The "Banana Peel" Exposure Method in Revision Total Knee Arthroplasty

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Abstract

We present an exposure technique, the "banana peel," that has been used exclusively for revision total knee arthroplasty (TKA) for more than 20 years. We retrospectively reviewed use of this technique in 102 consecutive patients (mean age, 62 years; range, 41-92 years) who underwent tibial-femoral stemmed revision TKA. There were 5 deaths, leaving 97 patients (98 knees) for the study.

The technique involves peeling the patella tendon as a sleeve off the tibia, leaving the extensor mechanism intact with a lateral hinge of soft tissue. A quadriceps "snip" is also done proximally.

Patients with a minimum follow-up of 24 months were included. Telephone interviews and chart reviews were conducted, and Knee Society scores were obtained. Mean follow-up was 39 months (range, 24-56 months). No patient reported disruption of the extensor mechanism or decreased ability to extend the operative knee. Mean Knee Society score was 176 (range, 95-200). Mean postoperative motion was 106°. No patient reported pain over the tibial tubercle.

The banana-peel technique for exposing the knee during revision TKA is a safe method that can be used along with a proximal quadriceps snip and does not violate the extensor mechanism, maintaining continuity of the knee extensors.

Revision total knee arthroplasty (TKA) can be a technically challenging procedure fraught with potential complications,[1,2] including delayed wound healing, extensor mechanism disruption, intraoperative fracture, arthrofibrosis, instability, and increased incidence of infection.[3-5] Patient-specific systemic comorbidities and significant adhesions can further potentiate the risk for damage to neurovascular structures, collateral ligaments, skin, and the extensor mechanism.

These complications may occur more commonly with poor surgical exposure and inappropriate soft-tissue management. In many cases, obtaining adequate exposure is difficult, and failure to do so can directly cause technical errors. The knee must be flexed at least 90° and the patella displaced laterally to allow enough exposure to remove the prosthesis. Wide exposure must be achieved to allow component removal, soft-tissue balancing, management of bone loss, and reimplantation without damaging important structures. Several methods have been described.[6-13] The procedure should be performed without excessive tension to the patellar tendon because of the risk for avulsion. The surgeon should be prepared to use specific surgical techniques to assist in exposing the stiff knee and to avoid injury to the patellar tendon and the extensor mechanism.

"The patella tendon is peeled as a sleeve off the tibia, leaving the extensor mechanism intact distally and laterally..."

We present an exposure technique, the "banana peel," that can be used in revision TKA. The patella tendon is peeled as a sleeve off the tibia, leaving the extensor mechanism intact distally and laterally and providing full exposure of the knee joint; this technique is always combined with a proximal "snip" of the quadriceps tendon. The banana-peel technique has been used exclusively for revision TKA for more than 20 years.

Materials and Methods

Between January 2001 and September 2003, 122 consecutive patients underwent 123 revision TKAs. One hundred two patients (103 knees) met the criteria for our study, with a minimum follow-up of 24 months (range, 24-56 months). Institutional review board approval was obtained at the University of Utah Medical Center. Telephone interviews and chart reviews were conducted. Each patient was

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Am J Orthop. 2007;36(10):526-529.

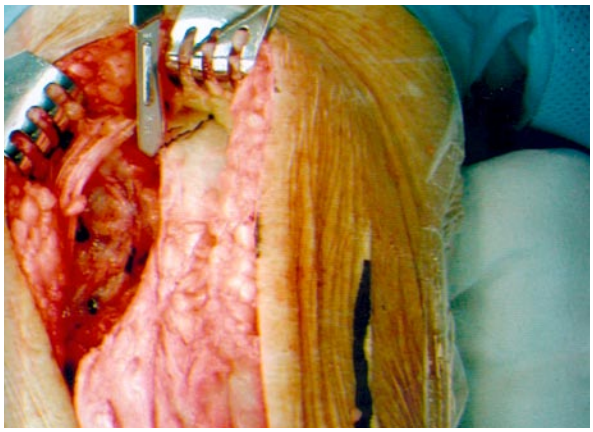

Figure 1. Proximal quadriceps snip.

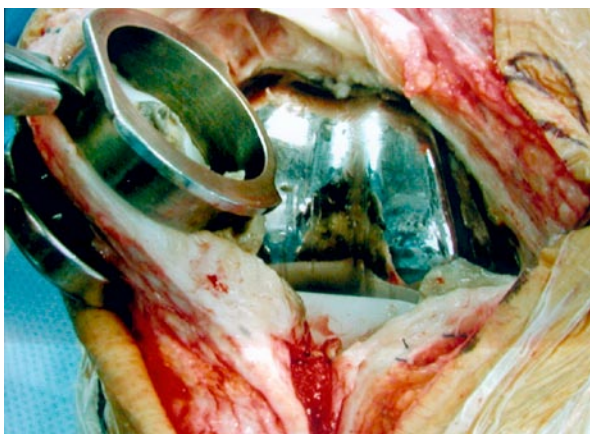

Figure 2. Patella eversion with the knee flexed causes the peel to begin.

