Clinical Results of Bone Ingrowth TKA in Patients with Rheumatoid Arthritis

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Abstract Patients with rheumatoid arthritis (RA) often are not considered for TKA with bone ingrowth fixation because of poor bone quality, but we asked whether implants with sintered metal bead surfaces could be used to durably fix implants in this group of patients. We prospectively evaluated a consecutive series of 47 patients (64 knees) between January 1, 1994, and December 30, 2001, in two separate medical centers using one TKA system. Standard primary implants were used in all knees except those with major bone defects, and in these patients we used long diaphyseal stems to stabilize the implants. Minimum followup was 61 months (mean $\pm$ standard deviation, 83 ± 6 months; range, 61–124 months). Survivorship was 98.4% at 10 years postoperatively. No components failed because of loosening. One femoral component was revised for fracture because of a massive intraosseous rheumatoid cyst. No knees had radiographic evidence of migration or widening radiolucent lines. Knee Society clinical, pain, and function scores improved after

surgery and were maintained throughout followup. These data suggest bone ingrowth implants can provide durable fixation in patients with RA.

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

Introduction

Total knee arthroplasty depends on good-quality bone support for long-term fixation, especially in patients in whom a porous ingrowth implant has been selected [2, 23]. Young, heavy patients with hard bone stock generally are considered the best candidates for porous ingrowth fixation, whereas older patients and patients with RA are considered the best candidates for cemented fixation [26]. However, there is some evidence to suggest implants fixed without cement can be successful in older female patients [18] and in patients with RA [1, 24, 26].

Innovations in porous ingrowth surfaces have led to more frequent use of implants without cement [15]. However, standard porous coatings such as sintered Ti or CoCr beads have been used successfully for decades in the hip [15, 29] and also have had considerable success in the knee [3, 10, 22, 25, 27, 28]. Enhancements to bone ingrowth surfaces with hydroxyapatite on porous metal and highly porous metals [14, 16] may offer advantages in challenging situations, such as with patients with RA. However, porous coatings that currently are readily available have been used in patients with RA with considerable success [1, 7, 24].

We asked whether sintered bead, porous-coated implants can achieve pain relief and durable fixation with high functional scores in patients with RA undergoing TKA.

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

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Materials and Methods

We prospectively followed 47 patients (64 knees) with RA who underwent TKA by two surgeons (RV, LAW) in separate medical centers between January 1, 1994, and December 30, 2001. All patients with RA in our centers having TKA had the same bone ingrowth prosthesis (Profix[®]; Smith & Nephew, Inc, Memphis, TN). We did not consider metaphyseal defects a contraindication to this prosthesis. None of the patients was lost to followup, none died during the study period, and all had radiographic followup. Fifty-two knees (39 patients) were in women and 12 knees (eight patients) were in men. Mean age of the patients at the time of surgery was 49.5 ± 8.6 years (range, 28–64 years). The minimum followup was 61 months (mean $\pm$ standard deviation, 83 ± 6 months; range, 61–124 months).

The features of the Profix[®] TKA system included an uninterrupted microporous sintered bead surface (mean pore size, 150 μ m) on all bone contact surfaces except the femoral pegs, tibial pegs, and tibial stem (Figs. 1, 2). The modular polyethylene component had a peripheral capture mechanism, and fixation of the tibial component was achieved with a central stem and peripheral screws.

The surgical procedure included intramedullary alignment of the femoral and tibial components. Precision bone cuts were made with an oscillating saw guided by slotted cutting guides, and a secondary tibial surface cut was made to ensure precise fit between the tibial component and bone surface. Constant irrigation was used for cooling during the

