Clin Orthop Relat Res (2011) 469:154–159
DOI 10.1007/s11999-010-1521-3

SYMPOSIUM: PAPERS PRESENTED AT THE ANNUAL MEETINGS OF THE KNEE SOCIETY

Liner Exchange and Bone Grafting

Rare Option to Treat Wear & Lysis of Stable TKAs

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Published online: 31 August 2010

Abstract

Background Liner exchange and bone grafting are commonly performed for wear and osteolysis around well-fixed modular acetabular components that otherwise would require structural allografting and revision THA. However, liner exchange in the face of substantial lysis around TKA has been performed rarely with reports of failure rates of up to 25% at 3 year followup.

Questions/purposes We therefore evaluated the technique of liner exchange and bone grafting for cases of wear and extensive osteolysis around TKAs in which the components were well-fixed and well-aligned to determine (1) rerevision rates; (2) fate of the bone graft; (3) radiographic loosening rates; and (4) functional scores.

Methods We retrospectively reviewed 22 patients (25 knees) who underwent revision TKA with exchange of the modular polyethylene insert and bone grafting in cases with well-fixed components and large areas of osteolysis (up to 54 cm^2 on a single projection) at the time of revision. The average area of osteolysis was 21 cm^2 and 10 cm^2 on the AP projection of the femur and tibia, respectively. On the lateral projection, the average area of osteolysis for the femur and tibia was 22 cm^2 and 9.3 cm^2. Minimum clinical and radiographic followup was 22 and 22 months (average, 61 and 59; range, 22–142 and 22–130, respectively).

Results One of the 25 knees was revised for aseptic loosening or recurrence of osteolysis. On radiographs, 84.6% and 70% of femoral and tibial osteolytic lesions, respectively, showed evidence of complete or near complete graft incorporation. The remaining lesions showed evidence of partial graft incorporation with the exception of one tibial lesion, which was in the revised case. All other components were well fixed with no evidence of radiographic loosening.

Conclusions In this selected series of cases with extensive osteolysis around well-fixed and well-aligned TKAs, liner exchange and bone grafting provided durable midterm results with extensive graft incorporation.

Level of Evidence Level IV, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

One or more of the authors has received royalties from DePuy (JJC); has received research/institutional support from DePuy (DDG); has received research/institutional support from Wright Medical (JCC); and has received royalties from Zimmer and Wright Medical (WJM). Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.
This work was performed at the University of Iowa, Iowa City, IA, USA.

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Introduction

After TKA, some patients present with extensive wear and osteolysis around well-fixed and well-aligned components. A similar scenario of osteolysis and polyethylene wear occurs around well-fixed modular acetabular components. In the hip, the technique of managing this scenario with liner exchange and bone grafting of the osteolytic lesions has been reported [7, 8]. One study of patients (24 hips) treated in this manner at mean 36 month followup reported 17 of 18 lesions regressed or resolved, and only two patients had additional revisions [9]. A longer term study of liner exchange for wear and osteolysis of the hip reported a decrease in the rate of lysis as well as hips remaining radiographically stable at 6.2 year followup [11].

Isolated liner exchange after TKA has had limited success when the indications have been for all causes. One series reported a 25% rerevision rate at mean three year follow-up for tibial insert exchanges for wear or instability [1]. Another series reported 17% failure of isolated insert exchanges for wear and other diagnoses at average 54 months [3]. A more recent study of isolated liner exchange and grafting for wear and osteolysis following TKA reported a 16.2% failure rate after a mean 44 month followup [5]. For the above reasons, this approach has not gained popularity in cases of extensive osteolysis and polyethylene wear after TKA.

With the use of modular tibial components, cases of extensive osteolysis around fixed total knee components have increased, presumably related to backside polyethylene wear as well as poor quality (ie, gamma irradiated in air) polyethylene. Occasionally, the lesions are so extensive that major structural allografts or even tumor-type prostheses are needed to reconstruct the defects. In cases in which the components were secure and well aligned, the authors decided to débride the lesions and fill the defects with bone grafting or bone graft substitute.

The purpose of this study was to evaluate the technique of liner exchange and bone grafting for cases of wear and osteolysis around TKAs in which the components were well-fixed and well-aligned to determine (1) rerevision rates; (2) fate of the bone graft; (3) radiographic loosening rates; and (4) functional scores.

