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QUESTION 7: Does the use of a tourniquet influence the incidence of surgical site infection (SSI) following arthroscopic surgery of extremity joints?

RECOMMENDATION: No. A direct relationship between use of a tourniquet for arthroscopic surgery of the extremity joints and the incidence of SSI has not been established.

LEVEL OF EVIDENCE: Moderate

DELEGATE VOTE: Agree: 100%, Disagree: 0%, Abstain: 0% (Unanimous, Strongest Consensus)

RATIONALE

The use of a pneumatic tourniquet during arthroscopy is a popular intraoperative measure to control bleeding, improve visualization, ease surgical procedures and possibly shorten the operative time, especially in knee procedures. For several decades, various studies have suggested that tourniquet application may result in an increased risk of postoperative pain, nerve paralysis, swelling, joint stiffness and functional weakness bringing into question the value of tourniquet use [1,2]. However, two meta-analyses found no difference in functional outcomes and general complications among patients undergoing arthroscopic surgery with and without the use of tourniquet [3,4]. Therefore, the use of tourniquets remains at the discretion of treating surgeon. A survey of the American Orthopaedic Society of Sports Medicine, Arthroscopy Association of North America and Delhi Arthroscopy Society members revealed that the majority of surgeons preferred to use tourniquet during arthroscopy surgery, thus making comparison of the outcome of these patients without the use of tourniquet somewhat difficult [5].

The potential influence of tourniquet use on the risk of subsequent SSI following arthroscopic surgery is not clear. If the tourniquet use results in a higher rate of SSI, a possible mechanism could be related to the effect of ischemia on antibiotic diffusion in the bone marrow. Administration of antibiotic while the tourniquet is inflated is unlikely to allow for proper diffusion of the antibiotics to the operated extremity and the joint. Because of the latter issue, a ten-minute delay between antibiotic administration and inflation of the tourniquet is proposed to allow the antibiotic to reach the required minimal inhibitory concentration (MIC) level in the operated joint [6].

Regarding the correlation between tourniquet use and the risk of infection after joint arthroscopy, no randomized controlled trials (RCTs) with this primary outcome were found. The available high-level studies on knee arthroscopy were underpowered due to the rarity of SSI, while no meta-analyses performed a pooled analysis of SSI events following tourniquet and non-tourniquet arthroscopic surgery [3,4]. Additionally, few single-center series of knee arthroscopies analyzed the risk factors for SSI. Sherman et al. retrospectively evaluated 2,640 arthroscopies, and did not report a direct correlation between tourniquet use and postoperative complications, including infection. However, a higher risk of postoperative complications was found only in patients older than 50 years and in a tourniquet time longer than 60 minutes [7]. Reigstad et al., focusing on SSI, reported two superficial infections after 876 simple arthroscopies (0.23%), mostly after medial meniscectomies, and failed to identify a significant correlation with tourniquet use. Rather, they rather reported a higher incidence of complications in cases of prolonged surgical time [8].

Also, Vachal et al. reported six SSIs after 908 anterior cruciate ligament reconstructions (ACLR) (0.7%), identifying previous surgeries as the only significant predictor for SSI [9]. The risk of infection has been specifically investigated in two large multi-centric series of ACLR, the Multicenter Orthopaedic Outcome Network (MOON) cohort and Kaiser-Permanente registry including 2,198 and 10,626 patients, respectively [10,11]. However, they were limited to the inclusion of tourniquet use and operative time in the multivariate logistic regression. The same limitation has been disclosed in other large multi-centric cohorts involving up to 700,000 patients undergoing knee arthroscopy [12,13].

Regarding elbow, wrist and ankle joints, few studies evaluated arthroscopic procedures without the use of the tourniquet, thus solid conclusion cannot be drawn regarding the impact of tourniquet use and SSI after ankle, elbow or wrist surgery [14–17].

Based on the available literature, no direct relationship between tourniquet use and SSI has been reported. What is clear is that there is a direct link between surgical time and the risk of subsequent infection in arthroscopic surgery of extremity joints. Thus, the use of tourniquets should be subordinated to the surgeon's preference and experience, and balanced with the patient's characteristics, comorbidities and the complexity of the procedure to limit the surgical time. When antibiotic prophylaxis is planned, the tourniquet should be inflated at least ten minutes after its administration.

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QUESTION 8: What strategies should be employed to minimize recurrent infection of a previously infected joint during subsequent joint reconstructive (non-arthroplasty) procedures?

RECOMMENDATION: We recommend that joints with remote or recent history of infection be aspirated and the synovial fluid analyzed for the presence of infection. The affected joint should not exhibit any clinical signs of infection such as erythema, swelling, warmth and others at the time of planned reconstruction.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 100%, Disagree: 0%, Abstain: 0% (Unanimous, Strongest Consensus)

RATIONALE

Our extensive literature search did not reveal any studies specifically focusing on the prevention of recurrent infection in previously infected joints during reconstructive (non-arthroplasty) procedures. It is, however, well-established that previous septic arthritis is a risk factor for subsequent surgical site infection (SSI) and periprosthetic joint infection (PJI) [1–4]. Furthermore, different studies described the risk factors for developing septic arthritis, such as morbid obesity, tobacco use, inflammatory arthritis, chronic kidney disease, diabetes and hemodialysis [5–7]. Cancienne et al. reported in their case-control study of over 530,000 shoulder arthroscopies that prior steroid injection, revision surgery and malnutrition were independent risk factors for infection [8].

Multiple PJI and SSI risk mitigation strategies may be considered in a patient with remote or recent history of joint infection undergoing a reconstructive non-arthroplasty procedure [1–3,9,10]. These are discussed in further detail below.

- Medical optimization: Consider optimization of modifiable risk factors such as treatment of any systemic or local infection, correction of malnutrition, weight reduction in patients with morbid obesity (> 40 kg/m^2), treatment of vascular insufficiency, smoking cessation, correction of hyperglycemia and preoperative cessation of immune-modifying medications [10].
- Antibiotics: Administer prophylactic antibiotics to reduce the risk of recurrent infection. In patients with previous methicillin-resistant *Staphylococcus aureus* (MRSA) infection, the addition of vancomycin or teicoplanin as perioperative antibiotic prophylaxis should be considered [10,11].
- Skin preparation: Preoperative surgical site preparation using soap (antimicrobial or non- antimicrobial) or an antiseptic agent on the night before the operative day should be considered [2,10].
- Particle-free operating environment: While there is no definitive evidence for the efficacy of laminar air flow in non-arthroplasty surgery, the number of theatre personnel and operating room traffic should be minimized to reduce the risk of recurrent infection [10].
- Respect the soft tissue: Meticulous surgical technique, proper wound closure and an effort to reduce the surgical time may help minimize the risk of recurrent infection [10,12].
- Intraoperative wound irrigation: Copious intraoperative irrigation is considered an effective strategy to reduce the number of pathogens in the surgical wound [10].
- Wound management: Antimicrobial dressings may reduce the risk of SSI [10,13].

More recently, pre-soaking of hamstring tendon autograft in a vancomycin solution has been shown to reduce septic arthritis following ACL reconstruction. As such, we recommend soaking the autograft (and possibly allograft) in an antibiotic solution such as vancomycin when used in previously infected knees [14–17].

In the absence of specific literature related to the above question, we recommend that all measures are taken to ensure that infection in the affected joint is resolved, which includes absence of erythema, swelling and so on. In addition, the affected joint should be aspirated and the synovial fluid analyzed for signs of infection.