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The justification for antibiotic prophylaxis in operative treatment of hand and wrist bone fractures: a review

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ABSTRACT

Introduction: Although there is no clear scientific evidence justifying antibiotic prophylaxis in operative treatment of hand and wrist bone fractures, it is commonly used, mostly due to the concern about possible medicolegal problems caused by bone infection after surgery.

The objective of this study was review of literature on the justification for the use of antibiotic prophylaxis in surgical treatment of hand and wrist fractures.

Results: For operative treatment of hand fractures 3 studies and 1 systematic review were found. All these articles indicate a lack of scientific evidence to justify the routine administration of antibiotics in these injuries. For operative treatment of distal radial fractures only 1 study was found suggesting that antibiotic prophylaxis does not affect risk of infection. Further literature review showed that redundant antibiotic use may be associated with harmful and adverse effects, as well as with substantial costs.

Conclusion: Current scientific evidence does not support routine use of antibiotic prophylaxis in operative treatment of hand and wrist bone fractures. Antibiotic administration in these operations has not effect for decreasing infection rate and therefore can be safely avoided.

Keywords: hand fractures; distal radial fractures; operative treatment; complications; antibiotic prophylaxis.

INTRODUCTION

Clinical practice guidelines in general and orthopaedic surgery recommend the use of antibiotic prophylaxis before some procedures, including large bowel surgery, operations for abdominal hernias, total joint replacement, hip and spine surgery, or open fracture fixation. However, antibiotic use in clean, soft tissue hand surgery procedures does not have the same scientific evidence of support. Results of many studies failed to find relationship between risk of surgical site infection and antibiotic prophylaxis for many elective hand procedures, such as carpal tunnel release, surgery for Dupuytren's disease, ganglion cyst, or benign tumour excision [1, 2, 3, 4, 5, 6]. Therefore, in these operations antibiotic prophylaxis is not routinely used, with exception of patients with immunodeficiencies, diabetes or other concomitant diseases that may increase risk of surgical site infection. In very recent study, Negri et al. based on results of a systematic review and meta-analysis of 10 studies conclude that there is no statistically significant difference between the use of preoperative antibiotic when compared with placebo or no drug prophylaxis for the prevention of surgical site infections in elective clean soft tissue surgeries of the hand and upper limb. They suggest that other perioperative prophylactic measures, such as hand washing, adequate skin preparation, and the use of surgical drapes and sterile technique, are more effective and less harmful than the administration of antibiotics and therefore they discourage their use in this class of operations [2].

The situation is different in the case of bone fractures of the hand and wrist. Although there is no clear scientific evidence indicating the validity of prophylactic antibiotic therapy, it is used in most units dealing with these injuries. This is mainly due to the concern about possible medicolegal problems caused by bone infection. The risk of perioperative infection in hand surgery is very low: the slightest at elective soft tissue surgery (<0.5%), minimal in fixation of closed fractures (1–5%) and a bit higher in complex hand injuries and open fractures [3, 7, 8]. Despite this, antibiotic prophylaxis in hand fractures fixation with implants is common practice.

Two techniques are generally employed in operative treatment of bone fractures within the hand and wrist – percutaneous fixation with K-wires (Fig. 1, 2, 3) and open fixation with various plates and screws (Fig. 4). It is believed that the risk of operative wound infection is greater after surgery with the use of K-wires than with the use of plates and screws. Reports were published on so called "pin-track infections" after percutaneous K-wire fixation (Fig. 5) [9]. Some authors emphasize the relatively high rate of this complication, in contrast to significantly lower after open fixation of fractures [10]. However, some of these reports are biased with regard to standards of diagnosing infections. Many of disorders reported as "infections" are not true infections, but simply irritation of soft tissue

by a steel wire left in, or buried under the skin. The symptoms may mimic infection (pain, redness, swelling around the pin), but bacterial culture tests taken from the wound are usually negative. Fast resolution of the inflammatory flare after retrieval of the K-wire without antibiotic therapy confirms, that it was not a pin-track infection but only irritation of the skin around the pin [11]. Only positive bacterial culture test provides definitive evidence of an infection. For this reason, the risk of infection after operations of hand fractures with percutaneous K-wires seems to be overestimated.

