

## Brief communication

# Avoiding Sepsis After Total Knee Arthroplasty: Be Gentle, Vigilant, and Proactive

Richard D. Scott, MD\*

Professor of Orthopaedic Surgery, Emeritus, Harvard Medical School, Boston, MA, USA

## ARTICLE INFO

## Article history:

Received 30 January 2022

Accepted 16 February 2022

Sepsis occurring after total knee arthroplasty (TKA) is a disastrous complication [1,2]. I was fortunate in my career that, to my knowledge, after more than 6000 consecutive primary TKAs, none of my patients had experienced an early deep operative infection within a year following surgery. I did see late “metastatic” infection to primary TKAs at a rate of 0.6% on an average follow-up period of 10 years [3]. As I observe the orthopedic literature fill up with publications that search for methods to decrease the incidence of early operative infection after TKA [4–8], I am motivated to share my experience.

### Perioperative prophylactic measures

It is obviously preferable to prevent an infection than to have to treat one. Prophylactic measures can be taken before, during, and after surgery to minimize the chance for infection.

All patients should be screened preoperatively for potential sites of active infection that could spread to the knee. Staphylococcus skin colonization screening has been recommended [9]. Other potential sites are oropharyngeal and urologic. Any patient with a chronic infection such as sinusitis or pharyngitis should be cleared by an otolaryngologist before surgery. My hospitals used routine preoperative nasal swabs to look for methicillin resistant Staphylococcus aureus [10]. Patients with positive cultures were treated preoperatively with mupirocin (Bactroban, GlaxoSmithKline, Brentford, United Kingdom).

Similarly, patients with chronic dental infection in need of reconstructive procedures should have these performed before the arthroplasty [11].

It is not unusual to encounter a female patient with a history of recurrent urinary tract infection. Many used to advocate that a urinalysis and urine culture should be obtained preoperatively on all patients. Most surgeons now feel that this is not necessary in asymptomatic patients [12].

Any active urinary tract infection should be treated, however, and chronic problems should be cleared by a urologist. If a preoperative urine culture is positive, but few white cells are present in the sediment and the patient is totally asymptomatic, it was my opinion that the surgery need not be canceled. A repeat clean-catch or catheterized specimen could be helpful to clarify whether contamination led to the positive culture and whether antibiotic treatment was necessary.

Male patients with a history of symptomatic benign prostatic hypertrophy have been shown to be at increased risk for post-operative infection and should be properly evaluated and treated prior to their knee arthroplasty [13].

Rheumatoid patients whose arthritis was being managed by immunosuppressive disease-modifying agents had these drugs discontinued perioperatively with the timing dictated by their rheumatologist [14].

### Preoperative germicidal skin scrub

All my patients were instructed to use a chlorhexidine germicidal skin scrub (eg, Hibiclens) twice daily for 2 days before their surgery. In theory, this should decrease the colonization of bacteria on the patient's skin and the chance for contamination [9].

### Surgical preparation and draping

It was my practice to prepare the entire extremity, including the foot, for TKA. The foot was draped out of the surgical field, but I was

\* Corresponding author. 10 Nickerson Rd, Dedham, MA 02026, USA. Tel.: +1 617 966 6056.

E-mail address: [rdscottmd@gmail.com](mailto:rdscottmd@gmail.com).

more comfortable with this area being surgically prepared in the event of any breakdown in the drapes that cover the foot. I used a surgical stockinette over the prepared foot up to the level of the tourniquet. The stockinette had a double layer. The outer layer was cut, and the incision was defined with a marking pen. The inner stockinette was then cut and reflected medially and laterally for a few centimeters. The skin incision was drawn out, and then the entire field was sealed with a povidone-iodine–impregnated adhesive drape [15]. Care was taken to not actually touch the skin during this draping procedure, and fresh outer gloves were applied after it was completed.

### Laminar air flow vs ultraviolet lights

I was often asked by fellows or residents whether it was better to have laminar airflow or ultraviolet (UV) light in the operating theater to help minimize the chance of infection. During my 40 years of practice at two hospitals, I used one of these methods. Each has advantages, and both have been shown to be effective deterrents [16,17]. The UV light method is less expensive and requires all operating room personnel to cover up to shield their eyes and skin. This may decrease the potential for the shedding of bacteria by personnel. The fact that UV lights are potentially “sterilizing” the field during the procedure is reassuring when performing sequential bilateral TKAs [18]. In the absence of UV lights, I sequestered the instruments that were used on the first knee during the skin closure and passed them off the operating field after they had been used. A change of outer gloves was also performed between the procedures.

