

Revision Total Knee Arthroplasty with Cemented Components and Uncemented Intramedullary Stems

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Abstract: Sixty-three failed total knee arthroplasties in 60 patients (27 females, 33 males; average age, 66 years) were treated consecutively with revision using cemented component fixation and an uncemented stem. Patients were followed for a mean of 5.75 years (range, 2–10 years); none were lost to follow-up. There were 12 (19%) re-revisions: 6 (10%) were revised for aseptic loosening, 4 (6%) for recurrent infection, and 2 (3%) for instability. Knee Society Pain Scores improved from 56 to 81, and function scores improved from 49 to 62 points. Latest radiographs in retained knees showed none with definite femoral loosening but 4 with tibial component loosening. Combining those revised for aseptic loosening and radiographic aseptic loosening, mechanical failure occurred in 10 patients (16%). **Key words:** revision, total knee arthroplasty, cement, uncemented stems.

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Revision total knee arthroplasty (TKA) often is performed in patients with poor bone quality or marked bone loss, and in these circumstances, stemmed components are helpful to obtain a stable construct [1–18]. There is general agreement that stemmed components should be used when there is substantial damage to the metaphyseal bone or when a large metal augment or bone graft is used, because stems can bypass areas of deficient bone and off-load interface stresses over a large area. Most surgeons presently prefer to cement the interfaces of the distal femur and proximal tibia, but it is controversial whether the intramedullary stems should be cemented or uncemented. There are theoretical advantages and disadvantages to each technique. Cemented stems increase the area of cement fixation to bone and can be used in many different

bone geometries, but can be difficult to remove. Uncemented stems that are not porous-coated can provide initial mechanical fixation but probably do not provide long-term biologic implant fixation. There are few studies, most with limited follow-up, that have been published regarding uncemented (press-fit) intramedullary stems and limited cement fixation in revision TKA [19–24].

The purpose of this study was to review the clinical and radiographic outcome of revision TKA using cemented component fixation with uncemented intramedullary stems.

Materials and Methods

Between 1991 and 1998, 60 patients (63 knees) were treated with revision TKA at our institution using limited cement fixation of the femoral and tibial components and uncemented intramedullary stems. Revisions in which hinged components were used, revisions in which only 1 of the 2 components (femoral or tibial) had a stem, and revision in which the stems were cemented were excluded. There were 27 females and 33 males, with a mean age of

From the Mayo Clinic Foundation, Rochester, Minnesota.
No benefits or funds were received in support of this study.
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0883-5403/03/1807-1239\$30.00/0
doi:10.1054/S0883-5403(03)00301-2

66 years (range, 38–85 years) at the time of revision. The reasons for revision of the previous arthroplasty were aseptic loosening in 33, 2-stage reimplantation of previous TKA infection in 21, polyethylene wear in 7, and instability in 2 knees.

Twenty-nine knees were treated with a PressFit Condylar (PFC) (DePuy, a Johnson & Johnson Company Wausaw, IN) knee components, and 34 knees received Genesis I (Smith and Nephew, Memphis, TN) implants. A posterior stabilized (cruciate substituting) polyethylene insert was used in 44 knees, a semiconstrained insert (stabilized plus) in 9 knees (PFC), and constrained condylar implants in 10 knees (4 PFC; 6 Genesis). If the patella was well fixed with minimal wear, it was left in place and not revised. Severely worn or loose patellar components were revised. Thirty-seven knees had the patella revised to a cemented all-polyethylene implant using these criteria, and 12 had the existing patellar component left in place. No patellectomies were performed.

An uncemented, press-fit, intramedullary stem was used for both the tibial and femoral component in all patients. The average femoral stem length was 140 mm (range, 90–200 mm), and the average tibial stem length was 85 mm (range, 40–150 mm). The canal fill was measured with a digital caliper at the point of maximal canal fill. The average femoral canal fill was 84% (range, 51–100%), and the average tibial canal fill was 88% (range, 67–100%). In all cases, the femoral and tibial components were cemented to their respective metaphyseal surface; no cement was placed within the medullary canal other than in the metaphysis. Modular metal augments were used for distal or posterior femoral condyle deficiencies in 36 knees and for proximal tibial deficiencies in 14 knees. Bone grafting with either bulk or particulate allograft bone was used to reconstitute the distal femur in 4 knees and the proximal tibia in 7 knees.

