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One-Stage Exchange Arthroplasty: A Surgical Technique Update

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ABSTRACT

Background: Standard surgical treatment for a periprosthetic knee infection has been based on a staged surgical technique, in order to assure infection eradication prior to implantation of a new prosthesis.
Methods: In this article, we discuss our surgical technique in undertaking a single-stage exchange of a chronic knee periprosthetic infection.
Results: This technique, which is based on the fundamental principles of controlling infection, preventing recurrence, and restoring function, has been shown to deliver high success rates.
Conclusion: As demonstrated, when undertaken under appropriate circumstances, a single-stage exchange combined with local and systemic antibiotic delivery can result in infection eradication comparable to a 2-staged exchange.

Single-stage exchange arthroplasty for periprosthetic joint infection goes against traditional dogma, as standard treatment has been based on a staged surgical technique in order to assure infection eradication prior to implantation of a new prosthesis. Despite the relatively high success rates of a 2-stage exchange [1], it is expensive with multiple hospital interventions, including but not exclusive to, at least 2 operations, serial blood tests, a prolonged hospital stay, and personal sacrifices by the patient that can have both physical and psychosocial repercussions [2,3].

Under appropriate circumstances, a successful single operation combined with local and systemic antibiotic delivery to eradicate infection enables a patient-centered solution [4], avoidance of 2 separate procedures and the associated anesthetic risk, shorter hospitalization, potentially less morbidity and mortality, an earlier return to activity, better function (compared to the first stage of a 2-stage), and higher satisfaction rates [5–7]. In addition, there may be direct, and indirect, socioeconomic advantages [8].

In this article, we discuss our surgical technique in undertaking a single-stage exchange of a chronic knee periprosthetic joint infection, based on the fundamental principles of (1) controlling infection, (2) preventing recurrence, and (3) restoring function [9].

Surgical Technique

We have divided our technique into 4 distinct stages: (1) preparation, (2) initial debridement, (3) "time-out," and (4) prosthesis implantation. The key steps have also been demonstrated in Figure 1.

Preparation

Patients undergoing an exchange knee arthroplasty are positioned supine, with the knee flexed to 90° maintained. This angle may vary depending on the degree of preoperative stiffness, but following soft tissue releases and debridement, 90-110 is typically easily achieved. A tourniquet is placed on the proximal thigh but is not usually inflated.

To prepare the patient's skin, we shave any hair within 4 inches of the planned incision using an electric razor. This is followed immediately by a "social" wash using a sterile brush if there is significant necrotic tissue on the skin that will need to be removed before undertaking the definitive skin preparations. We use a prepacked surgical scrub brush with 0.5% povidone-iodine, which is combined with water and left to remain on the skin for 3 min before being washed off.

The skin is then prepared from the ankle to the tourniquet at the upper thigh twice with 3M DuraPrep solution, which contains iodine

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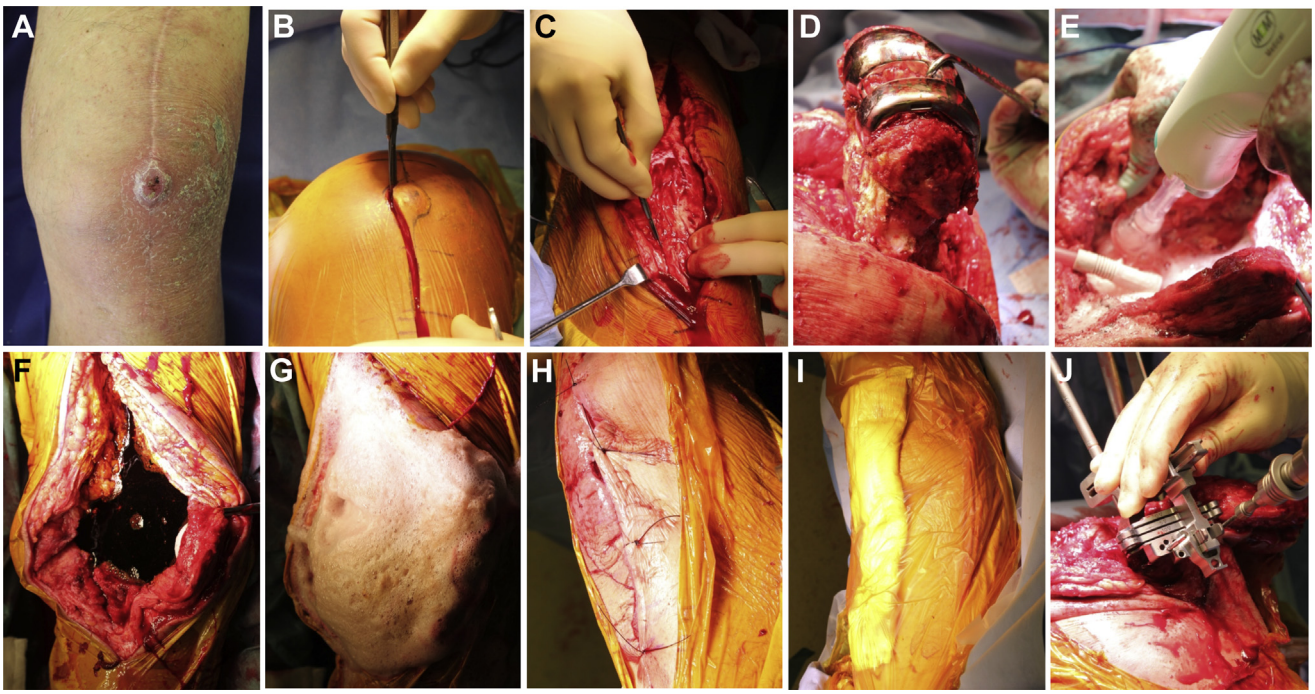

