



## Surgical technique

## Prepping the knee in maximal flexion: getting into every nook, cranny, and fold

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## ABSTRACT

This article describes a simple surgical skin preparation technique for total knee arthroplasty that permits the application of skin prep agent with the knee in maximal flexion. While most surgeons prep the knee in extension, it is believed that prep of the knee in flexion will provide superior coverage of the skin surface and reduce the potential for surgical-site infection, particularly in obese patients with large soft-tissue layers anterior to the knee.

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## Introduction

Infection continues to be an infrequent but devastating complication of total knee arthroplasty (TKA), affecting about 2% of TKAs nationally and accounting for 20%–25% of TKA revisions [1,2]. In addition to the morbidity to the patient, treating one infection can cost from \$40,000 to more than \$100,000, costing the health system an estimated \$1 billion annually by 2020 [3,4]. In addition to perioperative antibiotics and patient optimization, there is evidence to suggest that implant sterilization, timing of opening trays, limiting operating room traffic, and intraoperative technique can all influence infection rates [5,6].

Since a large percentage of surgical-site infections are from endogenous bacteria seeding the surgical site, decreasing local bacterial burden at the time of surgery is paramount [7]. Interventions to minimize local bacteria loads including serial skin washes in the days leading up to surgery and *Staphylococcus aureus*

decolonization have been shown to decrease bacterial burden at the time of surgery [8–11]. While these preoperative methods to decrease bacterial burden have supporting evidence in the literature, adequate skin preparation and sterile draping at the time of surgery have been a standard of care for decades and is a critical step to minimize skin flora contamination at the time of surgery. Despite numerous studies investigating type of scrubbing solution, 1 vs 2-step processes, adherence of adhesive dressings, and other details of the preparation, to the best of our knowledge there is no mention in the literature about the optimal position of the leg for prepping before a TKA.

It has been the author's observation that typically the leg is held in extension during the aseptic preparation for TKA. This is likely due to convenience as the leg is easiest to stabilize in extension, and it allows easy access to all aspects of the leg. However, the skin on the anterior aspect of the knee goes through a significant range of motion and is significantly more relaxed when in extension (Fig. 1). It has been our observation that if a leg is prepped in extension and then brought into flexion, close examination shows asymmetries in the prep and missed spots in the natural creases of the leg. When the leg is prepped in flexion, these asymmetries in skin prep are minimized (Fig. 2). This finding can be dramatic in obese patients with large soft-tissue folds anterior to the knee joint. The knee is also held in flexion when placing a plastic adhesive drape (Ioban, 3M, St. Paul, MN), which similarly we find has a more intimate adhesion that is retained throughout the case when placed in flexion vs extension.

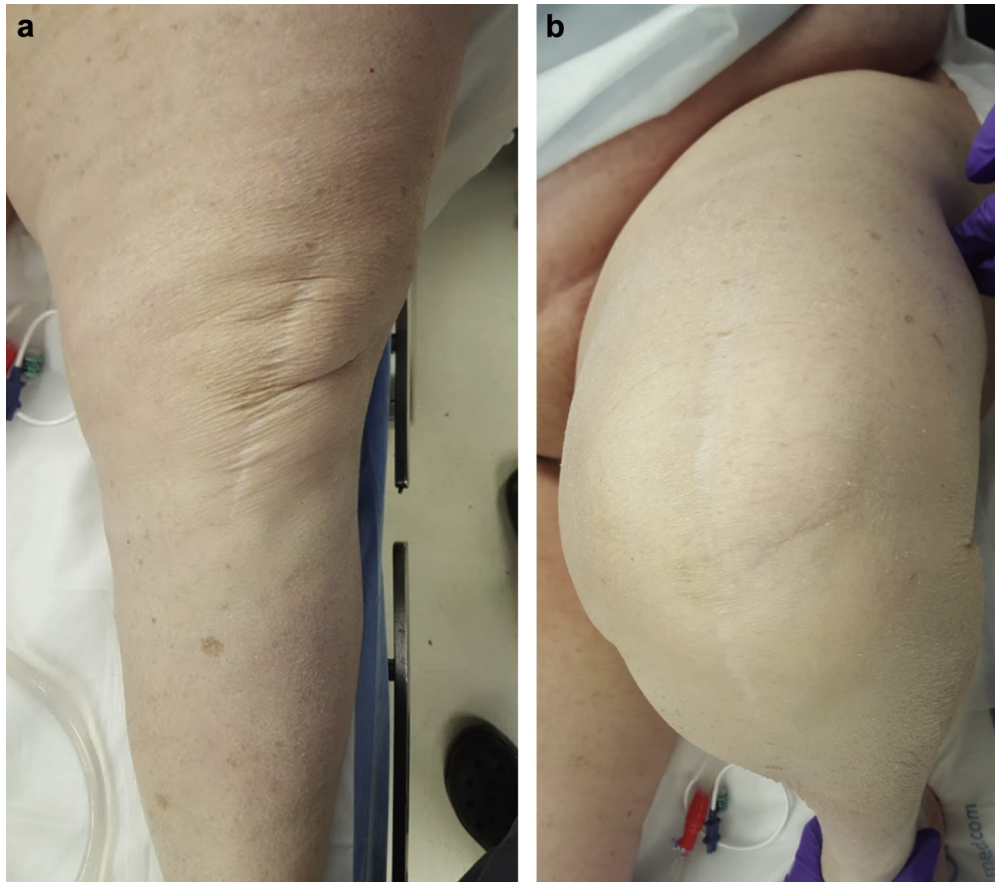
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**Figure 1.** (a) Example of a knee in extension before revision TKA showing numerous creases and overlapping skin. (b) The same knee as in (a) in maximal flexion, note the skin creases and large folds are now on tension.