Patients and Methods

We retrospectively reviewed 22 selected patients who underwent 25 total knee revisions with only exchange of the tibial liner and bone grafting of osteolytic lesions at four institutions (University of Iowa, Rush University, Des Moines Orthopaedic Surgeons, and Washington University) over a 10.5-year period (October 1995 through May 2006). The indication for revision TKA surgery was wear and osteolysis. All knees were well-fixed as determined radiographically with the final determination of fixation made intraoperatively, and all were well-aligned (mechanical axis of neutral $\pm$ 1 to 2° and anatomic alignment of 5–9° of valgus). We excluded any case having revision of either the femoral or tibial component (regardless of reason, including problems with the capturing mechanism of the tibial tray). In all of these patients, the alternate form of surgery would have been with structural allografts or extensive metal augmentation in the revision reconstruction. The typical scenario for these patients was that they returned for followup after not having been seen for several years, or they were new patients who had not been followed by their original surgeon. They presented with large osteolytic lesions and were not lesions that had been closely followed over time to decide when treatment was warranted. Twenty-five TKAs (less than 1% of the knee revisions performed by the seven surgeons) met the criteria and were included in the study. There were 17 females and five males. The average age at the time of the index liner exchange was 63 years (range, 45–85 years), which was on average 9 years (range, 3–14 years) after the primary TKA. The average BMI for the patients was 33 kg/m^2 (range, 23–48 kg/m^2). The minimum clinical followup was 22 months postliner exchange (average, 61 months; range, 22–142 months). The minimum radiographic followup was 22 months postliner exchange (average, 59 months; range, 22–130 months) with one knee excluded as a result of radiographic followup of less than 1 year. No patients were lost to followup. No patients were recalled specifically for this study; all data were acquired from medical records and radiographs.

The primary TKA components varied, but 48% consisted of the PFC total knee (DePuy). All but one knee was fixed with cement (Table 1). The average area of osteolysis was 21 cm^2 and 10 cm^2 on the AP projection of the femur

Table 1. Primary TKA components used

Implant design	Number (n = 25)	Percent
AMK*	4	16
Insall Burstein†	2	8
Miller Galante†	2	8
PCA‡	2	8
PFC*	12	48
Scorpio§	2	8
Whitesides Cementless‖	1	4

* AMK and PFC (DePuy, Warsaw, IN); †Insall Burstein and Miller Galante (Zimmer, Warsaw, IN); ‡PCA (Stryker, formerly Howmedica, Kalamazoo, MI); §Scorpio (Stryker, Kalamazoo, MI); ‖Whitesides (Smith & Nephew, formerly Richards, Memphis, TN).

Table 2. Areas of osteolysis before the index liner exchange and bone grafting

AP projection	Osteolysis
Femur	9 knees
	21.3 cm^2 average (range, 5–48 cm^2)
	Location
	Medial 5
	Lateral 2
	Global 2
Tibia	19 knees
	10.2 cm^2 average (range, 1–37.2 cm^2)
	Location
	Medial 11
	Lateral 2
	Global 6
Lateral projection	**Osteolysis**
Femur	12 knees
	21.7 cm^2 average (range, 9–54 cm^2)
	Location
	Anterior 0
	Posterior 2
	Global 10
Tibia	12 knees
	9.3 cm^2 average (range, 1–31.5 cm^2)
	Location
	Anterior 8
	Posterior 3
	Global 1

Table 3. Type of graft used

Graft source	Number	Percent
Allograft	11	44
Allograft and commercial graft	8	32
Commercial graft	4	16
Allograft and methylmethacrylate	2	8

and tibia, respectively. For the lateral projection, the average area of osteolysis for the femur and tibia was 22 cm^2 and 9 cm^2, respectively (Table 2). The type of graft used varied and was most commonly allograft alone (44%; Table 3).

