The components of a total knee arthroplasty (TKA) are fixed to the underlying bone by means of polymethylmethacrylate cement or by bone ingrowth. TKAs that combine these 2 methods of fixation are called hybrid knees. Bone ingrowth fixation of a TKA component has several potential advantages over cement fixation, such as decreased duration of surgery, decreased third-party wear from cement debris, and preservation of bone stock if a revision procedure becomes necessary at a later date. For these advantages to be realized, bone ingrowth must occur reliably, and it must be durable.

This study assessed a series of hybrid TKAs (bone ingrowth femoral component, cemented tibial and patellar components) with at least 12 years of follow-up, focusing on the incidence of failure of the femoral component. This report is unique in that it details the long-term follow-up of patients who were operated on by 1 surgeon using 1 prosthetic design.

**Materials and Methods**

### Inclusion Criteria

Institutional review board exemption was obtained to review and report the results of hybrid TKA in a consecutive series of patients. All of the patients in this series had a preoperative diagnosis of osteoarthritis or posttraumatic arthritis and underwent a unilateral TKA by a single surgeon consecutively from January 1999 through December 2000. All of the TKAs were hybrid, with a press-fit femur, a cemented tibia, and a cemented all-polyethylene patellar prosthesis. The NexGen knee (Zimmer, Warsaw, Indiana) was used in all cases.

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Received: September 2, 2015; Accepted: November 11, 2015.

doi: 10.3928/01477447-20160427-05
A total of 121 patients (123 knees) underwent TKA between January 1999 and December 2000. Seventy-seven knees in 75 patients had follow-up for at least 12 years (range, 12-13 years). Sixty-four TKAs in 62 patients were examined, and radiographs were obtained. Thirteen patients with 13 TKAs were interviewed by telephone. Forty-one patients (33%) were lost to follow-up, and 5 patients (4%) had died prior to 12 years of follow-up. For the 75 patients (77 knees) available for follow-up, mean age at surgery was 61 years (range, 23-83 years). The study population included 24 men and 51 women.

Clinical Evaluation

After the first postoperative year, patients were instructed to return yearly for follow-up. During the 12th and 13th postoperative years, the senior author examined patients and determined the Knee Society Score (KSS) and the Knee Society Function Score (KSFS). Patients who failed to make or keep their 12-year appointment were called and asked to come in for an appointment. If they could not or did not want to come to the office, the patient or a family member was interviewed via telephone, and a KSFS was determined.

Radiographic Evaluation

Anteroposterior and lateral radiographs were obtained postoperatively in the recovery room. Weight-bearing anteroposterior and lateral radiographs along with Merchant’s view were routinely obtained at 3 weeks, 6 months, and then at yearly intervals postoperatively. These radiographs were not under fluoroscopy.

Surgical Technique

Exposure. A standard medial parapatellar retinacular approach was used for all patients.1 The fat pad was left intact. The lateral patellofemoral ligament was palpated and incised from outside to inside.

Patella. The patella was everted and cut “free hand,” removing all cartilage and subchondral bone. No effort was made to duplicate the preoperative thickness of the patella. A 3-peg patellar component was used. The size selected was the largest size that would not overhang any part of the native patella. The patellar component was cemented and clamped in place with the knee extended. As the cement hardened, the tibia was prepared.

Tibia. The anterior and posterior cruciate ligaments were excised, and the tibia was subluxed anteriorly. An intramedullary guide was used to position the cutting block, with the cut being made at 90° to the long axis of the tibia in the frontal plane and with a 2° posterior slope. The depth of the tibial cut was set to remove minimal bone from the diseased side of the knee.

Femur. An intramedullary guide was used to position the cutting block for the distal femoral cut. This cut was made in 5° of valgus and 0° of flexion-extension. In cases without a preoperative flexion contracture, the depth of the distal femoral cut was 10 mm. In cases with a preoperative flexion contracture, the depth of the distal femoral cut was increased to 12 or 14 mm depending on the degree of the contracture. Using a posterior referencing system, the appropriate size cutting block was applied to the distal femur in 3° of external rotation. The anterior, posterior, and chamfer cuts were made with a saw matched to the cutting guide to give accurate cuts. A side-cutting reamer was used to cut the trochlear recess.

Trial Reduction. At this point in the procedure, the patellar cement had hardened, and the patellar clamp was removed. The trial femur was impacted on the distal femur. The tibial baseplate was sized to maximize coverage of the tibia and to minimize overhang. Trial reduction determined the thickness of the polyethylene component. The largest size that allowed 0° of extension was selected. Release of the lateral or medial collateral ligament was rarely necessary and performed only in cases in which there was a pronounced preoperative deformity.

Component Placement. The tibial baseplate was cemented and impacted into place. The femoral component was impacted on the femur using the handle of the impactor to gently lever the component anteriorly. To prevent the prosthesis from “rolling” into flexion during insertion, which can occur as the fiber metal backing of the anterior flange engages the femur prior to and to a greater extent than the fiber metal of the posterior condyles, the impactor handle was levered up. The polyethylene spacer was inserted. Re-infusion drains were used, and a Robert Jones dressing was applied.

