Revision Total Knee Arthroplasty for Aseptic and Septic Causes in Patients with Rheumatoid Arthritis

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Abstract Revision total knee arthroplasty in patients with rheumatoid arthritis can be challenging. We asked whether we could confirm previously reported high failure rates following revision total knee arthroplasty in patients with rheumatoid arthritis. We therefore determined the Knee Society knee score and function scores, radiographic evidence of failure, and overall survival of the revision procedure in these patients. We retrospectively reviewed 39 patients with rheumatoid arthritis who underwent 45 TKA revisions from 1994 to 2006. Twenty-seven of the 45 TKA revisions were for mechanical failure of the prosthetic components and 18 for infection. Five of the 27 knees (19%) revised for mechanical failure subsequently failed a second time. Five of the 18 patients who underwent revision for infection died within 6 months and three of the remaining knees failed secondary to reinfection. Excluding the knees that failed, the average Knee Society knee score and function score improved in both subgroups. Two knees had radiographic evidence of nonprogressive tibial radiolucencies. The probability of survival for all knees (revision as the end point) was $76\% \pm 9\%$ at 5 years. We confirmed the previously reported high mortality and subsequent failure rates following revision total knee

arthroplasty for both mechanical issues and infection in patients with rheumatoid arthritis and emphasize the potential difficulties in treating these patients.

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

Introduction

The number of revision total knee arthroplasty procedures performed in the United States is currently on the rise and is projected to continue increasing at a high rate [18–20]. A small fraction of these revision procedures are performed in patients with rheumatoid arthritis. The overall failure rate (subsequent revision) and the clinical outcome after a primary total knee arthroplasty are reportedly similar in patients diagnosed with either osteoarthritis or rheumatoid arthritis [7, 9, 11–14, 16, 17, 21, 22, 24, 25, 27]. In contrast, the reported failure rate following revision total knee arthroplasty in patients with rheumatoid arthritis ranges from 19% to 28% [26, 28–30]. Rösser, in the earliest report, demonstrated a failure rate of 28% in a selected series of 76 revisions for both mechanical reasons and infection [26]. Sheng et al. in a later report also demonstrated a high failure rate of 19% in a smaller series of 16 revision procedures [29].

Our objective was to confirm the findings reported by previous authors regarding the high failure rate following revision total knee arthroplasty in a selected series of patients with rheumatoid arthritis treated for either mechanical reasons or infection. We therefore report (1) the functional status of these patients (Knee Society knee score and function score); (2) radiographic signs of failure (bone-cement radiolucencies, osteolytic lesions, and

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Each author certifies that his or her institution has approved the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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component subsidence or migration); and (3) the overall survival rate of the revision procedure with a second revision procedure as the endpoint.

Patients and Methods

We retrospectively reviewed the medical records and radiographs of all 39 patients (45 knees) with rheumatoid arthritis who underwent a revision total knee arthroplasty procedure from January 1994 to January 2006. Our data analyzed were collected prospectively and stored in a total joint arthroplasty database. Thirty-two of the patients were women and seven men. Twenty-three revisions were performed on the right knee and 22 on the left. The average patient age ($\pm$ standard deviation) at the time of revision surgery was 61.9 ± 12.1 years (range, 32–83 years). The primary total knee arthroplasty procedure was performed at our institution in 30 of the 45 revision procedures reviewed. The average time to revision from the initial primary procedure in these 30 knees was 96.6 months (range, 0.5–204 months). For the remaining 15 revision procedures, the details of the primary total knee arthroplasty were not available for review as these patients were referred by neighboring institutions. Overall, 27 of the revision procedures were performed for mechanical failure (aseptic failure) of one or more of the prosthetic components and 18 of the revision procedures were indicated for either subacute or chronic infection (septic failure) (Table 1). The minimum followup was 2 years (range, 2–9 years). For patients with mechanical failure the average followup was 48.5 months (range, 24–108 months), while the average followup for patients with infection was 52.3 months (range, 24–129 months). Two patients were lost to followup (one aseptic failure, one septic failure). No patients were seen in followup specifically for this study, however, the senior authors (MJK, VMG) have evaluated and followed these patients continually. Institutional review board approval was obtained prior to the collection of any data.