### Intravenous antibiotics

Intravenous antibiotics have long been shown to decrease the incidence of perioperative orthopedic wound infection [19,20]. I commonly used a second-generation cephalosporin, 1 g intravenously at least 10 minutes before inflation of a tourniquet. A second 1 g was administered at the time the tourniquet was deflated to maximize the concentration of antibiotic in the evolving wound hematoma. The antibiotics were continued every 8 hours for 3 additional doses. In patients allergic to penicillin, I still administered the cephalosporin, unless the allergy had been one of anaphylaxis. A test dose was given with caution and under the surveillance of an anesthesiologist. If the test dose was well tolerated, the standard protocol was used. Although there is a potential crossover in sensitivity between penicillin and cephalosporins in terms of allergy, in hundreds of cases over 2 decades of using this protocol, I never saw this crossover. Passing this test dose also clears a penicillin-sensitive patient to receive a cephalosporin for any needed treatment in the future should that be appropriate.

### Proper skin incision

A tourniquet was always in place, but in recent years, I inflated it only for initial exposure and again for cementing the components (unless unusual bleeding was encountered during the procedure). By making the skin incision with the knee flexed, bleeding was minimized, and any vessels encountered could be easily coagulated. Many surgeons use “cutting” electrocautery for dissection and exposure. I refrained from this most of the time to avoid leaving avascular cauterized dead tissue behind as a nidus for infection.

Prior skin incisions around the knee must be respected [21]. The knee does not tolerate multiple parallel incisions, especially a medial incision made parallel to an old lateral incision. If skin breakdown were to occur, infection is more likely. My standard incision was approximately 15 cm long. It began 5 cm above the

patella centered over the shaft of the femur, crossed the medial third of the patella, and ended distally at the medial aspect of the tibial tubercle. In general, when prior incisions are present, it is best to use the most lateral incision that allows the arthrotomy planned or the most recent incision that healed without difficulty [21]. Medially based flaps are safer than laterally based flaps. In questionable cases, if the skin incision is made with the tourniquet deflated and the wound edges appear poorly vascularized, the surgery can be aborted and plastic surgical consultation obtained. I used tissue expanders successfully on several occasions in the presence of extremely thin or adherent skin after trauma, a skin graft, or an old healed sinus tract.

### Intraoperative wound care

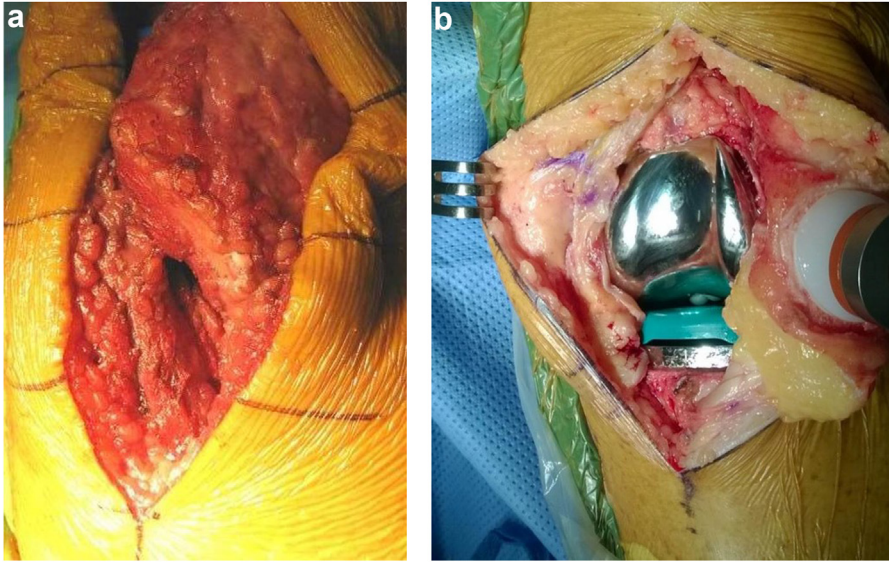
After the skin incision and arthrotomy, I always sewed in wound towels along the capsule that protected the subcutaneous tissue from debris and from drying out under the operating room lights. Wound protective methods have been shown to decrease the incidence of infection in other surgical specialties [22]. The towels and the arthrotomy were irrigated frequently with normal saline solution. When the wound towels were removed at the end of the procedure, it was always impressive to see how healthy the tissues appeared compared with the brown, desiccated appearance of the subcutaneous tissues when wound towels had not been used (Fig. 1).

