

Pin site soft tissue infection and osteomyelitis: literature review**V.D. Gayuk, N.M. Kliushin, S.I. Burnashov**

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The article deals with the pin-site infection in transosseous osteosynthesis. Domestic and foreign literature was analyzed; infectious complications were classified and their risk factors, prevention and treatment are discussed.

Keywords: pin-site infection, transosseous elements, pin-tract osteomyelitis, transosseous osteosynthesis, complications

INTRODUCTION

The use of external fixation devices (EFD) in traumatology and orthopedics implies insertion of wires and half-pins through the skin, soft tissues and then into the bone. The most frequent complication is inflammation and infection at the entrance and exit sites of transosseous elements which in foreign literature is commonly referred to as pin track/tract/site infection (hereinafter referred to as PSI), [1]. Inflammation may involve a small surface area at the border of the skin and transosseous element or may turn to deep infection and osteomyelitis, which is a serious complication [2]. Any of these complications can affect the treatment process to one degree or

another, therefore it is extremely important for the practitioner to be able to treat and prevent them [3].

Inflammation around the fixation elements is commonly associated with non-observance of the rules of asepsis and antiseptics during surgery and in the postoperative period, violation of the technique of transosseous elements insertion, insufficient stability of a separate element or the entire device as a whole [4].

Our purpose was to analyze the contemporary domestic and foreign literature on the problem of inflammation and infection round the transosseous elements of the external fixation apparatus and to formulate its relevance.

MATERIAL AND METHODS

Electronic database systems PubMed, eLIBRARY.RU, and the collection of the RISC for

RTO library were searched. One thesis on this topic was found.

RESULTS

The use of external fixation devices is a highly effective method for management of fractures and their complications, as well as in numerous orthopedic conditions [5, 6]. "It is not the device that cures the patient, but the doctor who skillfully uses this device", used to say G.A. Ilizarov [7]. This statement is true with regard to prevention of various types of complications after surgical interventions, especially purulent ones, since not only good organization of orthopedic and sanitary-epidemiological services, but also a technically correct intervention and a thorough rehabilitation period minimize these complications [8–11].

Postoperative complications are divided into three categories according to the classification of S.O.F.C.O.T. [12, 13]:

- Complications are absent or temporary and do not affect the final result of treatment;
- Complications require additional surgical interventions and do not worsen the end result;
- Complications that impair the patient's health or worsen the final result.

Complications of transosseous osteosynthesis may be associated with damage to blood vessels and nerves during surgery or in the postoperative period, development of contractures and joints malposition, displacement of bone fragments, delayed consolidation and development of refractures [4, 14]. The above problems deserve special attention, but infectious and inflammatory complications around the wires or half-pins are the most common [15–19], up to

100 % of cases [20]. Nevertheless, the rates of these complications are calculated differently [21]. A single universal registration protocol has not been developed [22], which makes it difficult to collect statistical data. There are several classifications for PSI.

V.Yu. Fuzaylov distinguishes two PSI types in soft tissues, limited (within the skin) and widespread (infiltrate, abscess, phlegmon) ones, as well as monofocal (around one wire) and polyfocal (around several wires). Osteomyelitis due to PSI may be superficial, characterized by moderate periosteal reaction at the point of pin entry or exit with involvement of soft tissues in the inflammatory process, limited (complete damage to one or both walls of the cortical layer with the formation of cylindrical/circular major or small sequestrs, fistulous passages in the soft tissues) and widespread (extensive) one with involvement of the medullary canal in the suppuration process with purulent cavities, sequestrs of various sizes and shapes [8, 17, 23, 24]. Figure 1 shows typical radiological signs of wire-tract osteomyelitis.



Fig. 1 Radiographs of the tibia: in the lateral view, the circular sequestr in the tibia is clearly visible distal to the consolidation site

There are early and late inflammations of soft tissues around wires. Early ones usually occur within 3-5 days after the operation and their reason is non-observance of the rules of asepsis and antisepsis, violation of the wire insertion technique. As a rule, the process is deep, and its signs are not specific (high body temperature, pain, hyperemia), which makes the diagnosis difficult. The treatment consists of immediate wire removal, soft

tissue dissection and drainage. Late complications are usually superficial. They are mainly caused by poor fixation, leading to displacement of the bone along the wires, which, in turn, results in injury to the skin and subcutaneous fat and their inflammation [4].

D. Paley distinguishes three stages: soft tissue inflammation, soft tissue infection and bone infection. The latter should be considered a true complication [25].

