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INFECTION RATE OF EXTERNAL FIXATION FRACTURES

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Abstract

External fixation is a commonly used technique of bone fixation among orthopaedic surgeons after major trauma. It has many advantages such as minimal vascular compromise, minimal soft tissue damage, and fixation away from the site of facture. However, infection at pin site remains a considerable complication that may result in pin site loosening, poor healing of wound and/or fractures, osteomyelitis, and subsequently fixation failure. To date, there is no definite cure for pin site infection, and the use of systemic antibiotics was not beneficial because it does not penetrate to the pin infection site. Thus, early identification of signs of infection, infection risk factors, and prevention strategies is fundamental to reduce the infection rate. This article aims at reviewing and discussing the infection rate and the risk factors for pin site infection following external fixation of bone fractures.

Keywords: *External fixation, fixation, infection rate, risk factors.*

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INTRODUCTION:

External fixation is a commonly used technique of bone fracture fixation among orthopaedic surgeons after major trauma. It comprises placing an external fixating device outside the skin to bone fragments with pins and wires connected together via a bar [1]. The main advantages of using external fixation technique are minimal vascular compromise, minimal soft tissue damage, fixation away from the site of facture, and being an appropriate option when significant local infection exists [2]. Therefore, external fixation is usually indicated for open fractures, for closed fractures with soft tissue injury, for polytrauma, for periarticular fractures, and for fractures in children. Tibia and distal radius fractures are the most common sites indicated for external fixation. Less common fractures indicated for external fixation include femur, humerus, forearm, and pelvic fractures. The main disadvantages of external fixation, on the other side, are restricted joint motion during fixation, heavy external fixators, being inadequate for certain types of fractures, and the risk of pin-tract infections [2].

In spite of the several advantages of external fixation, many complications might occur. The main complications, though rare, are external fixator-associated pin infection, pin site loosening, poor healing of wound and/or fractures, and osteomyelitis [2-4]. Infection is one of the most common and most important complications of external fixation. It usually occurs around pin and wire sites. The vast majority of infection are mild and localized. However, serious invasive infections may occur such as toxic shock syndrome and necrotizing fasciitis [5].

This article aims at reviewing and discussing the infection rate and risk factors for pin site infection following external fixation of bone fractures.

POST EXTERNAL FIXATION INFECTION RATES

Infection is one of the most common complications that may occur after external fixation of bone fracture, and it is fundamental for orthopaedic surgeons to be aware with its rates, risk factors, and prevention. This is because, to date, there is no definite cure for this infection. Systemic antibiotics do not reach the infection site and topical antibiotics did not show an adequate effect[6]. Thus, prevention is the only effective management strategy to reduce external fixation-associated infection and infection-associated morbidity, failure of external fixation procedure, and mortality. The most common bacterial infections at pin site are staphylococcus aureus, staphylococcus epidermidis, and Escherichia coli[7,8].

The rates of external fixation-associated infection reported among literature studies are highly variable and depend on many factors. Superficial simple non-invasive infections occur in 0.5-100% of patients undergoing external fixation[3,9,10], whilst deep invasive infections are very rare. They are reported to occur in up to 5% of the cases [8,9,11-15]. To date, a universal definition for pin site infection does not exit. There is a wide range of infection severity and complications, and the definition of infection varies widely among the reported research studies. This explains the high variability of the infection rates reported and the non-existence of meta-analyses or systematic reviews discussing the actual rate of post external fixation infection rates [5,16]. Lee-Smith *et al.* [17], in their review, categorized the pin site changes occurring after external fixation into three categories: pin site reaction, pin site colonization, and pin site infection. Pin site reaction is the mildest form of tissue reaction to pin insertion. It is characterized by minimal change in skin colour, temperature, and drainage. Pin site reaction is considered a physiological phenomenon that usually resolves within 72 hours and does not necessitate any intervention. Pin site colonization represents the stage of initiation of infection when bacteria start to colonize at the site of pin insertion but does not result in considerable reaction that necessitates management. Pin site colonization is characterized by inflammation (erythema, pain, hotness, oedema) and positive culture. Actual infection occurs when pus appears, pin gets loosened, and bacterial growth increases on cultures[16,17]. Appearance of any of these signs of infection requires immediate action such as antibiotic administration, debridement, or even pin removal [9]. Once infection is diagnosed, it can be classified into several grades according to its severity. Four classification systems for pin site infection severity exists namely Saleh and Scott classification system proposed in 1992[18], Dahl Wire classification proposed in 1994 [19], Ward classification system proposed in 1998 [20], and Checketts-Otterburns grading system proposed in 1999 [7]. Saleh and Scott classified the pin site infection into 7 grades from 0 to 6, with 0 referring to patients with no infection at pin site and 6 representing chronic osteomyelitis [18]. Dahl Ware classified the pin site infection into 6 grades with categories of normal, inflamed, serous drainage, purulent drainage, osteolysis, and ring sequestrum for grades 0, 1, 2, 3, 4, and 5, respectively [19]. Ward classified infection into minor infections characterized by prolonged drainage, oedema, erythema, and crusting and major infections characterized by pin bone resolution [20]. Checketts-Otterburns grading system consists of six grades with the first 3 representing minor infection and the next 3 representing major infection [7].

