**

To assess the evidence for the effects of cleansing, massage and dressing techniques for pin sites on postoperative infection.

**CRITERIA FOR CONSIDERING STUDIES FOR THIS REVIEW**

**Types of studies**

Randomised controlled trials which compare different methods of managing pin sites were included in this review.

For clarity this review will use the terms "pin [s]" rather than orthopaedic pins, percutaneous pins or fixator wires; "pin-site" rather than pin-tract; "external fixator" rather than external apparatus or framework or halo-frame. It will also consider material about skeletal traction.
Types of participants
Adults and children with pins inserted for either external fixators or skeletal traction. Studies of treatment regimens that set out to manage established infections were not included. Studies of people of any age and any care setting are included.

Types of intervention
A. Cleansing Solutions
1) Cleansing (any technique) versus no cleansing
2) Comparisons between cleansing solutions (including sterile normal saline, alcohol solutions, iodine solutions, cooled boiled water or ordinary tap water)

B. Methods of cleansing
1) Sterile technique versus a non-sterile technique (e.g. a simple shower or washing with a soft toothbrush)

C. Primary dressing
1) No dressing versus any dressing
2) Comparisons between dressings (e.g. simple gauze, cut foam dressings and those made specifically by fixator manufacturers)

D. Massage
1) Massage versus no massage
2) Comparisons between different massage regimens
3) The management of 'skin-tenting' around pins

Comparisons between specific comprehensive regimens of treatment such as the Kurgan Ilizarov method will be included.

Types of outcome measures
Studies will report their outcomes in terms of
Primary Outcome:
• Incidence of infection (as classified by Sims 1996)

The definition of infection given by Sims & Saleh (Sims 1996 pg 264) will be used in the review although it does not quantify bacterial counts it does provide a qualitative measure of infection.
Grade 1: responds to local treatment, increased cleaning and massage (local manipulation of the skin to prevent adherence to the pin and allow drainage)
Grade 2: responds to oral antibiotics
Grade 3: responds to intravenous antibiotics
Grade 4: responds to removal of pin
Grade 5: removal of pin and surgery required to control infection
Grade 6: chronic osteomyelitis (unresponsive to treatment)

We took at face value the definitions of infection used in the trial reports.

Secondary Outcomes:
• Frequency of pin re-siting due to infection
• Frequency of external fixator apparatus removal due to infection
• Patient comfort, as defined by the patient’s expression of discomfort at the pin site
• Patient acceptability, as being defined by the patient’s refusal to accept the treatment any longer
• Duration of treatment (i.e. time to pin removal)
• Duration of overall treatment time (i.e. any prolongation of treatment beyond the norm for this type of fixation)
• Cost of treatment regimen, in particular as linked to the treatment of pin site infections
• Limb amputation
• All cause mortality

SEARCH METHODS FOR IDENTIFICATION OF STUDIES

See: Cochrane Wounds Group methods used in reviews.

The following electronic databases were searched:
MEDLINE from 1966, The Cochrane Wounds Group Specialised Trials Register (up to March 2003), the Cochrane Central Register of Controlled Trials (issue 1 2003) using the following search strategy:

1. EXTERNAL FIXATORS explode all trees (MeSH)
2. BONE NAILS explode tree 1 (MeSH)
3. BONE WIRES explode all trees (MeSH)
4. BONE SCREWS explode tree 1 (MeSH)
5. BONE PLATES explode tree 1 (MeSH)
6. FRACTURE FIXATION explode all trees (MeSH)
7. ((external near fix*) or (bone near fix*))
8. ((bone near pin*) or (bone near wire*))
9. ((fracture and fix*) or (orthopaedic and pin*))
10. (#1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9)
11. BANDAGES explode all trees (MeSH)
12. DETERGENTS explode tree 1 (MeSH)
13. ANTI-INFECTIVE AGENTS LOCAL explode tree 1 (MeSH)
14. (wound* near infection*)

The following journals were handsearched: Orthopaedic Clinics of North America July 2000, Oct 2000, April 2001; Current Orthopaedics 1999-2000; Orthopaedic Nursing January 2000 to June 2001. The handsearching produced no additional studies and was not continued. Citations within obtained reviews and papers were scrutinised to identify additional studies.
METHODS OF THE REVIEW