All patients undergoing revision total knee arthroplasty for mechanical failure were treated with a similar surgical

protocol. We excluded deep periprosthetic infection in all patients by routine white blood cell count, erythrocyte sedimentation rate, C-reactive protein, and aspiration and culture of the joint. After removal of the tibial polyethylene component, each of the prosthetic components was individually evaluated for wear and mechanical stability. Severely worn or mechanically loose components were revised at the discretion of the operating surgeon and the tibial polyethylene was exchanged routinely. The degree and complexity of the revision procedure and the necessary revision components used varied within this subgroup of patients (Table 2).

Patients who underwent revision for infection presented with similar symptoms, including pain, a large knee effusion, knee erythema and warmth, difficulty with knee range of motion, and pain with weight bearing. Deep periprosthetic infection was confirmed in all 17 revisions by routine white blood cell count, erythrocyte sedimentation rate, C-reactive protein, aspiration with joint fluid cell count, and culture of the joint fluid. The infection was considered chronic in 14 patients (15 knees) and acute in two patients (two knees). A number of organisms were cultured from either the initial knee aspirate or from the intraoperative biopsy specimens (Table 3).

Twelve of the 17 knees treated for infection were managed with a two-stage periprosthetic infection protocol (Table 3). During the first stage, all prosthetic components were removed, a complete irrigation and débridement of the joint was performed, all remaining cement was removed using bone conserving techniques, and an antibiotic-laden cement spacer was inserted. After a 6-week course of intravenous antibiotic therapy and normalization of a patient's serologic markers, the second-stage reconstruction was performed. Three knees with a chronic infection and two knees with a more acute infection history were managed by complete irrigation and débridement of the knee on multiple occasions during the same hospital course with exchange of the tibial polyethylene component (Table 3). A two-stage periprosthetic infection protocol was not performed for the three knees with a chronic infection as this protocol was deemed too extensive and potentially life threatening in these patients.

Table 1. Patient demographics and surgical indications for revision

Variable	Revision TKA for mechanical failure	Revision TKA for infection
Patients identified	n = 24 (20 female, four male)	n = 17 (13 female, four male)
Revision procedures	n = 27	n = 18
Patients lost to followup	n = 1 (female)	n = 1 (female)
Age (mean $\pm$ SD)	61 $\pm$ 12 years (range, 32–84 years)	63 $\pm$ 12 years (range, 44–79 years)
Time to revision following primary TKA (mean $\pm$ SD)	101 $\pm$ 62 months (range, 0.5–188 months)	90 $\pm$ 61 months (range, 21–196 months)

TKA = total knee arthroplasty; SD = standard deviation.

Table 2. Revision components utilized following mechanical failure (aseptic)

