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QUESTION 6: What is the most appropriate/effective sterilization method of an anterior cruciate ligament (ACL) graft dropped on the operating room (OR) floor during ACL reconstruction (ACLR)? Should the tissue instead be disposed and alternate graft acquired?

RECOMMENDATION: Rinsing the contaminated graft in a 4% solution of chlorhexidine gluconate is the most effective decontamination method in the event that an ACL graft is dropped on the OR floor. When a chlorhexidine gluconate solution is used for decontamination of the dropped ACL graft, the subsequent rates of infection are very low, suggesting that there is no need to dispose of the ACL graft.

LEVEL OF EVIDENCE: Moderate

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

RATIONALE

Injuries to the ACL are among the most common injuries to the knee, with reconstruction being the preferred method of treatment when functional instability is present [1]. Autografts are frequently used for ACLR, but it has been shown that the use of autografts is associated with contamination as a result of the harvesting and manipulation process [2]. Contamination of the autograft can also occur accidentally, by dropping the graft on the OR floor or allowing it to come into contact with non-sterile surfaces. In fact, a 2008 survey showed that 75% of plastic surgeons had dropped an autograft on the OR floor at least once [3]. In 94% of those cases, the autograft was decontaminated and the operation was completed. This protocol may put the patient at risk for the development of an intraoperative infection if proper decontamination procedures are not followed. This is particularly concerning given the sheer volume of ACL autograft reconstructions done each year, which has led to a variety of case studies to attempt to identify the best method for sterilizing a dropped autograft during ACLR.

Numerous studies have shown that a contaminated autograft can be effectively decontaminated by rinsing it in a 4% chlorhexidine gluconate solution [4–8]. There is some discrepancy regarding the length of time that a graft should be rinsed in the chlorhexidine solution, with 90 seconds [8], three minutes [6,7], 15 minutes [9] and 30 minutes [4] all being recommended. Khan et al. determined that rinsing a contaminated autograft in a 4% chlorhexidine gluconate solution was the most effective decontamination technique in a systematic review of seven studies [10]. The studies included used samples from a variety of sources (fresh-frozen, autograft, cadaver) and they found that 98% of contaminated grafts soaked in chlorhexidine showed no bacterial growth [10].

Bacitracin, polymyxin B and povidone iodine were additional proposed methods of decontaminating a dropped graft, but there were conflicting recommendations regarding their use. Of note, bacitracin was shown to be highly effective in decontaminating hamstring autografts [6,7], but it did not decontaminate bone-patellar tendon-bone grafts [11]. The clinical relevance of the latter observation has not been explored further. While a povidone iodine rinse was found to be a useful method of decontamination when used on grafts dropped on the OR floor, it was ineffective on samples artificially contaminated with *Staphylococcus aureus* and *Pseudomonas aeruginosa* [12].

There is a lack of patient outcomes data and randomized control trials on the subject, as well as some discrepancy regarding the length of time a graft should be rinsed prior to implantation. However, there is agreement between numerous case studies indicating that rinsing a contaminated ACL graft in a 4% chlorhexidine gluconate solution is an effective and appropriate decontamination method.

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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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