cutting process, and direct irrigation of the cut surfaces was avoided thereafter to preserve the osteogenic potential of the bone tissue [17, 18]. A central stem was used on all tibial components. The central tibial stem used for standard procedures was made of Ti alloy with a fluted shape and a coarse grit-blasted surface. The inner core diameter was 14 mm and the outer diameter was either 18 mm or 20 mm. In patients with no peripheral defect, a metaphyseal stem 3.5 cm long and either 18 mm or 20 mm in diameter was press fit into the 10-mm alignment hole in cancellous bone in the center of the tibia. In the femur or tibia with very soft bone or a major peripheral defect, a long, fluted stem (150–200 mm long) was press fit into the medullary canal. In these patients, we reamed the diaphysis to a depth of 150 to 200 mm and the diameter was reamed 1 mm under size to the outer diameter of the flutes of the stem (Figs. 3, 4). Nine tibias (nine patients) had either medial or lateral peripheral defects or very soft bone that did not adequately support the tibial base plate. Six femurs (six patients) had either medial or lateral condylar defects

Fig. 2 A photograph shows the undersurface of a Profix[®] tibial component. Microporous sintered beads cover the entire undersurface of the implant except on the tibial stem and distal half of the tibial pegs. (Reprinted with permission of Lippincott Williams & Wilkins from: Whiteside LA, Viganó R. Young and heavy patients with a cementless TKA do as well as older and lightweight patients. *Clin Orthop Relat Res.* 2007;464:93–98.)

Fig. 1 A photograph shows the undersurface of a Profix[®] femoral component. Microporous sintered beads cover the entire undersurface of the implant except on the femoral pegs. (Reprinted with permission of Lippincott Williams & Wilkins from: Whiteside LA, Viganó R. Young and heavy patients with a cementless TKA do as well as older and lightweight patients. *Clin Orthop Relat Res.* 2007;464:93–98.)

Fig. 3 An anteroposterior radiograph shows a knee with RA and severe tibial bone deficiency.

Fig. 4 A lateral radiograph of the same knee as in Figure 3 shows lateral patellar dislocation and severe anterior femoral bone deficiency.

such that the bone did not adequately support the femoral articular component. In these knees, long, diaphyseal-engaging stems (150–200 mm) were used.

The patients were contacted yearly by telephone and evaluated by radiographic and physical examinations at intervals of 1, 2, 5, 7, and 10 years postoperatively. With telephone contact, knees were considered intact if patients did not report greater than mild pain, and if no deformity was developing. We measured valgus alignment in full extension in a supine position with a handheld goniometer.

Anteroposterior and lateral radiographs were taken at 1 month, 1 year, 2 years, 5 years, 7 years, and 10 years postoperatively. We (RV, LAW) measured radiolucent lines with a ruler accurate to 0.5 mm. Migration was estimated by measurement from the tip of the fibular head and cut upper surface of the tibia and the medial and lateral epicondyles of the femur to the surface of the implants. The interfaces of all the screws were visible on the radiographs and were inspected for signs of radiolucent lines and osteolytic cysts. We did not consider nonprogressive radiolucent lines as reflecting loosening.

We calculated Kaplan-Meier survivorship [12] using revision for any cause, revision attributable to loosening, and radiographic loosening as endpoints using OriginPro8 software (OriginLab Corporation, Northampton, MA). Radiographic criteria for loosening included progressive widening of radiolucent lines in two surfaces under either component observed over two evaluation periods, or any measurable migration of any component detected radiographically after the first month. The standard deviations of the Knee Society scores, pain scores, and function scores [11] of the entire cohort were used to develop a power analysis to estimate the number of knees that would be

necessary to achieve a confidence interval of 95% for rejecting the null hypothesis given a difference of 10% in overall Knee Society clinical score, pain score, and function score for the knees at each interval. The analysis showed 31 knees for overall Knee Society clinical score, 33 for pain score, and 41 for function score would be necessary to reject the null hypothesis. The number of knees in each group necessary to accept the null hypothesis for differences of 10% or less was 51 for overall Knee Society clinical score, 48 for pain score, and 53 for function score. Adequate numbers were present at each interval up to Year 7 to either accept or reject the null hypothesis. Insufficient numbers were present to accept the null hypothesis after Year 7. We used a two-tailed Student's *t* test to compare knee scores before and after surgery and to compare the scores with the previous scores obtained at different intervals.

