no abnormalities on radiographs [11]. Agout et al. [9], Sanchez and Hennrikus [10] and Stanitski et al. [12] reported no pain, symmetrical range of movement, no radiographic changes and < 5mm of LLD in all patients at final follow-up.

REFERENCES

[1] Peres LR, Marchitto RO, Pereira GS, Yoshino FS, de Castro Fernandes M, Matsumoto MH. Arthrotomy versus arthroscopy in the treatment of septic arthritis of the knee in adults: a randomized clinical trial. Knee Surg Sports Traumatol Arthrosc. 2016;24:3155–3162. doi:10.1007/s00167-015-3918-8.

[2] Jaffe D, Costales T, Greenwell P, Christian M, Henn RF. Methicillin-resistant Staphylococcus aureus infection is a risk factor for unplanned return to the operating room in the surgical treatment of a septic knee. J Knee Surg. 2017;30:872–878. doi:10.1055/s-0037-1598079.

[3] Balabaud L, Gaudias J, Boeri C, Jenny JY, Kehr P. Results of treatment of septic knee arthritis: a retrospective series of 40 cases. Knee Surg Sports Traumatol Arthrosc. 2007;15:387–392. doi:10.1007/s00167-006-0224-5.

[4] Böhler C, Dragana M, Puchner S, Windhager R, Holinka J. Treatment of septic arthritis of the knee: a comparison between arthroscopy and arthrotomy. Knee Surg Sports Traumatol Arthrosc. 2016;24:3147–3154. doi:10.1007/s00167-015-3659-8.

[5] Dave OH, Patel KA, Andersen CR, Carmichael KD. Surgical procedures needed to eradicate infection in knee septic arthritis. Orthopedics. 2016;39:50–54. doi:10.3928/01477447-20151222-05.

[6] Wirtz DC, Marth M, Miltner O, Schneider U, Zilkens KW. Septic arthritis of the knee in adults: treatment by arthroscopy or arthrotomy. Int Orthop. 2001;25:239–241.

[7] Johns BP, Loewenthal MR, Dewar DC. Open compared with arthroscopic treatment of acute septic arthritis of the native knee. J Bone Joint Surg Am. 2017;99:499–505. doi:10.2106/JBJS.16.00110.

[8] Bovonratwet P, Nelson SJ, Bellamkonda K, Ondeck NT, Shultz BN, Medvecky MJ, et al. Similar 30-day complications for septic knee arthritis treated with arthrotomy or arthroscopy: an American College of Surgeons national surgical quality improvement program analysis. Arthroscopy. 2018;34:213–219. doi:10.1016/j.arthro.2017.06.046.

[9] Agout C, Lakhal W, Fournier J, de Bodman C, Bonnard C. Arthroscopic treatment of septic arthritis of the knee in children. Orthop Traumatol Surg Res. 2015;101:S333–S336. doi:10.1016/j.otsr.2015.09.007.

[10] Sanchez AA, Hennrikus WL. Arthroscopically assisted treatment of acute septic knees in infants using the Micro-Joint Arthroscope. Arthroscopy. 1997;13:350–354.

[11] Ohl MD, Kean JR, Steensen RN. Arthroscopic treatment of septic arthritic knees in children and adolescents. Orthop Rev. 1991;20:894–896.

[12] Stanitski CL, Harvell JC, Fu FH. Arthroscopy in acute septic knees. Management in pediatric patients. Clin Orthop Relat Res. 1989:209–212.

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QUESTION 2: What type of lavage solution should be used in patients with a native knee infection being treated with arthroscopy?

RECOMMENDATION: We recommend that high volumes of saline without antibiotics should be used as the arthroscopic lavage solution for native knee infection.

LEVEL OF EVIDENCE: Limited

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

RATIONALE

Infection of the native knee can be treated surgically by open or arthroscopic methods [1–3]. Arthroscopic lavage techniques have been used widely, since the introduction of arthroscopic debridement offers the benefits of smaller incisions, decreased tissue damage and lower reinfection rates compared to open methods [1–3]. Arthroscopic treatment yields good to excellent results, though there are a limited number of comparative studies in the literature (many with small sample sizes) [1–10]. Irrigation aids in the removal of debris and decreases the intra-articular concentration of chondrolytic enzymes better than needle aspiration alone [11,12].