Titles and abstracts of studies identified by the search strategy were assessed in terms of their relevance and design according to the selection criteria, by the primary reviewer. Copies of all relevant and potentially relevant papers were obtained, if from this initial assessment, they satisfied the inclusion criteria. This was repeated independently by another reviewer with no disagreement. Papers published in languages other than English were translated in sufficient detail to determine whether it was an RCT. Details of the studies, such as setting, baseline characteristics, interventions, outcomes, analysis and results, were extracted and summarised using a data extraction sheet. Data extraction was completed by two reviewers independently and the data extraction sheets were compared for agreement.

The validity of the studies was assessed to detect potential sources of bias, using a checklist:

i) Was the assignment to the treatment groups really random?
ii) Was the allocation concealed?
iii) Was relatively complete (80% of subjects) follow up achieved?
iv) Were the control and treatment groups comparable at the start of treatment?
v) Were the outcomes of participants who withdrew described and included in the analysis?
vi) Were those assessing outcomes blind to treatment allocation?
vii) Were the control and treatment groups treated identically other than the named intervention?

In addition factors related to external validity of findings were assessed such as:

i) Reporting of clear inclusion and exclusion criteria
ii) Clear description of the type of pin / fixator used and the pin site treatment method
iii) Clear details of pin site complications
iv) Clear definitions of infection
v) Trial duration

DESCRIPTION OF STUDIES

Twenty four potential RCTs or CCTs were identified that considered any aspect of pin management, only 14 made any reference to aspects of pin site care and only one trial (Henry 1996) considered actual pin site care and was included in the review. The other 13 trials which consider aspects of pin form, pin function or infection are detailed in the Table of Excluded Studies.

HENRY 1996

Henry 1996 is both a review of existing literature and a prospective RCT of pin site care in which 120 pin sites in 30 females aged 11-18 years who were undergoing leg lengthening surgery were randomised to removal of crusts followed by either cleansing with 0.9% saline, or with 70% alcohol or no cleansing. All sites were sprayed with dry povidone iodine and covered with dry gauze.

METHODOLOGICAL QUALITY

HENRY

i) Was the assignment to the treatment groups really random?
Yes. The patients were allocated to the three groups by random sequence numbers, and then each of the 120 pin sites was included in the trial. All the pins on each patient were treated similarly (personal communication with author).

ii) Was there allocation concealment?
No.

iii) Was relatively complete (80% of subjects) follow up achieved?
From communication with the author it was reported that all subjects completed the trial however some patients did not adhere to the protocol.

iv) Were the control groups comparable at the start of treatment?
Unclear. Henry comments that the majority of pin sites were in the femur and tibia, suggesting that at least some were not. It has been noted elsewhere that infection rates in pin sites may vary with site on the body (Gordon 2000). Clearly in some aspects of the trial strenuous efforts were made to keep practice consistent. These include, the use of dry gauze to remove crusts, wearing gloves to carry out the procedures, a teaching programme to ensure adherence to the protocol and the application of a dry dressing after care.

v) Were the outcomes of participants who withdrew described and included in the analysis?
No.

vi) Were those assessing outcomes blind to treatment allocation?
It is not clear who undertook the outcomes assessment.

vii) Were the control and treatment groups treated identically other than the named intervention?
Yes.

RESULTS

There was one included trial and the results are presented according to the questions:

A. Cleansing solutions
(1) Cleansing versus no cleansing

HENRY

This study defines infection as pain, redness and swelling and a significant number of pathogenic bacteria on culture at the pin site with or without systemic symptoms. It was found that 92% of the infections were due to Staphylococcus aureus infections.
and all resolved with oral antibiotics. There were 30 patients and 120 pin sites such that there were 40 pin sites per experimental or control group. The pins were in situ from 56 - 244 days but no indication is given as to how this time span was distributed between the groups. Henry notes that the infection rate did not relate to the length of time the pin was in situ and that once an infection had occurred it would often reoccur at a later stage at the same pin.

