

Revision Total Hip Arthroplasty With Proximal Bone Loss

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Abstract: The presence of a deficient or mechanically compromised proximal femur represents a particular challenge to revision total hip arthroplasty. This article details the results of reconstructing these challenging cases using a modular, tapered, and distally fixed femoral stem component that allows independent control of length, offset, and anteversion of the femur. Mid-term results suggest that distal fixation in the presence of a deficient or mechanically compromised femur is a reliable solution to these difficult problems. **Key words:** total hip arthroplasty, revision, bone loss, osteolysis, modular femoral stem, distal fixation.

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Revision total hip arthroplasty (THA) is especially challenging when the proximal femur is absent, deficient [1–4], or mechanically incompetent [5,6]. The surgeon may not be able to rely on the proximal femur in cases of massive proximal lysis [7], debridement for infection, or when an extended trochanteric osteotomy or transfemoral exposure is selected to accomplish safe implant removal.

Alternatives for revision of the deficient proximal femur include extensively coated cylindrical implants; long, fluted implants; prosthetic-allograft composites; proximal femoral replacement prostheses; impaction grafting; and revision implants specifically designed for distal fixation in the absence of a competent proximal femur [4,8–14].

Extensively coated cylindrical implants have the disadvantage that leg length, tissue tension, and implant-bone stability must all be controlled simul-

taneously. This means that the height of the prosthesis could be too high or too low at the point that it becomes tight in the femur. As a result, in many cases, either implant fit or leg length must be compromised [15–18]. Furthermore, because these implants are typically not modular, the common problem of instability following these reconstructions requires removal of the entire prosthesis.

Long-stemmed, fluted components require proximal bone for their support. The lack of proximal bone in these cases of revision of the proximally deficient femur leave these implants unstable by definition, precluding long-stemmed, fluted components from addressing these problems without the augmentation by bulk allograft [19].

Proximal femoral allograft composites can be an effective way of dealing with proximal femoral bone loss [20]. However, disadvantages include the time-consuming nature of the procedure, the fact that most allografts have a much smaller inner diameter than the patient's remaining diaphysis, and that failures typically occur at the stem-host junction. These problems often result in a reconstruction that does not improve bone stock over reconstructions without proximal femoral allograft. Proximal femoral replacement prostheses are similar, with emphasis ultimately placed on the type of fixation chosen between the implant and remaining

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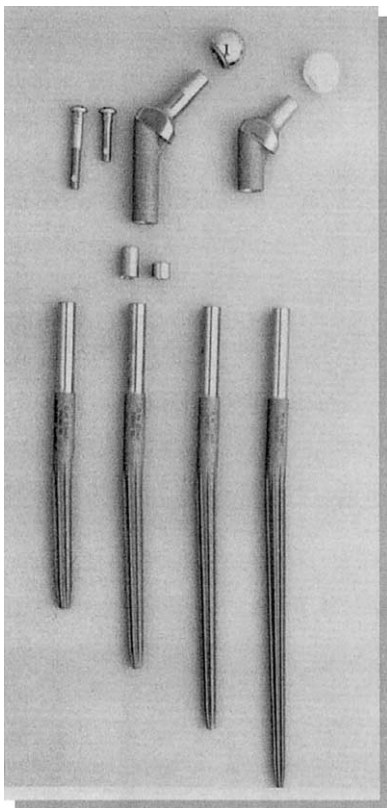


Fig. 1. The Link MP stem showing options for stem lengths, proximal bodies, and spacers to further adjust leg length.

bone [21]. Both methods have the disadvantage that any remaining proximal bone is ignored and prevented from healing by large, bulky proximal bone allograft or implants.

The use of impaction grafting is limited only to those femurs with cavitory lesions and is not widely applicable clinically [22]. Furthermore, the method is also time-consuming, is frequently complicated by intraoperative femur fracture or postoperative subsidence [23], and presents a challenge in balancing leg length with the height of the impacted bone mass.

A proximally modular, distally fluted component that achieves fixation in the diaphysis represents an excellent clinical alternative that allows solid fixation, wide adjustment of leg length, offset and neck anteversion, and potential healing of the remaining proximal bone. The current study reviews the clinical experience of a modular component that employs distal fixation with a tapered, fluted stem.

