orthopedic institution. ResearchGate 2016. https://www.researchgate.net/publication/304744960_Surgical_Site_Infections_in_Treatment_of_Musculoskeletal_Tumors_Experience_from_a_Single_Oncologic_Orthopedic_Institution (accessed July 18, 2018).
[5] Patel VP, Walsh M, Sehgal B, Preston C, DeWal H, Di Cesare PE. Factors associated with prolonged wound drainage after primary total hip and knee arthroplasty. J Bone Joint Surg Am. 2007;89:33–38. doi:10.2106/JBJS.F.00163.
[6] Chandratreya A, Giannikas K, Livesley P. To drain or not drain: literature versus practice. J R Coll Surg Edinb. 1998;43:404–406.
[7] Ong KL, Kurtz SM, Lau E, Bozic KJ, Berry DJ, Parvizi J. Prosthetic joint infection risk after total hip arthroplasty in the Medicare population. J Arthroplasty. 2009;24:105–109. doi:10.1016/j.arth.2009.04.027.
[8] Kurtz SM, Ong KL, Lau E, Bozic KJ, Berry D, Parvizi J. Prosthetic joint infection risk after TKA in the Medicare population. Clin Orthop Relat Res. 2010;468:52–56. doi:10.1007/s11999-009-1013-5.
[9] Grimer RJ, Aydin BK, Wafa H, Carter SR, Jeys L, Abudu A, et al. Very long-term outcomes after endoprosthetic replacement for malignant tumours of bone. Bone Joint J. 2016;98-B:857–864. doi:10.1302/0301-620X.98B6.37417.
[10] Jeys L, Grimer R. The long-term risks of infection and amputation with limb salvage surgery using endoprostheses. Recent Results Cancer Res. 2009;179:75–84.
[11] Parker MJ, Roberts CP, Hay D. Closed suction drainage for hip and knee arthroplasty. A meta-analysis. J Bone Joint Surg Am. 2004;86-A:1146–1152.
[12] Hsu JR, Stinner DJ, Rosenzweig SD, Salinas J, Dickson KF. Is there a benefit to drains with a Kocher-Langenbeck approach? A prospective randomized pilot study. J Trauma. 2010;69:1222–1225. doi:10.1097/TA.0b013e3181bc78cb.
[13] Walmsley PJ, Kelly MB, Hill RMF, Brenkel I. A prospective, randomised, controlled trial of the use of drains in total hip arthroplasty. J Bone Joint Surg Br. 2005;87:1397–1401. doi:10.1302/0301-620X.87B10.16221.
[14] Reiffel AJ, Barie PS, Spector JA. A multi-disciplinary review of the potential association between closed-suction drains and surgical site infection. Surg Infect (Larchmt). 2013;14:244–269. doi:10.1089/sur.2011.126.
[15] Tan MH, Mankin HJ. Blood transfusion and bone allografts. Effect on infection and outcome. Clin Orthop Relat Res. 1997:207–214.
[16] Pulido L, Ghanem E, Joshi A, Purtill JJ, Parvizi J. Periprosthetic joint infection: the incidence, timing, and predisposing factors. Clin Orthop Relat Res. 2008;466:1710–1715. doi:10.1007/s11999-008-0209-4.
[17] Sankar B, Ray P, Rai J. Suction drain tip culture in orthopaedic surgery: a prospective study of 214 clean operations. Int Orthop. 2004;28:311–314. doi:10.1007/s00264-004-0561-2.
[18] Drinkwater CJ, Neil MJ. Optimal timing of wound drain removal following total joint arthroplasty. J Arthroplasty. 1995;10:185–189.
[19] Willett KM, Simmons CD, Bentley G. The effect of suction drains after total hip replacement. J Bone Joint Surg Br. 1988;70:607–610.
[20] Bratzler DW, Dellinger EP, Olsen KM, Perl TM, Auwaerter PG, Bolon MK, et al. Clinical practice guidelines for antimicrobial prophylaxis in surgery. Surg Infect (Larchmt). 2013;14:73–156. doi:10.1089/sur.2013.9999.
[21] Bratzler DW, Houck PM, Richards C, Steele L, Dellinger EP, Fry DE, et al. Use of antimicrobial prophylaxis for major surgery: baseline results from the National Surgical Infection Prevention Project. Arch Surg. 2005;140:174–182. doi:10.1001/archsurg.140.2.174.

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QUESTION 3: Does the type of fixation (cemented vs. uncemented) of an oncologic endoprosthesis influence the incidence of subsequent surgical site infection/periprosthetic joint infection (SSI/PJI)?