Infections occurred in 25% of those participants whose pins were cleansed with 0.9% saline (n=10); 18% of those whose pins were cleansed with 70% alcohol (n=7) and 8% (n=3) of those in the control group. The infection rate was 35% higher in femoral than tibial pins, particularly in those situated near the groin or on swollen thighs, this was reported incidentally and was not a prespecified subgroup. All pins were massaged to remove crusts and none had to be surgically released because of tension. All pin sites were sprayed with povidone-iodine dry spray.

No trials were found that considered comparisons between cleansing solutions. No trials were identified that considered (B) Methods of cleansing; (C) Different types of dressings or (D) massage. Statistical synthesis was not applied as it was not appropriate

**DISCUSSION**

The included trial raises some important issues concerning the cleansing regimens used but has flaws in its methodology. Henry 1996 did use random allocation however the authors do not report whether groups were balanced at baseline for anatomical distribution of pin sites, given that pins at different sites are at different risks of infection. Furthermore the study by Henry did attempt to avoid differences between the groups in respect of co-interventions.

In conclusion there is a complete absence of evidence for any particular strategy of pin site care. Adequately powered randomised trials are required to examine the effects of different pin care regimens. Any new trials must be reported in line with CONSORT guidance and particularly data regarding baseline distribution of prognostic factors must be presented (Begg 1996). Prognostic factors include pre-drilling holes for pins, incising the pin sites prior to pin insertion and use of antimicrobial coating on pins. These factors were not reported in the trial identified.

**AUTHORS’ CONCLUSIONS**

**Implications for practice**

There is no good quality research to inform the best management of pin sites, however implementation of general strategies for minimising the risk of cross infection must be recommened.

**Implications for research**

Despite the wealth of published literature in the area of pin site care and as the body of research concerning the use of external fixators increases, the omission of research into pin site care becomes more apparent. Adequately powered, valid RCTs are required.

**NOTES**

The title of the published protocol was “Interventions to prevent infection associated with external bone fixators and pins” this has been amended to “Pin site care for preventing infections associated with external bone fixators and pins” at the review stage.

**POTENTIAL CONFLICT OF INTEREST**

None

**ACKNOWLEDGEMENTS**

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- No sources of support supplied

Internal sources of support

- University of Plymouth UK
- University of Bradford UK
- University of Hull UK
Pin site care for preventing infections associated with external bone fixators and pins (Review)

References

References to studies included in this review

Henry 1996 *(published data only)*


References to studies excluded from this review

Bednar 1996


Botte 1989


Collinge 1994


Darouiche 1998


Hutchinson 2000


Kapoor 2000


Masse 2000


Moroni 2001


Moroni/Heikkila 2001


Sproles 1985


Turcic 1998


Voos 1999


Vossinakis 2002


Additional references

Ahlborg 1999


Begg 1996


Behrens 1988


Blaiser 1997


Gordon 2000


Grant 1992


Green 1983


Green 1984


Jones-Walton 1991


Kroll 1973


Mahan 1991


McKenzie 1999

McKenzie L. In search of a standard for pin site care. *Orthopaedic Nursing* 1999;March/April:73–78.
Moroni 1998

Sims 1996

Sisk 1983

Tolo 1983

Wissing 1988

*Indicates the major publication for the study

**TABLES**

**Characteristics of included studies**

<table>
<thead>
<tr>
<th>Study</th>
<th>Henry 1996</th>
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</table>
| Methods | Allocation by random sequence numbers.  
Duration 56 to 244 days.  
No inclusion criteria identified |
| Participants | 30 patients, aged 11-18 years old having planned lengthening surgery were randomised into 3 groups with 40 pin sites in each group. Pins were external fixators located on the femur or tibia. |
| Interventions | Group 1 cleansing with 0.9% saline.  
Group 2 cleansing with 70% alcohol.  
Group 3 no cleansing.  
All sites sprayed with povidone iodine and covered with dry gauze. |
| Outcomes | Infection rates reported.  
After completion of the trial neither of the experimental regimes adopted |
| Notes | The research statistics identify issues such as infection rates in pin sites associated with area on the body |
| Allocation concealment | D – Not used |

**Characteristics of excluded studies**

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<td>Bednar 1996</td>
<td>This study focused on the use of external fixator in the management of back pain, it has a specific pin site care protocol but does not include this as part of the research</td>
</tr>
</tbody>
</table>
Characteristics of excluded studies (Continued)