There is a general consensus in the literature supporting high-volume (10 to 15 L) arthroscopic lavage with saline combined with intravenous antibiotics both in pediatric and adult patients for septic arthritis [1,3,9,10,13–25]. Based on microbiological findings, lavage plus intravenous antibiotics appears sufficient to eradicate *Staphylococcus aureus*, the most common cause of septic arthritis of the native knee [7]. Two studies with larger patient numbers support saline irrigation without intra-articular antibiotics as the lavage solution of choice [2,7]. A large number of other studies described using saline lavage solution for arthroscopic treatment of knee sepsis, with an average volume of 10.1 L [6,9,17,18,20,22,26–30]. Shinjo et al. compared the effects of two common arthroscopic irrigation solutions on meniscus tissue cells, and demonstrated that Ringer's lactate solution better maintained human meniscus cell integrity than the isotonic saline [31].

Additionally, there is a lack of agreement on the use of intra-articular antibiotics despite their frequent use during arthroscopic treatment of infected native knees in clinical practice without recommendation, thus warranting further investigation [32,33]. While some are proponents of intra-articular antibiotics, others are concerned about resultant chemical synovitis and potential chondral toxicity, not mentioning the risk of increasing antibiotic resistance [5,34,35]. Only one study by McAllister et al. specifically described using an antibiotic-loaded Ringer's lactate solution during arthroscopic treatment of four postoperative septic knees following anterior cruciate ligament reconstruction. The antibiotic name was not mentioned, but they reported a 100% eradication rate for infection [17]. The use of continuous irrigation-suction drains with antibiotics added to the irrigation solution has been both supported and refuted in the literature [4,5,34,36–38]. Some studies support the use of continuous suction irrigation drains with saline, whereas others caution against their use due to concerns of secondary infection [2,4–7,13,14,14,14,34,36,39].

In conclusion, other than saline, there is limited data to support the use of other arthroscopic lavage fluids for treatment of native knee infections and further comparative clinical studies are needed.

REFERENCES

[1] Travers V, Norotte G, Roger B, Apoil A. [Treatment of acute pyogenic arthritis of large joints of the limbs. Apropos of 79 cases]. Rev Rhum Mal Osteoartic. 1988;55:655–660.

[2] Stutz G, Kuster MS, Kleinstück F, Gächter A. Arthroscopic management of septic arthritis: stages of infection and results. Knee Surg Sports Traumatol Arthrosc. 2000;8:270–274. doi:10.1007/s001670000129.

[3] Johns BP, Loewenthal MR, Dewar DC. Open compared with arthroscopic treatment of acute septic arthritis of the native knee. J Bone Joint Surg Am. 2017;99:499–505. doi:10.2106/JBJS.16.00110.

[4] Jackson RW, Parsons CJ. Distension-irrigation treatment of major joint sepsis. Clin Orthop Relat Res. 1973:160–164.