Infection can possibly also be the result of skin necrosis secondary to compromise of blood supply to the skin and subcutaneous tissue. For this reason, when a lateral retinacular release was required, I always tried to preserve the lateral superior genicular artery (Fig. 2). Infection also can be the result of breakdown of the wound caused by a large hematoma. To minimize this possibility, I always deflated a tourniquet (if utilized) before wound closure to check for significant bleeding points.

During rehabilitation, if the capsular closure were to lose its integrity, a wound problem could occur. For this reason, I preferred an interrupted capsular closure with a strong monofilament suture. My preference was no. 1 polydioxanone.

The use of suction drains after TKA is controversial [23,24]. Fewer surgeons are using drains than in prior years, but they should still be considered in selected cases. These drains do their most important work during the first several hours after surgery. I always discontinued their use on the morning after surgery. If for some reason the drain output was excessive, I flexed the knee for 30 minutes and clamped the drains. If excessive output continued, I considered actually removing the drains. Range-of-motion exercises should be curtailed. The wound can then be observed carefully over the next 24 hours, and, if necessary, the patient can be brought back to the operating room to control any bleeding. In my experience, this was never necessary.

The skin closure is one of the most important parts of TKA. It must be meticulously performed with the skin edges accurately opposed. I preferred a modified Allgower-Donati suture [25] (Fig. 3). This is a vertical mattress suture that is subcuticular on the lateral side (the side more prone to skin necrosis). I preferred an interrupted closure over a running subcuticular stitch because the length of a knee incision increases as much as 40% from extension to flexion. This movement puts a repetitive strain on the subcuticular suture. An interrupted closure also allows the removal of a few localized stitches to deal with a superficial wound separation or infection. Many surgeons, however, utilize a subcuticular closure augmented by surgical glue. They also often leave wounds covered with an impervious antiseptic dressing for up to 10 days [26]. I personally preferred my patients to undergo an initial dressing on the second postoperative day to check for wound integrity and



**Figure 1.** (A) If unprotected by moist wound towels, the subcutaneous tissues dry out during surgery. (B) Moist wound towels keep the tissue from desiccating and make them more resistant to infection.

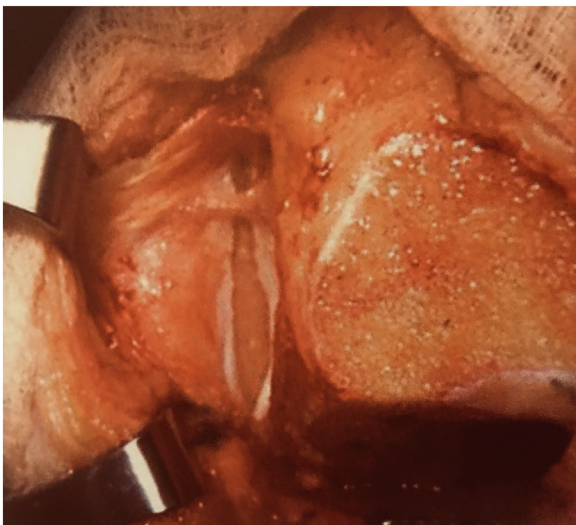
drainage, even minor. (With patients today sometimes being discharged on the day of surgery or on postoperative day one, this dressing change would have to occur as an outpatient or at home by a visiting nurse. A digital photograph of any wound concern could be sent to the operating surgeon.)

I believe that any perioperative wound problems should be dealt with aggressively to prevent the chance for secondary infection. If wound drainage persisted after 48 hours, my preference was to perform a sterile preparation on the area and apply benzoin and adhesive skin closure strips (Steri-Strips, 3M, Maplewood, MN) to reseal the wound. If the problem failed to resolve, I would take the patient back to the operating room for treatment using the following protocol: The knee joint would be separately aspirated for cell count and culture. Antibiotics (hopefully prophylactic rather than therapeutic) would be initiated after the culture had been obtained. The few interrupted sutures in the local area would be

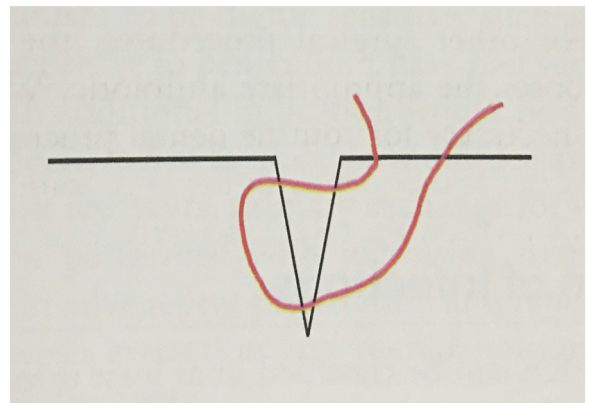
removed, the wound irrigated, and minor debridement performed. The wound would then be reclosed with interrupted vertical mattress sutures. Prophylactic antibiotics would be continued for several days until the wound appeared totally sealed and benign. If the joint aspiration returns positive with a high cell count or positive culture, major debridement and lavage of the knee joint would be necessary.