Patient	Femoral component	Femoral component augments/stem	Tibial component	Tibial component augments/stem	Patellar component
1	Nexgen—LCKK	Yes/Yes	Nexgen—CCK polyethylene	Yes/Yes	Genesis Biconvex
2	Nexgen—LCKK	No/Yes	Nexgen—CCK polyethylene	Yes/Yes	Nexgen
3	Nexgen—LCKK	No/Yes	Nexgen—CCK polyethylene	Yes/Yes	Genesis Biconvex
4	Nexgen—LCKK	No/Yes	Nexgen—CCK polyethylene	No/Yes	Nexgen
5	Nexgen—LCKK	Yes/Yes	Nexgen—CCK polyethylene	No/Yes	Genesis Biconvex
6	Nexgen—LCKK	Yes/Yes	Nexgen—CCK polyethylene	Yes/Yes	Genesis Biconvex
7	Nexgen—LCKK	Yes/Yes	Nexgen—CCK polyethylene	No/Yes	Genesis Biconvex
8	PFC	Yes/Yes	PFC—polyethylene	Yes/Yes	Genesis Biconvex
9	PFC	No/Yes	PFC—polyethylene	No/No	PFC
10	IB 2—CCK	No/No	IB 2—CCK polyethylene	Yes/Yes	IB 2
11	Howmedica rotating hinge	Yes/Yes	Howmedica rotating hinge	Yes/Yes	Howmedica
12	IB 2—CCK	No/Yes	IB 2—CCK polyethylene	Yes/Yes	Patelloplasty
13	Nexgen—LCKK	No/No	Nexgen—CCK polyethylene	Yes/Yes	*
14	Nexgen—LCKK	Yes/Yes	Nexgen—CCK polyethylene	No/Yes	*
15	Nexgen rotating hinge	Yes/Yes	Nexgen rotating hinge	No/Yes	*
16	MGI	Yes/Yes	* – Polyethylene exchanged	No/No	IB 2
17	Nexgen—LCKK	Yes/Yes	* – Polyethylene exchanged	No/No	*
18	Nexgen—LCKK	Yes/Yes	* – Polyethylene exchanged	No/No	*
19	*	No/No	IB 2—PS polyethylene	No/No	*
20	*	No/No	Apollo—polyethylene	Yes/Yes	*
21	*	No/No	MG 2—polyethylene	No/Yes	*
22	*	No/No	Apollo—polyethylene	No/Yes	*
23	*	No/No	* – Polyethylene exchanged	No/No	Genesis Biconvex
24	*	No/No	* – Polyethylene exchanged	No/No	Genesis Biconvex
25	*	No/No	* – Polyethylene exchanged	No/No	*
26	*	No/No	* – Polyethylene exchanged	No/No	*

NexGen LCKK = Legacy constrained condylar knee (Zimmer, Warsaw, IN); Genesis biconvex (Smith & Nephew, Memphis, TN); PFC = press-fit condylar (Johnson & Johnson, Rayham, MA); IB 2 CCK—Insall-Burstein II constrained condylar knee (Zimmer); PS = posterior stabilized (Zimmer); MG = Miller-Galante (Zimmer); MG2 = Miller-Galante II (Zimmer); Apollo = Apollo total knee system (Zimmer); * = component retained.

Each patient underwent supervised postoperative physiotherapy. All patients were allowed to weight bear to tolerance and were mobilized by postoperative Day 1. During the acute hospital course each patient participated in daily physiotherapy for 30 to 45 minutes. Following hospital discharge, patients continued an outpatient supervised physiotherapy regimen at a duration and intensity suggested by the physiotherapist.

Each patient was asked to return for evaluation following the revision procedure at 6 weeks, 3 months, 6 months, 12 months, and annually thereafter. Knee stability, range of motion, and a physical exam assessment of any ongoing symptoms were each performed. Patients were questioned specifically with regard to the Knee Society questionnaire form. The preoperative and postoperative Knee Society knee scores and Knee Society function scores were available for all patients at their most recent followup [15].

Radiographic analysis of the femoral, tibial, and patellar components was available for review in all patients. Postoperative and most recent followup radiographs of all patients were reviewed by the performing surgeon using the recommendations of the Knee Society [5]. Specifically, the treating surgeon examined the radiographs for any radiolucencies at the bone-cement interface of the femoral, tibial, and patellar components and recorded the findings in the database. Osteolytic lesions were noted and components were analyzed for any subsidence or component migration. Blinded radiographic analysis was not performed. Full-length weight-bearing radiographs were not available for the majority of patients; therefore, alignment parameters based on the anatomic axis were not analyzed.

For both subgroups of patients, we defined failure as the need for a subsequent revision procedure for any reason following the initial revision total knee arthroplasty. We

determined differences in the mean Knee Society knee score, Knee Society function score, and knee range of motion between patient's preoperative and most recent followup scores using a paired Student's *t*-test. Our data were tested for their overall distribution meeting the assumptions of a parametric test. Survival analysis with subsequent revision procedures for any cause as the end point was performed using a Kaplan-Meier survival plot with 95% confidence intervals. We did not perform

survival analysis for the subset of infection revisions because of the large number of early deaths. Minitab Release 15 software (State College, PA) was used for statistical analysis.