[5] Gainor BJ. Instillation of continuous tube irrigation in the septic knee at arthroscopy. A technique. Clin Orthop Relat Res. 1984:96–98.
[6] Shukla A, Beniwal SK, Sinha S. Outcome of arthroscopic drainage and debridement with continuous suction irrigation technique in acute septic arthritis. J Clin Orthop Trauma. 2014;5:1–5. doi:10.1016/j.jcot.2014.01.004.
[7] Aïm F, Delambre J, Bauer T, Hardy P. Efficacy of arthroscopic treatment for resolving infection in septic arthritis of native joints. Orthop Traumatol Surg Res. 2015;101:61–64. doi:10.1016/j.otsr.2014.11.010.
[8] Wirtz DC, Marth M, Miltner O, Schneider U, Zilkens KW. Septic arthritis of the knee in adults: treatment by arthroscopy or arthrotomy. Int Orthop. 2001;25:239–241.
[9] Indelli PF, Dillingham M, Fanton G, Schurman DJ. Septic arthritis in postoperative anterior cruciate ligament reconstruction. Clin Orthop Relat Res. 2002:182–188.
[10] Wang C, Ao Y, Wang J, Hu Y, Cui G, Yu J. Septic arthritis after arthroscopic anterior cruciate ligament reconstruction: a retrospective analysis of incidence, presentation, treatment, and cause. Arthroscopy. 2009;25:243–249. doi:10.1016/j.arthro.2008.10.002.
[11] Lane JG, Falahee MH, Wojtys EM, Hankin FM, Kaufer H. Pyarthrosis of the knee. Treatment considerations. Clin Orthop Relat Res. 1990:198–204.
[12] Sharff KA, Richards EP, Townes JM. Clinical management of septic arthritis. Curr Rheumatol Rep. 2013;15:332. doi:10.1007/s11926-013-0332-4.
[13] Schollin-Borg M, Michaëlsson K, Rahme H. Presentation, outcome, and cause of septic arthritis after anterior cruciate ligament reconstruction: a case control study. Arthroscopy. 2003;19:941–947.
[14] Monaco E, Maestri B, Labianca L, Speranza A, Vadalà A, Iorio R, et al. Clinical and radiological outcomes of postoperative septic arthritis after anterior cruciate ligament reconstruction. J Orthop Sci. 2010;15:198–203. doi:10.1007/s00776-009-1447-3.
[15] Reagan F, McInerny K, Treadwell V, Zarins J, Mankin J. Irrigating solutions for arthroscopy. A metabolic study. J Bone Joint Surg. 1983;65:629–631. doi:10.2106/00004623-198365050-00007.
[16] Burks RT, Friederichs MG, Fink B, Luker MG, West HS, Greis PE. Treatment of postoperative anterior cruciate ligament infections with graft removal and early reimplantation. Am J Sports Med. 2003;31:414–418. doi:10.1177/03635465030310031501.
[17] McAllister DR, Parker RD, Cooper AE, Recht MP, Abate J. Outcomes of postoperative septic arthritis after anterior cruciate ligament reconstruction. Am J Sports Med. 1999;27:562–570. doi:10.1177/03635465990270050301.
[18] Judd D, Bottoni C, Kim D, Burke M, Hooker S. Infections following arthroscopic anterior cruciate ligament reconstruction. Arthroscopy. 2006;22:375–384. doi:10.1016/j.arthro.2005.12.002.
[19] Williams RJ, Laurencin CT, Warren RF, Speciale AC, Brause BD, O'Brien S. Septic arthritis after arthroscopic anterior cruciate ligament reconstruction. Diagnosis and management. Am J Sports Med. 1997;25:261–267. doi:10.1177/036354659702500222.
[20] Abdel-Aziz A, Radwan YA, Rizk A. Multiple arthroscopic debridement and graft retention in septic knee arthritis after ACL reconstruction: a prospective case-control study. Int Orthop. 2014;38:73–82. doi:10.1007/s00264-013-2123-y.
[21] Barker JU, Drakos MC, Maak TG, Warren RF, Williams RJ, Allen AA. Effect of graft selection on the incidence of postoperative infection in anterior cruciate ligament reconstruction. Am J Sports Med. 2010;38:281–286. doi:10.1177/0363546509346414.
[22] Fong SY, Tan JL. Septic arthritis after arthroscopic anterior cruciate ligament reconstruction. Ann Acad Med Singap. 2004;33:228–234.
[23] Zalavras CG, Patzakis MJ, Tibone J, Weisman N, Holtom P. Treatment of persistent infection after anterior cruciate ligament surgery. Clin Orthop Relat Res. 2005;439:52–55.
[24] Stanitski S, Stanitski CL. Arthroscopy in acute septic knees. Management in pediatric patients. Clin Orthop Relat Res. 198904:209–212.
