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Review article

PREVENTION OF PIN TRACT INFECTIONS IN EXTERNAL FIXATION – A REVIEW ARTICLE

Preslav Penev, Anna Bergaoui
Department of Orthopedics and Traumatology, Faculty of Medicine, Medical University of Varna, Bulgaria.

ABSTRACT

Purpose: Many factors are responsible for the prevalence of pin tract infections in external fixation. Different authors' reports show great variance, with infection rates ranging from 3% - 80%. Such clashing data indicate physicians' differences of opinion in what constitutes a pin tract infection. This paper critically evaluates the main strategies, approaches, and outcomes for preventing pin tract infections in external fixation by systematically reviewing the literature.

Materials and Methods: This narrative review conducted a comprehensive search on PubMed and Web of Science for studies addressing pin tract infection prevention, covering literature from the databases' inception until February 20, 2025.

Results: Literature shows that infection prevention should be done throughout all stages of external fixation placement, from the pre- and peri-operative period to the postoperative period prophylaxis.

Conclusion: Taking appropriate measures for wound care allows for proper osteointegration, prevents bacterial adhesion and avoids osteomyelitis and premature pin removal. At this time, there is no consensus on which method of preventing biofilm formation and pin site infection yields the most favorable outcome.

Keywords: Pin tract infections, External fixation, Prevention,

INTRODUCTION:

Pin site inflammation and subsequent infection at the metal-skin interface, termed as pin-site infection, is the most common complication in external fixation.

There are significant variations in the rates of pin loosening, depending on the implemented pin coatings, materials, antibiotic therapy, wound care and surgical techniques applied during external fixation. By reviewing current literature, the aim of this study is to observe the rates of pin tract infection (PTI) prevention when using different methods of pin site care.

MATERIALS AND METHODS:

This narrative review utilized PubMed and Web of Science to search for studies related to the Prevention of pin tract infections from database inception until February 20, 2025. The inclusion criteria focused on full-text articles published in English, while excluding case reports, commentaries, studies involving pediatric patients over 18, and those with fewer than five patients due to insufficient statistical power. Data extraction was performed by a single author to compile relevant findings.

This review article explores the various strategies for preventing pin tract infections associated with external fixation devices.

RESULTS

Absence of standardized wound care protocols is a major factor in the prevalence of infections in external fixation.

To avoid misdiagnosis, several classifications of PTI have been created and implemented in practice, easing the process of definition and treatment.

The Ward, Melendez and Colon, Patterson, Dahl, Saleh and Scott, and Checketts-Otterburn classifications have been available to help clinicians apply targeted treatment to distinct stages of pin-site infection.

The Melendez and Colon classification categorizes infections as minor and major, based on outpatient or inpatient treatment. Both minor and major infections are thus divided into 3 subgroups, according to clinical and radiological signs. Yet, the lack of description of late complications makes grading somewhat incomplete.

Both classifications of Ward and Saleh and Scott suggest grading based on response to treatment [1].

Patterson et al developed a method of rating pin track infections by considering clinical features based on caregivers' reports. This unique approach provides a very thorough assessment of PTI. However, the lack of validity impedes adequate treatment.

Dahl et al present a classification of 6 grades, based on clinical and radiological criteria, with recommendations for management of each grade. The credibility of this grading is uncertain, and modifications of the original system have been made [1].

The Checketts-Otterburn classification provides an extensive and elaborate description of pin-site infection. By implementing clinical signs and symptoms, radiological signs, mechanical factors and late outcomes into 6 stages, the authors present a rather comprehensive guide to pin-site reactions, with management recommendations for each stage of infection [1]. Division is made with three subgroups of minor infection, and three subgroups of major infection, the latter of which describes osteolysis and sequestra [2]. The validity of this categorization is the reason for its expanding use in current literature. To date, the Checketts-Otterburn is one of the most widely employed classifications when diagnosing PTI.

Access to many criteria, combined with the lack of consensus on which classification fully encompasses all aspects of PTI, allows authors to classify pin-site reactions as infections somewhat ambiguously.

Available research also indicates the use of positive microbiology, the presence of erythema and pus, or response to antibiotics exclusively for diagnosis [3]. Consequently, the actual incidence of infection remains unknown.