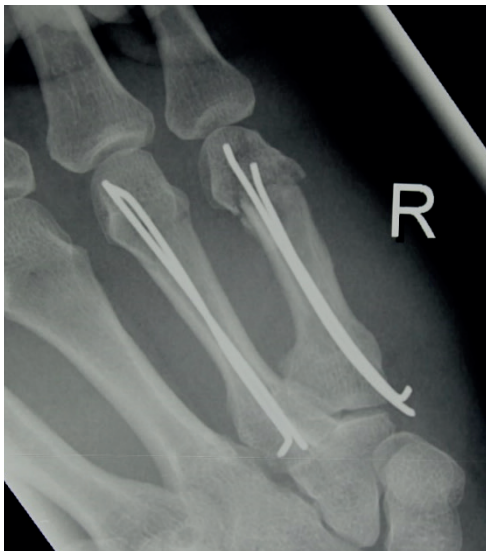

FIGURE 1. Multiple phalangeal fractures fixed with K-wires

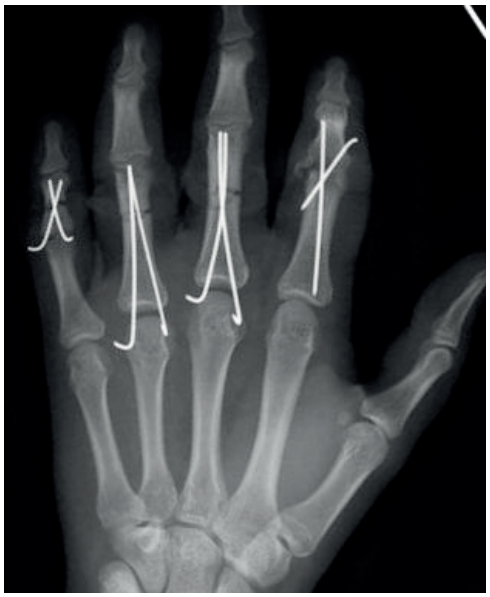

FIGURE 2. Fractures of the fourth and fifth metacarpals fixed with K-wires

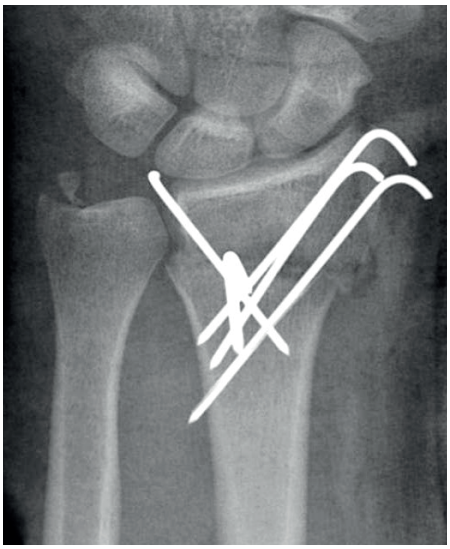

FIGURE 3. Distal radial fracture fixed with K-wires

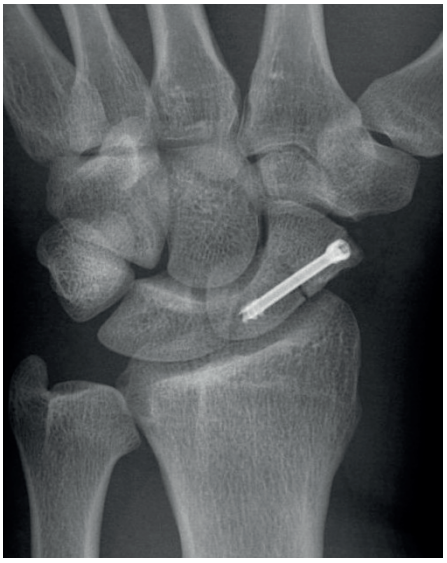

FIGURE 4. Scaphoid bone fracture fixed with the screw

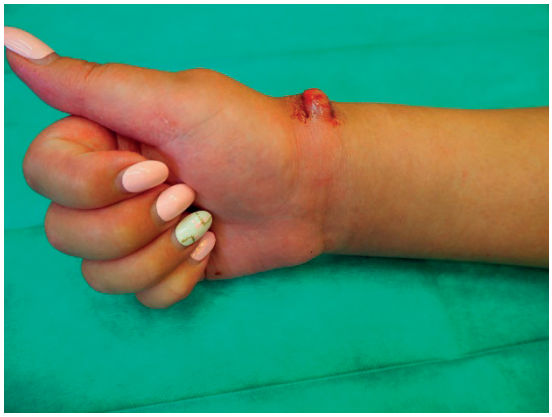

FIGURE 5. "Pin-track" infection at the K-wire used for fixation of distal radial fracture

Administration of antibiotic prophylaxis for internal fixation of hand fractures is a subject that has been scarcely studied. The objective of this study was review of literature on the justification for the use of antibiotic prophylaxis in surgical treatment of hand and forearm fractures. Moreover, we reviewed literature on concomitant factors increasing risk of surgical site infection and on possible harmful adverse effects of antibiotic prophylaxis in hand surgery.

MATERIALS AND METHODS

This article presents a review of the published literature from PubMed and Medline databases on the antibiotic prophylaxis in fractures of hand and forearm bones. Randomized clinical trials and observational studies reporting on use of antibiotics in surgical treatment of hand and forearm fractures in adult patients were reviewed. Studies in a language other than English were not included. Keywords used at searching articles were: hand and wrist fractures; operative treatment; antibiotic prophylaxis; surgical site infection; pin-track infection; adverse effects of antibiotics.

RESULTS

Hand fractures

We found 3 studies and 1 systematic review meeting the criteria of inclusion for this review. For operative treatment of hand fractures, all articles indicate a lack of scientific evidence to justify the routine administration of antibiotics prior to internal fixation of closed fractures of the hand and wrist.

