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SYMPOSIUM: GENDER-SPECIFIC ISSUES IN ORTHOPAEDIC SURGERY

Influence of Gender on Age of Treatment with TKA and Functional Outcome

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Abstract

Background Previous studies suggest differences may exist between men and women in terms of knee function before and after total knee replacement. This may be related to the efficacy of the procedure itself or to differences in the severity of disability of male and female patients at the time of surgery.

Questions/purposes We evaluated differences in the age, preoperative deformity, range-of-motion, and Knee Society scores of men and women who underwent TKA. All parameters were measured at the time of the initial preoperative evaluation and at postoperative followup.

Methods We studied 698 patients who underwent elective TKA between 1996 and 2007. This population consisted of 428 women (61%) and 270 men (39%), all of whom underwent rehabilitation utilizing a standardized hyperflexion protocol with immediate initiation of full weightbearing postoperatively.

Results The men were on average three years younger than the women (mean 63.5 versus 66.6 years, respectively). Preoperative ROM, postoperative ROM, and changes in ROM and body mass index were similar between groups. Knee Society Knee scores were similar preoperatively (47.4 [men] versus 46.7 [women]), but four points higher in men at followup (89.2 versus 85.2). Women had lower Knee Function scores than men preoperatively (45.2 versus 57.1), and postoperatively (65.3 versus 73.9).

Conclusions Women who undergo TKA seek treatment at a later stage than men and have greater functional disability at the time of surgery. Differences in functional scores persist after TKA. Earlier initiation of treatment may enhance postoperative outcome.

Level of Evidence Level II, prognostic study. See Guidelines for Authors for a complete description of levels of evidence.

Each author certifies that his or her institution has approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.
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Introduction

Osteoarthritis (OA) of the knee has a substantial impact on the quality of life of both men and women [7, 8]. The burden of TKA on our society continues to increase and, in fact, the projections show an exponential rise in the need for TKA over the next several years. By the year 2030, it is predicted as many as 3.48 million primary TKAs will be performed annually in the United States [15].

OA is the most prevalent chronic disease affecting more than 59% of Americans older than 65 years, and this disease affects a higher percentage of women than men [11, 21]. The number of women undergoing TKA continues to rise at a higher rate than men [11]. Meta-analysis and meta-regression have been used to better define site-specific

gender differences in prevalence, incidence, and severity of OA [23]. Men tend to have a reduced risk of OA of the knees, whereas women, especially those older than 55 years, reportedly have more severe disease in the knees at presentation [23]. This gender difference in disease presentation has been associated with a number of factors, including hormonal influences [22] and cartilage thickness [3]. Both men and women have an increased risk of developing OA of the knees with increased body weight [4, 5, 10].

The clinical presentation of the disease is the same for both genders with considerable pain, limitation of motion and activities, and limited ambulation resulting from pain with weight-bearing [4]. The radiographic findings are also similar for both genders, with severe joint space narrowing resulting from loss of cartilage and osteophyte formation [4, 23]. Whether the severity of disease differs between men and women at the time of the index procedure is unclear.

Previous epidemiologic studies have revealed additional differences between men and women in terms of the severity of their symptoms, in addition to radiographic and pathologic indicators of joint destruction prior to joint replacement [5, 6, 8, 17]. Katz et al. [14] reported that women undergo operative treatment of arthritic disease at a more advanced stage compared to men, and experience more pain and functional limitations after knee replacement. These findings were further corroborated by MacDonald et al. [17] who found the pre- and postoperative outcome scores of female patients were lower than those of males, though the improvement in scores was equal to or greater than that of men [2, 17].

Given the limited information on these gender differences at their time of first presentation for treatment of osteoarthritis of the knee with joint arthroplasty we examined differences in male and female total knee patients with respect to the following preoperative and postoperative parameters: (1) age at initial examination; (2) preoperative and postoperative Knee Society scores (Objective and Functional components); (3) preoperative and postoperative knee alignment; and (4) preoperative and postoperative range-of-motion.