RECOMMENDATION: There is conflicting evidence surrounding this topic. Multiple studies have demonstrated superiority with cemented fixation of an oncologic endoprosthesis while others have suggested superiority with uncemented fixation. Therefore, the choice of the method of fixation should be made on the basis of all clinical indications, other than the influence of fixation on subsequent SSI/PJI.

LEVEL OF EVIDENCE: Limited

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

RATIONALE

Limb salvage surgery has become the treatment of choice for musculoskeletal cancers due to advances within the field of orthopaedic oncology. The use of an oncologic endoprosthesis has become the procedure of choice in limb salvage surgery. Though there are many benefits in utilizing an endoprosthesis, the development of subsequent infection is one of the most common and feared complications.

Multiple studies have been conducted to examine the risk of postoperative infection associated with the type of fixation (cemented vs. uncemented). Moreover, the approval and universal use of antibiotic-impregnated cement has altered the landscape as it relates to the risk and type of infection.

A systemic review of 40 studies examining distal femoral replacement (DFR) cases and proximal tibial replacement (PTR) cases showed mixed results. One hundred and nine (5.8%) of 1,894 cemented DFR cases became infected while 65 (9.0%) of 721 uncemented DFR cases became infected. This difference was found to be statistically significant [1]. For cemented DFR replacements, linear regression analysis showed that the risk of infection increased over time ($p < 0.001$), but the risk for infection in uncemented DFR implants did not increase over time. The same systemic review showed that 109 (15.2%) of 716 cemented PTR cases became infected while 56 (14.1%) of 396 uncemented PTR cases became infected; this difference was not found to be statistically significant. The incidence of infection in PTR cases did not increase over time, regardless of the fixation method [1].

Pala et al. [2] reported that 20 (9.1%) of 220 endoprostheses originally implanted in patients with either a lower extremity primary bone tumor or metastatic disease became infected. Of these 20 cases, 12 (10.3%) were cemented and eight (7.7%) were uncemented. In addition, survival of cemented endoprostheses to infection was 68% at 60 months, while survival of the uncemented endoprostheses was 82% at 60 months [2]. Finally, in both univariate and multivariate analyses, the only variable that was found to be a predictor of survival was uncemented fixation [2].

The infection rates of endoprostheses vary widely in the literature. Studies investigating the infection rate after cemented fixation of an endoprosthetic device yielded an infection rate ranging from 5.2% to 21.9% [3–7]; studies investigating the infection rate after uncemented fixation yielded rates ranging from 9.7% to 12% [8–10]. A condition of equipoise exists resulting from the conflicting data supporting cemented or uncemented fixation and the incidence of subsequent SSI/PJI.

REFERENCES

[1] Haijie L, Dasen L, Tao J, Yi Y, Xiaodong T, Wei G. Implant survival and complication profiles of endoprostheses for treating tumor around the knee in

adults: a systematic review of the literature over the past 30 years. J Arthroplasty. 2018;33:1275-1287.e3. doi:10.1016/j.arth.2017.10.051.
[2] Pala E, Mavrogenis AF, Angelini A, Henderson ER, Douglas Letson G, Ruggieri P. Cemented versus cementless endoprostheses for lower limb salvage surgery. J BUON. 2013;18:496–503.
[3] Ahlmann ER, Menendez LR, Kermani C, Gotha H. Survivorship and clinical outcome of modular endoprosthetic reconstruction for neoplastic disease of the lower limb. J Bone Joint Surg Br. 2006;88:790–795. doi:10.1302/0301-620X.88B6.17519.
[4] Bickels J, Wittig JC, Kollender Y, Henshaw RM, Kellar-Graney KL, Meller I, et al. Distal femur resection with endoprosthetic reconstruction: a long-term followup study. Clin Orthop Relat Res. 2002:225–235.
[5] Zeegen EN, Aponte-Tinao LA, Hornicek FJ, Gebhardt MC, Mankin HJ. Survivorship analysis of 141 modular metallic endoprostheses at early followup. Clin Orthop Relat Res. 2004:239–250.
[6] Sharma S, Turcotte RE, Isler MH, Wong C. Experience with cemented large segment endoprostheses for tumors. Clin Orthop Relat Res. 2007;459:54–59. doi:10.1097/BLO.0b013e3180514c8e.
[7] Unwin PS, Cannon SR, Grimer RJ, Kemp HB, Sneath RS, Walker PS. Aseptic loosening in cemented custom-made prosthetic replacements for bone tumours of the lower limb. J Bone Joint Surg Br. 1996;78:5–13.
[8] Gosheger G, Gebert C, Ahrens H, Streitbuerger A, Winkelmann W, Hardes J. Endoprosthetic reconstruction in 250 patients with sarcoma. Clin Orthop Relat Res. 2006;450:164–171. doi:10.1097/01.blo.0000223978.36831.39.
[9] Mittermayer F, Krepler P, Dominkus M, Schwameis E, Sluga M, Heinzl H, et al. Long-term followup of uncemented tumor endoprostheses for the lower extremity. Clin Orthop Relat Res. 2001:167–177.
[10] Griffin AM, Parsons JA, Davis AM, Bell RS, Wunder JS. Uncemented tumor endoprostheses at the knee: root causes of failure. Clin Orthop Relat Res. 2005;438:71–79.