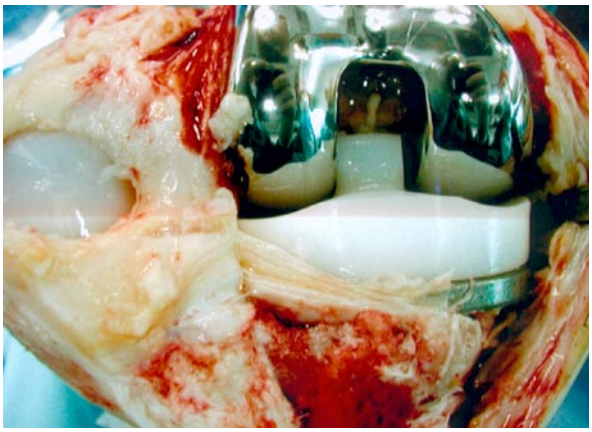

Figure 3. The proximal tibia is exposed after the peel is completed.

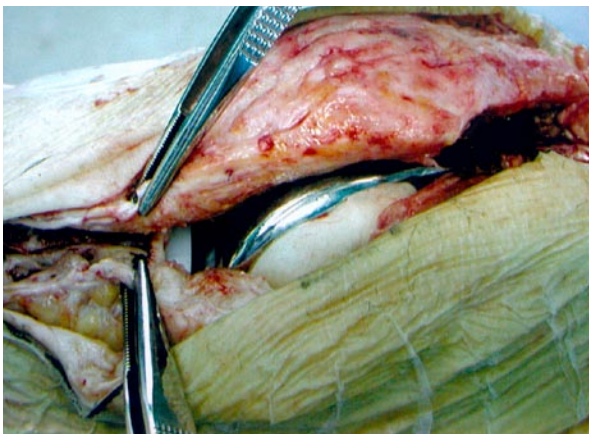

Figure 4. Closure of the peel by approximation of the soft tissue.

questioned about extensor mechanism function, and his or her Knee Society score was calculated. Each patient was specifically asked if there was any pain at the tibial tubercle. Patients consisted of 38 men and 64 women (mean age, 61.6 years; range, 32-92 years). In all patients, the banana-peel exposure method was used. Of the 103 revision TKAs, 47 were performed on the right knee, 56 on the left knee. Exclusion criteria included component revision, revision for unicondylar knee replacements, and articulating spacer placement.

Technique

The technique for banana-peel exposure of the knee joint in revision TKA is performed as follows. A standard anterior midline incision is made on the operative knee, using prior incisions when possible. Full-thickness skin flaps are raised to expose the quadriceps tendon and the patella. A medial parapatellar arthrotomy is performed entering the knee joint. Sharp dissection is then made on the anterior tibia just medial to the patella tendon in line with the medial arthrotomy so that the peel can be started. A quadriceps snip is made proximally[6,7] (Figure 1). The patella is then everted using gentle force (Figure 2).

Distally, a periosteal sleeve is carefully pealed off the tibia along with the patella tendon attached as a continuous sleeve exposing the anterior tibia as the patella is everted. Release of the sleeve can progress laterally and distally as much as needed for exposure of the components. Sharp dissection is not performed, as eversion of the patella pulls on the patella tendon and peels it off the anterior tibia and previous TKA component. No electrodissection, Cobb elevator, or knife is used in this part of the technique. Meticulous release of a single sleeve with the attachment of the patella tendon maintains continuity of the extensor mechanism. The skin incision needs to extend distally as far as the peel is performed in order to prevent truncating the sleeve from running into the distal skin.

- The patella tendon may be almost completely peeled off the tibial tubercle as long as no dissection is made distal or lateral to the patella tendon.
- Even when thin soft tissue is present over the tibial tubercle, as long as the peel maintains continuity of the soft tissues distally and laterally, rupture of the patella tendon can be avoided.

Posteromedially, a subperiosteal sleeve is raised, as has been done in previous exposures. This provides complete exposure of the knee joint (Figure 3).