Patients and Methods

We retrospectively reviewed all 902 patients (1143 knees) who underwent primary total knee replacements for OA between January 1996 and April 2007. Of these procedures, 695 (60.8%) were performed in women and 448 (39.2%) in men. From this cohort we identified patients whose knee function was not encumbered by comorbidities, including complications of the index procedure. One hundred and twenty patients had degenerative joint disease involving the ipsilateral hip resulting in surgery and so were excluded from further review. One hundred and thirty-three patients had postoperative complications necessitating knee manipulation (25 cases: 20 female (24%)/5 male (10%)), postoperative knee arthroscopy (42 cases: 26 female (31%)/16 male (33%)), or revision of one or all components (44 cases: 23 female (27%)/21 male (44%)). Six additional knees were treated for severe instability with implantation of a hinged type knee arthroplasty and were also excluded. One hundred and eighty-six cases were also excluded due to incomplete data, either preoperatively and/or postoperatively. The remaining 698 knee replacement patients (428 females (41%) and 270 males (39%)) had a complete set of data which included demographic information and preoperative and postoperative parameters with a minimum followup of 1 year. The mean period of followup for the entire study group was 569 days (1.56 years) and was similar for both genders (529 days for women versus 628 days for men). Institutional Review Board approval was obtained for prospective collection and retrospective review of these data.

All knee replacement procedures were performed by a single surgeon (BSP). The knee prostheses implanted in the patients in this study had five different styles of articulation: (1) cruciate retaining; (2) posterior stabilized; (3) rotating platform; (4) rotating platform with a posterior stabilization; and (5) ultracongruent. Approximately 80% of procedures in both men and women were performed using posterior-stabilized knee prostheses of both fixed and rotating-platform designs (Table 1). There were some differences between the two groups and the frequency of usage of individual design types. The femoral, tibial, and patellar components were cemented in all cases.

A standardized regimen of operative procedures and postoperative care was maintained throughout the duration of the study. Postoperatively, knee rehabilitation was

Table 1. Designs of knee prostheses implanted in patients in the male and female patient groups

Implant design	Women	Men	Total
Cruciate-retaining	5 (1.2%)	5 (1.8%)	10
Posterior-stabilized			
Rotating platform	35 (8.2%)	32 (11.8%)	67
Fixed bearing	270 (63.1%)	133 (49.3%)	403
PS total	305 (71.3%)	165 (62.2%)	470
Rotating platform (LCS)	67 (15.6%)	79 (29.3%)	146
Ultracongruent	51 (11.9%)	21 (7.8%)	72
Total	428	270	698

p-value (Pearson's Chi-squared test): 0.00003.

performed in all patients according to a standardized hyperflexion protocol. Knee flexion from 0° to 110° was performed in a continuous passive motion machine for 6 to 8 hours per day during the period of hospitalization, commencing as soon as each patient was admitted to the patient floor after surgery. Full weightbearing was also encouraged immediately postoperatively. Routine physical therapy was performed twice per day beginning on the first postoperative day and continued until discharge. All patients received perioperative antibiotics for 24 hours and thromboprophylaxis with Lovenox® (Sanofi-Aventis US LLC, Bridgewater, NJ) for 14 days postoperatively.

Patients were evaluated preoperatively, at a maximum of 6 months prior to surgery, and postoperatively at 1 month, 12 months, 24 months, and then annually. At each visit, the passive range-of-motion of the knee was measured using an 18 inch goniometer with the patient lying supine on the examination table. Using the guidelines provided by the Knee Society, both components of the Knee Society score (Knee score and Function score) were also completed [12]. Routine radiographs were performed preoperatively, at 1 month postoperatively, and at annual followup thereafter. This included a standing AP and 90° flexion lateral on 14- by 17-inch cassettes and a sunrise patellar view. The coronal alignment of each knee was defined by the anatomic relationship between the femur and the tibia as defined by the angle between the intramedullary axes of both bones. According to this definition, the alignment of the normal femur would be 5–8° of physiologic valgus. This angle was measured on each of the preoperative and postoperative radiographs.

We determined differences in each of the continuous variables (age, body mass index, knee flexion and extension, Knee score and Function score) between male and female patients using the Student's t test. For categorical data analysis such as comparison of usage patterns of different implant designs between male and female patients, and anatomical preoperative alignment comparison between both groups, the chi square test was used. All statistical analyses were performed using R analysis code (The R project for Statistical Computing, www.R-project.org).

Results

At the time of surgery, the male patients were an average of 3.0 years younger ($p < 0.001$) than the female patients (64.1 versus 67.1 years). Both genders had similar ($p = 0.592$) body mass index, with group averages (± SDs) of 30.8 ± 6.7 kg/m^2 for women and 30.5 ± 5.5 kg/m^2 for men. The followup patient evaluations after surgery were similar between groups (Table 2).

