Isolated All-polyethylene Patellar Revisions for Metal-backed Patellar Failure

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Abstract The outcome of isolated patellar component revisions after metal-backed patellar failure is variable with satisfactory results reported from 78% to 100%. To supplement information in the literature we determined the failure rate and the functional outcome based on the Knee Society clinical and roentgenographic evaluation systems of isolated patellar component revisions after metal-backed patellar component failure. We retrospectively reviewed 27 patients with 28 isolated patellar component revisions for metal-backed patellar component failure performed between 1988 and 2005. Twenty-five knees in 24 patients were available for review with a minimum followup of 24 months (mean, 90 months; range, 24–210 months). All knees were revised with a cemented all-polyethylene patellar component and all tibial polyethylene components were routinely exchanged. One failure (4%) occurred 122.6 months after the isolated patellar component revision secondary to femoral and tibial component loosening. The average Knee Society knee score improved from 73 to 89 points, whereas the average Knee Society function score improved from 56 to 65. Our data confirm those in the

literature suggesting a successful outcome can be achieved with an isolated patellar component revision for metal-backed patellar component failure.

Level of Evidence: Level IV, retrospective case series. See the Guidelines for Authors for a complete description of levels of evidence.

Introduction

The metal-backed patellar component was introduced in the early 1980s for patellar resurfacing in TKA. The design rationale for the metal-backed patellar component followed the underlying principles and experiences of metal-backed tibial components [4, 35]. The addition of metal backing to a patellar component was designed to resist polyethylene deformation while decreasing implant-bone interface stresses. Additionally, the metal backing provided a porous coating for cementless fixation. Shortly after the introduction of the metal-backed patellar component into clinical use, early and frequent failures of a variety of dome-shaped metal-backed patellar components became apparent [1, 3, 4, 7, 22, 23, 25, 26, 31, 32, 35, 36]. In contrast to these reports of metal-backed patellar failures, other authors have reported long-term successful outcomes with metal-backed patellar components of a mobile-bearing design [19]. The mechanisms of metal-backed patellar component failure have been summarized by Rosenberg et al. [35] and Stulberg et al. [36]. The most common mechanisms of metal-backed patellar component failure include local polyethylene wear resulting in damage to the locking mechanism and subsequent dissociation or fracture from the metal base plate, polyethylene delamination from the metal base plate, or loss of interface fixation by peg failure or shearing [35]. Risk factors associated with failure

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Each author certifies that his or her institution has approved the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research. A waiver of informed consent was granted and obtained before the collection of data for this study.

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include male gender, younger age, heavier body habitus, and knees with greater range of motion [35]. Evidence of metal-backed patellar component failure necessitates prompt revision surgery to restore function, relieve pain, and prevent further damage to the underlying femoral component.

The reported success, defined as not requiring a second revision procedure, after an isolated patellar component revision for metal-backed patellar failure is variable with a range of 78% to 100% [2, 8, 9, 11, 20, 21, 24]. Previous authors have cautioned that an isolated patellar revision can lead to an unsatisfactory result requiring a second revision procedure [2, 8, 9, 24]. Leopold et al. reported a 20% reoperation rate in a series of 40 knees most commonly for patellar subluxation [24]. Arredondo et al. [2] reported a slightly higher failure rate of 22% in a series of nine knees, two of which underwent a second reoperation for deep infection. Berry and Rand [8] reported a failure rate of 19% in a series of 42 knees; three knees were subsequently revised for patellar instability, two for patellar fracture, two for patellar polyethylene wear, and one for deep infection. Burke et al. [9] reported a reoperation rate of 15% in a series of 42 knees, most commonly for tibial polyethylene wear.

Despite the undesirable failure rates reported by some authors, more recently performed isolated all-polyethylene patellar revisions for metal-backed patellar failure have had promising results [11, 20, 21]. Koh et al. [21] reported a 100% success rate after isolated patellar revisions in a series of 29 knees. Chan et al. [11] reported a successful outcome in 21 of 22 patients with only one knee requiring a reoperation for deep infection. Finally, Kobori et al. [20] reported a successful outcome in 11 of 12 patients with only one subsequent reoperation being necessary for infection. Isolated patellar component revisions after the failure of a metal-backed patella component may therefore be an alternative to a more extensive revision procedure.

We hypothesized the clinical failure rate, defined as reoperation of the TKA for any reason, after the isolated all-polyethylene patellar component revision procedure for metal-backed patellar component failure is comparable to recently published literature. Furthermore, the clinical outcome of these revision procedures based on followup Knee Society clinical and roentgenographic evaluation systems will also be comparable to these published reports [14, 18]. Continued symptoms after the isolated patellar component revision procedure was also evaluated.