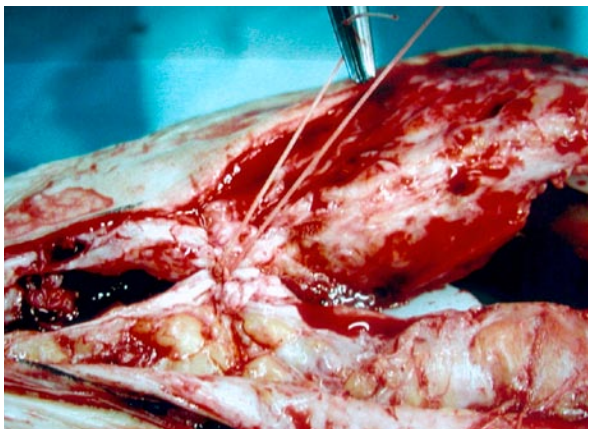

Figure 5. Closure with suture in place.

The revision TKA can then be performed at the discretion of the surgeon. At closure, the arthrotomy is closed in standard fashion over the anterior tibia without any need to address the peel that has been performed laterally or medially (Figures 4, 5). The thickened soft tissue is stable with suture alone, absent any suture anchors.

Results

One hundred two consecutive patients (103 knees) underwent revision TKA. Five patients had died by the time of the study, leaving 97 patients (98 knees) for evaluation. Mean age for this group was 62.2 years (range, 41-92 years). Of the remaining 98 revision TKAs, 47 were performed on the right knee, 51 on the left knee. Mean follow-up was 39 months (range, 24-56 months). The surgical exposure was done in the treatment of aseptic loosening of a TKA prosthesis in 62 patients (64%), septic loosening in 29 patients (30%), and fracture in 6 patients (6%). Three patients underwent a second revision: 1 with rotational deformity of the revision component needed adjustment for internal/external rotation, 1 had a femur fracture, and 1 had a tibial component that failed because of aseptic loosening. These 3 patients had been evaluated at least 24 months after their initial revision surgery. Five patients had to undergo a manipulation under anesthesia at approximately 6 weeks because of decreased range of motion. Their Knee Society score was obtained after their manipulation. Arthrofibrosis, aseptic loosening, a malpositioned component, and a femur fracture were the only complications in this set of 97 patients. No noted complications correlated directly with the patella tendon peel technique.

Mean postoperative Knee Society score was 176 (range, 95-200). No patient reported disruption of the extensor mechanism or decreased ability to extend the operative knee. Active extension was present in all knees. On physical examination, mean total arc of motion for the entire group was 106°. Flexion contraction of 0° to 10° was present. Maximum flexion obtained was 130° (range, 75°-130°). No pain over the tibial tubercle was reported.

Discussion

Exposure of the knee joint in the revision setting can be difficult. Multiple exposure options are available in revision TKA. Specific surgical techniques help to improve the surgical exposure and can minimize complications such as wound-healing problems, component malposition, and extensor mechanism disruption. Several surgical exposures have been advocated for revision of failed TKA.[2,5-13] Extensile exposure by dissection of scar, quadriceps snip or turndown, tibial tubercle osteotomy, or medial epicondylar osteotomy should be performed early to prevent patellar tendon disruption. Revision TKA may require an extensile approach to permit a satisfactory exposure without compromising attachment of the patellar tendon and the extensor mechanism. The importance of a well-planned operative approach with generous exposure during revision surgery cannot be overemphasized. Full extensile exposure of the failed implant is crucial because such exposure allows the surgeon to perform necessary bone work, component removal, soft-tissue balancing, management of bone loss, and reimplantation.

Extensile techniques can violate the extensor mechanism, but satisfactory revision TKA requires adequate exposure. Mendes and colleagues[8] described their results with tibial tubercle osteotomy in the surgical exposure of 67 knees in 64 patients undergoing revision TKA. Mean follow-up was 30 months (range, 5-60 months). Knee Society scores confirmed good or excellent results in 87% of the knees, and the mean score was 86. There were no patellofemoral complications, no component malalignments, and no avulsions of the patellar tendon. Serious complications directly related to the tibial tubercle osteotomy occurred in 5 patients (7%). Whiteside[9] described exposure with an extended tibial tubercle and tibial crest osteotomy. Clarke[10] also discussed tibial tubercle osteotomy. Engh[11] described the epicondylar osteotomy as a valuable tool in primary and revision TKA. Our technique does not involve the bony architecture, so there is no risk for nonunion, fracture, or fixation loss. All the bony work is saved for insertion of the TKA revision components.

Meek and colleagues[14] described their results with the rectus snip. One hundred seven patients who underwent revision TKA were followed up at a minimum of 2

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years (mean, 40.5 months). A standard medial parapatellar approach was used in 57 of these patients, the rectus snip in 50. These 2 groups were equivalent with respect to age, sex, and comorbidity scores. WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index) Function, Pain, Stiffness, and Satisfaction scores were not statistically different. Use of a rectus snip as an extensile procedure had no effect on outcome. Barrack[12] also described the quadriceps snip and patellar turndown. A variation on proximal release was described by Sharkey and colleagues[2] with regard to extensor mechanism tenolysis. Careful release of adhesions binding the extensor mechanism is advocated.