Table 2. The followup since surgery at the time of evaluation for the male and female patient groups

Followup ($p = 0.19$)	Women	Men
One year	251 (59%)	144 (53%)
Two years	177 (41%)	126 (47%)

Table 3. The preoperative, postoperative and change in Knee Society Knee Scores in the male and female patient groups

KSS—Knee Score	Women	Men	p value
Preoperative			$p = 0.4166$
Mean	46.6	47.7	
Min	3.0	10.0	
Max	100.0	94.0	
Postoperative			$p < 0.0002$
Mean	85.1	89.2	
Min	35.0	31.0	
Max	100.0	100.0	
Change			$p = 0.0631$
Mean	38.5	41.5	

Table 4. The preoperative, postoperative and change in Knee Society Function Scores in the male and female patient groups

KSS—Function score	Women	Men	p value
Preoperative			$p < 0.0001$
Mean	45.2	56.5	
Min	0.0	0.0	
Max	100.0	100.0	
Postoperative			$p < 0.0001$
Mean	65.4	73.9	
Min	0.0	0.0	
Max	100.0	100.0	
Change			$p = 0.1701$
Mean	20.3	17.6	

The Knee scores of the male and female groups were similar preoperatively (47.7 points in men versus 46.6 points in women; $p = 0.417$) (Table 3), however, the Knee Function scores of the women were an average of 11.3 points lower than those of the men (45.2 points in women versus 56.5 points in men; $p < 0.0001$) (Table 4). Postoperatively, women had lower ($p < 0.001$) Knee scores than men (85.1 points versus 89.2 points respectively), and displayed a lesser ($p = 0.0631$) improvement in the Knee score over preoperative values, with an average increase of 41.5 points versus 38.5 points for females. The lower ($p < 0.001$) Knee Function scores in

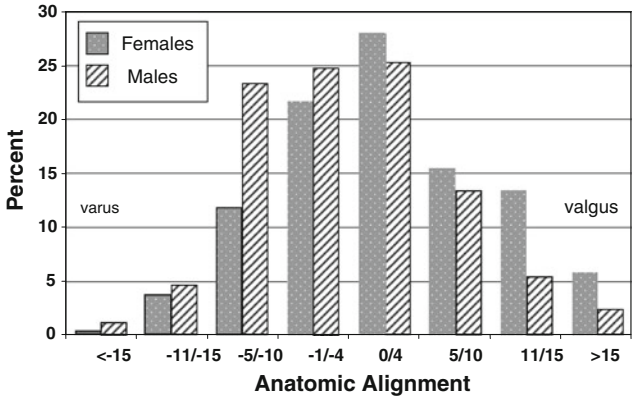

Fig. 1 A graph shows the distribution of preoperative values of varus-valgus deformity of the knee in male and female patients. An overall chi-squared test suggests the two distributions differ ($p < 0.001$). Female patients are seen to have more valgus deformities whereas in male patients varus knee deformities are more common.

Table 5. The preoperative, postoperative and change in range of motion in the male and female patient groups

Range of motion	Women	Men	p value
Preoperative			p = 0.6325
Mean	108.2°	108.9°	
Min	29.0°	35.0°	
Max	150.0°	145.0°	
Postoperative			p = 0.7441
Mean	118.3°	118.0°	
Min	76.0°	75.0°	
Max	144.0°	148.0°	
Change			p = 0.4559
Mean	10.5°	9.1°	

women persisted postoperatively (women: 65.4 points versus men: 73.9 points;)), although the preoperative to postoperative improvement in Knee Function scores (20.3 points in women versus 17.6 points in men) was similar ($p = 0.170$).

A higher percentage of males than females had knees aligned in varus (< 0°) on the preoperative AP radiograph (males: 54.3 % versus females: 37.8%) while a reverse pattern was observed in knees with valgus alignment preoperatively (> 10° valgus; males: 8.4% versus females: 19.6%) (Fig. 1).

Preoperatively, the average ROM of the knee was similar ($p = 0.633$) in women and men (108° versus 109°, respectively). The postoperative ROM was also similar ($p = 0.744$) with an average of 118° (Table 5). The improvement in ROM (+10° in women versus +9° in men) was similar ($p = 0.460$) between groups.

Discussion

Previous authors have demonstrated an increase in the prevalence and severity of osteoarthritis of the knee in females compared to males [23]. Others [14, 17, 18, 20] have found women undergo knee replacement at a later stage of the degenerative process than men, and experience more pain and functional limitations after knee replacement. The reasons for these differences are unknown, but have been attributed to disparities in access to health care, differences in the interpretation of knee symptoms, and gender bias on behalf of physicians and surgeons in recommending knee replacement to female patients. We therefore investigated differences between male and female patients undergoing knee arthroplasty, including age at time of first presentation, preoperative and postoperative Knee Society scores, and preoperative and postoperative knee alignment, and range-of-motion.