Materials and Methods

We retrospectively reviewed the medical records and radiographs of a consecutive series of 27 patients with 28

isolated patellar component revisions performed for metal-backed patellar component failure between 1988 and 2005. Seventeen of the patients were men and 10 women. We excluded three patients with followup less than 24 months, leaving 25 revisions in 24 patients with a minimum of 24 months followup (mean, 90 months; range, 24–210 months). Two of the excluded patients (two knees) had less than 24 months followup secondary to moving out of the surrounding area and one male patient (one knee) underwent the isolated patellar component revision procedure only 18 months before this report. The average patient age at the time of revision surgery was 65.5 ± 14.5 years (range, 34–86 years), the average patient weight was 83.9 ± 18 kg (range, 54–120 kg), and the average patient body mass index was 27.4 ± 5.3 kg/m² (range, 18–40 kg/m²). The preoperative diagnosis for the index TKA was osteoarthritis in 22 knees, rheumatoid arthritis in two knees, and osteonecrosis secondary to sickle cell anemia in one knee. All 25 knees had previously undergone primary patellar resurfacing using a metal-backed patella component at the time of their index TKA between 1984 and 1991. We had prior Institutional Review Board approval.

Primary TKA component designs included 20 Miller-Galante I (Zimmer, Warsaw, IN), three Porous-Coated Anatomic (PCA; Howmedica, Rutherford, NJ), one Miller-Galante II (MGII; Zimmer), and one Low-Contact Stress (DePuy, Warsaw, IN). The average time from the index TKA until the isolated patellar component revision procedure was 105 months (range, 11–167 months).

The mechanism of the failure of the metal-backed patellar components was typical of the mechanisms described by Rosenberg et al. [35]. We observed local polyethylene wear leading to damage of the locking mechanism and subsequent dissociation or fracturing from the metal base plate in 16 knees, loss of fixation at the bone-metal interface by peg failure or shearing in five knees, and polyethylene delamination from the metal base plate in four knees. Presenting symptoms included pain (25 knees), chronic sterile effusions (12 knees), crepitus with knee flexion (eight knees), limited range of motion (four knees), and patellar instability (two knees). All 25 knees had radiographic evidence of loss of interposed polyethylene between the metal-backed component and the femoral component causing metal-on-metal articulation. No femoral or tibial interface radiolucencies were noted and all femoral and tibial components appeared in appropriate alignment and position on preoperative radiographs. Preoperative computed tomography scans are not routinely obtained at our institution and were not performed to evaluate tibial and femoral positioning and rotation.

At the time of revision surgery, the metal-backed patella was removed either with an oscillating saw or an osteotome as necessary. No iatrogenic patellar fractures were noted.

Each of the patellar components was revised to a cemented all-polyethylene component. The status of patellar bone stock often dictated which revision patellar component was used. Thinner residual patellae were most commonly revised with a Genesis Biconvex (Smith and Nephew, Memphis, TN) [27]. Residual patellar thickness is routinely measured intraoperatively and in our experience, the minimal patellar thickness with an intact peripheral cortical rim necessary to accommodate the Genesis Biconvex is 4 to 5 mm. The femoral and tibial components were both mechanically stressed during the revision procedure to assess for component stability and fixation. Appropriate alignment of the femoral component was evaluated based on the transepicondylar axis. Nineteen femoral components demonstrated visible surface damage in the form of burnishing and scratching secondary to metal-on-metal articulation. The decision to retain these femoral components was made only if the defects were deemed superficial and not palpable. Overall, the revision patellar components included 11 Genesis Biconvex (Smith and Nephew), five Insall-Burstein II (Zimmer), four Insall-Burstein (Zimmer), three PCA (Howmedica), one Miller-Galante (Zimmer), and one MGII (Zimmer). The polyethylene tibial inserts were also exchanged in all 25 knees with the modular tibial insert corresponding to the index TKA component design. A lateral retinacular release was necessary in six knees to improve patellar tracking. All patellar components tracked centrally at the conclusion of the revision procedure. Medial femoral condyle osteolytic lesions were noted on the preoperative radiographs of two knees (Fig. 1A–B). These lesions were accessible during the isolated patellar

revision to allow complete curettage and subsequent bone grafting with morselized allograft without requiring femoral component removal.

We defined failure as a subsequent reoperation for any reason after isolated revision of the metal-backed patellar component. This included revision of the patellar component and any revision of the TKA. The preoperative and postoperative Knee Society knee scores and Knee Society function scores were available for all patients at the most recent followup [18]. Any symptoms were recorded at the patient's most recent followup. Symptoms were considered minor if they did not inhibit the patient from participating in their desired daily activities and were only intermittently problematic. All other symptoms were judged major.

