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Revision Knee Arthroplasty

The Limits of Press Fit Medullary Fixation

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Nonlinked (nonhinged) but constrained knee prostheses have been used with some success, usually by fully cementing narrow fixed stems in the medullary canal. Modular press fit stems augment fixation and limit cement to the cut bone surface. Forty-four revision knee arthroplasties were followed prospectively for 2 to 6 years. Thirty-one were reconstructed with posterior stabilized implants and 13 required constrained (condylar) articulations. Of these 13, 2 have been revised for loosening and another has radiographic evidence of impending loosening. All 3 were in patients who had reimplantations after a 2-stage protocol for infection, and none failed sooner than 3 years after surgery. No evidence of recurrent sepsis was observed. The press fit technique with limited cement use may not provide adequate fixation for the constrained condylar implant, especially when bone quality is poor.

How can the unique problems of the revision knee arthroplasty be solved? Restoring fixation, kinematics, and stability to the failed replacement is not simply a question of repeating the primary surgery. Modular knee prostheses, available from many manufacturers, offer wedges and blocks to reconstruct bone defects, constrained articulations when ligaments are deficient, and medullary stems when additional fixation is required.

Although fixed and rotating hinges have been abandoned for all but extreme cases, constrained condylar-type prostheses gained a surprisingly good reputation in the last 15 years.[2,3,6] These devices stabilize the knee, despite deficient collateral ligaments, through a prominent central spine on the tibial plateau that sits snugly between the femoral condyles. There is no fixed axis as in a hinge. All of the original designs had fixed narrow diameter stems that were fully cemented into the medullary canal of the femur. They had longer than usual tibial keels that were cemented into the tibia.

The major drawback to this type of implant was that the medullary canal had to be filled with cement. The surgeon does not want to compromise revision surgery, which increases the patient's risk for infection, with additional cement. However, these implants most frequently need additional fixation.

Early work by Bertin et al[1] described tibial components with very long, small diameter stems that were solidly attached (nonmodular) to the tibial component. Although the stems were not themselves cemented, methacrylate was applied to the cut bone surface and none was introduced into the canal. This technique was originally used to augment fixation in the presence of deficient bone. It was adapted in the mid 1980s at the Hospital for Special Surgery for use with the constrained condylar implant. Instead of long stems that might achieve 3-point fixa-

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TABLE 1. Failure Mode for 44 Cases in This Series

Class	Cause for Revision	Number	Percentage
I	Loosening/convert Uni	24	54.5
II	Instability	3	6.8
III	Malrotation and patellar instability	0	0.0
IV	Inexplicable pain	3	6.8
V	Component breakage	2	4.5
VI	Sepsis	9	20.4
VII	Extensor rupture	1	2.3
VIII	Stiffness	2	4.6

tion, shorter modular stems were designed. A stem might be attached to the femoral or tibial component or both that would match the intramedullary dimension of the canal, establish a press fit, and obviate the need for methacrylate inside the bone.[8]

Limitations of that technique are reported here. Specifically, the problem of loosening when press fit intramedullary fixation is combined with a constrained articulation is addressed.

MATERIALS AND METHODS

Forty-four revision knee arthroplasties were performed with the modular knee arthroplasty system described previously. These were studied prospectively for 2 to 6 years, with clinical and radiographic evaluations. All surgeries were performed by 1 surgeon (KGV).

The revision arthroplasties were required for various reasons. A classification system, originally suggested by Jacobs et al,[4] has been expanded to include all modes of knee arthroplasty failure (Table 1). More than 50% (24 of 44) of the original revision surgeries in this series were required because components loosened. There were 3 revisions for instability not due to loosening, none for component malrotation and patellar instability, 3 for inexplicable pain, 2 for breakage, 1 for rupture of the extensor mechanism, and 2 for stiffness. More important for the findings in this study, 9 knees were reimplanted as part of a 2-stage protocol for the treatment of infection.[9]

Thirteen (29.5%) revisions required constrained articulations, and the balance had posterior stabilized replacements. The former implant confers solid varus-valgus constraint, whereas the latter depends entirely on collateral ligaments for stability. The surgical technique, described elsewhere in detail,[5,7] was unchanged during this study. When possible, a posterior stabilized articular component was used. In the presence of either deficient collateral ligaments or irreconcilable flexion and extension gaps, a constrained condylar articulation was selected. This particular modular prosthesis uses the same tibial base plate and femoral component regardless of which tibial polyethylene is required. The degree of constraint is defined by the tibial insert. Inserts with a prominent spine confer varus-valgus and greater anteroposterior stability, and those with a lower spine function as a conventional Insall-Burstein, posterior stabilized arthroplasty.