Surgery was performed by one of seven surgeons (JJC, SGT, DDG, JCC, WJM, CJDV, AGR). Intraoperatively, fixation of the femoral and tibial components was verified. The surgical technique included curettage of the osteolytic lesion through a bone window (Fig. 1A–C) or through access at the periphery of the components. Graft material

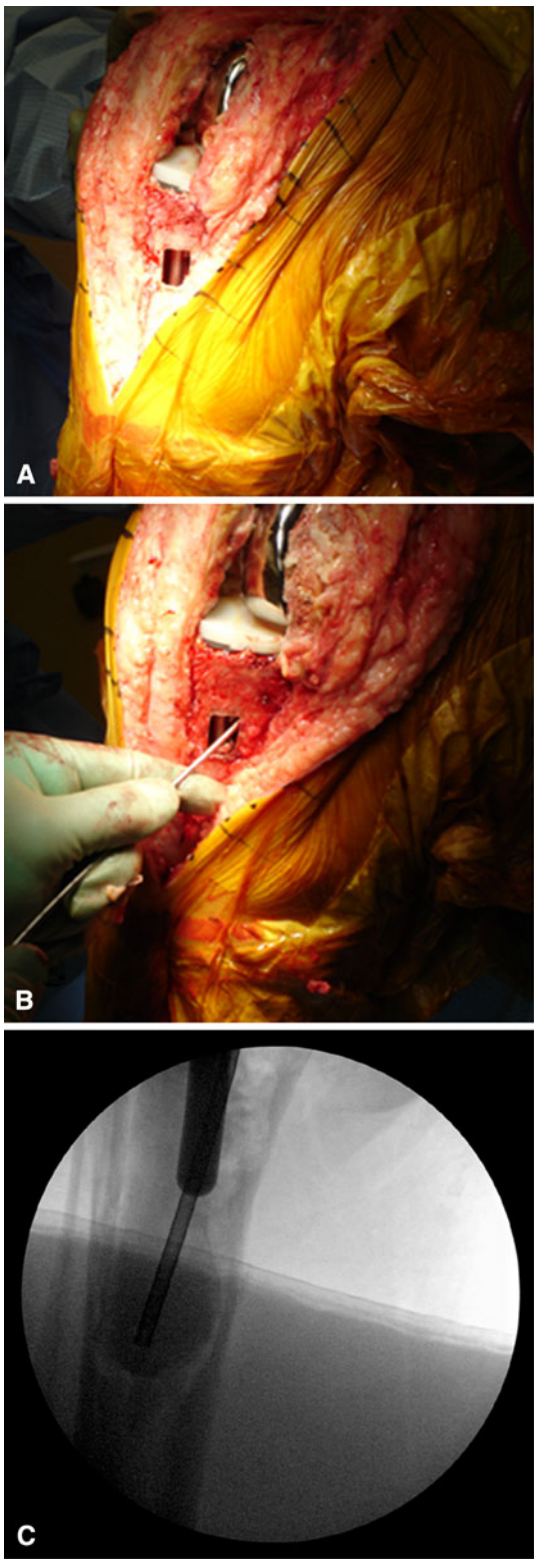

Fig. 1A–C Technique of débridement of the osteolytic lesion with bone grafting is shown. (**A**) A bone window created to gain access to the osteolytic lesion; (**B**) curettement of the osteolytic lesion through a bone window; (**C**) filling of the osteolytic defect with graft material under fluoroscopic control.

was impacted into the defects and for the largest lesions, fluoroscopy was used to assure complete débridement and filling of the defect. The ligaments were balanced, alignment was confirmed intraoperatively and rotational alignment was verified using the epicondylar axis and tibial tubercle. In all cases, a new liner was inserted (crosslinked polyethylene when available). Postoperatively, patients used crutches or a walker, and advanced to a cane as tolerated. Physical therapy occurred twice daily.

Followup included clinic visits at 6 weeks, 3 months, and 1 year postoperatively, with AP, lateral and Merchant radiographs taken at the 3 month followup. Further followup is at an interval of every 2–3 years, at which time radiographs are repeated. If patients are having problems or symptoms, they are followed more frequently. Knees were evaluated clinically for need for rerevision/reoperation (ie loosening, lack of graft incorporation, or component subsidence) and with the Knee Society score [6] at final followup.

Three of us (JJC, ERR, SSL) evaluated all AP and lateral radiographs with final determination by consensus. Radiographic analysis consisted of evaluation for loosening [4], osteolysis [10], and bone graft incorporation. Bone graft incorporation was determined by noting differences in defect filling on comparison of postoperative and final followup radiographs. Full incorporation was defined as no difference in defect filling, mostly incorporated was defined as a small amount of difference in graft resorption (ie < 1 cm^2), and partial incorporation was defined as at least 25% resorption of graft.

