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INFECTIONS IN SHOULDER AND ELBOW SURGERY – INCIDENCE AND PREDISPOSITION

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SUMMARY
A surgical site infection in shoulder and elbow surgery can be a devastating complication and should be prevented by all means. Several predisposing factors including preoperative preparation, technical equipment, surgical approach, dosing and timing of antibiotics and patient specific premorbidities should be acknowledged. We aimed to expose the incidence and predisposition for infections in shoulder and elbow surgery and strategies to prevent surgical site infections.

Keywords: shoulder and elbow infections, surgical site infection, infection prevention

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INFEKCJE W PRZYPADKACH CHIRURGII BARKU I ŁOKCIA – WYSTĘPOWANIE I PREDYSPOZYCJE

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STRESZCZENIE
Obecność zakażenia miejsca operowanego może być katastrofalnym powikłaniem w chirurgii barku i łokcia i należy jemu zapobiegać za pomocą wszelkich środków. Istnieje kilka czynników predysponujących występowanie zakażenia, w tym przygotowanie przedoperacyjne, sprzętu, dojścia operacyjne, dawkowanie i czas stosowanie antybiotyków, jak i predyspozycje samego pacjenta oraz występowanie wcześniejszych chorób. Celem tej pracy było scharakteryzowanie częstości występowania i predyspozycji do występowania zakażeń w okolicach barku i łokcia w trakcie i po zabiegach chirurgicznych, jak i strategii zapobiegania zakażeniom w operowanym miejscu.

Słowa kluczowe: zakażenia łokcia i barku, zakażenie w miejscu operowanym, zapobieganie infekcji

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Introduction

The incidence of postoperative infections in shoulder surgery is subject to the operative procedure. For anatomical shoulder prostheses an infection rate of 1.1% was reported (Gonzalez *et al.* 2011) whereas in reverse shoulder arthroplasty rates were observed at 3.8% (Zumstein *et al.* 2011). In rotator cuff repair rates between 0.4–1.9% were reported. The incidence in elbow arthroplasty is similar to shoulder arthroplasty with 3.3% (Voloshin *et al.* 2011) although earlier studies reported a much higher rate of elbow infections of up to 9% (Gschwend *et al.* 1996).

Aim, method

In this report, we aimed to expose the incidence and predisposition for infections in

shoulder and elbow surgery and strategies to prevent surgical site infections by the review of relevant literature on these topics.

Results

The cost of a postoperative infection is of socioeconomic relevance. If an infection occurs, an average of 9.7 additional hospital days stresses the patient and the health care system (Reichman and Greenberg 2009). The additional annual costs for the treatment of all postsurgical infections were calculated to be 1.4 billion euros only for England (Plowman 2000). A review from the United States reported that the costs of an infected patient add up to 115% of the costs of a non-infected patient (Reichman and Greenberg 2009). Strategies of prevention are of great importance in daily surgical routine. These areas include preoperative skin cleaning and shaving, the operative room environment, preoperative disinfection, the use of incision drapes, use of antibiotics, the surgical approach, drains, body temperature control, adequate oxygen and glucose levels, reduction of blood transfusions and the smoking behavior of the patient (Reichman and Greenberg, 2009). Whether a preoperative bath or shower with or without antiseptics is protective for infections has not been demonstrated yet (Webster and Osborne 2012). Much debate has been addressed to the preoperative skin shave. In a Cochrane review by Tanner *et al.* (2011) clippers were reported to be superior compared to razors and that shaving and depilatory creams show similar results. It has been further demonstrated that shaving should be restricted only to those cases where it is necessary for the surgical access and it should be performed directly before the incision (Alexander *et al.* 2011). The operative room environment also is of great importance to reduce infections. HEPA filters are reported to provide the best effect. Laminar airflow systems may help, but their effect is concluded to be only minimal (Brandt *et al.* 2008). However, the most important rule affects the operative room team, reducing unnecessary conversations and movements are still reported as a very effective method of precaution and prevention of infections (Alexander *et al.* 2011).

In a review of 33 years of register data patients with young age and male gender were observed to be at greater risk for periprosthetic infections after total shoulder arthroplasty (Singh *et al.* 2012). This might be linked to the observation that male patients are at a 2.5 greater risk for obtaining positive cultures for Propionibacterium acnes (P. acnes) in first time shoulder surgery (Hudek *et al.* 2014). P. acnes is a gram-negative bacterium, which has been associated multiply with, orthopedic and implant associated infections (Hudek *et al.* 2014). It resides deep in the pilosebaceous unit of the skin and disinfection is known to insufficiently eradicate P. acnes preoperatively (Lange-Asschenfeldt *et al.* 2011). Therefore, it can be displaced into deeper tissue layers during surgery leading to a typical „low-grade“ infection. These infections are evolving over a much longer period compared to acute infections provoked by germs with greater pathogenicity. Because low-grade infections do not necessarily elevate c-reactive proteins or leukocytes it is often difficult to detect them. Therefore, aseptic loosening might be in fact an infection with P. acnes. The germ can reside intracellular in humans for many years hiding within macrophages (Fischer *et al.* 2013). The observation of a higher incidence of shoulder infections in young males (Singh *et al.* 2012) and the simultaneous observation of a high P. acnes burden linked to the antero-lateral approach (Hudek *et al.* 2014) should alert the orthopedic surgeon when planning operative procedures. The most pilosebaceous units are situated around the acromion showing much greater P. acnes burden when compared to the knee or the hip region (Patel *et al.* 2009). The deltopectoral approach seems to be 2-times safer than