Press fit medullary fixation (without cement in the canal) with cement fixation of the cut bone surface was used for all cases. Modular titanium rods, with a cross section resembling that of a Sampson rod, were selected to achieve a tight fit in the medullary canal. Each was attached to the respective component with a Morse taper coupling and an axial screw.

There were no remarkable postoperative complications, certainly none that would explain differences in later clinical or radiographic outcome.

Followup examinations were done 2 weeks, 3 months, 6 months, and then annually after surgery. Some patients were assessed more frequently. Knee scores and radiographs were obtained. Anteroposterior and lateral radiographs were taken as weightbearing films on long cassettes. Merchant (patellofemoral) and full limb radiographs (including hip, knee, and ankle on one 36-inch cassette) were obtained and were evaluated according to Knee Society guidelines.

TABLE 2. Percentage Fill of Medullary Canal With Intramedullary Stem

Location of Rod	Anteroposterior Radiograph	Lateral Radiograph
	Range of Fill (mean)	*Range of Fill (mean)*
Femoral	56–100 (78)	60–94 (75)
Tibial	47–100 (85)	38–100 (79)

RESULTS

Radiographic Evaluation

The femoral components were aligned in 4° to 12° valgus (mean, 7.5°). The position of the components was largely determined by the large, press fit medullary stem in the canal (Table 2). When viewed on the lateral radiograph, the components were flexed from 0° to 10° (mean, 4.5°). This position was largely influenced by the anteroposterior position of the stem on the component.

The tibial components were aligned in valgus that ranged from 0° to 6° (mean, 3.5° valgus). Again, the position was determined by the position of the medullary stem that was attached symmetrically to the tibial component but was implanted in the asymmetric proximal tibia. Viewed on lateral radiographs, the tibias had a posterior slope ranging from 0° to 8° (mean, 3°). The overall tibiofemoral alignment ranged from 4° to 12° of valgus, with an average of 7.6°.

Whereas cement was applied to the parts of the bone that remained in contact with the prosthesis itself and not the rod, the rods were inserted into the bone without cement. The capacity of the canal with the rod was assessed radiographically.

Clinical Evaluation

Clinical scores generally improved. By definition, the failed knees were awarded 0 points by the Knee Society scoring system. At 2 to 6 years after surgery, the knee scores (in the knees that had not failed) ranged from 45 to 100 points (mean, 84.1 points). If the 2 failures reported here are included and receive 0 points, then the mean knee score is 79.4.

The function scores ranged from 40 to 100 points (mean, 82.9 points). Inclusion of the 2 failed results as 0 gives a mean function score of 77.58 points.

Two female patients had repeated revision arthroplasty because of loosening (Figs 1, 2). The original revision surgeries were reimplantations after infection in both patients and required constrained condylar articulations. The failed revision surgery resulted from loosening of the femoral component only in 1 patient, and loosening of both components in the other. A third female patient had a reimplantation with a constrained implant after infection. An identical radiographic appearance has developed and loosening is anticipated. No preoperative or intraoperative cultures have been positive in either of the second revisions. There has been no clinical manifestations of infection in these patients. No patient with a posterior stabilized articulation has had loosening.

Although the weight of all patients ranged from 128 to 280 pounds (mean, 189 pounds); the patients with loosening weighed 224 and 165 pounds, respectively. Failure cannot be attributed to obesity alone.

All 3 patients in whom loosening developed had better than average fill of the medullary canal with press fit rods. Most radiographic views showed cortical contact with the rod with 100% fill.