Results

A total of eight failures occurred in (21%) at a mean of 43.6 months (range, 0.7–123 months) following revision total knee arthroplasty in patients with rheumatoid arthritis. Failure occurred in five of the 26 knees (19%) that underwent revision total knee arthroplasty for mechanical failure (aseptic failure). These failures occurred at a mean of 46.1 ± 49.3 months (range, 0.7–123 months) postoperatively (Table 4). Five patients (five knees, 29%) who underwent a two-stage periprosthetic infection protocol died within 6 months of the first stage (Table 5). Of the remaining 12 knees that underwent revision for infection, three failures occurred from recurrent infection at a mean of 39.6 ± 61 months (range, 3–110 months) postoperatively (Table 6).

Patients who underwent revision total knee arthroplasty for mechanical reasons experienced pre- to postoperative improvements in the mean Knee Society knee score ($p < 0.001$), knee function score ($p = 0.001$), and knee

Table 3. Organisms cultured and the treatment algorithm used for patients who underwent revision TKA for infection

Patient	Organism cultured	Treatment
1	Streptococcus pneumonia	Retention of prostheses, I/D, chronic suppressive Abx
2	MRSA	2-staged periprosthetic protocol
3	MRSA	2-staged periprosthetic protocol
4	MRSA	2-staged periprosthetic protocol
5	MRSA	2-staged periprosthetic protocol
6	MRSA	2-staged periprosthetic protocol
7	MSSA	2-staged periprosthetic protocol
8	MSSA	Retention of prostheses, I/D, chronic suppressive Abx
9	MSSA	Retention of prostheses, I/D, chronic suppressive Abx
10	MSSA	Retention of prostheses, I/D
11	Coag. (–) staph	2-staged periprosthetic protocol
12	Coag. (–) staph	2-staged periprosthetic protocol
13	No growth	Retention of prostheses, I/D
14	No growth	2-staged periprosthetic protocol
15	No growth	2-staged periprosthetic protocol
16	No growth	2-staged periprosthetic protocol
17	No growth	2-staged periprosthetic protocol

TKA = total knee arthroplasty; I/D = irrigation and débridement; Abx = antibiotic; MRSA = methicillin-resistant *Staphylococcus aureus*; Coag. (–) staph = coagulase-negative staphylococci; MSSA = methicillin-sensitive *Staphylococcus aureus*; No growth = no specific organism was cultured.

Table 5. Cause and time to death after revision TKA for five patients treated for infection

Patient	Cause of death	Time to death after revision TKA
1	Bacteremic septic shock	4 days
2	Bacteremic septic shock	2 months
3	Bacteremic septic shock	6 months
4	Gastrointestinal carcinoma hemorrhage	3 months
5	Unknown	2 months

TKA = total knee arthroplasty.

Table 4. Patients who failed revision TKA for mechanical reasons

Patient	Component revised—first revision	Time to failure	Surgical indication—second revision	Treatment—second revision
1	Femoral, tibial	1 month	Acute periprosthetic infection	Retention of prostheses, I/D
2	Femoral, tibial	6 months	Arthrofibrosis, poor knee ROM	Lysis of adhesions
3	Tibial	42 months	Mechanical failure—tibial component	Complete revision—constrained TKA
4	Tibial	59 months	Mechanical failure—tibial component	Complete revision—constrained TKA
5	Patella	123 months	Mechanical failure—femoral, tibial components	Complete revision—constrained TKA

TKA = total knee arthroplasty; I/D = irrigation and débridement; ROM = range of motion.

Table 6. Patients who failed revision TKA for infection

Patient	Surgical indication—first revision	Treatment—first revision	Organism—first revision	Time to failure	Organism—second revision	Treatment—second revision
1	Acute periprosthetic infection	Retention of prostheses, I/D	MSSA	6 months	MSSA	2-staged periprosthetic protocol
2	Chronic periprosthetic infection	2-staged periprosthetic protocol	Coag. (–) staph	3 months	Coag. (–) staph	Retention of prostheses, I/D, chronic suppressive Abx
3	Chronic periprosthetic infection	2-staged periprosthetic protocol	MRSA	110 months	MRSA	Retention of prostheses, I/D, chronic suppressive Abx

TKA = total knee arthroplasty; I/D = irrigation and débridement; Abx = antibiotic; MSSA = methicillin-sensitive *Staphylococcus aureus*; Coag. (–) staph = coagulase-negative staphylococci; MRSA = methicillin-resistant *Staphylococcus aureus*.