While this technique is only a small piece of our global infection-prevention program, we believe it is an important component which has helped us maintain a primary total joint infection rate well below 1% at our teaching institution.

### Surgical technique

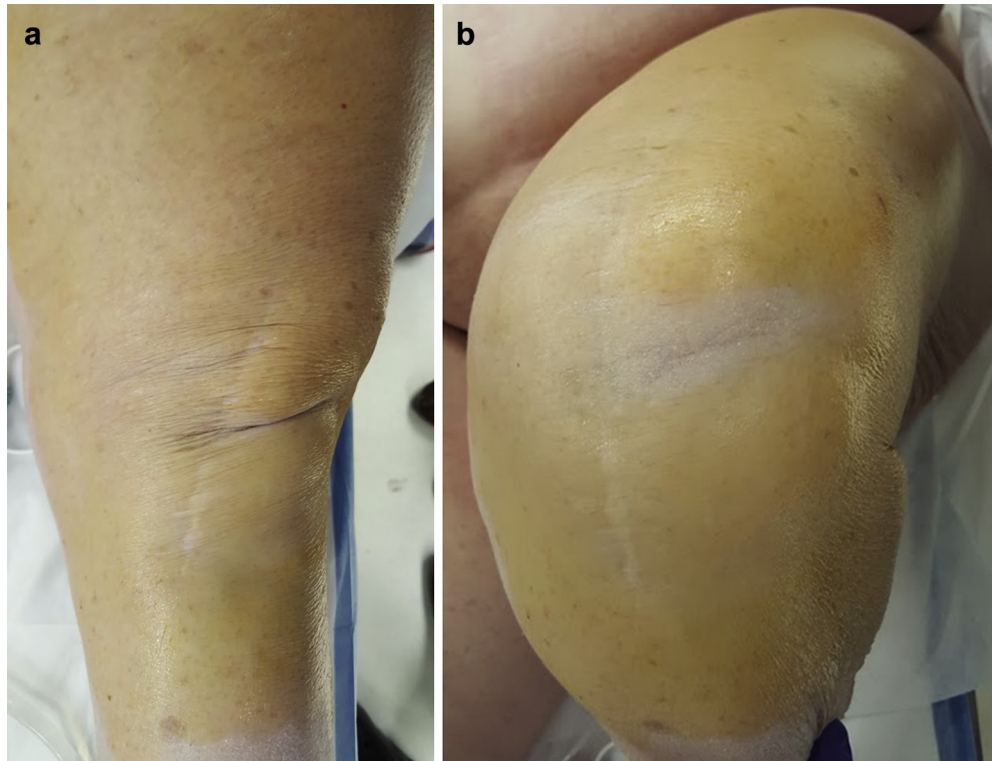
After induction of anesthesia, the patient is positioned supine on the operating table and a nonsterile tourniquet is placed on the thigh. A nonsterile U-shaped drape is placed over the tourniquet. A leg holder or post is placed at the surgeon's discretion.

The technique involves 2 rounds of skin preparation. The first prep is facilitated by having a nonsterile hand stabilize the leg in maximal flexion while the anterior knee, thigh, and lower leg are scrubbed (Fig. 3a and b) according to the manufacturer's instructions (at our institution, we use 26-mL Chloraprep sticks [BD Co, Franklin Lakes, NJ], though any prep solution can be used with this technique). After this, the leg is then brought into extension and held elevated by a nonsterile hand at the foot while the posterior aspect of the leg is prepped (Fig. 3c). The nonsterile hand is then shifted to the forefoot, and the heel is prepped. A second person with a sterile glove then holds the ankle when the remainder of the foot is prepped. While held extended, the entire leg is then revisited with new skin prep sticks 2 more times.