One knee, treated as part of a 2-stage reimplantation protocol, had recurrent infection with a different organism 2 years af-

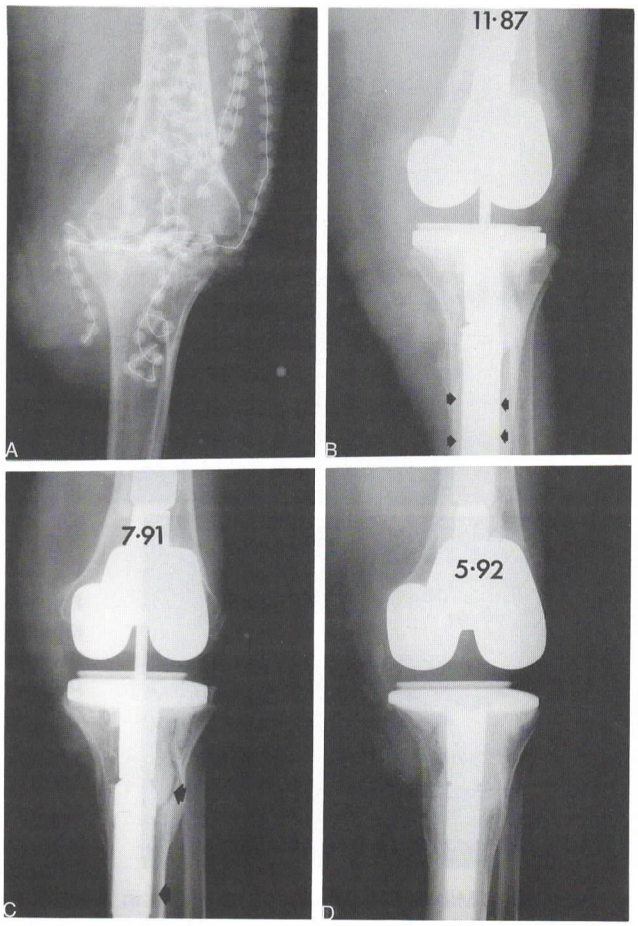

Fig 1A–D. (A) Anteroposterior radiograph of the knee of a 68-year-old woman after resection arthroplasty for septic primary total knee replacement before the first reimplantation. (B) Anteroposterior radiograph after reimplantation with constrained condylar articulation. Arrows indicate good cortical contact with a press fit rod. Cement use was restricted to areas of cut bone surface. (C) Anteroposterior radiograph shows gross radiolucencies (arrows) around the tibial stem. The patient had pain and the components were loose at revision. Results from cultures taken before and during revision surgery were negative. (D) Anteroposterior radiograph 1 year after second revision with fully cemented intramedullary stems and posterior stabilized (not constrained condylar) articulation.

ter reimplantation. This was interpreted as an acute onset and was treated with arthrotomy, irrigation, debridement, and primary closure.

One patient with a constrained articulation and distal femoral allograft had spontaneous dislocation of the tibial component posteriorly while sleeping. The knee locked in this position, was reduced closed in the office, and the complication has not recurred.

One patient had buckling with medial instability after insertion of a posterior stabilized articulation. For a second arthrotomy after revision, a constrained condylar insert was substituted and the symptoms resolved.

DISCUSSION

The literature describing nonlinked, constrained condylar implants fixed by inserting small diameter, fixed stems into a fully cemented medullary canal shows surprisingly good results. Many of these were primary implants in knees in which bone quality was generally good.[2,3,6]

To avoid filling the whole canal with cement, uncemented rods were introduced. Some had narrow diameters but were quite long and achieved 3-point fixation.[1] This technique has not been applied to constrained devices. The technique reported here uses modular stems available in a range of diameters. The thickest