Results

Durable cementless fixation of implants to bone was achieved in these 47 patients. One femoral component was revised 12 months postoperatively for fracture of the supporting bone stock through a massive intraosseous rheumatoid cyst. The patient had a pain score of 46 until sudden onset of pain, deformity, and limp. At the time of revision, wear of the tibial polyethylene component was minimal and there were no signs of polyethylene osteolysis. None of the tibial components loosened or required revision. Survivorship was 98.4% at 10 years postoperatively (Table 1). The mean valgus angles were $6^\circ \pm 4^\circ$ preoperatively, $5^\circ \pm 2^\circ$ at 1 month postoperatively, $4^\circ \pm 2^\circ$ at 1 year, $5^\circ \pm 2^\circ$ at 5 years, and $4^\circ \pm 1^\circ$ at 10 years. None of the implants had widening radiolucent lines or evidence of migration (Figs. 5, 6; Table 2). Two tibial components had complete medial-to-lateral radiolucent lines under the tibial tray visible on the anteroposterior radiograph but did not have radiolucent lines around the stem. None of these radiolucent lines has widened during the 5- to 10-year followup. No knees had visible polyethylene wear or osteolysis. None of the screws had radiolucent lines or osteolytic cysts visible on radiographs.

The mean pain score improved ($p = 0.005$) from 10 ± 2 preoperatively to 34 ± 7 at 1 year postoperatively and improved ($p = 0.04$) additionally to 46 ± 4 at 2 years postoperatively (Fig. 7). The pain score was 47 ± 3 at 5 years and 46 ± 8 at 10 years. No decrease in pain score occurred during the 10-year followup. The power was adequate to accept the null hypothesis at 2 and 5 years but not at 10 years.

The mean Knee Society clinical score was 34 ± 11 preoperatively and improved ($p = 0.04$) to 76 ± 13 at

Table 1. Survivorship data

Interval (year)	Number at start (risk)	Radiographic loosening	Revised (loosening)	Revised (other)	Intact knees	Lost to followup	Survival rate (radiographic failure) (%)	Survival rate (loosening) (%)	Survival rate (any cause) (%)	95% Confidence intervals
0 to 1	64	0	0	1	63	0	100	100	98.4	95.4 to 100
1 to 2	63	0	0	0	63	0	100	100	98.4	95.4 to 100
2 to 3	63	0	0	0	63	0			98.4	95.4 to 100
3 to 4	63	0	0	0	63	0			98.4	95.4 to 100
4 to 5	63	0	0	0	63	0	100	100	98.4	95.4 to 100
5 to 6	59	0	0	0	59	0			98.4	95.4 to 100
6 to 7	54	0	0	0	54	0	100	100	98.4	95.4 to 100
7 to 8	44	0	0	0	44	0			98.4	95.4 to 100
8 to 9	40	0	0	0	40	0			98.4	95.4 to 100
9 to 10	33	0	0	0	33	0	100	100	98.4	95.4 to 100

Fig. 5 A lateral radiograph of the femur of the same knee as in Figures 3 and 4 shows fixation of the femoral component by means of the diaphyseal stem and distal and posterior femoral bone surface contact. A large anterior bone deficit persists, but the anterior flange surface is aligned with the anterior cortex of the tibia.

1 year postoperatively and to 89 ± 7 at 2 years postoperatively (Fig. 8). No change in the clinical knee score occurred at the 5-year evaluation, at which time the knee score was 90 ± 11 ($p = 0.15$), or at the 10-year evaluation, at which time the knee score was 88 ± 9 ($p = 0.20$).

The mean Knee Society function score was 43 ± 11 preoperatively and increased ($p = 0.04$) to 68 ± 9 at 1 year postoperatively (Fig. 9). The function score was similar at 5 years (65 ± 11) and 10 years (58 ± 13) postoperatively.