Materials and Methods

Fifty-four hips in 54 patients underwent femoral revision from 1997 to 2003 at 2 centers. There were

27 males and 27 females, with an average age of 70 years (range, 35–92 years) All patients were treated using a proximally modular, distally tapered and fluted implant that achieves diaphyseal fixation (Link MP stem, Waldemar-Link, Hamburg, Germany). The method allows for independent control of leg length, offset, and anteversion of the component after the real diaphyseal component has been inserted (Fig. 1). Thirty-five hips in 35 patients were evaluated at a minimum of 2 years following surgery. The mean age at surgery was 67 years (standard deviation [SD], 13.7 years).



Fig. 2. Method of performing the transfemoral exposure. A lateral bone flap is developed, including the greater trochanter, and extends down to the region of the stem tip. The quadriceps attachment to the bone flap is meticulously preserved. The quadriceps fibers are gently spread anteromedially with a schmidt to preserve the branches of the femoral nerve. (A) Osteotomes are placed through the quadriceps intervals to perforate the anteromedial cortex. The posterior and distal edges of the bone flap are developed with a saw. (B) The flap then is gently levered open to (C) reveal the device to be removed (C).

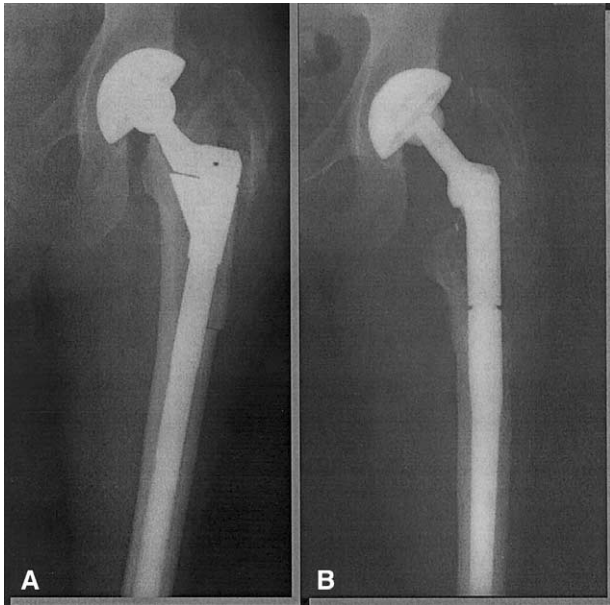


Fig. 3. Anteroposterior radiographs of the hip of a 44-year-old man showing a (A) loose femoral component with an ununited greater trochanter and lateral cortex and (B) 2 years following reconstruction.

A transfemoral exposure (lateral femoral bone flap with attached quadriceps and abductors) was used in 30 of the 35 patients (Fig. 2A–C). Fixation was achieved by reaming the diaphysis into a tapered shape; impacting the distal portion of the stem into the bone; performing reduction with provisional proximal segments, adjusting leg length, anteversion, and offset as necessary; and then assembling and reducing the definitive implant (Fig. 3). The flap was closed with limited cerclage wiring with the aim of maximally preserving blood supply to the proximal femur. The remaining 11 procedures were performed using the posterior exposure. Patients were followed clinically and radiographically for evidence of osseointegration and postoperative complications.

Results

The mean follow-up was 42.6 months (SD, 14.8 months). Of the 35 procedures evaluated at a minimum of 2 years, 34 developed radiographic evidence of osseointegration [24]. None of these implants demonstrated measurable subsidence. One implant failed to osseointegrate in a patient, with only the distal one third of the femur remaining, and that distal femur had cavitory and segmental defects. That hip was subsequently successfully re-

constructed in 2 stages by cancellous and onlay grafting, followed by another implant of the same type after incorporation of the grafted bone, thereby avoiding a total femoral replacement. Three of 54 hips operated on overall (5.5%) sustained a postoperative supracondylar fracture, all treated successfully with open reduction internal fixation and/or allograft with retention of the components. Six patients were re-operated for instability/dislocation with exchange of the proximal body to one of a different length, offset, or version with retention of the stem within the femur. Two of these had the addition of a constrained acetabular liner. None of these patients had subsequent instability or dislocation. There were no implant fractures. One patient died 3 weeks after surgery from end-stage liver failure, and 1 patient died more than 2 years after surgery from recurrent leukemia.