There were 12 failures (19%) that resulted in re-revision. The remaining 48 patients (49 knees) were reviewed and followed with radiographs and either a clinical exam or standardized letter or telephone questionnaire. Clinical outcomes were measured in accordance with the Knee Society Clinical Rating System [25,26].

Radiographic zonal measurements were performed in accordance with the Knee Society Total Knee Arthroplasty Roentgenographic Evaluation and Scoring System [25,26]. The modified Knee Society radiographic zones for long-stemmed tibial and femoral components were used to assess those zones along the intramedullary stems [12]. The standard radiographs included anteroposterior, lat-

eral, and merchant views [27,28]. Radiographs were reviewed by 3 of the authors (D.J.B., R.T.T., B.D.S.). Axial alignment was recorded from the immediate postoperative radiograph and at final follow-up.

Statistical analysis was performed using the Fisher exact test for 2-group comparisons and analysis of variance for comparisons of >2 groups with continuous outcome variables. Final mean follow-up was 5.75 years (range, 2–10.6 years). No patients were lost to follow-up.

Results

Twelve knees (19%) failed and were treated with component removal or another revision. Six were revised for aseptic loosening (10%), 2 (3%) for pain and instability, and 4 (6%) had their implants removed for infection. For those 6 knees that failed as a result of aseptic loosening, the femur was alone was loose in 0, the tibia alone in 4, and both components were loose in 2. The patella was loose in 3. The 4 knees that failed as a result of infection all were reimplantations of a previously infected knee arthroplasty.

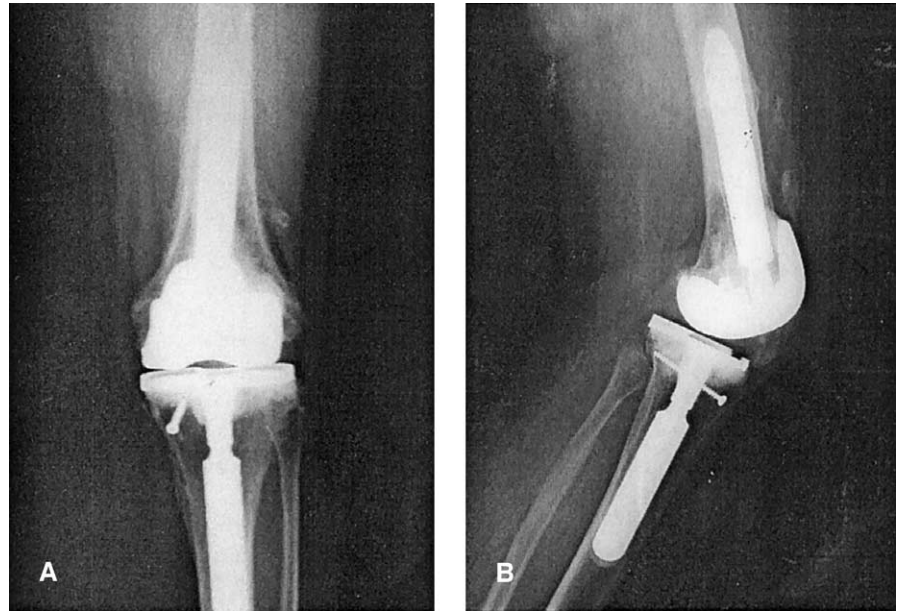
For patients with surviving prostheses, the Knee Society scores improved significantly from an average of 56 (range, 0–78) preoperatively to 81 (range, 45–99) at final follow-up ($P<.05$). The average function scores showed significant improvement from 49 (range, 5–80) preoperatively to 62 (range, 20–100) at final follow-up ($P<.05$). No significant differences could be shown between patients with a posterior stabilized tibial insert and those with a semiconstrained insert or constrained implant.