**Skin necrosis**

If skin necrosis were to occur, my goal was to keep the problem superficial [21]. To allow the capsular closure to seal, all flexion exercises were stopped, and the knee was protected in a knee immobilizer. The size of the necrosis was assessed, along with the extent of any drainage. At least five treatment options existed for me. The most common was to allow the skin beneath the eschar representing the necrosis to granulate in. This was appropriate if the wound remained dry and the necrotic area was only a few millimeters in width. If the patient had pliable skin, the second option was to excise the area of necrosis and perform a primary closure. A third option was to excise the area and perform a split-



**Figure 2.** When performing a lateral retinacular release, the lateral superior genicular vessels should be preserved whenever possible for their blood supply to the patella and the overlying skin flap.



**Figure 3.** A modified Allgower-Donati interrupted suture protects the lateral skin flap from necrosis.



thickness skin graft. Fortunately, I never encountered this need. If ever necessary, however, this would most likely be a late procedure, taking place after the deep tissues were well healed. If the necrotic area was very large and the wound had broken down with capsular dehiscence, the fourth option, a gastrocnemius flap, would likely be necessary. A fifth option, a patellectomy, can be considered in a rare situation. I encountered this once in my career. The patient had undergone an extensive lateral release associated with a medial arthrotomy. I was concerned that the patella itself might have been avascular. A technetium bone scan was performed and showed no activity whatsoever in the patella [27]. In this case, a patellectomy was performed as a way to gain enough skin and capsular tissue for a primary closure after excision of the area of skin necrosis.

## Summary

Infection associated with TKA is a devastating complication. It is crucial to prevent this complication so that treatment will be unnecessary. The incidence of early primary infection should be less than 0.5%. I was fortunate in my career that after over 6000 consecutive primary knee arthroplasties, to my knowledge, I had no patients experience an early deep infection. There were many patients who had wound complications that could have led to deep infection, but by being gentle with the soft tissues, vigilant to uncover potential healing issues, and proactive in their treatment, postoperative deep infection was avoided.

## Conflicts of interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: R. D. Scott receives royalties from Innomed, Springer and Elsevier.