Discussion

Revision THA presents significant challenges for the surgeon when the proximal femur is deficient or mechanically unreliable. The current study demonstrates that tapered fixation of a prosthetic femoral component to the diaphysis is very reliable. These reconstructions transfer stress to the remaining distal femur, providing long-term support. However, some osteoporotic distal femurs cannot sustain the applied stresses, as evidenced by the 3 postoperative supracondylar fractures seen in this study and also reported by Zalzal [25]. Supplemental prophylactic supracondylar reinforcement with onlay allografts and supracondylar blade plates may be considered in these more severe cases. The finding of hip instability as the most common complication following revision reinforces previous studies, particularly where the trochanter is absent or chronically ununited [26]. Larger bearings, narrower neck designs, and constrained components certainly have a role in addressing this difficult issue.

The absence of bony support proximally necessitates that the implant endure adverse loading conditions that greatly stress the implant. Greenwald and Postak (personal communication, May 2003) tested this design and demonstrated that a 4,400-N endurance limit (10 million cycles without failure) can be achieved even using the smallest stem with the highest offset. (Fig. 4A and 4B).

The finding of no implant failures in this series is consistent with both the mechanical testing and with the previous 10-year experience with this implant [11]. This finding is especially important because complete lack of proximal support is a hall-

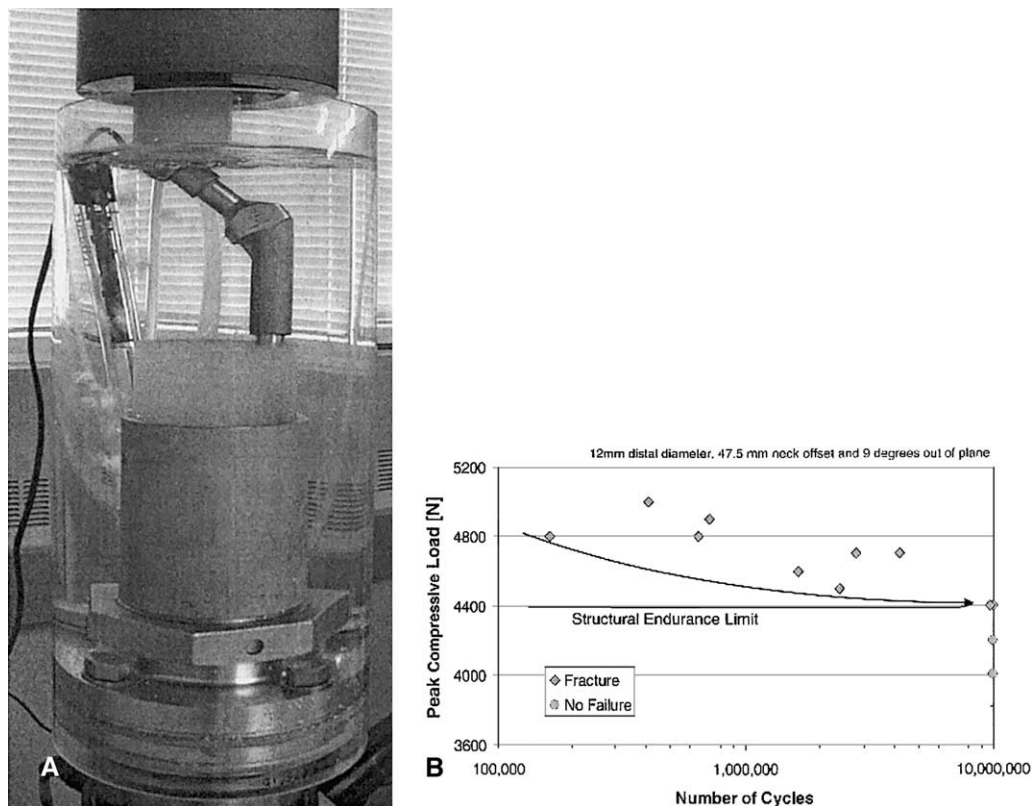


Fig. 4. The endurance limit (survival to 10 million cycles) of the stem, loaded in (A) an extreme cantilever fashion with no proximal support, is (B) 4400 N (980 lb) [27]. This is significantly greater than that reported for most other modular revision stems. In more than 10 years of use, there have been no reported cases of stem fracture.

mark of these challenging procedures and suggests that allograft support of the proximal part of the implant is unnecessary. This simplifies the surgery and facilitates retention and healing of any remaining host bone in the proximal femur. Based on this experience, fluted, tapered diaphyseal fixation with a proximally modular design remains an effective treatment option for the mechanically compromised proximal femur.