External Fixation:

According to current research, the types of external fixators used in fracture management directly correlate to instances of pin tract infection. Unilateral external fixators with application of unicortical pins show a far more rigid fixation when compared to bicortical pins. Thus, PTI rates could be minimized with the utilization of such unicortical pins [4].

Considerable variations in infection have been observed among unilateral, ring and hybrid fixators. Parameswaran et al. report significantly lower instances of PTI with the employment of ring fixators (3.95%), compared to unilateral (12.9%) and hybrid fixators (20%). Moreover, infection in hybrid fixation can be attributed to the utilization of half-pins [5], rather than fine-wires. Minimizing pin-site reactions when using half-pin fixators can be achieved by manual insertion of self-drilling half-pins [5]. Osteomyelitis, bacterial endocarditis and toxic shock syndrome were found to be complications mainly of half-pin external fixators. 3.4% of reported cases led to chronic osteomyelitis.

Tensioned fine wires provide excellent fracture fragment fixation with low PTI rates [5] [6]. Their ability to pass through compromised tissues, imparting almost no additional trauma, and thus leaving no additional damage on the sites of insertion, is beneficial for the pin-site condition.

Prolonged length of hybrid fixation was found to be a critical factor contributing to infection and subsequent complications. Due to high specificity, the optimal duration of external fixation is individual. However, the majority of reports in the available literature describe that pin tract infection rates start escalating 3 months after fixation has been placed. Nonetheless, no association of longer fixation placement and elevated morbidity has been made [5].

A subsequent problem of external fixation is the risk of infection when converting the external pins. The best results of conversion are obtained when the replacement is done in two steps, removing the external fixation and waiting at least 9 days to perform intramedullary nailing [7].

Pin Coatings:

1. Hydroxyapatite

Because of its close resemblance to mineral bone and superior osteoconductive properties, hydroxyapatite makes an excellent biocompatible material with extensive use in orthopedic surgery. Bone stabilization, osteointegration and stabilization of the bone-pin interface are hallmark qualities of hydroxyapatite coatings.

Hydroxyapatite (HA)has no direct antibacterial activity; however, due to the greater fixation of HA-coated pins, loading the latter with antimicrobial substances has become prevalent as a way to decrease complications at pin sites.

Moroni et al. report elevated extraction torque, now a well-known corollary of hydroxyapatite coated pins. Increased contact area at the bone-pin interface, leading to better external fixation stabilization, was also noted. In spite of that, no difference in infection rates with the implementation of HA coated pins was made apparent [8].

Ongoing research indicates that increased extraction torque and the pin-bone interface due to osteointegration lead to amplified fracture stabilization, but there are no definitive outcomes for the decline of pin tract infection.

2.Silver/Nanosilver: Silver is one of the most extensively studied and utilized biomaterials in the medical practice. Among clinicians, it has found widespread use pertaining to its broad range of antimicrobial properties. The lack of any major development of bacterial resistance, and the extensive spectrum of antimicrobial activity make it particularly relevant in orthopedic surgery for the prevention of PTI [9].

Compared to hydroxyapatite, which offers no direct antimicrobial activity, silver coatings directly prevent bacterial aggregation and biofilm formation at the pin surface. Despite this beneficial effect, a crucial detail when employing silver for wound healing is to avoid high concentrations that cause toxicity [1]. Regrettably, levels of silver, where optimal antibacterial effects are observed, also exhibit cytotoxicity. Such adverse effects limit the use of silver coatings in the medical practice [10].

Nanosilver offers a promising solution to the current problem. It represents a cluster of silver ions with a diameter of around 1-100nm. This nanomaterial provides an increased surface area to volume ratio, which is thought to possibly decrease the toxic effects of Ag. However, antibiofilm properties and range of activity strongly depend on particle size [11].

Although many studies on nanosilver have been published during the past decades, more conclusive results are needed for its mass utilization as a pin coating material in the orthopedic practice [12, 13].

