Postoperative infection after closed and open ankle fractures

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Ankle fracture is one of the most common traumas, the surgical treatment of which is usually performed by residents in traumatological training. The area is prone to postoperative infections due to swelling and circulatory problems. Wound dehiscence and superficial skin infection are the most common complications of operative ankle fracture treatment (4.6%), while the incidence for deeper infection around the ankle is 1.8% (1). In high-energy fractures infection complications are much more common – in the most difficult Gustilo type IIIB/C open ankle fractures infections are seen in up to 50% of the cases (2). The most important single factor predisposing to infection around the ankle is diabetes (3). The most common cause of postoperative osteomyelitis is an infection sustained by the presence of foreign material, and 80% of all cases are caused by Staphylococcus aureus (4). Soft tissue problems are directly proportional to the energy of trauma, and as soft tissue problems predispose to infections, the traumatologists should be familiar with the common classifications of closed and open fractures and soft tissue damage (5).

Reimbursement of patient injuries related to postoperative ankle problems in Finland 2002–2007

Hirvensalo et al (6) analyzed all patient injuries resolved in the Finnish Patient Insurance Center between 2002 and 2007 due to complications after malleolar ankle fracture treatment, and found out that 273 injuries were reimbursed in 239 patients. 35% of the reimbursed injuries were due to technical failures during the surgical procedure, 13% were due to infection. All infections were classified as deep. With infection the additional in-hospital stay was significantly longer (28 days/ person), and only one (2.9%) of these patients could be managed without re-operation. 51.4% of the patients needed two to three reoperations. The average duration of disability was 383 days, and in two patients the infection caused a permanent disability. Surprisingly, Hirvensalo et al observed that reimbursed infection complications occurred more frequently at university hospitals than in smaller ones. They concluded that it was due to the fact that most difficult fractures are likely to be treated in university hospitals.

Symptoms and definition of a postoperative infection

The classical signs and symptoms of an infection are increasing pain, swelling, redness, and bad smelling pus in the wound. C-reactive protein can lead to suspect of an infection if its value suddenly starts to rise after a calm postoperative period. The bacterial cultures must always be taken from the wound, and they have to be positive to set up the diagnosis of a postoperative infection. It is important to differentiate a postoperative infection of a limited necrosis of the wound, where the bacterial cultures remain negative.

Around the ankle there is no real fascia on top of the deeper structures, and therefore the traditional classification of superficial and deep infection based on its limitation to the fascia does not really work well. We classify as superficial all the infections, where cultures are positive with the classical sings of an in-

fection, but where the osteosynthesis material is neither visible nor palpable in the bottom of the infected wound. On the contrary, when the material is seen or felt, the infection is classified as deep.

Factors predisposing to infection

In addition to the personality of the injury, also patient-, surgeon-, and implant-related factors affect the incidence of infection. When considering the injury type, it is of great importance, whether the fracture is closed or open, what are the possible other injuries, and what is the degree of tissue contamination. The most important components of soft tissue injury include fracture dislocation, swelling, possible blood vessel injuries, additional surgical trauma, too abundant osteosynthesis material, and possible too tight closure of the wound. The most important patient aspects are diabetes, systemic vascular disease, age, smoking, drugs or alcohol abuse, steroids, nutritional/immunological status, compliance, and a possible infection in another organ. Surgeon aspects include surgical incision planning, tissue handling and wound closure technique, as well as skin preparation, surgical handwash and the amount of people visiting OR during the intervention. Biocompatibility of the materials used, implant surface properties, implant design, number of possible dead spaces, are important implant-related factors (7).

SooHoo et al (8) investigated in a large population-based study the complication risks for operative treatment of ankle fractures, and concluded that systemic vascular disease and diabetes are the most important risk factors for immediate postoperative complications. In the whole population the average incidence of infection was 1.4% and of amputation 0.2%, but in patients with diabetes the incidence of infection was 7.7% and of amputation 3.8%. In patients with systemic vascular disease the numbers were 6.7% and 3.8% respectively.