References

- Huddleston HD: Femoral lysis after cemented hip arthroplasty. *J Arthroplasty* 3:285, 1988
- Harris WH, Schiller AL, Scholler JM, et al: Extensive localized bone resorption in the femur following total hip replacement. *J Bone Joint Surg Am* 58A:612, 1976
- Tallroth K, Eskola A, Santavirta S, et al: Aggressive granulomatous lesions after hip arthroplasty. *J Bone Joint Surg Br* 71B:571, 1989
- Mallory TH: Preparation of the proximal femur in cementless total hip revision. *Clin Orthop* 235:47, 1998
- Charnley J: The histology of loosening between acrylic cement and bone. *J Bone Joint Surg Br* 57: 245, 1975
- Gruen TA, McNeice GM, Amstutz HC: Modes of failure of cemented stem-type femoral components: a radiographic analysis of loosening. *Clin Orthop* 141: 17, 1979
- Harris WH: The problem of osteolysis. *Clin Orthop* 311:46, 1995
- Lawrence JM, Engh CA, Macalino GE: Revision total hip arthroplasty: long-term results without cement. *Orthop Clin North Am* 24:635, 1993
- Paprosky WG, Jablonsky W, Magnus RE: Cementless femoral revision in the presence of severe proximal bone loss using diaphyseal fixation. *Orthop Trans* 17:965, 1993
- McCarthy JC, Mattingly D, Turner RH, et al: Revision of the deficient femur with a modular femoral component. *Orthop Trans* 17:966, 1993
- Kwong LM, Miller AJ, Lubinus P: A modular distal fixation option for proximal bone loss in revision total hip arthroplasty. *J Arthroplasty* 18(3 suppl 1): 94, 2003
- Bohm P, Bischel O: Femoral revision with the Wagner SL revision stem: evaluation of one hundred and

- twenty-nine revisions followed for a mean of 4.8 years. *J Bone Joint Surg Am* 83:1023, 2001
13. Malkani AL, Sim FH, Chao EY: Custom-made segmental femoral replacement prosthesis in revision total hip arthroplasty. *Orthop Clin North Am* 24:727, 1993
 14. Wagner H: Revisionsprothesen für das Hüftgelenk. *Orthopäde* 18:438, 1989
 15. Barrack RL: Stem modularity is unnecessary in revision total hip arthroplasty. In the affirmative. *J Arthroplasty* 18 3(suppl 1):98, 2003
 16. Paprosky WG, Greidanus NV, Antoniou J: Minimum 10-year results of extensive porous-coated stems in revision hip arthroplasty. *Clin Orthop* 369:230, 1999
 17. Weeden SH, Paprosky WG: Minimal 11-year follow-up of extensively porous-coated stems in femoral revision total hip arthroplasty. *J Arthroplasty* 17(suppl 1):134, 2002
 18. Engh CA Jr., Ellis TJ, Koralewicz LM: Extensively porous-coated femoral revision for severe femoral bone loss: minimum 10-year follow-up. *J Arthroplasty* 17:995, 2002
 19. Chandler HP, Ayres DK, Tan RC: Revision total hip replacement using the S-ROM femoral component. *Clin Orthop* 319:120, 1995
 20. Head WC, Berklacich FM, Malinin TI, et al: Proximal femoral allografts in revision total hip arthroplasty. *Clin Orthop* 225:22, 1987
 21. Sinha RK, Kim S-Y, Rubash HE: Long-stem cemented calcar replacement arthroplasty for proximal femoral bone loss. *J Arthroplasty* 19:141, 2004
 22. Knight JL, Helming C: Collarless polished tapered impaction grafting of the femur during revision total hip arthroplasty: pitfalls of the surgical technique and follow-up in 31 cases. *J Arthroplasty* 15:159, 2000
 23. Eldridge JD, Smith EJ, Hubble MJ: Massive early subsidence following femoral impaction grafting. *J Arthroplasty* 12:535, 1997
 24. Engh CA, Massin P, Suthers KE: Roentgenographic assessment of the biologic fixation of porous surfaces femoral components. *Clin Orthop* 257:107, 1990
 25. Zalzal P, Gandhi R, Petruccioli D, et al: Fractures at the tip of long-stem prostheses used for revision hip arthroplasty. *J Arthroplasty* 81:741, 2003
 26. Alberton GM, High WA, Morrey BF: Dislocation after revision total hip arthroplasty: an analysis of risk factors and treatment options. *J Bone Joint Surg* 84A:1788, 2002