Complete radiographic analysis of the femoral, tibial, and patellar components was available for 22 of the 25 knees. We (RMG, MJK, VMG) reviewed postoperative and followup radiographs of all patients using the recommendations of the Knee Society to assess for radiolucencies, component alignment, and component positioning [14].

We used a paired Student's *t* test to compare the mean differences in preoperative and postoperative knee scores and knee function scores. Minitab Release 14 software (State College, PA) was used for statistical analysis.

Results

One failure occurred (4%). This single patient presented 122.6 months after an isolated patellar component revision for metal-backed patellar failure with pain, swelling, and the sensation of instability. Additionally, this single patient had radiographic evidence of femoral and tibial component loosening and malalignment (Fig. 2A–D). This patient subsequently underwent a second revision procedure necessitating revision of the femoral, tibial, and patellar components to a NexGen Legacy Constrained Condylar Knee (Zimmer). At 36 months, this patient is without further symptomatic complaints or radiographic evidence of further component failure (Fig. 2E–F).

The mean Knee Society knee score improved ($p < 0.01$) from 73 points (range, 49–96) preoperatively to 89 (range, 70–98), whereas the average knee function score improved ($p = 0.01$) from 56 (range, 0–90) preoperatively to 65 (range, 0–100). The mean improvement for the Knee Society knee score and the knee function score was 16 and 9, respectively. The average followup range of motion for all 25 knees was 107° (range, 60 – 120°). Postoperative quadriceps weakness or lag was not noted in any patient.

The single patient who underwent a second revision procedure radiographically demonstrated both femoral and tibial component loosening (Fig. 2C–D). The remaining radiographs of 21 knees had no evidence of femoral, tibial,

Fig. 1A–B Preoperative (A) anteroposterior and (B) lateral radiographs before an isolated patellar component revision depict evidence of an osteolytic lesion at the medial femoral condyle (white arrow). This lesion was curettaged and bone grafted without necessitating the removal of the femoral component.

◀ **Fig. 2A–F** Preoperative (A) anteroposterior and (B) lateral radiographs before an isolated patellar component revision for metal-backed patellar component failure in a patient with rheumatoid arthritis. Femoral and tibial components are in appropriate position and alignment. Additionally, four tibial screws were removed at the time of the isolated patellar revision to prevent the progression and extension of debris particles. This single patient subsequently presented 122.6 months after this isolated patellar component revision with clinical symptoms of pain, swelling, and mechanical instability. (C) Anteroposterior and (D) lateral radiographs at this time demonstrated tibial interface radiolucencies in addition to poor femoral and tibial component alignment. This patient underwent a second TKA revision procedure, which is depicted on the postoperative (E) anteroposterior and (F) lateral radiographs.

these three patients with sterile knee effusions was noted to have a limited degree of femoral component burnishing and scratching during the isolated patellar revision procedure. Two patients had intermittent mild anterior knee pain most commonly in the morning that occurs once or twice per week. One patient had mild chronic patellar subluxation not affecting the function of the knee. One patient had intermittent “patellar clunk”-type symptoms but denied functional limitations. Despite these symptoms, these seven patients had satisfactory knee function without evidence of radiographic failure. No evident reason or obvious explanation for these symptoms could be determined and no further surgical intervention has been offered.

Discussion

Failure of the metal-backed patellar component in TKA has been well documented throughout the literature [1, 3, 4, 7, 22, 23, 25, 26, 31, 32, 35, 36]. This high rate of failure has subsequently led to the markedly decreased use of these components [12, 16, 31, 36]. The need for revision after failure of the metal-backed patella has led some authors to attempt an isolated revision of the patellar component with variable success [2, 8, 9, 11, 20, 21, 24]. We asked whether the clinical outcome of isolated patellar component revisions for metal-backed patellar failure performed at our institution was comparable to recently published reports in the literature with regard to the subsequent failure rate, the Knee Society knee score and function score, the Knee Society roentgenographic evaluation, and continued knee symptoms.

We recognize some limitations. It is a retrospective study of a nonrandomized patient population; thus, selection bias may be an influencing factor. The size of our cohort is relatively small and all isolated patellar revisions were performed for a specific diagnosis, namely, failure of the metal-backed patellar component. Therefore, our study population may not be representative of isolated patellar component revisions performed for reasons other than for metal-backed patellar failure. Furthermore, the primary

or patellar component loosening. There were no radiolucent lines or osteolytic lesions observed at the femoral, tibial, or patellar interfaces.