Postoperative Care

On the first postoperative day, the Robert Jones dressing and the drains were removed, and a light dressing was applied to the incision and the drain sites. Physical therapy included: weight-bearing as tolerated; and active and passive range-of-motion exercises, with emphasis on extension. On the third or fourth postoperative day, the patient was discharged to home with “in home” physical therapy or to a skilled nursing unit. The first office follow-up visit was at 3 weeks, at which time outpatient physical therapy was prescribed. The next follow-up visit was at 10 weeks to check the range of motion and to assess the need for more physical therapy. The next follow-up visit was at 6 months postsurgery, then at yearly intervals or as needed.

RESULTS

Clinical Results

Of the 77 knees (75 patients) with follow-up for at least 12 years, 64 TKAs (62 patients) were examined and radiographs were obtained. Thirteen patients (13 TKAs) were contacted by telephone for follow-up; radiographic follow-up was not performed for these patients. Average KSS and KSFS at final follow-up were 88 and 85, respectively (Table).
Femoral Component Failure

In 1 patient, the femoral component was revised for loosening (Figures 1-4). At the time of surgery, the patient’s age was 50 years. The patient progressed as expected until approximately 12 weeks after surgery when he began complaining of increasing pain. Radiographs at 12 weeks (Figure 2) were suspicious for loosening with a radiolucent area at the superior part of the anterior flange of the femoral prosthesis. In addition, reactive bone formation was noted superior to the anterior flange.

The patient’s next follow-up visit was 35 months after surgery. Clinically, he experienced pain and swelling with weight-bearing; the pain and swelling resolved with rest. Radiographically, the femoral component was loose (Figure 3). The patient’s femoral component was revised 39 months after the index procedure (Figure 4). His last examination was 5 years after revision surgery. There were no clinical or radiographic signs of loosening. Since then, the patient has been lost to follow-up. No other patients had radiographic signs of femoral component loosening at the time of last follow-up (Figure 5).

Tibial Component Failure

Four knees (5%) in 3 patients required revision to a thicker polyethylene spacer. One patient required bilateral revision; these revisions were performed at another facility at 16 and 20 months after his index procedures. His KSFS (obtained by telephone interview) at 140 and 148 months following the index procedure was 70. This patient is a type C patient with debilitating pulmonary disease, and he has not had further surgery.

The other 2 patients who underwent polyethylene revisions were revised 136 and 145 months after the index procedure. Their KSFS was obtained only in the 64 patients who were examined. One patient underwent revision of his tibial baseplate for loosening 118 months after the index procedure. During surgery, the tibial polyethylene was found to be loose and also was revised. In all of the revision surgeries, the femoral component was carefully examined and was found to be firmly attached to the underlying bone.

Patellar Component Failure

Two patients (3%) underwent revision of their patellar component for loosening. In the first patient described previously, the patellar component was found to be loose during a tibial component revision. The second patient underwent revision of the patellar component for loosening 108 months after the index procedure. During surgery, the tibial polyethylene also was revised because it appeared worn and the surface was pitted.

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Abbreviations: KSFS, Knee Society Functional Score; KSS, Knee Society Score.

$^a$ Patients are not limited by their other knee or by infirmity or multiple arthritis.

$^b$ Patients have a symptomatic contralateral knee that limits their function but do not have multiple arthritic joints or infirmities that limit their function.

$^c$ Patients have multiple arthritic joints or other infirmities that limit their function.

$^d$ KSS was obtained only in the 64 patients who were examined.

$^e$ KSFS was obtained in the 64 patients who were examined and in an additional 13 patients interviewed by telephone.

Figure 1: Lateral radiograph showing hybrid total knee arthroplasty in a 50-year-old man 3 weeks after surgery.

Figure 2: Lateral radiograph 12 weeks after surgery for the patient in Figure 1 showing a radiolucent line between the femur and the anterior flange superiorly and ossification superior to the anterior flange.
Infection, Fracture, and Amputation

One patient developed a deep postoperative infection treated with a 2-stage revision. He is currently 10 years post-re-implantation and has had no further signs of infection. He is a type A patient with a KSS of 85 and a KSFS of 80 at the time of last follow-up.

One patient developed bilateral hematogenous infections 120 and 117 months after her index procedures. She was treated with debridement, tibial polyethylene revision, and 6 weeks of intravenous antibiotics. She had no signs of recurrent infection at 32 months after treatment. She is a type A patient with a KSS of 95 bilaterally and a KSFS of 90.

The patient who underwent a tibial polyethylene revision at 136 months fell and sustained a supracondylar femur fracture 20 months after her revision. The fracture was treated successfully with a retrograde intramedullary nail.

One patient had a patellar tendon rupture that was repaired surgically 126 months following the index procedure. One patient underwent an above-knee amputation for vascular disease 147 months after the index procedure. The knee was not infected.