One of the main determinants of the infection rate after external fixation is the existence of risk factors. Many factors have been established to increase the risk for pin site infection [3,7-9,12,21]. These factors include host related factors, pin related factors, and technical factors. Host related risk factors include advanced age, smoking, and immunosuppressant states such as using corticosteroids, connective tissue diseases, rheumatoid arthritis, or diabetes mellitus[5]. Pin related factors include pin design, pin material, pin coating, pin site loosening, and fixator pin-bone interface stability [3,8]. Technical factors include preoperative management, surgical technique used, pin insertion technique, extent of soft tissue damage during insertion, pin site care, pin dressing, cleansing solution, frequency of pin site cleaning, and the use of prophylactic antibiotics [3,5].

Advanced age was reported to be significantly associated with high risk of pin site infection with external fixation around the wrist ($p=0.004$) [22]. Smoking was shown to significantly increase the risk of pin site infection. In a randomized controlled trial, the pin site infection rate among smokers was 52% in comparison to 18% among patients who stopped smoking [22]. Pin design and material is another important determinant of pin site infection rate. The most common types of pin materials are titanium, copper, and stainless. Stainless pins were reported to be associated with the highest bacterial load and pin site infection in comparison to titanium. Pieske et al.

reported an infection rate of 5% among patients who had stainless pins fixators versus zero% among patients who had titanium pin fixators [23]. Titanium is known to form a stable oxide layer after exposure to oxygen, and this layer is proposed to prevent bacterial adhesion and subsequently prevent their growth and colonization. In an in vitro study, titanium was shown to reduce staphylococcus aureus and staphylococcus epidermidis adhesion [24]. Copper pins were reported to be associated with significantly lower bacterial load than both titanium and stainless steel due to its broad-spectrum antibacterial effect [25]. It was shown to prevent growth of staphylococcus aureus and Escherichia coli in invitro studies [26]. However, potential toxicity with high doses of copper makes its use in external fixation controversial. Pin coating was also reported to affect the rate of pin site infection. Silver, hydroxy apatite, nitric oxide, chlorhexidine, and chitosan were reported to have an antimicrobial or bacteriostatic effecs [8]. Hydroxy apatite coatings were reported to be associated with 5% infection rate versus 10% rate among non-hydroxy apatite coatings[27]. Moreover, hydroxy apatite and non-hydroxy apatite coatings were associated with zero% and 43.5% infection rates, respectively [28]. Hydroxy apatite is composed of osteoconductive calcium phosphate that reduces pin loosening and pin site infection [8].

Surgical techniques also play a considerable role in development of pin site infection. For instance, Gordon et al. reported that the infection rates with periarticular pin placement and diaphyseal pin placement in children were 1.6 and 4.5, respectively (p=0.01) [29]. They attributed this difference to the possible different soft tissue motion and damage around the placement sites. Also, Parameswaran et al. [9], in their study on 285 patients in 2003, reported that infection rate among ring fixators was 3.9%, whereas unilateral fixators and hybrid fixators were associated with 12.9% and 20% infection rates, respectively (p=0.04). Postoperative pin site care is another determinant of pin site infection rate. For example, Lee et al. noted that the use of polyhexamethylene biguanide dressing was associated with 1% infection rate, whilst dry gauze dressing was associated with an infection rate of 4.5% [30]. Prophylactic use of antibiotics was also reported to affect the rate of pin site infection after external fixation. Magyar et al., studying 308 patients, reported that the use of antibiotics for more than 2 weeks was associated with an infection rate of 40% versus 80% among patients who did not use or did not complete a course of antibiotics [31].

CONCLUSION:

Infection is a common and important complication after external fixation. The actual infection rate is not well-established because a high variability exists between the reported studies. The definition, severity, and risk factors for infection seems to be the main determinant for this high variability in the rates off infection reported among literature. The main risk factors for pin site infection include include host related factors (e.g. advanced age, smoking, and immunosuppressant states such as using corticosteroids, connective tissue diseases, rheumatoid arthritis, or diabetes mellitu), pin related factors (e.g. pin design, pin material, pin coating, pin site loosening, and fixator pin-bone interface stability), and technical factors (e.g. preoperative management, surgical technique used, pin insertion technique, extent of soft tissue damage during insertion, pin site care, pin dressing, cleansing solution, frequency of pin site cleaning, and the use of prophylactic antibiotics). Because to date there is no cure for external fixation associated infection, early identification and proper management of these risk factors is fundamental to reduce infection rate and complications.

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