Höiness et al (9) evaluated in a prospective study primary and peri/postoperative (>12weeks) soft-tissue problems in 154 patients based on Tscherne-classification. 22 patients (14.2%) had a primary soft-tissue injury. In the follow-up 29 patients (18.8%) developed minor and 5 patients (3.2%) major soft tissue complications. The incidence of deep infection was 1.9%. In their analysis the important risk factors for peri/postoperative complications were alcohol abuse, high-energy trauma and a primary soft tissue problem.

Antibiotic prophylaxis

According to Cochrane- review (21 randomized, controlled studies) intravenous antibiotic prophylaxis reduces the incidence of deep infection from 4.3% to 1.4% (10). The concentration of antibiotics in circulation reaches its maximum level 20 minutes after the dosing, so the antibiotics should be administered 30 minutes before the surgical incision. There is no consensus on the appropriate duration of prophylaxis – several meta-analyses have been conducted to compare the effect of single versus multiple-dose treatment, without conclusion. It has been estimated that a total amount of 25000 patients should be recruited to a study to show the superiority of either of the treatment options. According to a recent study single dosing is more cost-effective than multiple-dosing in infection prophylaxis of closed long bone fractures (11).

Blisters

Edema, blisters and skin problems are not uncommon with ankle fractures. Possible skin problems can be avoided with a very early (<24h) or delayed surgery - when edema does not yet complicate the operative field. But how should we deal with ankles that have already formed blisters in the area of the planned incisions. Blisters are formed as a consequence of the dermal-epidermal junction separation. Red blood-filled blisters indicate deeper injury that blisters filled with clear liquid. The blisters contaminate rapidly, and the colonization continues until re-epitelization occurs (within 4-12 days). Varela et al (12) retrospectively analyzed 1468 ankle fractures, and found 831 fractures with blister formation. Fractures that were treated within 24 hours after the initial trauma developed blisters in only 2 % of the cases, whereas fractures treated later on developed blisters in 8%. They noted that distal tibia and ankle are especially prone to blister formation.

Strauss et al (13) followed prospectively 47 patients with blister formation after a lower extremity fracture (17 ankle, 13 proximal tibia, 5 tibia, 8 calcaneus, 4 pilon tibiale). All blisters were unroofed and treated with silver-sulfadiazin 2x/day until re-epitelization. The fracture was stabilized with a plaster cast or external fixator, and the average delay to surgery was 7.7 days. 13.3% (6/45) had soft-tissue com-

plications, 4 minor and 2 more severe infections. Both severe infections occurred in patients with diabetes and in patients where the incisions were made next to the blisters. They noted that in patients with diabetes the soft tissue injury reaches much further than the visible border of the blister, and therefore incisions in the vicinity of the blisters should be avoided. The safest method is to use a temporary external fixator, wait for edema to disappear and the blisters to re-epitelize, and postpone the operation.

Diabetes and ankle fracture

Ankle fractures in diabetic patients are especially challenging. Vasculopathies, neuropathies, and delayed wound and fracture healing predispose to infections. A marked amount of complications occurs in patients treated both conservatively and operatively, especially, if the patient has already developed a neuropathy as a complication of diabetes. Micro- and macroangiopathies lead to local tissue ischemia which worsens healing conditions of the wound. Therefore in all diabetic patients ADP- and ATP- pulses must be palpated and evaluated preoperatively to assess the vascular healing conditions of the wounds. A palpable ADP or ATP is normally a sign of sufficient circulation for wound healing. Also TCPO2 can be measured, and a pressure >30mmHg is considered sufficient for wound healing. If the pulses are not palpable, a vascular surgeon should be consulted, and an angiography performed preoperatively (14).

