INTRODUCTION

The objectives of femoral reconstruction during revision total hip replacement (THR) are implant stability, preservation of bone stock, pain reduction and functional improvement. Failure of a primary hip replacement often results in proximal femoral bone loss, which can compromise support for a revision femoral component. Many long-stem uncemented calcar replacement prostheses were designed to address these problems. Proximal porous coating is intended to achieve proximal fixation in the femur while promoting maintenance and restoration of femoral bone stock through mechanical loading on the medial femur. Femoral revision using cemented stems has proven to be an adequate option, but uncemented stems appear to more reproducibly achieve long-term stability. Uncemented stems have been utilized with extended trochanteric osteotomies with excellent survivorship. Cemented stems are less effective in cases with more severe femoral deformities. Fully-coated uncemented femoral stems have shown much better survival rates than cemented implants, but stress shielding and proximal bone loss have been a concern. Recent attention has been focused on stem modularity and distally fixed splined stems.

This study’s purpose is to report the results of a series of revision THR that received a long-stem uncemented calcar replacement femoral component, and evaluate survivorship based on age, Paprosky class, implant length, modularity and mode of failure. We hypothesized that implant survivorship and clinical results would be negatively influenced by increasing femoral defect severity.

MATERIALS AND METHODS

Between 1988 and 2009, there were 1,613 hip revisions performed at our center. Of these, 461 hips in 435 patients received the Mallory-Head calcar replacement femoral stem and had complete postoperative data set. The average follow-up time was 5.6 years (SD ± 4.6, range: 0.1 to 18.5 yrs), and 75% (326) of these patients had greater than 2-year follow-up. Average patient age was 68.2 years (SD ± 12.5, range: 34-96) and 87 patients died during the study. 224 of the 435 patients (51.5%) were female. Preoperative and postoperative radiographs were taken at 2 months, 6 months, 1 year, and at regular annual or biannual intervals thereafter. Routine clinical scores including the Harris hip score (HHS) and gait evaluations were taken as well. This data was reviewed for this study to determine the preoperative condition of the femur, long-term success or failure of the implant, mode of failure and complications encountered related to the hip replacement over the life of the femoral implant.

Preoperative femoral deformity was characterized according to the Paprosky femoral defect classification system. Type I defects are characterized by some loss of metaphyseal bone with an intact diaphysis. The type II femur exhibits extensive loss of the metaphysis, but still contains an intact diaphysis. In a type IIIA deformity, the metaphysis shows severe damage and is nonsupportive, and the femoral canal contains a minimum of 4 cm of intact cortical bone. Type IIIB femurs have serious metaphyseal defects, but have less than 4 cm of usable cortical bone in the diaphysis. Type IV femurs display rare and serious defects, with extensive metaphyseal damage and a widened femoral canal.

Statistical analysis was performed using statistical analysis software (SAS, Cary, NC). Survival at various intervals thereafter.
end-points was tested against other variables, specifically Paprosky class, age, gender, implant modularity, component length and mode of failure, to determine any statistical significance. Odds ratios were reported with corresponding p-values and a significance level of 0.05.

RESULTS

Of the 461 hips that received the calcar long-stem in revision THA, there were 18 re-revisions in 15 hips, giving an overall re-revision rate of 2.4%. Re-revision was defined as the removal and/or replacement of the original revision femoral component. Thirteen of the 18 re-revisions were due to infection, thus there were only five aseptic failures in three patients. Of these five re-revisions, two were due to femoral loosening, two due to recurrent dislocations, and one was the result of a femoral fracture. The survival rate with aseptic failure for any reason as the end-point was 98.9%, and survival with aseptic loosening of the femur as the end-point was 99.6%.

The Paprosky classification system was used to categorize the revision hips according to the severity of femoral bone defects. Of the 461 femoral revisions, 18 (3.9%) were type I, 130 (28.2%) were type II, 240 (52.1%) were type IIIA, 55 (11.9%) were type IIIB and 18 (3.9%) were type IV (Table 1). With failure defined as aseptic re-revision for any reason, none of the type I or II femurs, one (0.6%) type IIIA, two (5.1%) type IIIB and two (12.5%) type IV femurs failed. With increasing femoral deformity, revision rate for any reason increased (p = 0.0101, Jonckheere-Terpstra). The two re-revisions for aseptic loosening exhibited severe defects as one was type IIIB and the other was type IV, so the same trend was detected (p = 0.0014, Kaplan-Meier Log Rank) with the numbers available. One case had a femoral perforation and the other patient had a brief incarceration and was lost to follow-up. Paprosky classification was also statistically related to femoral component diameter. As femoral defects increased, larger diameter components were required (p < 0.0001, ANOVA).

Sixty-three patients (13.6%) had significant complications after the initial revision surgery, but did not require re-revision of the femoral component (Table 2). Thirty-one patients (7%) experienced dislocations, requiring a variety of treatments depending on the severity of the dislocations and condition of the hip. Of those 31, 13 had a closed reduction, six required an acetabular revision, five had a femoral head and liner exchange, three had an open-reduction, two had a head exchange and two had a liner exchange. Twenty patients required an acetabular revision for mechanical loosening of the acetabular component in which the femoral component was not loose. Eight patients had a femoral fracture. Seven required an open reduction internal fixation and one had a closed reduction. Two patients had bolt and claw repairs, one had a wound infection not requiring surgery and one had hip debridement and a head exchange.

Femoral bone grafting was performed as needed for patients with deficient femoral bone stock. Allograft or autograft was used at the discretion of the surgeon and tibial strut grafts were most commonly used. Ninety-nine (21%) of the femoral revisions had femoral bone grafts and the other 362 did not receive bone grafts. The need for grafting increased with worsening femoral defects and a higher Paprosky class (p = 0.006). Three of the five aseptic failures received bone grafts, including both of the failures for loosening.