Lidauer et al. reported results of a prospective study investigating the effectiveness of antibiotic prophylaxis in operative treatment of closed hand and wrist fractures. A total of 119 adult patients underwent K-wire fixation for phalangeal, metacarpal or wrist bone fracture. Of this number 67 patients (56%) received antibiotic prophylaxis, while 52 (44%) did not. The rate of minor skin irritation or infection of the pin tract occurred in 9 patients (13%) in the group with antibiotic prophylaxis and in 5 (10%) in the group without antibiotic (χ^2-test, p = 0.27). These superficial infections or irritations did not required any antibiotic therapy and healed spontaneously after K-wire retrieval. Two cases of deep surgical site infection occurred, 1 in each group (1.5% vs. 1.9%, difference insignificant) which required prolonged antibiotic treatment. The authors conclude that use of antibiotic prophylaxis could be reduced in the treatment of closed fractures of the hand treated with removable pins [7].

Feldman et al. reported results of a retrospective comparative study in 107 patients who underwent open or closed reduction and internal fixation of a hand and wrist fractures. Forty four patients (41%) received preoperative antibiotic prophylaxis, whereas 63 (59%) did not (the control group). Follow-up period lasted for 1 year, during which any form of clinically evident surgical site infection, such as pus formation, wound dehiscence and positive bacterial culture was documented. There were 7 cases of infection (6.5%): 3 in the in the group with antibiotic prophylaxis and 4 in the control group – difference statistically not significant (χ^2-test, p = 0.44). All cases were pin-tract infections that resolved completely after pin extraction. No specific fracture pattern was associated with increased risk of infection. The authors found no support for routine administration of antibiotics prior to internal fixation of closed fractures of the hand and wrist. Likewise in the previous study, they recommend antibiotic prevention in patients with decreased immunity or in open fractures [12].