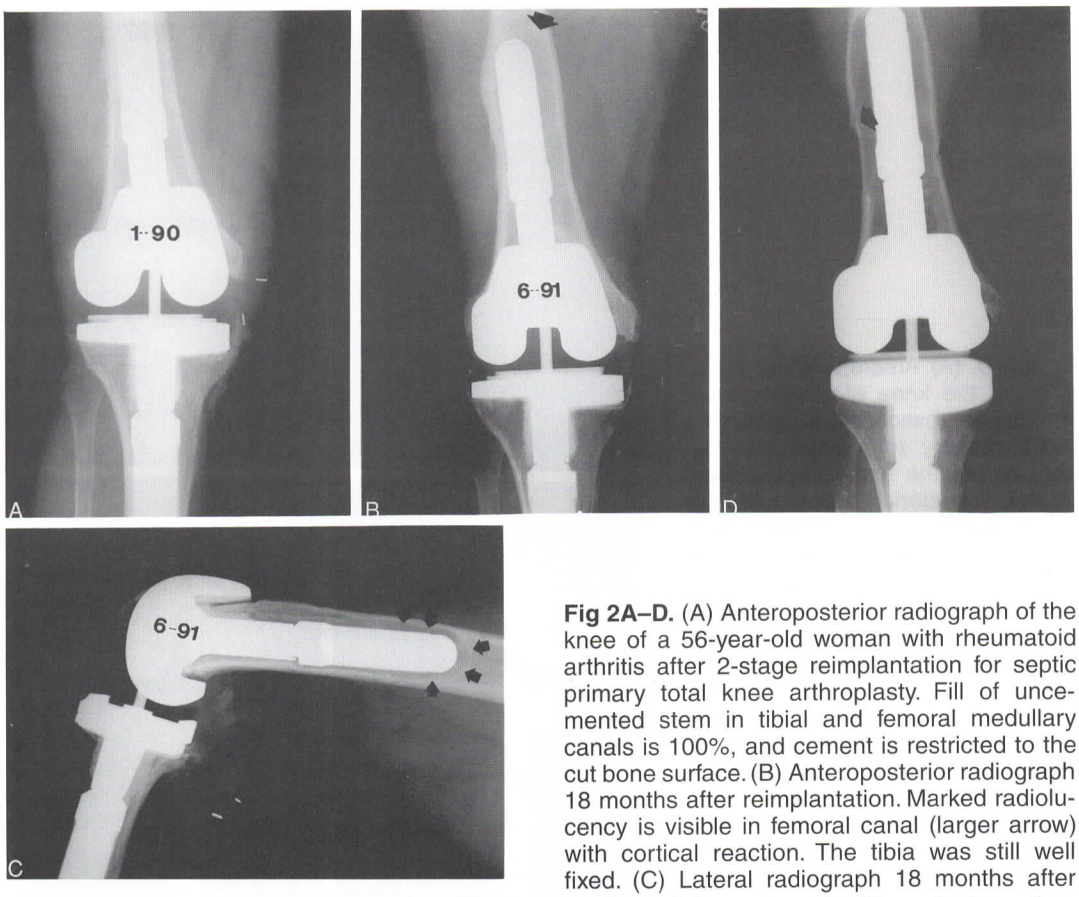

Fig 2A–D. (A) Anteroposterior radiograph of the knee of a 56-year-old woman with rheumatoid arthritis after 2-stage reimplantation for septic primary total knee arthroplasty. Fill of uncemented stem in tibial and femoral medullary canals is 100%, and cement is restricted to the cut bone surface. (B) Anteroposterior radiograph 18 months after reimplantation. Marked radiolucency is visible in femoral canal (larger arrow) with cortical reaction. The tibia was still well fixed. (C) Lateral radiograph 18 months after reimplantation. Marked radiolucency is visible in femoral canal (larger arrow) with cortical reaction. The tibia was still well fixed. (C) Lateral radiograph 18 months after reimplantation. Arrows indicate marked radiolucency. The patient had moderate symptoms and declined further surgery. (D) Anteroposterior radiograph of the knee after the patient had an abrupt increase in pain. Arrows indicate a fracture around the uncemented femoral stem. At second revision all cultures were negative.

possible is selected, with the goal of achieving a press fit. These are used with posterior stabilized or constrained condylar articulations.

The limitations of this technique have become apparent. Two (4.5%) of 44 knees having revision surgery had gross loosening in this series, and similar problems are developing in a third patient (total, 6.8%). All were women who had constrained condylar implants for reconstruction after a 2-stage protocol to treat infection. The failures cannot be explained by recurrent or persistent infection.

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