8. Mendes MW, Caldwell P, Jiranek WA. The results of tibial tubercle osteotomy for revision total knee arthroplasty. *J Arthroplasty.* 2004;19(2):167-174.
9. Whiteside LA. Exposure in difficult total knee arthroplasty using tibial tubercle osteotomy. *Clin Orthop.* 1995;(321):32-35.
10. Clarke HD. Tibial tubercle osteotomy. *J Knee Surg.* 2003;16(1):58-61.
11. Engh GA. Medial epicondylar osteotomy: a technique used with primary and revision total knee arthroplasty to improve surgical exposure and correct varus deformity. *Instr Course Lect.* 1999;48:153-156.
12. Barrack RL. Specialized surgical exposure for revision total knee: quadriceps snip and patellar turndown. *Instr Course Lect.* 1999;48:149-152.
13. Fehring TK, Odum S, Griffin WL, Mason JB. Patella inversion method for exposure in revision total knee arthroplasty. *J Arthroplasty.* 2002;17(1):101-104.
14. Meek RM, Greidanus NV, McGraw RW, Masri BA. The extensile rectus snip exposure in revision of total knee arthroplasty. *J Bone Joint Surg Br*. 2003; 85(8): 1120-1122.

"Keeping the extensor mechanism essentially intact can reduce complications associated with the patella and quadriceps tendons..."

Fehring and colleagues[13] described the patella inversion exposure method in revision TKA. No attempt was made to evert the patella. This exposure technique was used in 397 (95%) of 420 patients. There were no episodes of patellar tendon avulsion in this series. The patella inversion method afforded adequate exposure in most patients without violating the extensor mechanism.

The banana-peel exposure method provides the revision surgeon with another safe technique that can be used in revision TKA. Keeping the extensor mechanism essentially intact can reduce complications associated with the patella and quadriceps tendons and provide faster recovery for the extensor mechanism and therefore faster return to activities for the patient.

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article. They wish to thank Tanya Hanberg for her assistance with this study.

References

1. Gioe TJ, Killeen KK, Grimm K, Mehle S, Scheltema K. Why are total knee replacements revised? Analysis of early revision in a community knee implant registry. *Clin Orthop.* 2004;(428):100-106.
2. Sharkey PF, Homesley HD, Shastri S, Jacoby SM, Hozack WJ, Rothman RH. Results of revision total knee arthroplasty after exposure of the knee with extensor mechanism tenolysis. *J Arthroplasty.* 2004;19(6):751-756.
3. Ritter MA, Carr K, Keating EM, Faris PM, Meding JB. Tibial shaft fracture following tibial tubercle osteotomy. J Arthroplasty. 1996;11(1):117-119.
4. Aglietti P, Windsor RE, Buzzi R, Insall JN. Arthroplasty for the stiff or ankylosed knee. *J Arthroplasty.* 1989;4(1):1-5.
5. Clarke HD, Scuderi GR. Revision total knee arthroplasty: planning, management, controversies, and surgical approaches. *Instr Course Lect.* 2001;50:359-365.
6. Garvin KL, Scuderi G, Insall JN. Evolution of the quadriceps snip. *Clin Orthop.* 1995;(321):131-137.
7. Arsht SJ, Scuderi GR. The quadriceps snip for exposing the stiff knee. *J Knee Surg.* 2003;16(1):55-57.

Commentary

The article by Lahav and Hofmann addresses a challenging problem in revision total knee arthroplasty, namely, exposing the stiff and scarred knee.

The seemingly effective solution that Dr. Hofmann's group has described and reviewed in this article, the "banana peel" method, is compelling but certainly carries a potential for disruption of the extensor mechanism, which can be a catastrophic problem in the setting of a total knee arthroplasty. At first glance, this technique seems to be a bit of an oxymoron, namely, the disruption of the extensor mechanism to avoid disruption of the extensor mechanism. However, the results presented are intriguing.

The article raises some questions that need to be studied further before it receives universal endorsement. In this series, 25 of 123 knees, nearly 20%, were excluded from the final analysis, for a variety of reasons. The authors mention that active extension was present in all patients, but we do not know from this analysis whether patients had extensor lags and what the grade of motor strength was in this group. We also do not know how these patients did functionally. Were they able to climb and descend stairs, did they need a brace, etc.? To be sure, if this technique leaves the extensor mechanism weaker than other extensile exposure options, such as a Whiteside osteotomy or a quadriceps snip, then it may be less desirable than those techniques. Intuitively, it is difficult to come to terms with the differences between this technique and iatrogenic patellar tendon avulsions. Further study is needed to look at functional recovery and strength after this exposure method.

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