Ninety-one percent of patients who were not re-revised had no or mild knee pain at final follow-up. Nine percent had moderate pain, and no patient complained of severe pain. Fifty-seven percent were walking with minimal ambulatory aids. Range of motion increased from an average of 83° preoperatively to 101° at final follow-up.

Radiographs at last examination of knees that were not re-revised showed 0 with definite femoral loosening, but 4 with tibial loosening. None of these 4 patients had more than mild pain.

Five knees (10%) had radiolucencies at the bone-cement interface of the femur at final follow-up. These were located in zone 1 in 1 knee, zones 1 and 3 in 2 knees, and zones 1, 3, and 4 in 2 knees. Two of the 5 knees had radiolucent lines on the initial postoperative films. New, incomplete, parallel sclerotic lines <2 mm from the stem were seen in multiple zones about the noncemented femoral

Fig. 1. Typical anteroposterior (A) and lateral (B) radiograph 10 years after revision. Patient has minimal pain and implants are stable. Note halo about press-fit femoral and tibial stems.



stem in the majority of knees (90%) at final follow-up, and all but 1 patient (97%) had a halo about the proximal femoral stem tip (Fig. 1).

Fifty-seven percent of patients had radiolucent lines at the tibial bone-cement interface at final follow-up. Incomplete, parallel sclerotic lines <20 mm from the stem also were common around the noncemented tibial stem (97%) (Fig. 2).

Combining those knees revised for aseptic loosening and radiographic aseptic loosening, mechanical failure occurred in 10 knees (16%). Therefore, a total of isolated femoral components (0%), 8

isolated tibial components (13%), and 2 femoral/tibial components (3%) were either removed for aseptic loosening or were radiographically loose.

Complications included heterotopic ossification in 3 (1 was treated with heterotopic bone excision to improve range of motion with limited success), patellar osteolysis associated with a previous implanted metal backed device in 1, and prolonged wound drainage requiring debridement in 1. One patient had a nonfatal postoperative myocardial infarction.

Discussion

Component Radiolucencies

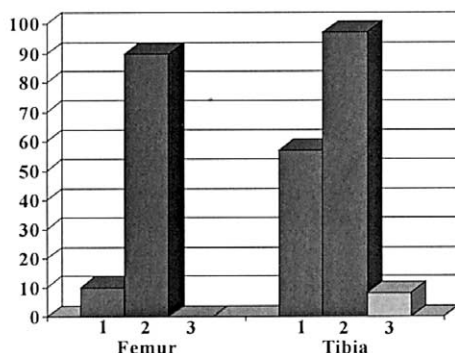


Fig. 2. Graph depicting component radiolucencies. 1, bone cement radiolucencies; 2, halo about pressfit stem; 3, loose components.

Revision TKA is commonly associated with poor bone quality and significant bone loss of the proximal tibia and/or distal femur [1,3,4,7-9,13-15,17,18]. The use of an intramedullary stem helps to provide load transmission to diaphyseal cortical bone and away from the distal femoral implant interface or proximal tibial implant interface [29-40]. Stems also help neutralize shear stresses caused by the prosthesis constraint required in some revision TKAs. However, Bourne and Finlay noted that this transfer of axial load might result in stress shielding and possibly affect long-term implant fixation [41].

The ideal method of intramedullary stem fixation remains controversial. There are advantages and disadvantages of uncemented and cemented stems in revision knee arthroplasty. The potential advantages of uncemented stems include ease of removal and preservation of bone stock if re-revision is

necessary. Disadvantages of uncemented, nonporous, coated stems include the ability to provide a press-fit mechanical stability without providing rigid long-term biologic fixation. Therefore, the limited cement-bone interface must provide all the long-term bone fixation. Additionally, large, press-fit stems possibly can produce pain at the tip of a stiff implant.

The advantages of cemented stems include immediate secure fixation, increased flexibility in placement of the implants (because minor adjustments may be made in the sagittal and coronal planes), and the ability to deliver an increased load of local antibiotics. The greatest problem of fully cemented stems is the difficulty of removal should another revision surgery be necessary. There are also concerns of stress shielding of the proximal tibia or distal femur.