DISCUSSION

Aseptic loosening of the prosthetic components due to breakdown of the bone-cement interface has been recognized as an important cause of arthroplasty failure since the 1970s.\(^2\) Recognition of bone-cement interface failure led to the introduction of cementless TKAs. The goal of cementless TKAs was sufficient bone growth into the components to fix them to the underlying bone. The premise was that this “biologic” interface would not gradually deteriorate as a bone-cement interface does.\(^3,4\) Results of cementless TKA surgery varied, with some authors reporting good results\(^5-7\) and some authors reporting unacceptable results.\(^4,8\) As disparate as the results of these studies were, there were 2 areas of agreement: first, metal-backed patellar components were associated with a high incidence of failure, and second, loosening of the femoral component occurred infrequently.

Retrieval studies of cementless TKAs confirmed that bone growth occurred more reliably into the femoral component than either the patellar or tibial component.\(^9\) Hybrid TKAs with a cementless femoral component and cemented tibial and patellar components evolved from these studies. In theory, the hybrid TKA would take advantage of the more reliable bone growth into the femoral component. Cement fixation of the tibial component
would eliminate the risk of aseptic loosening due to failure of bone ingrowth. Cement fixation of the patella would eliminate the requirement for a metal back and therefore the failures associated with metal-backed patellae. The major potential advantage of a hybrid TKA over a cemented TKA is the formation of a durable biologic femoral prosthesis-bone interface. Other potential advantages of a hybrid TKA over a cemented TKA are decreased duration of surgery, decreased third-party wear from cement debris, and preservation of bone stock if a revision procedure is necessary later. Nevertheless, these potential advantages fade to insignificance if femoral fixation is inadequate due to failure of bone ingrowth or early osteolysis and loosening.

Short- and mid-term studies of hybrid TKAs (2-10 years) were promising, with no instances of revision for aseptic loosening of the femoral component. The results of long-term studies (10-17 years) have been mixed. Duffy et al13 reported a series of 74 hybrid TKAs with 11 to 17.8 years of follow-up. Salient aspects of this series are: the decision to use a hybrid knee or a cemented knee was made during surgery based on bone quality and patient age, 1 prosthesis design was used (Press-Fit Condylar prosthesis; Johnson & Johnson, Raynham, Massachusetts), the prostheses used were cruciate retaining, and more than 1 surgeon was involved in the study. Eleven of the 74 TKAs failed due to aseptic loosening of the femoral component for an incidence of 16%.13 Yang et al14 reported a series of 235 hybrid TKAs with 10 to 17 years of follow-up. This series also was selected. A total of 5 prosthesis designs were used, all of the surgeries were cruciate retaining, and 1 surgeon performed the surgeries. Twelve of the 235 knees failed due to aseptic loosening of the femoral component for an incidence of 5%.14

The current series included 77 hybrid TKAs with 12 to 13 years of follow-up. The series was not selected. One prosthesis design (Nexgen) was used, all of the surgeries were cruciate sacrificing, and 1 surgeon performed all of the surgeries. One instance of failure of bone ingrowth and resultant loosening of the femoral component was observed in the current study.

The differences between the current authors’ study and those reported by Duffy et al13 and Yang et al14 may account for why there was only 1 femoral component failure in 77 TKAs, whereas Duffy and Yang reported incidence rates of 16% and 5%, respectively, for femoral component failure. The Nexgen prosthesis differs from those used by Duffy and Yang in that it has a fiber metal backing as opposed to porous plasma spray or cobalt-chromium beads. In comparison with porous plasma spray and cobalt-chromium beads, fiber metal backing may provide a more stable initial friction interference fit or it may be a better stratum into which bone can grow. In the current authors’ study, all of the TKAs were cruciate sacrificing, whereas all of the TKAs in Duffy’s and Yang’s series were cruciate retaining. This is significant because the cruciate-sacrificing prosthesis used in the current series is posterior stabilized. The femoral component has a box to accommodate the tibial post. This box is cut into the trochlear recess and adds to the surface area of the bone-prosthesis interface, which may increase the initial stability of the friction interference fit of the prosthesis to the bone.

In the current series, 1 surgeon performed all of the surgeries using 1 prosthetic design. The same technique was used in all cases; for example, tibial and femoral intramedullary guides were always used, the fat pad was always left intact, and captured cutting blocks with a specific saw blade that precisely matched the cutting block were always used. Whether intramedullary guides result in better alignment, whether leaving the fat pad decreases the incidence of patellar avascular necrosis, or whether captured cutting blocks yield more accurate cuts is open to debate. However, the fact that the same technique was used in all of the cases eliminates differences in technique as a confounding variable.

Whether the other potential advantages of the hybrid TKA (ie, decreased operative time, decreased third-party wear from cement particles, and preservation of bone stock for revision surgery later) are realized is beyond the scope of the current study. However, based on this series and subsequent experience, the current authors believe the goal of a reliable durable biologic femoral prosthesis-bone interface has been achieved using a hybrid cruciate-sacrificing TKA for a specific knee design.

REFERENCES


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