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QUESTION 1: Should culture samples be taken during arthroscopic treatment of a knee joint infection? If so, how many and from which area in the joint?

RECOMMENDATION: Yes, culture samples should be taken during arthroscopic treatment of a knee joint infection. We recommend that at least three culture samples from different sites be taken.

LEVEL OF EVIDENCE: Moderate

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

RATIONALE

Infections of the knee joint can occur either from hematogenous spread or directly due to local trauma or a medical intervention. Infections after an arthroscopy for anterior cruciate ligament reconstruction (ACLR) or meniscal pathology are reported throughout the literature [1–18]. Infection can also occur in healthy native knees [13,19–24]. Sending intraoperative samples of synovial fluid and tissue for microbiological analysis is commonly reported in the literature [1–12,14–24], with only one study reporting no intraoperative samples for culture [13]. Two studies described the number of samples taken during the arthroscopy [11,19]. In both of the studies, five samples were taken and sent for culture. Unfortunately, no studies described an optimal area of the joint from which to take the samples.

When considering the existing research, it can be concluded that samples should be taken during arthroscopic treatment for a knee infection. However, based on the review of the literature, no conclusion can be drawn about the number of samples.

There is more research describing the number of samples to be taken during debridement in periprosthetic joint infection (PJI). In their study on 113 PJIs, Gandhi et al. concluded that the optimal number of cultures needed to obtain a positive test result was four (specificity = 0.61, sensitivity = 0.63). Furthermore, they stated that increasing the number of samples increases specificity but reduces sensitivity [25]. In the same study, the samples were collected from representative areas of the joint, including, but not limited to, synovium, intramedullary tissue, prosthetic interface and tissue from the adjacent bone [25].

During the previous consensus meeting in 2013, it was concluded that three to six samples should be obtained intraoperatively in suspected PJI cases [26]. Similarly, other authors confirmed that three to five samples should be obtained from deep tissues during surgery for suspected PJI [27,28].

There is no agreement about the area of the joint the samples should be taken from during arthroscopic treatment of septic knee arthritis. In their review, Bauer et al. reported that the samples should be taken from the deep tissue [29]. In their systematic review, Mouzopoulos et al. suggested that during arthroscopic treatment of septic ACLR, samples for culture should be taken from multiple areas, such as synovial lining, graft, femoral and tibial tunnel [30].

Based on the available data, no definitive conclusion can be drawn on the number of samples needed and the area of the joint they should be taken from during arthroscopic treatment of septic knees. Studies based on PJI were considered, as well as literature reviewed on knee septic arthritis after ACLR. Based on this data, it may be extrapolated that at least three samples should be collected during arthroscopic treatment of knee joint infection. Furthermore, they should be taken from multiple areas of the joint: graft, synovial lining and from the femoral and tibial tunnels when present. It is reasonable to also collect samples from other areas, such as the medial and lateral gutters and the suprapatellar pouch.

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QUESTION 2: What diagnostic "algorithm" should be used to diagnose infection following anterior cruciate ligament reconstruction (ACLR)?

RECOMMENDATION: The "algorithm" to diagnose postoperative infection in patients with ACLR should include clinical presentation, serological tests including C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR) and analysis of the synovial fluid aspirate including gram staining and culture.

LEVEL OF EVIDENCE: Moderate

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

RATIONALE

Postoperative infections following ACLR are rare, occurring in only 0.14–5.7% of cases [1–5]. As a result, clinical studies are limited and have small sample sizes. However, the general consensus is that the clinical presentation, laboratory blood tests, (specifically (CRP) and ESR) and synovial fluid aspiration analysis are essential for the diagnosis of infection after ACLR [6–13]. Magnetic resonance imaging can detect joint effusion, synovitis, edema of adjacent soft tissues and bone marrow, bone erosions, sinus tracts and soft tissue abscesses, though this has only been reported in one study [14].

Features of the clinical presentation that raise suspicion of infection include fever, malaise, sudden change in knee pain of moderate intensity, local incision drainage, local warmth, local swelling, erythema, decreased knee range of motion and inguinal lymph node enlargement, though each of these symptoms is not present in all cases [8,11,15–17].

Laboratory blood analysis should be included in the diagnosis of infection after ACLR. Interpretation of results can be challenging, as elevated levels are routinely seen postoperatively, (typically peaking by postoperative day three), as a result of the surgical trauma [3,7,13,18]. C-reactive protein levels, which increase within six to eight hours after infection, have been shown to have the highest sensitivity and specificity. Reported average C-reactive protein levels in patients after ACLR with knee infection range from 55.8 to 203 mg/L (range, 10-400 mg/L) (normal 0-0.5 mg/L) [11,15–17]. ESR levels typically rise within 24 to 48 hours [19–21]. Average ESR values in patients with knee infection after ACLR range from 57 to 76 mm/h (range, 9-108 mm/h) in the literature (normal 1-10 mm/h) [11,13,15,17,18]. Peripheral white blood cell count has also been shown to be elevated in patients with postoperative knee infection after ACLR (9.1 to 10.8 x 109/L), though this is not a consistent finding in the majority of patients [13,15,17]. Polymorphonuclear neutrophils (average 71.7%) and fibrinogen levels (average 774.7 mg/mL) have also been assessed and shown to be elevated in patients with ACLR and postoperative knee infection [13].

Gross inspection of knee joint aspiration commonly reveals turbid, yellow-green synovial fluid.[3] Microbiological analysis of synovial fluid aspirate is the most widely studied diagnostic method for septic arthritis [1,6,8,9,19,22,23]. Analysis includes gram staining, leukocyte counts, aerobic and anaerobic cultures and antibiotic sensitivities [6,13]. Positive leukocyte counts of aspirated knee fluid in knee infections after ACLR have also been reported [average 91,000 (range 64,000 to 129,000)] [6,11]. Several retrospective studies have shown that in most cases synovial fluid bacterial cultures are positive to coagulase-negative Staphylococci (*Staphylococcus epidermidis*), *Staphylococcus aureus*, *Streptococcus non-hemolytic*, *Staphylococcus schleiferi*, *Escherichia coli* or Propionibacterium in acute septic arthrosis [6,11,13,15,17–19,23,24].

Overall, there is consensus that the diagnostic algorithm for postoperative knee infection following ACLR should include sudden change in history and presentation to include change in knee pain profile, swelling and range of motion, in addition to elevated CRP