<table>
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<td>Botte 1989</td>
<td>This prospective clinical trial considered the need for stab wound incision prior to the placement of halo skeletal fixator pins. It does not meet any inclusion criteria.</td>
</tr>
<tr>
<td>Collinge 1994</td>
<td>This was a clinical trial involving the placement of silver-coated fixation pins in sheep. The coated pins and the control pins were inoculated with Staphylococcus aureus and examined for infection at 2.5 weeks. No dressing regimes are involved.</td>
</tr>
<tr>
<td>Darouiche 1998</td>
<td>This trial, involving rabbits, considered the efficacy of coating intramedullary nails with antiseptic chlorhexidine and chloroxylenol, as compared with standard nails, when inoculated with Staphylococcus aureus. This trial does not use external fixators.</td>
</tr>
<tr>
<td>Hutchinson 2000</td>
<td>This RCT considered the advantages of pre-drilling before the insertion of external fixation pins in treating distal radius fractures. A pin care regime was prescribed but not considered as part of the research.</td>
</tr>
<tr>
<td>Kapoor 2000</td>
<td>This RCT study considers 3 different methods of treating distal radius fractures, their findings recommend that displaced severely comminuted intra-articular fractures should be treated with an external fixator. They make mention of pin site care but do not consider it in the trial.</td>
</tr>
<tr>
<td>Masse 2000</td>
<td>This RCT compared silver coated and standard stainless steel screws used with an external fixator. A pin site regime is included but not considered as part of the research.</td>
</tr>
<tr>
<td>Moroni 2001</td>
<td>This RCT considered the improvement in the bone-pin interface and thus fixation, of pins hydroxyapatite-coated pins compared with standard tapered pins. In the application of external fixation for wrist fractures in osteoporotic women. There is no information of pin site care but considerable detail on pin site infection.</td>
</tr>
<tr>
<td>Moroni/Heikkila 2001</td>
<td>This RCT compared biomechanical &amp; clinical properties of standard tapered pins and hydroxyapatite-coated pins in patients with femoral or tibial fractures treated with external fixation. A pin site cleaning regime is stated but is not discussed as part of the research.</td>
</tr>
<tr>
<td>Sproles 1985</td>
<td>A CCT where patients were allocated by location in hospital, therefore experimental and control groups were systematically different for reasons other than pin site care.</td>
</tr>
<tr>
<td>Turic 1998</td>
<td>This study considers the outcomes of converting original external fixation treatment to AO screw fixation with maintaining the external fixation for the duration of treatment of fractures due war wounds. A wound care protocol is included but not discussed in the research.</td>
</tr>
<tr>
<td>Voos 1999</td>
<td>This clinical study compared the effectiveness in preventing pin-tract infection, between normal pins and those with a tobramycin -impregnated polymethylmethacrylate sleeve in goats. No dressing protocols.</td>
</tr>
<tr>
<td>Vossinakis 2002</td>
<td>This RCT compared the effectiveness of an external fixator with a sliding hip screw in the treatment pertrochanteric femoral fracture. Entry points for pins were prevented from tenting and a daily dressing regime was carried out, but not considered as part of the trial.</td>
</tr>
</tbody>
</table>

**GRAPHS AND OTHER TABLES**

This review has no analyses.

**INDEX TERMS**

Medical Subject Headings (MeSH)

- Bandages
- Bone Nails [*adverse effects]
- Bone Wires [*adverse effects]
- External Fixators [*adverse effects]
- Fracture Fixation [*instrumentation]
- Irrigation [methods]
- Randomized Controlled Trials as Topic
- Surgical Wound Infection [*prevention & control]
- Traction [instrumentation]

**MeSH check words**

- Humans

**COVER SHEET**

**Title**

Pin site care for preventing infections associated with external bone fixators and pins

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Contribution of author(s)

Jenny Temple (formerly Lee-Smith) and Julie Santy separately assessed trials for inclusion and trial methodological quality. Jenny Temple drafted the review.

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What's New

Information not supplied by author

Date new studies sought but none found

Information not supplied by author

Date new studies found but not yet included/excluded

Information not supplied by author

Date new studies found and included/excluded

Information not supplied by author

Date authors' conclusions section amended

Information not supplied by author

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