Brief communication

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

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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 mupriocin (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 postoperative 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...
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 de-
terrents [16,17]. The UV light method is less expensive and requires fewer centimeters. The skin incision was drawn out, and then the entire field was sealed with a povidone-iodine–impregnated ad-
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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 subcu-
taneous tissue. For this reason, when a lateral retinacular release was required, I always tried to preserve the lateral superior gen-
icular artery (Fig. 2). Infection also can be the result of breakdown of the wound caused by a large hematoma. To minimize this possi-
bility, 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 exer-
cises 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 experi-
ence, 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
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-
thick tissue to close the wound. 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 arthroplasty. 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.

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