Discussion

Total knee arthroplasty depends on good-quality bone support for long-term fixation, especially in patients in

Fig. 6 A lateral radiograph taken 5 years postoperatively shows the tibial component of a knee with RA. Hypertrophic bone is present under the anterior portion of the tray, and a thin radiolucent line is present under the peripheral rim where there is no porous coating on the implant.

whom a porous ingrowth implant has been selected. Many surgeons do not consider bone ingrowth implants in patients with RA owing to poor bone quality despite some evidence to suggest they can be successful [1, 18, 24, 26]. We therefore sought to answer the question whether cementless TKA can achieve durable fixation of implants to bone along with pain relief and high functional scores.

Table 2. Number of knees with radiolucent lines at various followups

Location	1 month	1 year	5 years	10 years
Femur				
Anterior flange	1	3	3	3
Anterior bevel	0	0	0	0
Distal	1	3	2	1
Posterior bevel	4	3	1	4
Posterior flange	2	1	2	2
Tibia				
Medial	1	2	2	1
Lateral	2	2	3	4
Anterior	6	5	6	5
Posterior	6	7	7	6
Stem	0	0	0	0

Fig. 7 A graph shows the mean Knee Society pain score at each interval. The postoperative pain score improved up to 2 years, and then was maintained through the followup intervals.

Our study involves one system of TKA implants and surgical technique used by two surgeons, and therefore the conclusions cannot be generalized to all types of TKAs or to all surgical techniques used with osseointegration. Although all the patients had soft, fragile bone stock, we used long stems to stabilize the components in only nine tibias and six femurs (Fig. 5). We did not evaluate other aspects of knee function such as activity score and ligament laxity.

We observed durable fixation and high functional scores during intermediate-term followup. Whereas we commonly found radiolucent lines (Table 2), we observed neither

Fig. 8 A graph shows the mean Knee Society clinical score at each interval. The postoperative clinical knee score improved by 1 year postoperative, continued to improve through the second year, and then remained stable through 10 years. **Fig. 9** A graph shows the mean Knee Society function score at each interval. Function scores improved until 2 years postoperatively, then remained stable through 10 years.

expanding radiolucent lines nor migration in any knees throughout the study period. Total knee arthroplasty in knees affected by RA generally is thought to require cement for fixation because of deficiency of supporting

Table 3. Comparison of published results in patients treated for rheumatoid arthritis

Authors	Type of fixation	10-year survivorship (%)		Radiographic loosening (%) (complete radiolucent lines)
		Loosening	For any reason	
Current study	Cementless	100	98	0
Rodriguez et al. [20]	Cemented	100	95	7
Crowder et al. [5]	Cemented	100	100	N/A
Gill and Joshi [8]	Cemented	N/A	90.7	N/A
Schai et al. [21]	Cemented	N/A	97.3	0
Himanen et al. [9]	Cemented	N/A	96.5	N/A
	Cementless	N/A	94.9	N/A
Sharma et al. [24]	Cementless	N/A	94	N/A
Robertsson et al. [19]	Cemented	95	95	N/A

N/A = not assessed.

bone stock [19]. Nevertheless, there are published reports of success with cementless TKA in short-term followup [1, 4, 13, 22, 26], and comparisons of cemented and cementless fixation suggest cementless fixation sometimes yields better results in patients with RA [9, 15]. Our data suggest bone ingrowth surfaces can produce adequate fixation of total knee components in patients with RA over intermediate-term followup (5–10 years), and that the results are comparable to those reported with cement fixation techniques (Table 3). We do not, however, interpret the data as suggesting the technique is superior to cement technique for this patient population. The frequent use of long stems and supplementary autograft for defects in this series illustrates that cementless technique can be used to address conditions involving severe bone loss. Similar conditions are addressed with long stems and grafts when cement is used for fixation [6].

Our data suggest a TKA system that uses an osseointegration technique for fixation offers good clinical function and pain relief for patients with RA. The interface is durable and the bone stock appears capable of supporting press-fit implants in knees affected by RA, even when bone stock is deficient and requires supplementary fixation of the implants.

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