Effect of Gender and Preoperative Diagnosis on Results of Revision Total Knee Arthroplasty

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Abstract Recent studies question an effect of gender on outcome of primary TKA. We questioned whether the results of revision TKA were affected by gender. We separated 67 revision TKAs by gender and preoperative diagnosis into four groups (arthrofibrosis, infection, instability, and wear and loosening). Each revision TKA was individually matched by age and gender to two primary TKAs. Postoperative Knee Society pain and function scores after revision TKA were lower than for primary TKA for both females and males. However, postoperative Knee Society pain and function scores were similar in males and females. Postoperative pain and function scores were lower for all revision groups compared with primary TKA, except for pain and function scores after revision for instability. Postoperative pain and function scores were higher for instability and wear or loosening than for arthrofibrosis. Our data suggest the results of revision TKA are affected by preoperative diagnosis but not gender.

Level of Evidence: Level III, retrospective matched cohort study. See Guidelines for Authors for a complete description of levels of evidence.

Introduction

Recent studies have questioned whether the outcome of primary TKA is affected by gender [1, 6, 12, 17]. Hitt et al. identified differences in the aspect ratio (mediolateral to anteroposterior dimension) of the distal femur in males and females undergoing TKA [6]. The authors concluded that for women, there was a major positive association between the component size and the amount of mediolateral overhang and suggested this could produce less favorable clinical results [6]. However, other investigators have reported the improvement in pain and function after primary TKA is not influenced by gender [1, 12, 17]. Currently, it is unclear whether any of these observations apply to revision TKA.

The results of revision TKA are generally less favorable than primary TKA. Hanssen and Rand reported primary TKA resulted in 92% good and excellent results, whereas revision TKA was associated with a lower (81%) rate of good and excellent results [5]. In a meta-analysis of 74 studies in the literature, Efgem et al. suggested primary TKA offered greater improvement than revision TKA [3]. The reason for revision has been noted to affect survivorship after revision TKA [19]. Failed primary TKA requiring revision is associated with multiple causes and variable amounts of bone loss, ligament support, soft tissue coverage, and integrity of the extensor mechanism. The population of patients who undergo revision TKA is generally older than patients having primary TKA, and the surgical time and technical complexity of revision is greater than that of primary TKA, both of which can increase the risk of complications and contribute to poorer clinical results. However, the effect of gender on the outcome of revision TKA is not clear.

We therefore questioned whether the results of revision TKA would be affected by gender and if the outcome of

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revision TKA was related more to the preoperative diagnosis than the gender of the patient.

Materials and Methods

To compare the results of revision TKA with primary TKA, we used a retrospective matched cohort study design. We retrospectively reviewed 212 consecutive revision TKAs in the senior author's (MDR) practice between 1998 and 2005. During the study period, all patients undergoing TKA in our practice had preoperative and postoperative Knee Society scores [7], demographic information, and outcome data prospectively collected and entered into a database, which served as a source of information used in this study.

Revision TKAs were separated by gender and also categorized into four groups based on the clinical indication for revision TKA: arthrofibrosis, infection, instability, and wear or loosening. Patients with previous revision TKA (36), revision TKA for patellar instability or extensor mechanism disruption (17), multiple causes of failure or unexplained pain (13), periprosthetic fracture (six), isolated tibial insert revision (11), isolated patellar revision (eight), or revision from a unicompartmental arthroplasty (nine) were excluded. Patients revised for axial or rotational malalignment (four), metal allergy (one), and implant breakage (one) were also excluded because the number of patients in these categories was too small to provide a meaningful comparison to the other groups. Five patients died before the 2-year followup. Thirty-four patients (16% of the total number of revision TKAs) did not return for the 2-year followup. The revision TKA cohort consisted of 67 patients (67 knees) representing 35 women and 32 men with a minimum 2-year clinical and radiographic followup. The average age of the patients undergoing revision TKA at the time of surgery was 60 years, average body mass index was 30.7 kg/m², and minimum followup period was 2 years (average, 3 years; range, 2–8 years). Each revision TKA case was individually matched to two primary TKA cases in our practice with similar age (within 3 years),

gender, and length of followup. To achieve an alpha error rate of 5% with 80% power, we estimated a need to include at least 12 revision TKA cases and at least 24 primary TKA cases per group. There were no differences in age or body mass index between the groups, although there were more female patients in the arthrofibrotic group than other revision categories (Table 1).

All patients who underwent revision TKA during the study period were evaluated by the senior author with a clinical history, physical examination, plain radiographs, erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP) level. If the ESR and CRP were elevated or infection was suspected, additional workup for infection with an aspiration and/or labeled white cell scan was performed.