3. Chitosan: Chitosan is a non-degradable bioactive material with a similar chemical structure to hyaluronic acid [1]. Its antibacterial properties are due to its effect on cell permeability and ability to inhibit RNA synthesis[14]. By coating implant surfaces, or loading chitosan particles with antimicrobial agents, literature describes cases of reduced rates of S.aureus and S.epidermidis aggregation in vivo [15].

Tan et al. also describe greater success in suppression of biofilm formation when using quaternized chitosan derivatives on polymethyl methacrylate (PMMA) cement, in comparison to gentamicin-loaded PMMA.

This non-degradable bioactive material is a novel way to decrease bacterial aggregation and biofilm formation at pin sites, thus leading to PTI prevention in external fixation [14].

4. Chlorhexidine gluconate, a chlorphenylbiguanide, is a popular antiseptic with extensive use in the surgical practice. Its well-known qualities as a cheap, broad-spectrum antibacterial agent, effective against both Gram positive and negative bacteria, explain its widespread utilization.

In a study done by Harris et al., chlorhexidine coated pins were shown to inhibit S. aureus and S. epidermidis in an in vitro setting. However, it was noted that they had a certain toxic effect on fibroblasts. Subsequently, it was established that such cytotoxic effects may prevent osteointegration and healing, limiting the use of chlorhexidine coated pins [16].

Ceroni et al. report hydroxyapatite–chlorhexidine-coated pins exhibiting dual benefits of enhanced bone stability through bonding to the pin (due to hydroxyapatite), and localized release of chlorhexidine [17].

Chlorhexidine-coated pins in external fixation are useful antiseptic agents, popular amongst medical professionals, because of their wide-spectrum antimicrobial effect. Bearing in mind its cytotoxic qualities and impact on osteointegration and healing [1], this pin coating should be utilized with caution.

5. Antibiotics: Use of local-release forms of antibiotics for the prevention of pin tract infections has multiple benefits over the implementation of systemic treatment. As a result of bacterial adhesion, biofilm formation is the ground from which pin tract infections develop. Rendered inactive by the presence of biofilm at the pin site, systemic antibiotics are hardly effective in the cases of PTI.

Over the years, several devices have been developed for fighting infections using local forms of antibiotics (AB), from antibiotic impregnated polyurethane sleeves that fit over pins to AB impregnated pin coatings.

An important factor for proper use of local release AB forms is that if released too slowly, antibiotic levels may not reach the needed minimal inhibitory concentrations for bactericidal effects. This leads to developing highly resistant strains of bacteria [18].

6. Nitric oxide: Nitric oxide (NO) coatings have bacteriostatic effects with a broad spectrum of activity. NO modifies bacterial cell wall adhesion proteins, its main actions being against S.aureus, S.epidermidis and E.coli [19].

Pin coatings containing active release formulas prevent bacterial adhesion to pin tracts in the presence of adsorbed proteins. NO has been observed to significantly decrease rates of bacterial adhesion in wound sites containing an adhesion-promoting protein layer, with reports of a decrease of 96% and 88% from S.aureus and E.coli. Inhibition of S.aureus was reported to be significantly stronger than that of E.coli and S.epidermidis [19].

However, NO coatings for pins in external fixation are a newly applied form of infection prophylaxis, with insufficient amounts of evidence on the effects of their use [1].

PIN MATERIALS

1. Titanium: Titanium's roughened surface and low elastic modulus contribute to direct soft tissue integration and high levels of osteointegration [9], leading to increased mechanical fixation. When exposed to oxygen, this material forms a stable oxide layer over the pin [20], making it resistant to corrosion. Moreover, titanium has been found to have a minimal inflammatory response regarding wound sites, in comparison to stainless steel [21]. These valuable qualities contribute to its high biocompatibility.

The reduction of PTI is thought to be due to titanium's anti-inflammatory properties and its increased mechanical fixation over stainless steel pins [22]. Owing to these characteristics, a trend of heightening costs of titanium pins has been noticed.

Puckett et al. describe that the facilitation of pin tract infection is caused by the disruption of the skin-metal interface at the pin tract site. It is thought that infection rates will significantly decrease when a continuity between skin-metal interface is achieved [23].