Results

At mean 61-month followup, one patient (one knee) underwent reoperation for aseptic loosening of the femoral and tibial components with osteolysis of both the femur and tibia as well as wearthrough of the metal-backed patellar component. The patient originally had the index liner exchange and bone grafting for wear and tibial osteolysis. The bone graft showed little to no incorporation 8 years postliner exchange. One additional patient (one knee) had arthroscopic débridement approximately 2 years postliner exchange for peripatellar fibrosis. No other patients had further reoperations.

Only one knee (one patient) did not show evidence of graft incorporation (the knee that was revised for loosening and osteolysis). All remaining knees (20 patients), with the exception of the one knee that had less than 12 month radiographic followup, showed radiographic evidence of graft incorporation with the majority of lesions demonstrating full or mostly incorporated graft (85% of femoral lesions and 70% of tibial lesions, respectively) (Table 4).

Table 4. Graft incorporation*

Lesions	Number	Percent
Femoral lesions (13)		
Fully incorporated	9	69.2%
Mostly incorporated	2	15.4%
Partially incorporated	2	15.4%
No incorporation	0	
Tibial lesions (20)		
Fully incorporated	12	60%
Mostly incorporated	2	10%
Partially incorporated	5	25%
No incorporation	1	5%

* One knee with less than 24-month radiographic followup.

Six of 17 medial tibial lesions (35%) demonstrated some graft resorption peripherally.

At a mean of 59 months, no additional components demonstrated evidence of radiographic loosening (component position change or complete or near complete circumferential radiolucent lines) other than the one knee that was revised. All other components were well fixed at final followup with no evidence of loosening.

At last followup, the mean clinical and functional Knee Society scores were 90 (range, 58–100) and 73 (range, 40–100) points, respectively.

Discussion

After TKA, some patients present with extensive wear and osteolysis around well-fixed and well-aligned components. A similar scenario of osteolysis and polyethylene wear occurs around well-fixed modular acetabular components. Several authors have reported liner exchange and bone grafting of periacetabular osteolytic lesions [7, 8], but not liner exchange and substantial osteolysis around a TKA. We therefore evaluated the technique of liner exchange and bone grafting for cases of wear and extensive osteolysis around TKAs in which the components were well-fixed and well-aligned to determine (1) rerevision rates; (2) fate of the bone graft; (3) radiographic loosening rates; and (4) functional scores.

There are several limitations to the present study. First, we had a relatively small number of cases. This is not a widely used technique and, when combined with the specific indication and exclusion criteria, resulted in a very few cases. Second, multiple surgeons at multiple institutions contributed to the study to obtain adequate numbers. However, the larger number of surgeons likely means the findings are more generalizable. Further, although this is a multicenter study, the indications and exclusion criteria for