Gillis et al. reported results of a multicentre prospective study involving 1042 patients undergoing operative treatment of metacarpal or phalangeal fractures; 719 patients (69%) were operated on in a ward procedure room, outside the operative theatre and under field sterility, whereas 323 patients (31%) were operated on in the operative room, in full sterility. The authors compared infection rates that occurred in these 2 settings. Infection rates were lower in the group operated on in the procedure room than in the theatre (redness around the pins 2.5% vs. 3.4%; pus around the pin 1.4% vs. 2.5%, respectively), but this difference was not statistically significant. The authors found that pre- or postoperative use of antibiotics did not affect infection rates. The variables that statistically significantly increased risk of surgical site infection were: longer operation time, tourniquet use, type of injury (metacarpal fractures were more likely to be infected comparing to phalangeal fractures) and size of the K-wire used for fixation (thicker wires increased the risk of infection). The authors conclude that K-wire fixation of closed hand fractures outside of the operative room under field sterility is safe, because it does not increase the overall risk of infection [13].

Abul et al. presented results of a systematic review and meta-analysis of all randomised and non-randomised studies comparing the outcomes of antibiotic prophylaxis group vs. those without antibiotic in patients undergoing surgery of bone fractures with K-wire fixation. Incidence of surgical site infection was considered the primary outcome. Random effects modelling was used for the analysis. The authors found 4 retrospective cohort studies and 1 randomised, controlled study involving a total of 2316 patients. Results of the analysis indicated no significant difference between the incidence of surgical site infections in groups with vs. without antibiotic prophylaxis (OR = 0.72, p = 0.18). The authors conclude that results of reviewed studies do not justify peri-operative use of antibiotics for patients undergoing operative treatment of bone fractures using K-wire [14].

Another study in 2010 also reported that antibiotic prophylaxis was not effective in both elective and trauma hand surgeries [8]. The hand is thought to be less prone to infection than other parts of the body, perhaps due to the anatomy and vascular supply of the bones and soft tissue [15]. There are also studies reporting no significant effect of antibiotic prophylaxis on infection rates in open hand fracture [16], although there is some evidence supporting the use of antibiotics in complex open hand trauma and open fractures with contaminated wounds [10].

Distal radial fractures

In contrast to hand fractures, there is lack of the studies analysing infection rates after operative treatment of distal radial fractures. We found only 1 study reporting the infection rates after K-wire fixation of distal radius fractures for which no antibiotic prophylaxis was given. More and above we found 2 studies in which the authors compared infection rates between exposed and buried K-wires when used to treat phalangeal, metacarpal and distal radius fractures.

Subramanian et al. reported the results of the protocol for K-wire fixation of dorsally displaced distal radius for which no antibiotic prophylaxis was given. The authors did not bury the K-wires under the skin and removed them after 4 weeks. The results of the treatment of 100 consecutive patients over a 2-year period were analysed retrospectively. Superficial pin-track infections were noted in 2 patients and they withdrew after removal of K-wires. The authors do not advocate the use of prophylactic antibiotics in operative treatment of distal radial fractures, postulating that they do not affect infection rate and thereby eliminating potential antibiotic adverse effects. Furthermore, the authors did not bury the K-wires, which allows for their removal in clinic, thus preventing risks of further operative procedures [11].

Ridley et al. reported results of the study comparing the incidence of surgical site infection rates between exposed and buried K-wires when used to treat phalangeal, metacarpal, and distal radius fractures in 695 patients. K-wires were buried in 207 patients (30%) and left exposed in 488 (70%). Infections occurred more frequently in exposed K-wire cases than in buried ones. Subgroup analysis based on fracture location revealed a significantly increased risk of being treated for infection when exposed K-wires were used for metacarpal fractures. The authors conclude that patients with exposed K-wires are more likely to be treated for a pin-site infection than those with K-wires buried beneath the skin. Metacarpal fractures treated with exposed K-wires were 2 times more likely to be treated for a pin-site infection (18% vs. 9%) [17].

Lakshmanan et al. reported results of the study investigating the infection rate in 43 patients, 30 women and 13 men, aged a mean of 49 years, who underwent percutaneous K-wire fixation for distal radius fractures. The wires were left protruding through the skin for easy removal, with their ends bent outside the skin to prevent migration. The authors noted 9 (21%) pin tract infections in the study group, of which in 3 required premature removal of K-wires. They conclude that K-wires should be buried under the skin to decrease the infection rate [18].