An innovative measure in this direction is the development of Ti-pins coated with human recombinant fibroblast growth factor (FGF)-2–calcium phosphate (CP) composite layers, which could reduce the risk of impaired bone-pin interface strength, thus lessening the chances of developing complications [24].

Although the prospects of a superior, altered version of titanium pins are thrilling, more research and observation are needed for this material to be applied in clinical practice

2. Stainless steel: In most instances, stainless steel pins have a polished surface, leading to fibrous encapsulation of dead space at the bone-implant interface with a liquid film [9]. In this space, bacteria can spread without repercussions from defence mechanisms.

In a study done by Pieske et al., over 80 patients were monitored after external fixation of wrist fractures, where stainless steel and titanium pins were applied, respectively into 2 groups.

A trend of increased pin related complications in patients with stainless steel pins was noticed, with a rate of infection at 27.5%. Due to complications of pin loosening, two of the external fixators in the steel-pin group had to be removed. One of the cases developed a deep infection, followed by osteomyelitis. In comparison, patients with titanium pins had a much lower infection rate, at about 15%. Results from the conducted research show that titanium led to less pin loosening and micromotion at the bone pin interface [25].

Additionally, novel coatings, such as calcium phosphate–fibroblast growth factor (Cp-FGF) and FGF with enhanced biological activity on stainless steel pins, do not exhibit elevated bone fixation strength and do not lower infection rates in rabbit models [26].

Described pin loosening, bone-implant dissociation and elevated infection rates in various studies imply the need for a stainless steel pin substitution, due to the less than satisfactory outcomes mentioned.

3. Copper: Copper is a trace metal with a broad spectrum of antibacterial activity and low incidence of bacterial resistance. Although copper is a key element in collagen production and bone mineralization, and has the ability to be metabolized, its beneficial effects are largely concentration dependent [22]. Accumulation of copper in the body, whether exogenous or intrinsic, has a cytotoxic effect and leads to inflammation and necrosis. Research brings forth the fact that, unlike titanium, copper lacks osteoconductive abilities, a necessary aspect for osteointegration [27].

In a study done by Shirai et al., titanium-copper alloy pins of 1% and 5% were designed and compared both in vitro and in vivo, and results were evaluated on aspects of implant infection.

Due to copper's broad spectrum antibacterial activity, Ti-1% Cu alloy pins exhibit exceptional rates of S.aureus and E.coli strain reduction, without inducing the toxic effects of copper coated pins. Implementing Ti-1% Cu pins in vivo shows minimal inflammation and infection, with a high degree of antimicrobial activity. Observation of osteoid formation, on account of the presence of titanium, was also noted, marking pins at a 1% copper value as a suitable biomaterial for pin design. Ti-5% Cu alloys had an even greater effect on the eradication of microorganisms at the pin-site. Osteomyelitis was a major complication of deep infection, connected to the use of 5% copper in vivo. These results signify that such a percentage induces not only bactericidal benefits, but also cytotoxic side effects. Moreover, the disruption of osteoid formation indicates a severe impediment to bone conduction [22]. Observation of copper blood levels did not show any significant changes in the pre- and postoperative analysis. Therefore, a conclusion can be made that, unlike silver, Cu lacks any systemic toxic effects in both the 5% and 1% concentrations.

It is expected that the bactericidal and toxic effects of copper are strongly linear, and merits are observed at lower concentrations.

PIN SITE CARE

Although reports of infection in external fixation continue to increase, there has not been an agreement on a generally accepted protocol for pin site care. Varied care regimens and prophylaxes in the pre- and postoperative period are utilized amongst different clinical practices. The use of disinfectants, wound cleaning methods, dressing materials and regularity of dressing changes are all based on the physicians' discretion, lacking a peer-reviewed basis. This could be one reason for the prevalence of infection amongst external fixation patients.

First steps in prophylaxis and care of pins and holes comprise of saline irrigation of crusts for softening, moderate massage, eventual use of alcohol, and application of povidone iodine or chlorhexidine, followed by packing of dry gauze [28]. Application of cadexomer iodine ointment on pin tracts has been shown to significantly reduce rates of complications [29].

Coating the pin sites with sucralfate gel 25% is a novel way for preventing microbial invasion [30].