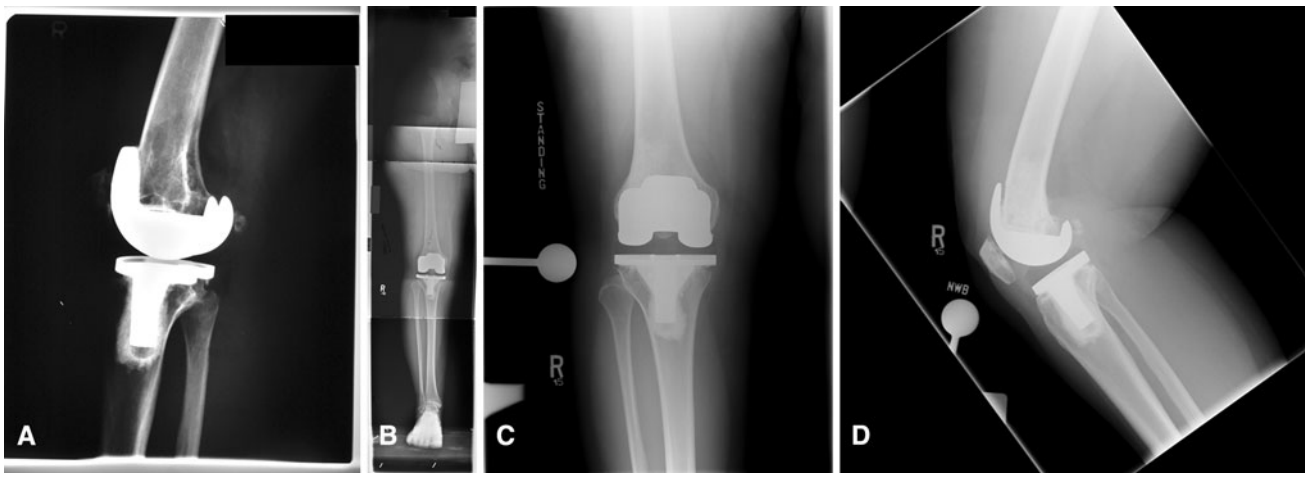

Fig. 2A–D Radiographs of a 45-year-old woman who underwent liner exchange and bone grafting of a femoral osteolytic lesion are shown. (**A**) The prerevision radiographs are shown; (**B**) the postrevision lower limb alignment view; (**C**) the 7-year postrevision radiographs, AP view and (**D**) lateral view, demonstrate restoration of anatomic alignment and complete incorporation of bone graft. At 7-year followup, the patient's Knee Society clinical and functional scores were 95 and 90, respectively, with a ROM of 0° to 125°.

this procedure were similar for all surgeons. Third, different types of prostheses were used in the total knees in this series. Because this study cohort involved revisions of the liner and bone grafting only, we were constrained by the fact that the prostheses used in the initial situation were dictated at the time of primary TKA. Fourth, there were a number of different types of bone grafting material used. The decision regarding what type of material to use was left to the discretion of the surgeon performing the procedure. Ideally, it would have been better if all surgeons used the same material, but this could not be the case because not all institutions have the same materials available. Fifth, we are aware of the possible limitations of examining osteolytic lesions on radiographs. Radiographs reportedly underestimate the extent of osteolysis [2]. While it would have been better to do further imaging, such as CT evaluation, it was not available in this retrospective study. Sixth, alignment was determined on an AP radiograph since long cassettes were not always available. However, alignment was reconfirmed intraoperatively. Seventh, quantification of articular and backside wear was not performed on the removed tibial liners. Finally, the results reported are the initial results of our combined experience at average 5-year followup. Further followup is warranted.

At a mean of 61 months followup, only one case (4%) was revised for loosening 8 years after the initial revision. This compares more favorably than the other rerevision rates reported in the literature for liner exchange revisions in TKA, with rates reported as high as 25% at mean 3 year followup [1, 3, 5]. One key difference is that those previous studies had indications for liner exchanges beyond just wear and osteolysis and included instability and stiffness among other diagnoses. To our knowledge, there are no reported series of liner exchange only and bone grafting for cases of extensive osteolysis around TKAs.

Fully or mostly incorporated graft occurred in 11 of 13 (84.6%) femoral lesions and 14 of 20 (70%) tibial lesions, respectively. This is similar to other published results for liner exchanges in TKAs with 97% of osteolytic lesions demonstrating no progression at mean 44 month followup [5] and THAs with 94% of osteolytic lesions regressing or resolving at 3 year followup [9].

Besides the revised case, all other components were well fixed with no evidence of radiographic loosening (Fig. 2). The 4% loosening rate of our study was lower than reported other series, despite the massive (up to 54 cm^2 on a single projection) osteolysis [5].

Mean clinical and functional Knee Society scores were 90 (range, 58–100) and 73 (range, 40–100) points, respectively, which was comparable to the mean 92 reported at mean 44 month followup in another series [5].

The present series of 25 cases with extensive osteolysis around well-fixed and well-aligned components in which débridement of the osteolytic lesions, bone grafting of the lesion, and liner exchange with appropriate ligament balancing has demonstrated excellent results at an average of 61 months with only one case (4%) rerevised 8 years after the initial revision and no additional component loosening. Most of these cases would have required massive allografts or metal augmentation at revision surgery. The authors continue to selectively use this approach and recommend that it be included in the options at the time of revision TKA. The only caveats are that the strict indication and exclusion criteria should be adhered to and that this is not a common scenario (< 1% of the revisions performed by the surgeons involved).

Acknowledgments We thank Steve S. Liu, MD, Matthew E. Lovell, MD, Stephen G. Taylor, MD, Craig J. Della Valle, MD, and Aaron G. Rosenberg, MD for their role in data collection and analysis, manuscript preparation and revision, as well as contributing cases.

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