This study has several limitations. First, as with any uncontrolled clinical study, some variables defining the treatment (e.g. pain management procedures, rehabilitation protocols, length and location of incision, adherence to clinical pathways, indications for selection of different prostheses) of each patient over a long period of study will no doubt have changed and may have the effect of increasing the variability of outcome scores and hence the power of the study to detect differences attributable to gender. Second, a source of bias is the selection of different designs of knee prostheses for male and female patients. While the great majority of patients received prostheses of a posterior-stabilized design, there were differences between the utilization of rotating-platform prostheses and some other less common designs (Table 1). This may have caused some systematic disparity between the postoperative parameters studied, however, it would not explain the substantial differences observed between the groups preoperatively. Moreover, our previous work suggests little effect of prosthesis design on the range-of-motion of the knee, or the Knee Society score at followup [19]. Third, ours was a retrospective study based on information from a database collected prospectively from the practice of a single surgeon using a specific standardized regimen of operative procedures and postoperative care. While consistency facilitates comparison between different groups of patients, it necessarily limits the findings of this study to the environment in which the treatment was performed and examined. As a result, our findings may not directly apply to a wider patient population or different demographic or geographic region.

The difference in the objective and functional components of the Knee Society scores is consistent with previous studies within the literature [2, 13, 17]. We found no difference between the mean preoperative Knee Society

scores of male and female patients in contrast to the Function scores which differed by 11.3 points in favor of the males. Postoperatively, males had higher scores than females on both the Knee Society score (difference: 4.1 points) and the Function score (8.5 points). Overall, male patients experienced greater improvement in Knee score after TKA (3.0 points more than women), however, women had greater improvement in their Function scores (2.7 points more than men). Our findings are similar to those of MacDonald et al. [17] who reported that the pre- and postoperative outcome scores of female patients were lower than those of males, though the improvement in scores was equal to or greater than that of men [2, 17]. This persistent disparity in the knee function of male and female patients after TKA has been termed the "never catch up syndrome" [16].

Our female patients were an average of 3 years older than the men at the time of their initial surgical consultation, however, we have no data demonstrating the extent to which this difference in age affected the outcome of each patient or their function after TKA. The reason for this age difference is not known. It could potentially be due to our own selection bias, especially when considered in conjunction with the fact that the function scores of our female patients were lower than those of our male patients. Borkhoff et al. [1] reported the odds of an orthopaedic surgeon recommending TKA to the male standardized patient was 22 times (95% confidence interval, 6.4–76.0) greater than to a female patient. This gender bias may cause female patients to seek an orthopaedic consultation later for the symptoms of knee OA, or may cause them to postpone joint replacement until their functional level has deteriorated further than in their male counterparts. Katz et al. [14] reported women undergo operative treatment of arthritic disease at a more advanced stage compared to men. This may reflect a personal decision by female patients to postpone surgical intervention. A number of factors, including lack of social support at home and lack of willingness to undergo surgery [18], could contribute to this trend. This is supported by the work of Hawker et al. [9] who reported that no more than 15% of a study group of patients with severe arthritis were definitely willing to undergo arthroplasty.

Our data also confirm the conclusion of other investigators that range-of-motion of the knee is not correlated with functional ability [13, 20]. In male and female patients, the preoperative ROM was virtually identical, and yet there were substantial differences in the preoperative Knee Function scores. A similar observation was made by Petterson et al. [20] in studying ROM of the knee and functional capacity of healthy and osteoarthritic subjects. They found that though healthy men and women had similar ROM, women exhibited worse function than healthy men in walking and functional performance tests, and that these gender differences were magnified in patients with degenerative joint disease.

Our data confirm those of previous investigations that TKA is less successful in restoring normal knee function in women than men. To a large extent this appears related to the fact that women undergo surgery for treatment of more advanced joint degeneration than men. If female patients underwent TKA at an earlier stage in their disease process it appears likely that their knee function after TKA would be highly improved. Why women wait longer to receive definitive treatment is presently unknown. It may be the result of greater stoicism than men in coping with the symptoms of joint degeneration; it could be indicative of greater reluctance of women than men to entrust their care to orthopaedic surgeons, or it could be the result of gender-based bias amongst surgeons in delaying the recommendation to perform surgery. Additional work is needed to elucidate these factors and to provide effective solutions to ensure early and equal access of all patients to care.

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