Pin site care should correlate to the particular state of the wound at the time of dressingThe presence of blood, swelling, or exudates requires a more intensive cleaning regimen, which should be applied daily or once every second day. Healed and dry wounds do not require as extensive of an approach, and could be managed weekly [17].

A nihilistic path of no active pin-site care is a method implemented in a study done on external fixation by Gordon et al. [31].

Wound statuses on a patient cohort consisting of children was observed. Daily showers as a form of wound care were implemented exclusively, with no physical cleansing. Reports observe that showering on postoperative day 5 after gauze removal shows beneficial effects for pin track sites, as no occurrence of deep infection was noted, and oral antibiotics were sufficient to handle emerging complications. Nevertheless, conclusions cannot be made, as 75% of the pin sites became infected at some point during the study. Furthermore, results must be scrutinized, for no control groups were employed in this research.

CLEANING SOLUTIONS

Cleaning solutions are an indispensable part of wound care and infection prevention. Options include hydrogen peroxide, polyhexanide, isopropyl alcohol, chlorhexidine, povidone-iodine and polyhexamethylene biguanide. The efficacy of PTI prevention through the implementation of certain kinds of antiseptic solutions over others is a topic of interest for many authors, although the validity of existing research is uncertain.

Rates of pin-site infection were observed in a clinical trial analyzing 568 pins treated with either a solution of 10% povidone-iodine or chlorhexidine-alcohol 2%. No substantial differences in the Prevention of complications were noticed in the two groups, an indication of equal efficacy of both cleaning solutions [32].

Moreover, applying either traditional formulations or emollient antiseptic formulas in the pin site care process does not show a notable change in the outcomes of infection prevention [33].

Data from scientific literature contains no statistical significance on the superiority of any particular wound cleaning solution over the other thus far.

SURGICAL TECHNIQUE

Infection prevention must start with appropriate preoperative care and should encompass both the intra- and postoperative period.

Certain surgical techniques, which impart less of a stress response from soft tissues and bones, must be considered during preoperative planning, as this has a significant effect in limiting inflammation and lowering the chances of complications at the pin tract site. Utilization of sharp drill bits and drill sleeves for protection; avoiding thermal necrosis when using power drills and implanting wires or pins without excessive skin tension for ischaemia prevention, are a few measures that have a protective effect over vulnerable tissues.

During the intra-operative period, excess trauma to various tissues handled by the surgeon is one of the main sources of inflammation. Initial skin incisions should not exceed the size of the pin, and great care must be taken to avoid any tension [34]. It has been observed that mechanical damage and thermal necrosis of bones during external fixation leads to increased amounts of pin loosening, fibrotic tissue, ring sequestra, and infection. Using a tourniquet during pre-drilling and wire insertion leads to decreased blood flow to the operative zone. Preventing blood from cooling the bone naturally increases the chances of thermal necrosis. For that reason, continuous cold saline irrigation during drilling is beneficial [35]. After drilling, vigorous saline irrigation prevents impediment of optimal bone-pin fixation by removing any bone swarf [34, 35].

Davies et al. recommend using a no-touch technique during the insertion of implants. Chlorhexidine and iodine soaked gauze ensure an aseptic condition when handling pins and wires, thus minimizing chances of infection.

A meticulously kept sterile field limits bacterial adhesions to pin surfaces and subsequent aggregation and colonization of the surgical wound. As a result, chances of biofilm formation at the pin site are reduced. Checketts et al. observe that periarticular external fixation led to heightened infection rates, compared to diaphyseal pin placement, presumably due to the excess soft tissue motion around joints. In their study, the presence of open fractures and screw threads outside the skin surface did not increase the risk of infection, compared to rates of complication in closed fractures [3].

The lengthening and then nailing (LATN) technique is a novel method that can reduce infection rates by decreasing the duration of treatment with external fixators. It offers more flexibility, faster healing and gradual correction of deformations, provided that a relatively straight bone is achievable by the end of distraction for nail insertion. Nailing then stimulates endosteal and periosteal bone formation, thus making LATN an excellent technique for patients with healing challenges [36].