The cause of failure was determined by the preoperative evaluation and intraoperative findings at the time of revision TKA. Arthrofibrosis was considered the underlying cause of failure if the arc of motion was less than 90°, the knee was aligned between 3° and 10° of valgus, the tibial component did not overhang the tibial cortex, and the femoral component size did not overstuff the anterior or posterior compartments seen on the lateral radiograph [16]. Preoperative computed tomography scans were obtained to evaluate malrotation of the femoral and tibial components if patellar tilting or subluxation was present. Infection was diagnosed by an elevated ESR and CRP and positive preoperative aspiration culture or intraoperative soft tissue culture. Instability was considered the cause of failure if the patient reported pain and swelling after activity, there was more than 1 cm of laxity to mediolateral stress testing at 30° of knee flexion, and no other causes of failure were identified. Wear or loosening was considered the cause of failure if the patient had weightbearing pain and either osteolysis or a change in implant position on serial radiographs. Wear and loosening were included in the same group because these two processes often occur together and are difficult to separate clinically in many cases.

All surgery was performed under the direction of the senior author using a standard approach. Prior scars were used when possible and the knee was exposed through a

Table 1. Demographic data in revision TKA groups

Demographics	Arthrofibrosis	Infection	Instability	Wear/loosening
Gender				
Female no. (%)	11 (85)	10 (60)	4 (27)	10 (47)
Male no. (%)	3 (15)	7 (40)	11 (73)	11 (53)
Total no.	14	17	15	21
Average age (years)	58 (range, 42–78)	58 (range, 37–78)	65 (range, 33–82)	61 (range, 41–81)
Average body mass index (kg/m ²)	30.48	32.37	28.89	30.00
Average followup (years)	2.33 (range, 2–4)	2.87 (range, 2–6)	3.21 (range, 2–6)	3.91 (range, 2–8)

medial parapatellar arthrotomy. Arthrofibrosis was treated by resection of arthrofibrotic scar. The femoral component was revised and the joint line elevated by resecting distal femoral bone to correct any flexion contracture. The rotational position was determined by orienting the femoral component in line with the epicondylar axis. The tibial baseplate was retained. Constrained nonlinked components were used having relatively loose flexion and extension spaces to permit increased range of motion after surgery [16]. Infection was treated with a two-stage débridement, including implant removal, insertion of an articulating antibiotic-impregnated cement spacer, and 6 weeks of intravenous antibiotic therapy followed by delayed revision TKA approximately 8 weeks after removal of the infected implants [11]. Instability was treated by revision to achieve balanced flexion and extension spaces demonstrating 0 to 1 mm of mediolateral gapping during manual stress testing in both flexion and extension with a nonconstrained trial insert. A constrained insert with the same thickness as the trial insert was then implanted. Wear and loosening were treated by revision of the femoral and tibial components to a posterior-stabilized stemmed implant. Bone defects were filled with metal augments or bone grafts, and revision to an unconstrained posterior-stabilized implant was performed with diaphyseal-length stems in all cases. All revisions were cemented with stemmed components, and the diaphyseal portion of the stems was press-fit [15].

The senior author (MDR) performed clinical and radiographic evaluations preoperatively and at 6 weeks, 3 months, 6 months, and yearly after surgery. Knee Society scores were obtained preoperatively and at each followup visit. We used the radiographs to determine alignment for calculation of Knee Society scores.

We used paired t-tests to compare preoperative Knee Society scores with the most recent postoperative Knee Society scores for each revision TKA group. The relative benefit of surgery was calculated as the difference in postoperative and preoperative Knee Society scores. Paired t-tests were also used to compare Knee Society scores between revision and matched primary TKA groups and between genders. Postoperative Knee Society scores for the four revision groups were compared with a univariate analysis of variance using Tukey's correction for multiple post hoc comparisons. Analyses were performed in Analyse-it, version 1.73 (Analyse-it Software, Ltd, Leeds, UK).

Results

The postoperative Knee Society pain and function scores after revision TKA were lower than for primary TKA for both females ($p < 0.001$) and males ($p < 0.001$). However, postoperative Knee society pain ($p = 0.22$) and function

Fig. 1A–B Preoperative and postoperative Knee Society (A) pain scores and (B) function scores for male and female patients undergoing revision TKA and postoperative scores for age- and gender-matched primary TKA were compared. The differences between groups are noted at the top of each bar graph.

($p = 0.11$) scores were similar in females and males (Fig. 1). There was a trend demonstrating greater relative benefit from revision TKA for females than males with female postoperative Knee Society pain ($p = 0.03$) and function ($p = 0.52$) more closely approximating the relative benefit of primary TKA as compared with male postoperative Knee Society pain ($p = 0.003$) and function ($p = 0.14$) scores (Fig. 2).