Seven patients (seven knees) had intermittent minor knee symptoms at last followup. Three of the seven patients continued to have intermittent sterile knee effusions that occur approximately once every month. One of

TKA components and the isolated patellar revision components used in this study were of a heterogeneous population and comparison to a specific control was not possible. We also used an older clinical and functional outcome scoring system. With regard to the seven patients with continued intermittent minor symptoms, a more objective determination of their level of disability and pain either through a SF36-v2 or visual analog score may have proved helpful.

In this cohort of 24 patients (25 knees), at an average of 90 months after an isolated patellar component revision for metal-backed patellar component failure, only one reoperation has been necessary resulting in an overall success rate of 96%. The reoperation rate and results of our series are similar to the findings of previous authors [11, 20, 21]. Koh et al. [21] reported a successful outcome in 29 of 29 knees, Chan et al. [11] reported a successful outcome in 21 of 22 knees, and Kobori et al. [20] reported a successful outcome in 11 of 12 knees after isolated patellar revisions for metal-backed patellar failure. In contrast, other authors have reported limited success and higher failure rates after isolated patellar component revision procedures for metal-backed patellar component failure [2, 8, 9, 23].

The Knee Society knee score and the Knee Society functional score both considerably improved in this series of isolated patellar revisions for metal-backed patellar component failure. The overall mean improvement in the Knee Society knee score from 73 to 89 and the Knee Society function score from 56 to 65 is comparable to the findings of other authors who had similar success rates [11, 20, 21]. Koh et al. [21] reported a Knee Society knee score improvement of 63 to 90 and a Knee Society function score improvement of 20 to 50, whereas Chan et al. [11] reported a Knee Society knee score improvement of 75 to 84. A direct comparison to the results of Kobori et al. [20] cannot be made because an alternative scoring system was used. However, the considerable improvement in the Japan Orthopaedic Association knee score from 45 to 79 seems similar to our results [20].

Only the single failure in this series had radiographic evidence of tibial and femoral component loosening and this patient has subsequently undergone a second revision procedure (Fig. 2C–F). Similarly, Koh et al. [21] reported one patient in a series of 29 isolated patellar revisions after metal-backed patellar failure had radiographic evidence of femoral osteolysis. This single patient was otherwise asymptomatic and a second revision procedure was not performed [21].

Minor clinical symptoms have been recognized in 28% of patients. These patients are without evidence of radiographic failure or compromised knee function. An obvious explanation for these minor symptoms has not been determined nor have these symptoms been directly related

to the patellofemoral articulation. Minor clinical symptoms described in our cohort are a relatively common finding after patellar resurfacing in TKA [10, 28]. Mayman et al. [28] reported 20% of patients who underwent a primary patellar resurfacing were only “satisfied” with their results, most likely as a result of minor pain with functional activities. Additionally, Burnett et al. [10] reported at a 10-year followup that seven of 19 of patients who had patellar resurfacing experienced some level of anterior knee pain. Furthermore, despite this subset of patients with continued anterior knee symptoms, 33 patients or 34 of 40 knees (85%) who underwent TKA with patellar resurfacing at 10-year followup were extremely satisfied and all would undergo the operation again [10].

The favorable outcomes in our series may be attributable to a variety of factors. All patients in this series were treated specifically for metal-backed patella failure. Although a small number (two knees) of patellar revisions in this series was performed in patients with symptoms of patellar instability, these patients were without clinically detectable subluxation. All patellar components were determined at the time of revision surgery to track within the intercondylar groove and have satisfactory anatomic relationships to the joint line. Satisfactory patellar tracking is associated with improvements in function, pain relief, and overall patient satisfaction [6, 13, 15, 29]. Recognition of proper component alignment is also an important aspect with primary and revision TKA [5, 33, 34]. The decision to retain the femoral and tibial components was made only after preoperative radiographs and an intraoperative evaluation was performed for satisfactory anatomic alignment and positioning [17]. Eleven patellae were also revised with a Genesis Biconvex patellar component (Smith and Nephew) previously reported to result in improved knee scores, knee function scores, and knee range of motion in patellar revisions with deficient bone stock [27]. Although not used in this series, patellae with severely deficient bone stock that cannot accommodate the Genesis Biconvex patellar component may be revised with the porous tantalum patellar component with clinical success (Trabecular Metal, Zimmer Trabecular Metal Technologies, Zimmer, Allendale, NJ) [30].

Our results confirm those in current literature and suggest an isolated patellar component revision is a reasonable alternative to a more extensive TKA revision after failure of the metal-backed patella. It is possible a cohort of patients with a similar presentation that underwent a complete revision of the femoral, tibial, and patellar components may have resulted in similar or better outcomes. However, we believe avoiding the revision of the femoral and tibial components has a variety of potential benefits, including the preservation of bone stock associated with removal of well-fixed implants, decreased

operative time, decreased blood loss, and avoidance of any potential ligament disruption after the removal of well-fixed components.

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