CONCOMITANT FACTORS INCREASING RISK OF INFECTIONS AFTER SURGERY FOR HAND FRACTURES

There are some associated factors that may contribute in increasing risk of surgical site infections following operations of hand fractures. They include concomitant diseases (diabetes mellitus, rheumatoid arthritis, gout, etc.), compromised immunity as a result of chemo- and immunotherapy for malignant neoplasms or systemic diseases, smoking and alcohol abuse. The role of these factors should be considered in studies assessing effectiveness of prophylactic antibiotic therapy in hand surgery. There are only single studies addressing this issue.

Bykowski et al. in a single-center retrospective analysis of 8850 elective hand surgery cases, using a multivariate regression analysis showed, that diabetes mellitus (OR = 2.8, 95%CI: 1.2–6.5, p = 0.02), smoking (OR = 3.0, 95%CI: 1.5–6.2, p = 0.003), and longer surgical time (OR = 1.02, 95%CI: 1.01–1.03, p = 0.001) are independent positive predictors of surgical site infection, regardless of the administration of antimicrobials [5].

Shapiro et al., in a critical analysis review, found that there is a paucity of literature evaluating the use of preoperative antibiotic prophylaxis in patients with rheumatoid arthritis, those with cardiac valves, and those taking corticosteroids for systemic inflammatory diseases. These authors suggested that patients suffering from these diseases are at greater risk of infection following hand surgeries, however this is just a guess, without clear scientific evidence [6].

HARMFUL AND ADVERSE EFFECTS OF ANTIBIOTIC PREVENTION IN HAND SURGERY

Routine use of antibiotic prophylaxis is not neutral for general health and is not free of potential adverse events. Problems associated with the excessive use of antibiotics include an increase in bacterial resistance with consequent reduction in the overall efficacy of these drugs and delayed wound healing, anaphylactic shock, infections by *Clostridium difficile* and other adverse reactions [19, 20, 21]. This raises questions if antibiotic prophylaxis in hand surgery causes more harm than benefits, especially if it is unnecessary. Although there is no reasonable evidence to answer this question, some related facts are well established in the literature. For example, the potential harmful effects of general and universal antibiotic prophylaxis which is probably minimal in the prevention of surgical site infections. In this context, Sandrowski et al. observed 1.5% of adverse reactions after the preoperative single-dose administration of antibiotics to a cohort of 551 patients undergoing outpatient surgeries of the hand and upper limb [19].

Wachtel et al. reported that 10% of patients who received antibiotic prophylaxis experienced adverse reactions [20]. Likewise, a recent review described rates of up to 0.1% anaphylaxis due to the administration of cephalexin, as well as 21% diarrhoea, and up to 8% infection caused by *Clostridium difficile* after the administration of clindamycin [1]. Finally, Tacconelli et al. in a systematic review of the literature and meta-analysis of total 24,230 patients found, that exposure to antibiotics almost doubles the risk of infection by methicillin-resistant *Staphylococcus aureus* organism (95%CI: 1.7–1.9, p < 0.001) [21].

COSTS OF ANTIBIOTIC PREVENTION IN HAND SURGERY

From the perspective of an individual patient or even single surgical ward the antibiotic prophylaxis is not particularly

expensive. It changes substantially if the entire hospital or entire medical care system is taken into account. Dunn et al. reported that if prophylactic antibiotics were not routinely administered, at least 15–30 mln USD (US dollars) would be saved every year in the USA [1]. In this regard, Johnson et al. noted that total healthcare expenditures in the first 30 days after surgery are higher in cases where preoperative intravenous antibiotics are administered when compared with cases that do not receive drug prophylaxis (USD 6070 vs. 4891, respectively; $p < 0.001$) [22].

In conclusion, current scientific evidence does not support routine use of antibiotic prophylaxis in operative treatment of hand and wrist bone fractures. Antibiotic administration in these operations does not decrease the infection rate and therefore can be safely avoided. Although in most of the reviewed studies the authors suggest antibiotic prevention in patients with diabetes, impaired immunity and in open fractures, these opinions are not supported by convincing evidence.

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