Preoperative pain and function scores were improved ($p < 0.05$) after revision surgery in all groups (Fig 3). However, the postoperative revision TKA pain and function scores were lower ($p < 0.05$) than age- and gender-matched patients undergoing primary TKA in all groups except for revision for instability ($p = 0.08$ and 0.36 for pain and function, respectively). The postoperative pain scores for both instability and wear or loosening were higher than for revision for arthrofibrosis ($p = 0.0003$) and infection ($p = 0.0003$). The postoperative function scores for instability were higher ($p = 0.03$) than those for revision for arthrofibrosis.

Knee Society pain and function scores were lower ($p < 0.0001$) after revision TKA than age- and gender-matched primary TKA. The postoperative pain and function

Fig. 2A–B The relative benefits of surgery (calculated as the difference in postoperative and preoperative Knee Society scores [KSS]) were compared between genders for (A) pain and (B) function. The differences between groups are noted at the top of each bar graph.

scores for revision TKA (all groups combined) were 68.9 (± 22.2) and 63.5 (± 25.0), respectively, whereas the postoperative pain and function scores for primary TKA were 85.9 (± 11.4) and 81.5 (± 12.0), respectively.

Discussion

Recent studies have questioned the effect of gender on the outcome of primary TKA [1, 6, 12, 17]. Hitt et al. suggested mediolateral overhang of the femoral component in female patients could result in less favorable results than in males [6]. Lim et al. reported patients with lower postoperative scores after TKA also had lower preoperative scores [9]. Ritter et al. [17], MacDonald et al. [12], and Bourne and Mariani [1] all compared the improvement in knee scores (difference in preoperative and postoperative scores) between male and female patients and found either no differences between genders or females had a slightly greater improvement in scores than males. We also questioned whether the results of revision TKA were more affected by preoperative diagnosis or cause of failure than gender.

Despite the findings in this study, there are also several limitations. Retrospective studies have potential problems

Fig. 3A–B Preoperative and postoperative Knee Society (A) pain scores and (B) function scores for revision TKA and postoperative scores for age- and gender-matched primary TKA were compared. The differences between groups are noted at the top of each bar graph.

of incomplete data collection, patients lost to followup, and changes in diagnosis or treatment during the study period. However, the data for all patients were collected prospectively, which should minimize errors resulting from incomplete data collection. The revision and matched patients undergoing primary TKA in this study were also evaluated and treated by a single surgeon using a consistent surgical technique, implant selection, and postoperative management during the study period, which should minimize variability in outcomes. However, the findings reported in this study represent relatively short-term results and cannot be used to determine long-term durability or survivorship of the arthroplasty.

Our results are consistent with previously published results of revision TKA. Kim et al. [8] reported on 43 patients revised for arthrofibrosis. The mean Knee Society function score improved from 40 to 58 points, the mean Knee Society pain score improved from 15 to 47 points, and the mean arc of motion improved from 55° to 82°. The authors concluded the benefits were “modest” [8]. Mont et al. reported on 27 patients who underwent revision for unexplained pain [14]. Patients were separated into those with pain and stiffness (less than 80° of motion) and those with pain and motion greater than 80°. For the group with pain and stiffness, range of motion improved from 43° to

81°, and 60% were considered to have good or excellent results, which is similar to our findings for the arthrofibrosis group [14].

In contrast, revision for mechanical causes of failure has been associated with excellent results. In our study, the patients revised for instability or wear and loosening had the best results with postoperative pain and function scores that approached the results of primary TKA. Schwab et al. reported on 10 patients revised for instability [18]. Pain scores improved from 68 to 89 points, and stability was restored and satisfaction improved in nine of the 10 patients. Revision for aseptic loosening is also associated with favorable results. Mabry et al. reviewed 72 patients revised for aseptic failure [10]. The survivorship at 10 years was 92%. Haas et al. reported 84% good and excellent results in 65 patients (67 knees) revised for aseptic loosening with modular cemented components [4].

A successful outcome after revision TKA for treatment of infection is usually considered a functioning knee arthroplasty free of infection [2]. Meek et al. reported the functional outcome in 47 patients treated with two-stage revision TKA for infection [13]. Range of motion improved from 78° before the first stage to 87° at 2 years and the average normalized WOMAC function and pain scores were 69 and 77, respectively. The authors concluded two-stage revision TKA for infection was associated with reasonable function and satisfaction scores. Our results are similar and indicate pain and function after revision for infection is better than revision for arthrofibrosis, but less favorable than revision for instability or wear and loosening.

We found postoperative pain and function scores for revision for instability were similar to those for primary TKA, whereas revision for arthrofibrosis and infection were associated with lower postoperative Knee Society scores than either instability or wear and loosening. The poorer scores were observed in both the arthrofibrosis and infection groups despite a majority of females comprising the arthrofibrosis group and a majority of males comprising the infection group. These findings indicate the results of revision TKA are affected by preoperative diagnosis more than gender.

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