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QUESTION 4: Does the use of incise draping with antibacterial agents (iodine) influence the risk for subsequent surgical site infection/periprosthetic joint infection (SSI/PJI) in patients undergoing musculoskeletal tumor surgeries?

RECOMMENDATION: There is some evidence claiming that antimicrobial-impregnated incise drapes result in a reduction in bacterial contamination at the surgical site. However, there is little evidence to demonstrate that it results in a subsequent reduction in the incidence of SSI and/or PJI.

LEVEL OF EVIDENCE: Limited

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

RATIONALE

Surgical incise drapes are often used by surgeons to reduce bacterial recolonization of the surgical site with host flora that may potentially predispose the patient to subsequent infection. Furthermore, it is important to differentiate antimicrobial-impregnated drapes from non-impregnated drapes as the addition of an antimicrobial agent, such as iodophor, may have a different effect on the rate of recolonization. The rationale behind the antimicrobial drape is that the incise drape can act as a physical barrier to block bacterial proliferation on the skin and potential entry into the surgical wound.

Multiple studies have demonstrated that incise drapes can result in a reduction in bacterial recolonization. In a prospective randomized controlled trial of 101 hips undergoing hip preservation surgery, Rezapoor et al. found that iodine-impregnated drapes resulted in a significant reduction (12.0% vs. 27.4%) in bacterial colonization compared to those without drapes [1]. Furthermore, Milandt et al. reported that the use of iodine-containing incision drapes did not increase bacterial recolonization in simulated total knee arthroplasty [2]. Dewan et al. reported that the use of an iodophor-impregnated plastic incise drape in abdominal surgery reduced the contamination of the wound [3]. Casey et al. evaluated the antimicrobial efficacy of an iodine-impregnated incise drape against methicillin-resistant *S. aureus* (MRSA) in a skin model and concluded that it had detectable antimicrobial activity [4].

While there is evidence to suggest that impregnated incise drapes result in a reduction of bacterial colonization, there is conflicting evidence demonstrating that impregnated incise drapes result in a significant decrease in the infection rate. Ritter et al. demonstrated a considerably low rate of SSI incidence (0.46%) in total arthroplasties performed with an antimicrobial incise drape [5]. In addition, Yoshimura et al. found that the lack of an iodophor-impregnated drape was a significant risk factor for wound infection after liver resection [6]. In contrast, a randomized study by Dewan et al. suggested that iodine-impregnated drapes did not result in a significant reduction in SSI rate in abdominal and cardiac surgery [3]. Furthermore, a randomized study by Segal and Anderson showed only a tendential reduction in the rate of SSIs by iodophor-impregnated adhesive drapes in high risk cardiac surgery [7]. Additionally, no SSIs were observed in a retrospective review of 581 patients undergoing anterior cervical fusions without iodophor-impregnated incision drapes. It was concluded that the use of iodophor-impregnated incision drapes during anterior cervical fusion was not needed [8].

In a Cochrane review of 3,082 patients, Webster et al. found that a higher proportion of patients developed surgical site infection with plastic drapes than patients in whom no drapes were used ($p = 0.03$) [9]. However, no difference was found when iodophor-impregnated drapes were used (rate ratio (RR) 1.03, 95% confidence interval (CI) 0.06 to 1.66, $p = 0.89$), which further highlights the importance of discriminating between antimicrobial and regular plastic incise drapes. In the World Health Organization guideline [10], four of the above-mentioned studies (one randomized-controlled trial (RCT) [7], one quasi-RCT [11] and two observational studies [6,12]) were identified that assessed the effect of using single-use adhesive incise drapes to reduce SSI. They commented that the two RCTs showed the use of antimicrobial-impregnated incise drapes may have some adverse effect, but the effect estimate was not statistically different from the control group. Furthermore, they noted that the observational studies reported that there may be a benefit in using antimicrobial-impregnated incise drapes, but the effect was not statistically different from the control group. They concluded that the quality of evidence for these comparisons was very low for both the randomized control trials and the observational studies due to the risk of bias and imprecision or inconsistency.