Table 7. Preoperative and postoperative knee scores and range of motion

Surgical indication for revision TKA	Preoperative Knee Society knee score	Preoperative Knee Society function score	Postoperative Knee Society knee score	Postoperative Knee Society function score	Preoperative knee ROM	Postoperative knee ROM
Mechanical failure	37 (range, 8–65)	37 (range, 0–93)	75 (range, 33–99)	54 (range, 0–90)	86°	105°
Infection	44 (range, 38–50)	18 (range, 0–45)	75 (range, 53–99)	52 (range, 5–90)	69°	99°

TKA = total knee arthroplasty; ROM = range of motion.

Fig. 1 Survival curve following revision total knee arthroplasty in rheumatoid arthritis patients with a second revision for any reason as an end point. Indications for revision included both mechanical failure and infection. 95% confidence intervals are depicted above and below the survival curve.

range of motion ($p = 0.003$) (Table 7). Patients who had revisions performed for infection had improvements in the mean Knee Society knee score ($p = 0.001$), the knee function score ($p = 0.008$), and knee range of motion ($p = 0.002$) (Table 7).

Of the patients who underwent revision for mechanical reasons (excluding the five failures) one knee had a 2-mm to 3-mm radiolucent line along the tibial bone-cement interface at the medial joint line. Of patients revised for infection (excluding the five deaths in the early postoperative period and the three failures for recurrent infection) one knee had a 1-mm to 2-mm radiolucent line along the tibial bone-prosthesis interface. We observed no osteolytic

Fig. 2 Survival curve following revision total knee arthroplasty for mechanical failure in rheumatoid arthritis patients with a second revision for any reason as an end point. 95% confidence intervals are depicted above and below the survival curve.

lesions in the other patients and no evidence of subsidence or migration of the components.

The probability of survival for both revision indications (mechanical and infection) was $76.8\% \pm 9.6\%$ (95% confidence interval, 58.1% to 95.5%) at 59 months (Fig. 1). Survival for mechanical issues alone showed the probability of survival was $74\% \pm 12.5\%$ (95% confidence, 49.5% to 98.6%) at 58 months (Fig. 2).

Discussion

The survival rate and clinical outcome following primary total knee arthroplasty is reportedly similar in patients with

osteoarthritis and rheumatoid arthritis [7, 9, 11–14, 16, 17, 21, 22, 24, 25, 27]. Outcomes of revision surgery for osteoarthritis have been extensively reviewed but less has been reported on the outcomes following revision for selected patients with rheumatoid arthritis [26, 28–30]. The purpose of this study was to confirm the findings reported by Rööser et al. [26] and Sheng et al. [29] regarding the high failure rate (19–28%) following revision total knee arthroplasty in a selected series of patients with rheumatoid arthritis treated for either mechanical reasons or infection. Additionally, we aimed to expand the literature by reporting (1) the clinical function of the revision procedure based on the Knee Society knee score and function score; (2) our radiographic findings at the time of followup including bone-cement radiolucencies, osteolytic lesions, and component subsidence or migration; and (3) the overall survival rate of the revision procedure with a second revision procedure as the endpoint.

We recognize some limitations in this study. First, ours was a select patient population and selection bias may have influenced the outcomes. Second, the size of our cohort is also relatively small particularly when evaluating patients undergoing revision for mechanical failure separately from those who underwent revision for infection. However, the small number of patients reviewed reflects the rarity of these procedures in patients with rheumatoid arthritis but may nonetheless lead to small-sample bias. Despite the small number of patients reported, only two patients were lost to followup of less than 2 years. Third, we did not perform a blinded radiographic analysis. Fourth, our analysis of patients treated for infection was limited owing to the number of deaths (29%) that occurred within 6 months of the revision procedure. Fifth, the primary and revision

total knee arthroplasty components were of a heterogeneous population. Finally, the revision procedures performed and the level of surgical complexity were also heterogeneous and comparison to a control population was not possible.