Checketts et al. describe minor and major infection, and each, in turn, includes three grades (Table 1) [26]. From the second grade, it is necessary to involve medical staff into further treatment.

The classification of Patterson (2005) offers a comprehensive and measurable approach to the assessment of PSI. The protocol takes into account the date of observation, redness, swelling, discomfort, covering of the transosseous element with a crust and a skin bridge around, the nature of the discharge and, the most significant, instability or break of the transosseous element. The use of antibiotics, drainage, removal of TE and change in score in the protocol are evaluated [27].

Chan scale has four grades from 0 to 3, where grade 0 is no skin erythema and purulent discharge, grade 1 features skin erythema or the presence of purulent discharge, grade 2 with erythema and purulent discharge, and radiological signs of osteomyelitis are added to the second gradation in grade 3 [28].

Santy-Tomlinson et al.'s criteria (2011) distinguish between calm, irritated, and infected pin site (Table 2), as well as the presence of various factors in the development of inflammation (according to the patient). Patient's perception of infection is important in clinical evaluation, as patients are the first to notice minor changes in symptoms [29].

Thus, most of domestic and foreign researchers divide the PSI into two large categories: only soft tissues involved and bone also involved into the process. It is fair to assume that primary soft tissues inflammation and the damage to the bone with a wire or half-pin (bone burn, bone chips) are equally aggravating risk factors in PS osteomyelitis [17].

Among the reasons of postoperative osteomyelitis, the most common is nonobservance of the osteosynthesis technique (42 %) and non-observance of the rules of asepsis and antisepsis (31 %) [18]. We consider it necessary to provide general rules of wire and half-pin insertion in external fixation.

Table

Infection grading according to Checketts et al. (1993)

Grade	Manifestations	Treatment
Minor infection		
1	Slight redness, little discharge	Improved PS care
2	Redness of the skin, discharge, pain and tenderness in the soft tissue	Improved PS care, oral antibiotics
3	Grade 2 but no improvement with oral antibiotics	Affected pin or pins resited and external fixation can be continued
Major infection		
4	Severe soft tissue infection involving several pins, sometimes with associated loosening of the pin	External fixation must be abandoned
5	Grade 4 but radiographic changes	
6	Infection after fixator removal. Pin track heals initially, but will subsequently break down and discharge in intervals. Radiographs show new bone formation and sometimes sequestra	Curettage of the pin tract

Table 2

Santy-Tomlinson et al.'s criteria (2011)

Pain	Redness	Discharge	Swelling	General symptoms
<i>Calm</i>				
1. May be painless 2. Only mild pain 3. Reduces after application of fixator	1. Often none 2. Sometimes a little 3. Not spreading	Sometimes none Sometimes minor	None	None
<i>Irritated</i>				
1. Mild to moderate 2. Uncomfortable	1. Some redness but not spreading 2. No hot or taut skin	1. Weepy 2. Begins to weep when it did not before/increased amount of discharge 3. Remains the same consistency and color 4. Can be persistent in specific pin sites 5. Sometimes bleeding 6. No odour 7. Dressing changes needed more often	Swelling around pin site only, not spreading	1. Skin movement around the pin 2. Allergy to antiseptic 3. Irritated upon physical activity 4. Itchy (owing to reaction/allergy) 5. Dry, flaky skin 6. Does not respond to antibiotics 7. May affect all pin sites or just one or two
<i>Infected</i>				
1. Severe 2. Sudden 3. Increased intensity 4. Throbbing/stinging 5. Joints nearby may be painful 6. Unable to weight-bear 7. Unrelenting on rest 8. Poor response to analgesia	1. Deep red 2. Angry looking 3. Spreading 4. Definite borders 5. Associated with heat	1. Increased 2. Change in consistency 3. Thicker/more viscous 4. Sometimes unpleasant to odour 5. Change in color 6. Sometimes purulent 7. Dressings changes needed much more frequently	1. Local swelling around affected pin site 2. May spread 3. May be severe	1. Feeling unwell 2. Fever 3. Taut, shiny skin 4. Loss of function/weight bearing 5. Tired/lethargic 6. Disturbed sleep 7. Loss of appetite 8. Responds to antibiotics

A low-speed drill is used by insertion. The drill is disconnected (turned off) before the introduction into the first cortical layer and after passing through the second cortical bone layer. The wire should be hammered. Screws should be inserted through a preliminary small incision, using a trocar to protect soft tissues, as well as a low-speed drill to form a canal [30]. It is necessary to avoid passing the element

through only one cortical layer because it is the cause of bone burn and may provoke PS osteomyelitis [3, 14, 31]. The most important measure of PS osteomyelitis prevention is the use of wires with special sharpening. Wires with one-sided sharpening of their cutting end are used in the diaphyseal parts and sclerosed bone areas, and wires with trihedral sharpening of their ends are used in the bone metaphysis. Soft tissue

bulk is produced by an appropriate shift of the skin or giving a limb a position with a tissue tension in the introduction area helps to prevent their eruption (including in the bone) and further inflammation. The maximum tensioning of wires is achieved with wire-tensioner [4, 7, 31].