the antero-lateral approach with regard to P. acnes detection (Hudek *et al.* 2014). Interestingly, patients who report "loss of hair" are reportedly at lesser risk for obtaining P. acnes positive cultures form intraoperative samples when compared to those who report no loss of hair (Hudek *et al.* 2016). Another important predisposition for surgical site infections is obesity (Edmiston *et al.* 2004). Pharmacokinetic analysis suggests that dosing strategies may fail to provide adequate perioperative prophylaxis if the patient is obese. Tissue levels of Cefazolin at wound closure were reported to be much less when compared to a control with normal BMI. Patients with a mean BMI of 47 the antibiotics concentration at the surgical site was only 48% and just 10% in those with a BMI of 69 (Edmiston *et al.* 2004) compared to normal sized patients. Therefore, adequate dosing of antibiotics is mandatory in shoulder and elbow surgery. For example, 2 grams of Cefazolin are recommended in patients weighing between 80–160 kg while 1 gram is sufficient in those ≤ 80 kg (Alexander *et al.* 2011). The timing of preoperative antibiotics is also of great importance. One to thirty minutes before incision is recommended as the optimal time window (Bowater *et al.* 2009). However, a recent analysis calculated on the basis of over 7000 surgical procedures revealed that the optimal time point to apply prophylactic antibiotics is 4 minutes before the incision (Koch *et al.* 2013). However, the time point has to be modified for those antibiotics with slower tissue penetration properties. For example, Vancomycin has to be applied 1 hour before the incision (Alexander *et al.* 2011). In cases of time consuming surgical procedures the dosing interval has to be adapted (Alexander *et al.* 2011). The body temperature of the patient is also associated to the infection incidence. Normothermia or even hyperthermia is beneficial. In contrast, hypothermia will provoke vasoconstriction. The reduced blood flow in the subcutaneous area will reduce O2 tension and thereby increase the infection risk (Dharan and Pittet 2002). A relative infection risk of 6.3 has been linked to hypothermia when compared to Normothermia (Flores-Maldonado *et al.* 2001). Infection is also inversely related to tissue oxygen in a time dependent fashion. Neutrophils will lose their function and potential to eradicate bacteria when the O2 tissue level is < 30 mmHG (Hopf and Holm 2008). Therefore, patients with lesser O2 tissue levels are at greater risk for postsurgical infections, which is even more a problem for the obese. Therefore, postoperative O2 therapy reduces the infection risk and should be applied particularly in obese patients or those with decreased respiratory function (Qadan *et al.* 2009). Diabetics are also at greater infection risk. Their blood glucose levels should therefore be targeted preoperatively between 120–160 mg/dl for at least 3 days before surgery with the maximal target of reportedly 180 mg/dl (Alexander *et al.* 2011). The rate of deep infections rises by factor 6 if glucose levels are above 250 mg/dl (Alexander *et al.* 2011). Another predisposition for infections is a blood transfusion. It should therefore be avoided if possible. For each unit red packed blood cells the risk for an infection is reportedly raised by 5% (Bochicchio *et al.* 2008). If more than 4 units were given, the odds ratio raises even to 6.4 (Edna and Bjerkeset 1992). Another critical predisposition is smoking. It increases surgical wound infections via several well-established mechanisms including vasoconstriction, which is associated with decreased tissue pO2. Smoking is the only modifiable predisposition for post-surgical infections. The risk is almost doubled and even higher when the smoker is obese (Alexander *et al.* 2011). A recent study involving 489 patients for ambulatory surgery, smoking had an adjusted odds ratio for wound complications of 16.3 in smokers vs. non-smokers (Myles *et al.* 2002). The time interval for

smoking abstinence is discussed to be at least 4 weeks, however conclusive data are missing (Sorensen *et al.* 2003).

Conclusions

In summary, the incidence of infections in shoulder and elbow surgery is ranging between 1–4%. A predisposition is male gender and young age. Low-grade infections are of special importance because of the pathogenicity of P. acnes and its strategies to persist within humans. Therefore, surgeons should be cautious when planning an antero-lateral approach to the shoulder in males. In obese patients dosing of antibiotics and postoperative O2 supply should be considered. Smoking is the only modifiable risk factor for infections and the patient should be explained to quit smoking in any case.

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