After this initial skin preparation, sterile sheets are placed above and below the leg followed by sterile adhesive U-shaped drapes to seal off the sterile field. A longitudinal strip of loban is placed over the posterior aspect of the leg starting on the sterile drapes and extending to the distal calf sized appropriately to cover the posterior half of the leg (Fig. 3d). An impervious stockinette wrapped with Coban (3M, St. Paul, MN) is then placed over the foot and lower leg (Fig. 3e). The final drape is then placed.

The knee is brought back into deep flexion, and an additional skin prep stick is used to paint the skin one last time, ensuring that all potential skin folds have been addressed (Fig. 3f). The skin prep solution is allowed to dry while electrocautery, suction, light handles, and other surgical equipment are readied for the surgical procedure.

Once the solution has dried, a final sheet of loban is used to circumferentially seal the leg. For this step, the leg is held in flexion, and a sheet of loban dressing is placed over the anterior aspect of the knee while assistants on both sides of the knee keep tension on the ends of the loban (Fig. 3g). Once adhered to the anterior skin in maximal flexion, the knee is extended and the medial and lateral flaps of the loban are wrapped around the leg to create a circumferential seal by overlapping the posterior strip of loban that was previously placed. (Fig. 3h). Once fully draped, a timeout is performed and the surgery commences.



**Figure 2.** Example of knee prepped in extension (a) and then brought into flexion (b). Note the large area of inadequate prep where the large skin fold is now on stretch.

## Discussion

Though the technique itself is quite simple and hardly needs a step-by-step tutorial, it has been our observation that it is not intuitive to prepare the skin in this manner prior to knee replacement. It has been our experience that most surgeons prep the skin with the knee in full extension. This is likely for the convenience and ease of handling the leg since all aspects of the leg can be accessed with one hand stabilizing the heel in extension. Furthermore, if not stabilized in flexion properly, the leg can rotate at the hip and contaminate the leg. However, despite this technique being slightly more challenging, we do feel this technique has improved the quality and thoroughness of surgical-site preparation.

Our technique involves an additional scrub in maximal flexion after the final drapes are placed. Recent work by Morrison et al [11] indicated that reprepping the surgical site after draping was completed to the significant reduction in surgical-site infections. However, in this report, there was no mention of the leg position for this final prep. In our technique, we do this step with the knee in maximal flexion as well. Since we have placed a strip of loban drape over the posterior aspect of the knee before this final scrub, we are able to maintain the knee in maximal flexion for drying and application of the final piece of loban.

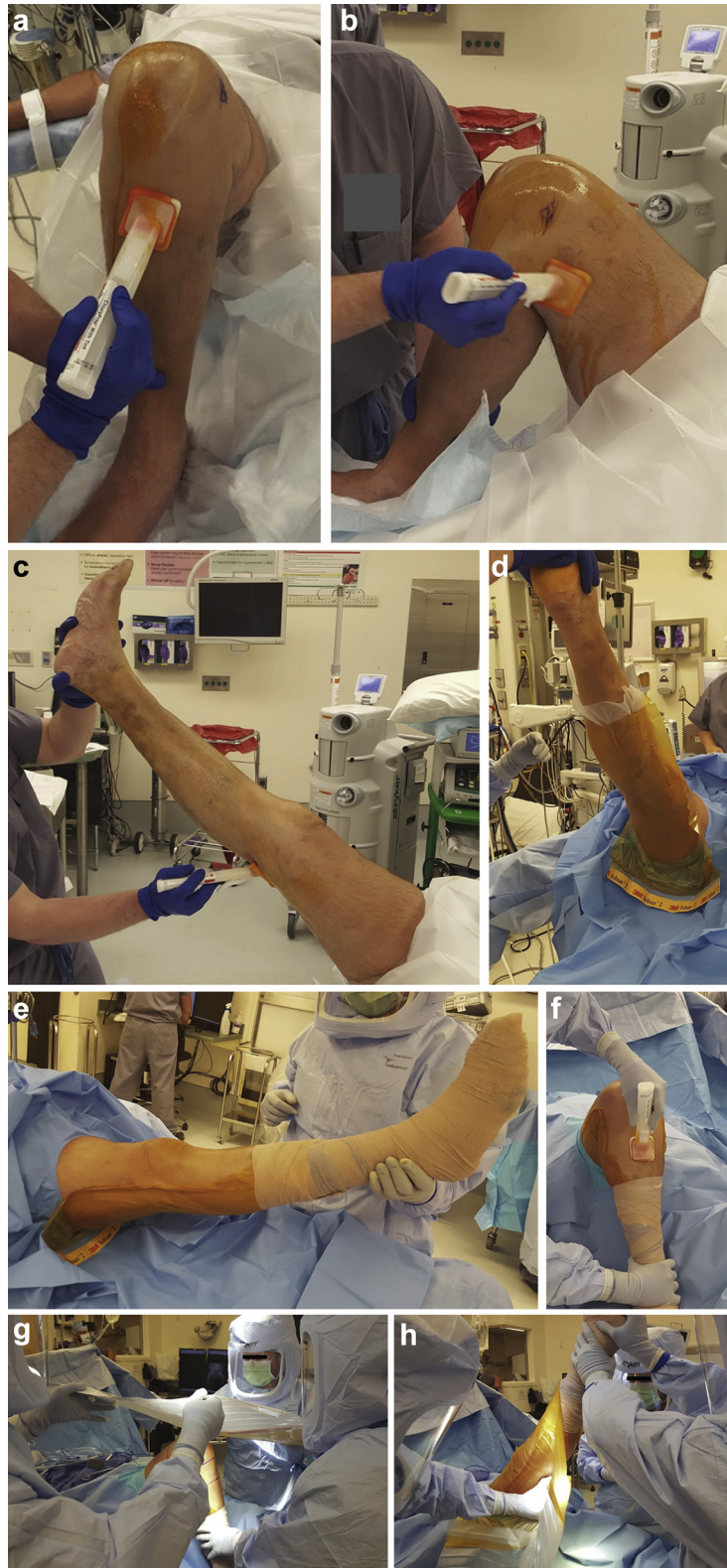
Use of an adhesive drape such as loban is common practice among arthroplasty surgeons. Despite some studies suggesting it is not necessary [12], others have suggested that these drapes decrease bacterial burden and prevent lateral migration of bacteria [13]. It is most effective when it stays in place throughout the case, as Alexander et al [14] showed a 6-fold increase in infections when the loban drape had lifted off during the case. While there is evidence in the literature that loban will stick better when using duraprep compared to chloraprep [15], there again is no mention in