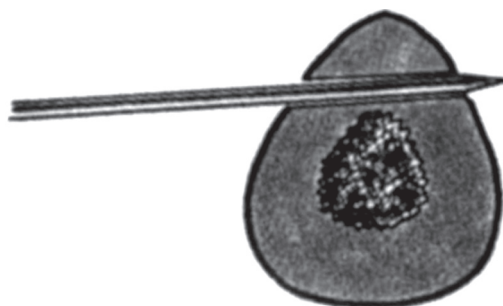


Fig. 2 Wire insertion through one cortical layer is not recommended.

The use of a tourniquet reduces local blood supply, therefore, the bone is less cooled during drilling; hematoma at the PS is also a risk factor of infection [32].

The use of wires or half-pin with hydroxiapatite coating reduces the likelihood of PSI due to better osseointegration. The ability of transosseous elements made of stainless steel, titanium and impregnated with antibiotics and antiseptics, with a pulsed beam after polishing, has also been investigated [3, 33, 34].

An important role is also played by somatic causes in a particular patient. PSI risk factors are the patient's age, uncompensated comorbidities, deterioration of the immune status (diabetes mellitus, intake of corticosteroids, rheumatoid arthritis and other collagenopathies), as well as smoking [3, 35].

Dressing and care play a significant role in preventing infection around the transosseous elements. There is still no evidence to effectively reduce the risk of infection around the wires or half-pins of the external fixation device [36]. There are various types of studies that compare the presence, methods and frequency of dressings, the use of antiseptics and antibiotics. Contradictory data have been obtained (removal or preservation of "crusts" around the wires [27, 35], variability of dressing

materials), but in some cases it was possible to prove effectiveness, for example, using gauze with polyhexamethylene biguanide [2, 37].

Возбудителями хронического спинового остеомиелита, по нашим данным [38], в 64 % является *Staphylococcus aureus*, в 18 % – *Staphylococcus epidermidis*, в 9 % – *Enterococcus* spp. и в 9 % случаев микробная ассоциация. Сопоставимые данные отмечаются и в других исследованиях, где *S. aureus* прочно удерживает первое место [21, 39]. Существенным фактором является микробиологическая диагностика анаэробной флоры [17].

The causative agents of chronic spoke osteomyelitis, according to our data [38], are *Staphylococcus aureus* in 64 %, *Staphylococcus epidermidis* in 18 %, *Enterococcus* spp. in 9 % and microbial association in 9 % of cases. Comparable data are found in other studies where *S. aureus* firmly holds the first place [21, 39]. A significant factor is the microbiological diagnosis of anaerobic flora [17].

The treatment of the superficial PSI consists, first of all, in checking the stability and integrity of the elements, increased number of dressings (daily), antibiotics, and correction of related disorders [40]. In late infection, perifocal administration of antibiotics is also added, and fixation is improved (in the case of the Ilizarov apparatus, it is a uniform tensioning of wires with wire-tensioner). If inflammation does not stop within 3–4 days, the wire should be removed from the side of greater infection, then, after the inflammation subsides, a new wire can be added and fixed if indicated [4].

Deep PSI and PS osteomyelitis require surgical treatment, which consists in the debridement of the focus accompanied by local and/or systemic antibacterial therapy. In most cases, the results of treatment are good. In PSI spreading, bone resection may be required, and large bone loss after sequestrectomy will also need to be considered as can lead to a pathological fracture [8]. There are cases of segment amputation and sepsis which was caused by PS osteomyelitis [4, 17].

CONCLUSION

Analysis of domestic and foreign literature has shown that infectious and inflammatory processes around the transosseous external fixation elements are common and happen frequently. They may affect the

treatment of the underlying disease and provoke local and systemic complications. Observance of all the rules and technical features of the method of transosseous osteosynthesis can reduce these complications to a

minimum. Generally accepted criteria for diagnosis, prevention and treatment of this pathology have not been formulated and should be further studied and developed. Multicenter clinical studies with a carefully planned design are required for solving the problem of inflammation around transosseous elements.

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