In the cohort of 24 patients (26 knees) treated for mechanical failure of one or more of the prosthetic components, five failures occurred (19%) at a mean of 46 months following revision. The failure rate in our selected series is similar to previously published reports (Table 8) [26, 29]. With regard to patients treated for infection, our failure rate of 25% is also comparable to the results of others (Table 8) [1, 3]. Bongartz et al. questioned whether this high rate of reinfection was actually due to persistent undetectable bacteria [3], whereas, Berbari et al. demonstrated that a two-staged infection protocol may yield the best survival for patients with rheumatoid arthritis [1]. The high rate of failure observed in patients with rheumatoid arthritis is likely multifactorial as this autoimmune disease can directly affect a patient's bone quality [32], ligament integrity [22], and reactivation of joint synovitis can lead to further implant loosening [6].

When excluding the failures that occurred, the Knee Society knee score and the Knee Society knee function score improved in patients treated for mechanical failure and infection. Improvements in knee scores were overall higher than improvements in knee function scores that may reflect multiple joint involvement associated with rheumatoid arthritis. For patients undergoing revision for mechanical failure, the overall improvement in the Knee Society knee score and the Knee Society knee function score is comparable to the findings of Sheng et al. (Table 8) [29]. Further comparison of our results to other

Table 8. Comparison of our results with previously published reports

Author	Number of revision TKAs	Indication for revision	Failure rate	Time to failure	Survival (%)	Average Knee Society knee score (preoperative–postoperative)	Average Knee Society knee function score (preoperative–postoperative)
Berbari et al. [1]	200	Infection	21–68%	*	*	*	*
Bongartz et al. [3]	24	Infection	29%	*	*	*	*
Rööser et al. [26]	76	Mechanical and infection	28%	≤ 6 Years	71% at 6 years	*	*
Sheng et al. [29]	16	Mechanical and infection	19%	≤ 4 Years	81% at 4 years	37–88	26–34
Garcia et al. [current study]	43	Mechanical and infection	19–25%	average, 46 months (mechanical) and 40 months (infection)	77% at 5 years	37–75	37–54

* = data unavailable; TKA = total knee arthroplasty.

authors was not possible as either a comparable clinical evaluation system was not used or patients with rheumatoid arthritis were not analyzed independently from patients with osteoarthritis [8, 26].

After excluding the patients who either died or failed, nonprogressive tibial radiolucencies were noted in only two patients (two knees). Both patients have been asymptomatic at 76 months and 44 months postoperatively. These patients are closely followed and no further revision procedure has been indicated. Similarly, Sheng et al. also noted radiolucent lines in five of 16 knees; all were less than 1 mm in width and none required subsequent revision [29]. No additional radiographic osteolytic lesions have been identified in the remainder of patients and no component has subsided or migrated.

The overall survival rate following revision total knee arthroplasty in this series of rheumatoid arthritis patients was 77% at 59 months. The survival rate at our institution is comparable to the reports of others (Table 8) [26, 29], but is substantially lower than the reported survival rate of 94% to 97% following revisions performed in patients with osteoarthritis [10, 23, 33].

In conclusion, revision total knee arthroplasty can be a challenging and complex endeavor in patients with advanced rheumatoid arthritis. Revision total knee arthroplasty in these patients carries a substantial risk of morbidity and mortality that is higher than patients with osteoarthritis [2, 31]. One contributing factor may be the use of disease-modifying antirheumatic medications and high-dose corticosteroids leading to an increased risk of adverse long-term outcomes [4, 31]. Our high failure rate following revision total knee arthroplasty for both mechanical issues and infection in patients with rheumatoid arthritis is similar to other studies and emphasizes the potential difficulties in treating these patients.

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