the literature regarding adhesion of such drapes when placed on the knee in flexion or extension. Though we do not track objective data related to this, it has been our experience that there is less peelback of the loban at the incision side when placed in flexion vs extension.

A clear limitation of this article is a lack of objective evidence for decreased rate of surgical-site infection using this technique. While all of our fellowship-trained arthroplasty surgeons have adopted this technique for primary and revision TKAs, it was adopted over time and there was no defined transition between prepping in flexion and extension. Therefore, we are unable to retrospectively compare infection rates before and after incorporating this technique. Furthermore, our institutional infection-prevention protocols evolve periodically such that it would not be possible to isolate this technique change as the only variable between 2 historical groups. Any comparison of our patient population would likely be underpowered as well, since our rate of infection is <1% and a high number of patients in each arm would be required to show a measurable difference.

Despite these limitations, it is our opinion that universally adopting this technique has helped both the completeness of our surgical-site preparation for TKAs and the adherence of our loban drapes. We feel this has been an improvement in our global infection-prevention protocol, and it is an easy modification that can be quickly adopted by staff physicians, residents, and surgical support staff with minimal learning curve and no additional morbidity to the patient. We are not aware of any downsides to prepping the knee in flexion, and there are intuitive reasons why this technique could help improve the sterility of the skin. Therefore, we feel that even without objective evidence that it decreases infection rates, it is reasonable to adopt this technique when prepping and draping primary and revision TKAs.





**Figure 3.** The knee is stabilized in maximum flexion using the positioning post and one nonsterile hand (a). The anterior, medial, and lateral aspects of the leg are prepped in maximal flexion (b). The knee is then brought into extension and held at the ankle by a nonsterile hand while the posterior aspect of the leg is prepped (c). Before placing the final drape, a strip of loban dressing is applied to the posterior aspect of the knee starting proximally on the sterile drapes and extending down to the calf (d). An impervious stockinet is then placed over the foot and extends proximally over the posterior strip of loban and wrapped with Coban (e). After sterile drapes are placed, the knee is again flexed and skin prep agent is again applied one last time with the knee in flexion (f). Once the prep solution has dried, loban is placed on the anterior aspect of the knee with the knee in flexion (g). The 2 sides of the loban are held by surgical staff as the anterior aspect is pressed against the taught anterior skin. After the loban has adhered to the anterior surface of the knee, the knee is brought into full extension and the loban is then wrapped on the medial and lateral aspects of the leg creating a circumferential seal of the leg by overlapping the posterior strip of loban that had been previously placed (h).

## Summary

Skin preparation before TKA is an important part of preventing periprosthetic joint infection. Given that the skin surface is thought to be a source for pathogens, complete and thorough coverage of the entire skin surface is critical. The technique we describe, centered around skin preparation with the knee in maximal flexion, provides a method for achieving maximal skin coverage even in obese patients with large soft-tissue folds anterior to the knee.

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