Another approach shown to minimize infection is the application of mono cortical screws held by a specialized clamp. In this manner, penetration of the IM canal is avoided, and chances of infection development are minimized [21].

ANTIBIOTIC THERAPY

The majority of orthopedic surgeons have adopted a systematic manner of treatment of pin tract infections, despite the lack of evidence-based guidelines on prophylaxis [5].

By following the Checketts-Otterburn classification, specific medical care corresponding to the wound status and stage of complication at the pin site could be implemented. Pin sites graded class 1 and 2 require a transition from cephalosporins to fluoroquinolones and meticulous local pin care. Grade 3 complications should be treated with pin removal, curettage and debridement.

One of the major factors in PTI is pin-bone instability. Thus, removal of pins must not destabilize the frame construction, as this will result in increased movement at the fixator pin–bone interface of the remaining pins and wires, with the potential for further infection [5]. Grade 4 and 5 infections need curettage, debridement, antibiotic beads implantation, culture specific parenteral antibiotics and partial removal of the external fixator [3].

Grade 6 and the presence of osteomyelitis warrants extensive debridement of sequester and sinuses, implantation of antibiotic beads, and complete removal of the external fixator.

Local antibiotic injections are of considerable benefit for the prevention of pin tract complications. Nigam et al. conducted research on 60 patients who were hospitalized due to various orthopedic conditions [37]. Accordingly, they were separated into 2 groups, receiving either 250mg cephazolin injections along the pin site border or no antibiotic prior to skeletal traction. After 25 days of traction in the antibiotic group and 29 days in the control group, pin infection rates were 3% and 30%, respectively. Therefore, authors agree that local antibiotic administration over pin sites lowers infection rates.

Unfortunately, due to the unregulated use of antibiotics in the cases of PTI, resistance to existing antibiotics is ever-growing. For this reason, antibacterial treatment should be carefully planned and carried out by an attending physician [9].

Reviewed articles led to the conclusion that ring fixators are superior in preventing PTI, with a 3.95% rate of infection, in contrast to unilateral fixators (12.9%) and hybrid fixators (20%). Moreover, fine wires have exhibited lower rates of infection, in contrast to half pins. Current trends in using manually inserted self-drilling half-pins and the prevalence of tensioned fine wire fixation show a substantial decrease and reduction of PTI. Results from available literature set forth fine wire ring external fixation as the superior method for avoiding pin-tract infection.

Comparisons of hydroxyapatite coated pins to stainless steel and titanium external fixation show unclear results as to which of the materials' implementation lowers rates of pin tract infection. More data is needed on the beneficial impact of HA coated pins for their establishment as the superior way of fighting infections [9]. Silver coatings give better results in minimizing infection, due to its antimicrobial property. However, its concentration dependence limits its clinical use. Chitosan exhibits excellent outcomes in inhibiting biofilm formation, thus preventing complications. Chlorhexidine has limited use as a pin coating material due to fibroblast toxicity. Local release antibiotic pin coatings also have limited use in external fixation, due to their concentration dependency, and the risk of contributing to the growing bacterial resistance. Observation of nitric oxide coatings shows a decrease of S. aureus and E.coli bacterial strains on pin sites at a rate of 96% and 88% respectively. However, the insufficient amount of evidence on their effects limits their use in clinical practice.

The most effective of the common pin materials for limiting infection in external fixation is titanium, due to its anti-inflammatory properties and excellent mechanical fixation. Studies show increased instances of complications using stainless steel (SS) pins, at a rate of 27.5%, in contrast to titanium, with a 15% infection rate. Reports from available literature unanimously acknowledge the advantages of titanium pins over stainless steel for external fixation.

Ti-1% Cu and Ti-5% Cu alloy pins show exceptional rates of S.Aureus and E.Coli suppression, however, their beneficial effects are concentration dependent.

Prevention of wound complications initially starts with pin site care. The use of cadexomer iodine, sucralfate gel, povidone iodine and chlorhexidine is common, and there are various methods of application. Despite this fact, there are inconclusive results on which approach produces the best result for site management.

The application of different cleaning solutions at the wound site does not significantly change the statistical results regarding the minimization of PTI.