Barrack et al [19] described diaphyseal pain in 11% of 66 patients with press-fit femoral stems and 14% of 50 patients with press-fit tibial stems at 4-year follow-up. Nineteen percent of patients with cemented tibial stems also experienced pain at the end of the stem. However, patients with press-fit stems were noted to have lower Knee Society clinical scores and were more likely to express dissatisfaction with the procedure than their counterparts with cemented tibial stems. Murray et al [12] reported on the clinical outcome of cemented long-stem revision TKA of 35 patients (40 knees) with an average follow-up of 58 months. They noted improvement in both Knee Society Scores and an overall tibial component radiolucency incidence of 32%. Whaley et al [42] reported on 38 cemented posterior stabilized revision TKAs using the stemmed kinematic stabilized prosthesis at a mean clinical follow-up of 10.1 years. They showed an increase in Knee Society pain scores from 17 to 51 and an increase in functional scores from 48 to 57 at last follow-up. They also noted a 10-year component survival free of revision or removal for any reason of 96.7% and an 11-year component survival free of revision for aseptic loosening at 95.7%.

Bertin et al [20] expressed concerns regarding infection and removal of cemented intramedullary stems and reported the preliminary results of revision TKA with uncemented intramedullary stems. They reported short-term results of 53 revision knee arthroplasties using minimally constrained implants with smooth, uncemented, intramedullary stems. Ninety-one percent had improvement of their pain and ambulatory ability, with an average follow-up of 18 months. Radiographically, there were no progressive radiolucent lines and no loose

components. The majority (65) developed thin, radiodense lines around the stem, and 5 developed cortical hypertrophy at the stem tip, which the authors believed indicated stress transfer to the bone through the stem.

Haas et al [21] reported the results of 76 revision TKAs with cemented components and uncemented stems at an average follow-up of 3.5 years. Improvement in Hospital for Special Surgery knee score, pain, walking, and range of motion were noted, with 83% having a good or excellent result at final follow-up and only 8% failures at 42 months. There was, however, a 20% incidence of activity-related pain. Progressive radiolucent lines were noted in 1% of femoral components and 3% of tibial components. The study included patients in whom only the femoral or tibial components were revised as well as those in whom the entire knee was revised. Smith et al [43] reported on the natural history of radiolucent lines using limited component fixation with cement and uncemented stems. They concluded that in the presence of a low-wear prosthesis, nonprogressive radiolucent lines were not predictive of tibial component failure. Jazrawi et al [44] reported on micromotion and stress transfer of tibial stems in a cadaver knee. He noted that long, press-fit stems produced equivalent stability compared with short cemented stems and avoided the potential problems of cement.

The present study of TKA with limited tibial and femoral component cement fixation and uncemented intramedullary stems suggests that satisfactory clinical results can be obtained in the majority of patients at >5 years after surgery. However, we are concerned that the overall mechanical failure rate (10 of 63 knees [16%]) was relatively high. These results are inferior to those seen in other reports of revision TKA with cemented stems, although the patient groups in each series may not be comparable.

Nonprogressive, partial radiolucencies and parallel, radiodense lines were observed around the majority (90%) of tibial components at the bone-stem interfaces. The significance of these radiodense lines remains unknown and warrants further observation.

Stem fixation in the present series was obtained with line-to-line intramedullary reaming until diaphyseal cortical fit could be obtained as evidenced on intraoperative radiographs. Our technique of press-fit intramedullary stems is different than other investigators. A "clinical press-fit" was used by Haas et al [21] because of concerns for excessive bone loss with reaming to cortical fit.

The limitations of this study include multiple surgeons each with their own indications for use of this technique and the length of stem needed. This study was conducted during the early phase of uncemented stem use at our institution. This technique may be best suited for patients with reasonable metaphyseal bone in which the stem can give initial implant stability but is not needed for long-term implant fixation.

Conclusion

This study found that patients with cemented components and uncemented stems had acceptable midterm clinical results, but the overall rate of mechanical failure, 16% at almost 6 years, is a concern.

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