[25] Agout C, Lakhal W, Fournier J, de Bodman C, Bonnard C. Arthroscopic treatment of septic arthritis of the knee in children. Orthop Traumatol Surg Res. 2015;101:S333–S336. doi:10.1016/j.otsr.2015.09.007.
[26] Kim HJ, Lee HJ, Lee JC, Min SG, Kyung HS. Evaluation of infection after anterior cruciate ligament reconstruction during a short period. Knee Surg Relat Res. 2017;29:45–51. doi:10.5792/ksrr.16.019.
[27] Schuster P, Schulz M, Immendoerfer M, Mayer P, Schlumberger M, Richter J. Septic arthritis after arthroscopic anterior cruciate ligament reconstruction: evaluation of an arthroscopic graft-retaining treatment protocol. Am J Sports Med. 2015;43:3005–3012. doi:10.1177/0363546515603054.
[28] Torres-Claramunt R, Pelfort X, Erquicia J, Gil-González S, Gelber PE, Puig L, et al. Knee joint infection after ACL reconstruction: prevalence, management and functional outcomes. Knee Surg Sports Traumatol Arthrosc. 2013;21:2844–2849. doi:10.1007/s00167-012-2264-3.
[29] Van Tongel A, Stuyck J, Bellemans J, Vandenneucker H. Septic arthritis after arthroscopic anterior cruciate ligament reconstruction: a retrospective analysis of incidence, management and outcome. Am J Sports Med. 2007;35:1059–1063. doi:10.1177/0363546507299443.
[30] Kuo CL, Chang JH, Wu CC, Shen PH, Wang CC, Lin LC, et al. Treatment of septic knee arthritis: comparison of arthroscopic debridement alone or combined with continuous closed irrigation-suction system. J Trauma. 2011;71:454–459. doi:10.1097/TA.0b013e3181ec4734.
[31] Shinjo H, Nakata K, Shino K, Hamada M, Nakamura N, Mae T, et al. Effect of irrigation solutions for arthroscopic surgery on intraarticular tissue: comparison in human meniscus-derived primary cell culture between lactate Ringer's solution and saline solution. J Orthop Res. 2002;20:1305–1310. doi:10.1016/S0736-0266(02)00062-1.
[32] Kruckenhauser EM, Nogler M, Coraça-Huber D. Use of lavage fluids in arthroplasty to prevent postoperative infections. Drug Res (Stuttg). 2014;64:166–168. doi:10.1055/s-0033-1354367.
[33] Tejwani N, Immerman I. Myths and legends in orthopaedic practice: are we all guilty? Clin Orthop Relat Res. 2008;466:2861–2872. doi:10.1007/s11999-008-0458-2.
[34] Parisien JS, Shaffer B. Arthroscopic management of pyarthrosis. Clin Orthop Relat Res. 1992:243–247.
[35] Argen RJ, Wilson CH, Wood P. Suppurative arthritis: clinical features of 42 cases. Arch Intern Med. 1966;117:661–666. doi:10.1001/archinte.1966.03870110053011.
[36] Jackson RW. The septic knee--arthroscopic treatment. Arthroscopy. 1985;1:194–197.
[37] Ivey M, Clark R. Arthroscopic debridement of the knee for septic arthritis. Clin Orthop Relat Res. 1985:201–206.
[38] Smith MJ. Arthroscopic treatment of the septic knee. Arthroscopy. 1986;2:30–34.
[39] Tsumura H, Ikeda S, Torisu T. Debridement and continuous irrigation for the treatment of pyogenic arthritis caused by the use of intra-articular injection in the osteoarthritic knee: indications and outcomes. J Orthop Surg (Hong Kong). 2005;13:52–57. doi:10.1177/230949900501300109.

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QUESTION 3: Should a synovectomy routinely be performed during arthroscopic treatment of an acute infection following anterior cruciate ligament reconstruction (ACLR)?

RECOMMENDATION: No. Total or partial synovectomy should be reserved for cases of severe or chronic infection.

LEVEL OF EVIDENCE: Limited

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

RATIONALE

According to Gaechter and the proposed classification, the synovial membrane serves as a natural barrier in infection [1,2]. As a result, a primary synovectomy should be avoided in acute infections except for later stages [1,2]. The four stages of joint infection described by Gaechter were:

Stage I: Synovitis, turbid fluid, possible petechiae

Stage II: Fibrin clots, franc pus

Stage III: Thickening of the synovial membrane (up to several centimeters), multiple pouches due to adhesions

Stage IV: Pannus. Aggressive synovitis, radiographically visible changes, subchondral erosions