One of the most important moments in the prevention of pin site complications is the intraoperative period. It is crucial for the surgeon to avoid excess trauma to the various tissues being handled, to assure sterility of the surgical field, and to prevent thermal necrosis of bone. Monocortical screws, shown to have a beneficial effect for infection prevention in external fixation, should be used with priority.

Research illustrates the benefits of local antibiotic injections at the pin site in external fixation. Infection with application of local AB was reported at 3%, versus 30% in a control group, where no injections were used.

DISCUSSION:

The disagreement between authors as to what constitutes a pin tract infection and the lack of a generally accepted definition and criteria stalls recognition of early signs of complications and impedes pin-site care. In addition, the wide gap in reported results emphasizes the inaccuracy with which PTI is reported in the literature.

Clinicians should be well adept at utilizing external fixators with techniques proven to decrease pin tract infections. Literature has shown that frame symmetry and multiplanar half-pin configurations are crucial in hybrid fixation. The effectiveness of various materials and systems has been evaluated through in vitro and in vivo observation of different pin coatings, pin materials, cleaning regimens, and surgical techniques.

More data is needed on the beneficial impact of HA coated pins for their establishment as the superior way of fighting infections. Silver is a known, reliable material, used for the treatment of infection in various fields of medicine. Its toxicity, however, is a side effect that limits its use in practice. Nanosilver is part of the exciting new arsenal of materials being developed in recent years. More research has to be done for it to be an established material used against infection in pin-tracts. Chitosan is a novel way of limiting bacterial aggregation, thus preventing complications at the pin site in external fixation. Use of local-release forms of antibiotics for the prevention of pin tract infections has multiple benefits over the implementation of systemic treatment, since biofilm formation limits the effect of systemic antibiotic treatment. For that reason, antibiotic pin coatings are an effective way of limiting biofilm formation. Chlorhexidine's effects of reduced risk for bacterial resistance, cytotoxic qualities and impact on osteointegration and healing make it a pin coating that should be utilized with caution. Nitric oxide coatings for pins in external fixation are a newly applied form of infection prophylaxis, with insufficient amounts of evidence on the effects of their use.

The merits of using titanium pins over stainless steel and copper for the prevention of pin complications are evident in the available scientific literature.

The available data do not show any statistical significance for the superiority of any particular wound cleaning solution over the others thus far.

Increased danger for bacterial colonization exists during the intraoperative and postoperative period. Physicians must be well adept at techniques minimizing excessive stress on tissues and bones, as this could lead to intensifying postoperative inflammation and microbial aggregation.

The absence of a peer-reviewed regimen for pin site care allows physicians to use disinfectants, dressing materials, and wound cleaning methods without proof of effectiveness.

Pathogens are evolving and becoming immune to fundamental antibiotics used in clinical practice, increasing the rate of bacterial resistance. The primary cause of that is the unregulated use of such drugs by the general public. In the case of pin tract infections in external fixation, clinicians must be diligent in the prescription and application of antibiotic medication, so as to avoid contributing to this ever-growing problem.

CONCLUSION:

In the cases of pin tract infections in external fixation, the high incidence of complications reported in the scientific literature are due to several different aspects pertaining both the managing staff and the available materials. Misassessment of infection classification and the dual nature of harmful and beneficial aspects of certain materials, depending on the used concentrations, are what make infection prevention in external fixation such a prevalent issue in the orthopedic field.

This review article explores the various strategies for preventing pin tract infections associated with external fixation devices. It discusses the importance of maintaining strict aseptic techniques during pin insertion, appropriate pin care post-surgery, and the use of prophylactic antibiotics. The article also highlights evidence-based practices such as the selection of pin sites, the use of different pin coatings, and the role of patient education in infection prevention. Additionally, it examines emerging technologies and materials aimed at reducing infection rates. The review emphasizes the need for standardized protocols and ongoing research to optimize outcomes and improve the overall effectiveness of external fixation in clinical practice.

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Address for correspondence:
Preslav Penev
Department of Orthopedics and Traumatology, Medical University, Varna;
55, Marin Drinov Str., Varna 9002, Bulgaria
E-mail: dr_penev@abv.bg,