## References

- [1] Koh CK, Zeng I, Ravi S, Zhu M, Vince KG, Young SW. Periprosthetic joint infection is the main cause of failure for modern knee arthroplasty: an analysis of 11,134 knees. *Clin Orthop Relat Res* 2017;475(9):2194.
- [2] Kurtz SM, Lau EC, Son MS, Chang ET, Zimmerli W, Parvizi J. Are we winning or losing the battle with periprosthetic joint infection: trends in periprosthetic joint infection and mortality risk for the medicare population. *J Arthroplasty* 2018;33(10):3238.
- [3] Cook JL, Scott RD, Long W. Late hematogenous infections after total knee arthroplasty: a single surgeon's experience after 3031 consecutive total knee arthroplasties. *J Knee Surg* 2007;20:27.
- [4] Rodriguez-Merchan EC, Liddle AD. Prevention of periprosthetic joint infection in total knee arthroplasty: main studies reported between November 2017 and January 2020. *Arch Bone Joint Surg* 2020;8(4):465.
- [5] Daines BK, Dennis DA, Amann S. Infection prevention in total knee arthroplasty. *J Am Acad Orthop Surg* 2015;23(6):356.
- [6] Kerbel YE, Kirchner GJ, Sunkerneni AR, Lieber AM, Moretti VM. The cost effectiveness of dilute betadine lavage for infection prophylaxis in total joint arthroplasty. *J Arthroplasty* 2019;34(7S):S307.
- [7] Wong MT, Sridharan SS, Davison EM, Ng R, Desy NM. Can topical vancomycin prevent periprosthetic joint infection in hip and knee arthroplasty? A systematic review. *Clin Orthop Relat Res* 2021;479(8):1655.
- [8] Buchalter DB, Kirby DJ, Teo GM, Iorio R, Aggarwal VK, Long WJ. Topical vancomycin powder and dilute povidone-iodine lavage reduce the rate of early periprosthetic joint infection after primary total knee arthroplasty. *J Arthroplasty* 2021;36(1):286.
- [9] Ribau AI, Collins JE, Chen AF, Sousa RJ. Is preoperative staphylococcus aureus screening and decolonization effective at reducing surgical site infection in patients undergoing orthopedic surgery? A systematic review and meta-analysis with a special focus on elective total joint arthroplasty. *J Arthroplasty* 2021;36(2):752.
- [10] Zhu X, Sun X, Zeng Y, et al. Can nasal staphylococcus aureus screening and decolonization prior to elective total joint arthroplasty reduce surgical site and prosthesis-related infections? A systematic review and meta-analysis. *J Orthop Surg Res* 2020;15(1):60.
- [11] Kohler JG, Holte AJ, Glass NA, Bedard NA, Brown TS. Dental screening in elective total joint arthroplasty: risk factors for failure. *J Arthroplasty* 2021;36(5):1548.
- [12] Bouvet C, Lübbecke A, Bandi C, et al. Is there any benefit in pre-operative urinary analysis before elective total joint replacement? *Bone Joint J* 2014;96-B(3):390.
- [13] Yazdi H, Restrepo C, Foltz C, et al. Symptomatic benign prostatic hyperplasia: a risk factor for periprosthetic joint infection in male patients. *J Bone Joint Surg Am* 2020;102(7):543.
- [14] Goodman SM, Springer B, Guyatt G, et al. 2017 American College of Rheumatology/American Association of Hip and Knee Surgeons guideline for the perioperative management of antirheumatic medication in patients with rheumatic diseases undergoing elective total hip or total knee arthroplasty. *Arthritis Care Res (Hoboken)* 2017;69(8):1111.
- [15] Fairclough JA, Johnson D, Mackie I. The prevention of wound contamination by skin organisms by the preoperative application of an iodophor impregnated plastic adhesive drape. *J Int Med Res* 1986;14:105.
- [16] Jutte PC, Traversari RA, Walenkamp GH. Laminar flow: the better choice in orthopaedic implants. *Lancet Infect Dis* 2017;17(7):695.
- [17] Hooper GJ, Rothwell AG, Frampton C, Wyatt MC. Does the use of laminar flow and space suits reduce early deep infection after total hip and knee replacement?: the ten-year results of the New Zealand Joint Registry. *J Bone Joint Surg Br* 2011;93(1):85.
- [18] Simmons S, Dale C, Holt J, Velasquez K, Stibich M. Role of ultraviolet disinfection in the prevention of surgical site infections. *Adv Exp Med Biol* 2017;996:255.
- [19] Siddiqi A, Forte SA, Docter S, Bryant D, Sheth NP, Chen AF. Perioperative antibiotic prophylaxis in total joint arthroplasty: a systematic review and meta-analysis. *J Bone Joint Surg Am* 2019;101(9):828.
- [20] Myers TG, Lipof JS, Chen AF, Ricciardi BF. Antibiotic stewardship for total joint arthroplasty in 2020. *J Am Acad Orthop Surg* 2020;28(18):e793.
- [21] Scott RD. Staying and getting out of trouble during total knee arthroplasty. "Total knee arthroplasty, a technique manual 3rd edition". Philadelphia, PA: Elsevier; 2020.
- [22] Edwards JP, Ho AL, Tee MC, Dixon E, Ball CG. Wound protectors reduce surgical site infection: a meta-analysis of randomized controlled trials. *Ann Surg* 2012;256(1):53.
- [23] Zhang QD, Guo WS, Zhang Q, Liu ZH, Cheng LM, Li ZR. Comparison between closed suction drainage and nondrainage in total knee arthroplasty: a meta-analysis. *J Arthroplasty* 2011;26(8):1265.
- [24] Si HB, Yang TM, Zeng Y, Shen B. No clear benefit or drawback to the use of closed drainage after primary total knee arthroplasty: a systematic review and meta-analysis. *BMC Musculoskelet Disord* 2016;17:183.
- [25] Shannon SF, Houdek MT, Wyles CC, et al. Allgower-donati versus vertical mattress suture technique impact on perfusion in ankle fracture surgery: a randomized clinical trial using intraoperative angiography. *J Orthop Trauma* 2017;31(2):97.
- [26] Sharma G, Lee SW, Atanacio O, Parvizi J, Kim TK. In search of the optimal wound dressing material following total hip and knee arthroplasty: a systematic review and meta-analysis. *Int Orthop* 2017;41(7):1295.
- [27] Wetzner SM, Bezreh JS, Scott RD, Bierbaum BE, Newberg AH. Bone scanning in the assessment of patellar viability following knee replacement. *Clin Orthop* 1995;199:215.