Costigan et al (15) reported 2007 the largest study until now on diabetic patients treated operatively after suffering an ankle fracture. Of the 84 patients, 12 (14%) developed a complication, and 10 (12%) had an infection. Two patients with infection suffered a lower extremity amputation and one patient developed Charcot arthropathy. In the statistical analysis peripheral neuro- and vasculopathy significantly increased the risk of complications (p=0.001). White et al (16) retrospectively analyzed 14 open ankle fractures in patients with diabetes, and found wound complications with nine patients (64%). An average of five interventions was needed to deal with one complication. Only three patients had an uneventful recovery, and five patients suffered eventually a transtibial amputation.

Egol et al (17) clarified in a prospective study different factors affecting postoperative functional recovery after operative treatment of an ankle fracture, and noticed, that one year postoperatively the diabetic pa-

tients had functionally recovered significantly worse that the controls. Only 72% of 31 diabetic patients had recovered >90% of the preoperative value compared to controls where >90% functional score was observed in 92% of the patients (p=0.02). Ganesh et al (18) carried out a wide retrospective cohort-study (n=160,598) evaluating the results of diabetic patients (n=9174) compared to non-diabetic patients after operatively treated ankle fracture. They found a significant difference in the amount of postoperative complications, in-hospital mortality, length of hospital stay and overall costs (P<0.001).

All diabetic patients need a thorough preoperative neurovascular examination, intraoperative tissue handling must be very gentle, a rigid fixation must be achieved, and postoperative immobilization has to be long enough. The basis for everything is the optimization of blood glucose level (4).

Treatment of postoperative infection

Superficial infection can be treated with a bedside revision, local wound treatment, and orally administered antibiotics, but in deeper infections treatment must be chosen according to the type of infection, its bacteriology, antibiotic sensitivity, implant stability, and general state of the patient. The principles are aggressive wound revision, a prolonged course of antibiotics, treatment of possible bony and soft tissue defects, stabilization of the fracture, and possible removal of the infected hardware. The most important part is a proper debridement and extraction of all dead tissue. Vacuum assisted closure (VAC) is often used to prepare the wound for a closure. Sometimes a direct wound closure can be achieved, but in most cases a skin graft or a skin flap is needed (19). The significance of a soft tissue flap is not only to provide coverage, but also to enhance local defence capability. A vascularized muscle flap obliterates dead space and supplies oxygen to the injured area, which results in increased bactericidal activity and better healing (20).

Fractures present a dilemma when infection occurs in the acute postoperative period, as the vast majority of fractures will not have achieved osseous union in this time period. Either fracture stabilization and healing are optimized through the retention of hardware, or the hardware is removed to give the patient the best chance to clear the infectious process (21). If the fixation material is loose or osteosynthesis unstable, the hardware should be removed. If the hardware

is removed, the fracture has to stabilized, for example with an external fixator, since ridig fixation is the basis of infection eradication and fracture healing. If the osteosynthesis is stable and fracture has not consolidated yet, the implants can be retained and not removed until the fracture has achieved osseous union (21).

Conclusion

The most important factor in infection prophylaxis is to stabilize an unstable fracture. When operating on high-energy fractures special attention has to be paid on mini-invasive techniques to minimize the problems with soft tissue healing. Antibiotic prophylaxis is an essential part of fracture surgery, and the timing has to be correct. If the definitive fracture treatment is carried out later on, the fracture must be reduced and stabilized in an adequate reduction with a plaster cast or external fixator. If the wound is infected, intravenous antibiotics have to be started, and revision surgery considered. A stable osteosynthesis can be left untouched, especially if the fracture has not consolidated yet, but an unstable osteosynthesis material has to be removed. Wounds are primarily left open, and not closed until the infection has settled down. Multifacetal co-operation between trauma and plastic surgeons and an infection specialist is needed in the treatment of deep postoperative infections. An infected unhealed fracture is one the most difficult challenges in trauma care, and therefore aggressive surgical procedures and attitude are needed to stop the progression of the infection.

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