A trochanteric bolt and claw can be used with this implant to improve proximal fixation and trochanteric stability as with greater trochanteric reattachment after osteotomy. Wires were also frequently used to provide implant stability and/or aid graft stabilization. 308 of the 461 (66.8%) revisions received some type of adjuvant cerclage or trochanteric fixation.

DISCUSSION

Some authors have reported high rates of failure, loosening, and subsidence with uncemented, proximally-coated femoral components in revision THA, but these have not included the Mallory-Head calcar prosthesis. Extensively-coated, long-stem femoral components have
Twenty-one Years Clinical Experience of 461 Femoral Revision Total Hip Arthroplasties with a Calcar Replacement Prosthesis

performed well in femoral revision surgery. Various studies have reported better than 97% survival with mechanical failure as the end-point in revision surgery with this type of implant.\(^8\) Extensively-coated components have been associated with stress shielding, which can result in femoral bone loss, but these studies have not seen a connection between stress shielding and clinical failure.\(^17,18\)

The Mallory-Head implant is designed to achieve initial stability, proximal bone loading and long-term bony ingrowth. The combination of the stem’s proximally coated surface, length, distal scratch fit, and bowed geometry provide rotational stability. Proximal bone loading is achieved by the medial calcar collar, which creates physiologic loading with the proximal portion of the femur. A study by Whiteside et al demonstrated that collared implants show decreased subsidence and can withstand a greater load to bone failure than noncollared prostheses.\(^19\)

The titanium alloy construction of this implant is not as stiff as chromium-cobalt alloy, with increasing stem flexibility reducing stress shielding and bone resorption, thus larger implants that can achieve maximum fill of the femoral canal can be utilized with less rigidity.\(^20\)

The Mallory-Head stem design has shown excellent results in revision THA.\(^1,21\) Emerson et al reported a 97% survival rate with mechanical loosening as the end-point at 11 years average follow-up.\(^21\) A study by Head et al included a series of 1,179 femoral revisions done with the uncemented calcar prosthesis used in this study. At an average of 6.2 years follow-up, there were only 9 femoral revisions due to aseptic loosening. They projected 95% survival at 13 years for any revision, and 99% survival for mechanical failure.\(^1\)

This study did not look at the relationship between femoral deformity and overall hip survivorship. In the present study, we wanted to examine whether preoperative femoral defects affected stem and overall hip replacement survivorship.

In our series, most femoral failures occurred within the first few years after the initial revision surgery, with the mean time to aseptic failure being 2.1 years. In the successful cases, achieving initial fixation and stability was vital to the component’s durability. There were only five aseptic femoral component failures in three patients, two of which were due to femoral loosening. The failure rate increased as the degree of femoral deformity increased. In hips with severely damaged femurs (Types IIIB and IV) the entire hip construct was more likely to fail than the type II or IIIB femurs that had less damage. Although eight of 95 type II femurs were re-revised, these were all a result of infection; no type II femur failed mechanically.

The two failures resulting from femoral loosening were somewhat unique cases. The first patient was incarcerated during the postoperative recovery. He had two re-revisions, the first for loosening and the second for a femoral fracture. When the second patient received his first hip revision, the femoral component was not placed entirely within the femur, but perforated the distal femur so that the distal 25% of the component was outside of the femur in a type IV femur. This hip required two re-revisions, one for aseptic loosening and one for recurring dislocations.

Bone grafting has been shown to be a reliable option for treating femoral bone deficiencies and restoring femoral bone stock.\(^22,23\) Weeden and Paprosky recommended the use of femoral bone grafting in treating severely damaged type IIIB or IV femurs. This has been proven successful as Head et al noted 96% survivorship at 10 years and unification of all bone grafts in a study of femoral revisions with severe defects. We found that bone grafting was more often utilized as femoral condition worsened likely due to greater femoral damage and lack of quality bone stock. Three of the five aseptic failures received grafts, including both failures for loosening. We believe that the fact that these cases received grafts is not a reflection of the graft’s failure, but is most likely related to the cases more severe femoral deformities.

Stress shielding has been a concern with uncemented femoral stem revisions. We did not quantify the occurrence of stress shielding in this study, but similar studies have noted that stress shielding is not a clinically significant factor with this implant. Emerson et al reported that 89% of revision hips showed no stress shielding on the proximal femur in their most recent radiographs. The incidence of stress shielding did not affect survivorship in their study.\(^19\)

This study had several limitations, and some factors were not taken into account. All data was collected and analyzed retrospectively, so some factors, such as bone grafting, modularity and stem size were uncontrolled variables. Also, some data was missing or incomplete. Paprosky classification was determined using preoperative radiographs, so potential bone loss from removing the old femoral component during revision surgery was not accounted for during the assessment of femoral defects. Another limitation of this study, which is also an advantage, is its time span. During the 21-year period of this study, surgical techniques changed and improved, so the cohort that received this implant was not completely identical. Finally, this study only evaluates the success of the uncemented Mallory-Head prosthesis in revision THA; we did not compare this implant to the other 1,152 cases that received a different femoral component during revision surgery.

The Mallory-Head calcar replacement femoral stem performed very well in revision THA, producing over 99% survivorship with aseptic loosening as the end-point.
Its versatility allowed it to be used for a wide range of femoral deformities, and we found, not unexpectedly, that the likelihood of failure increased with increasing femoral defects. Some patients experienced postoperative complications, but these were largely unrelated to the stability and functionality of the femoral implant. We believe that our data supports the continued use of the Mallory-Head femoral component in hip revision surgery.

REFERENCES


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