Fig. 1. Top row, from left: (A) Preoperative photograph of the patient undergoing revision of infected right revision total knee arthroplasty with involvement of the distal femoral metaphysis, a chronic sinus can also be seen; (B) use of the previous incision and excision of the sinus; (C, D) complete debridement of soft tissue and bone to an adequate margin; and (E) pulse lavage of 12 L warm 0.9% sodium chloride to wound bed. Bottom row: (F) Betadine applied to the bed followed by a further 0.9% sodium chloride wash and (G) hydrogen peroxide; (H) temporary closure of the wound; (I) sterile dressings to wound and leg redraped; and (J) tibial preparation for the definitive implant.

povacrylex and isopropyl alcohol [10]. Drapes are applied to isolate the area distal to the mid-tibia, and proximal to the mid-femur.

We try and use the previous incision whenever possible, and mark these with a sterile marker pen. The exposed skin is then covered with a 3M Ioban antimicrobial incision drape, protecting the full circumference of the knee.

Prophylactic antibiotics are administered, based on previous aspiration and biopsy sample culture and sensitivity [11], and agreed after multidisciplinary meeting discussions [12,13].

Initial Debridement

Utilizing the previous incision, or if the position is suboptimal, a new midline incision that leaves a sufficient bridge to maintain vascularity, the knee joint is accessed via a medial parapatellar approach. Exposure is often difficult in a revision procedure and therefore a larger incision may be needed, a rectus snip or tibial tuberosity osteotomy may need to be considered, and a synovectomy is often mandatory before appropriate exposure is achieved.

Once the current implant is exposed, all contaminated tissues and bones are debrided and a complete synovectomy is undertaken. It is important to respect key soft tissue structures to prevent unnecessarily destabilizing the knee, but any potentially contaminated or granulating material is excised. It is necessary to create a surgical margin free of necrotic tissue to help reduce the risks of infection recurrence—this is achieved through a combination of curettage, knife excision, and surgical diathermy. Multiple samples (a minimum of 5) are sent for microbiological analysis from the operative wound, and labeled specifically from their location.

The implant is then removed using either generic or implant-specific explant devices, to avoid any unnecessary bone loss.

Debridement of the posterior knee joint and of the tibial and femoral shaft can now be undertaken, being sure to remove any remaining cement. In certain patients, intramedullary reaming can be helpful when the bone is sclerotic, and access to the distal end of the tibia or proximal part of the femur is a challenge. In these situations, a guidewire is passed along the medullary canal and we sequentially ream until we are happy the remaining cancellous bone is healthy and bleeding freely. When doing so, the reamings are also sent for microscopy and culture.

Chemical debridement is then achieved using a low-pressure pulsatile lavage of 0.9% sodium chloride which combines mechanical debridement to dislodge nonviable tissue, with dilution of the bacterial bioburden [14]. We typically use a minimum 12 L of warm 0.9% sodium chloride, across the surgical field using the standard spray nozzle, and use a brush to access the femoral and tibial shafts, applying further mechanical debridement to the cancellous region. We do not use antibiotic irrigation on the wound despite its potential benefits in primary arthroplasty procedures [15].

Aqueous povidone-iodine (1% available iodine) solution is poured into the wound and left to settle for up to 5 min. This enables the antimicrobial actions of the iodine sufficient time to work, rather than be washed off the wound immediately after application [16]. This is then washed off with more 0.9% sodium chloride solution, then a mix of 100 mL of 3% hydrogen peroxide and 100 mL of sterile water solution is applied, to lift any remaining loose debris out of the wound.

After a further 0.9% sodium chloride wash to remove the hydrogen peroxide, we reinspect the field in order to ensure that it is devoid of any necrotic tissue or loose cement.

We then proceed to a “time-out” before proceeding with the second part of the procedure.

Time-Out

The operative site has been adequately debrided, and may be compared to the first stage of a 2-stage exchange arthroplasty. We