Implant Survival, Knee Function, and Pain Relief After TKA

Are There Differences Between Men and Women?

Mary I. O'Connor MD

Published online: 26 January 2011
© The Association of Bone and Joint Surgeons® 2011

Abstract

Background As efforts continue to improve the results of TKA, the potential influence of sex and gender on long-term survival of implants, knee function, pain relief, and patient satisfaction remains relevant, particularly given the increased incidence of osteoarthritis of the knee in women and reports that women derive equal benefit from TKA.

Questions/purposes This article reviews the literature pertinent to the question of whether long-term survival, knee function, pain relief, and patient satisfaction after TKA differ between men and women.

Methods Large clinical series (> 1000 patients) published in the last 10 years were identified in PubMed and reviewed.

Results Men may be at higher risk of revision surgery than women. Sex/gender has been consistently shown to impact both function and pain relief both before and after TKA. Although women achieve at least the same degree of functional improvement as men, women have worse pre-operative physical function and do not reach the same final level of physical function as men. Likewise women may have similar or even greater improvement in pain after arthroplasty than men but still have final pain scores that are less favorable.

Conclusions Further research is required to understand the sex and gender differences contributing to implant survival, physical function, and pain relief after TKA.

Strategies need to be developed to identify any patient who is at higher risk of implant failure, suboptimal postoperative function, and incomplete pain relief.

Introduction

Osteoarthritis of the knee can severely impact a patient's functional status and quality of life. TKA is a highly effective treatment for many patients. With the aging of the US population, it is projected that the demand for primary TKA may approach 1.5 million procedures in 2020; the number of revision procedures is also expected to substantially increase [16]. Moreover, the demand for these procedures in patients younger than 65 years is projected to exceed 50% of all primary and revision TKAs by 2016 and 2011, respectively [17]. Clearly TKA will remain a surgical procedure in great demand. Although TKA is a cost-effective procedure for improving pain and function in patients with severe osteoarthritis [20], unfortunately, not all patients do well or are satisfied with their results [1, 2, 13]. Patients who are not satisfied with their outcomes often seek further evaluation and use additional healthcare resources.

Osteoarthritis of the knee is more common in women than men [7, 33]. Women lose articular cartilage at four times the annual rate of men in the proximal tibia and three times in the patella [9]. Although more women than men undergo TKA in the United States, data suggest TKA for severe knee osteoarthritis is underused by both men and women, but the degree of underuse is three times greater in women [10]. This combination of higher disease burden and potential for more appropriate utilization creates the scenario in which even higher numbers of women could undergo TKA in the upcoming years.

The author certifies she has received or may receive payments or benefits from Zimmer, Inc (Warsaw, IN).

M. I. O'Connor (✉)
Department of Orthopedics, Mayo Clinic, 4500 San Pablo
Road South, Jacksonville, FL 32224, USA
e-mail: oconnor.mary@mayo.edu

The introduction of a knee implant designed for female patients was potentially based on the presumption that existing designs did not provide adequate pain relief, function, or implant survival for females and promoted interest in the question of whether women have the same clinical results as men after TKA. Some investigators have concluded women derive as much benefit as men from the procedure [22, 29]. While improvement may be comparable, the question remains as to whether final results are the same.

The purpose of this review was to identify potential differences between men and women with respect to (1) implant survival, (2) function, (3) pain relief, and (4) patient satisfaction after TKA. The need for new strategies for optimizing outcomes for all patients after TKA is discussed. The role of an implant specifically designed for women is addressed in a different article in this symposium [12].

Search Strategy and Criteria

The PubMed database was searched for English-language articles published since 2000. Search words included TKA, gender, and female, with 970 articles identified. Clinical series with a minimum of 1000 TKAs were reviewed for inclusion in the data analysis. Additional studies with a specific focus on function, pain relief, and patient satisfaction were reviewed to provide additional data.

The terms sex and gender are used in this article and merit definition. Sex is determined by an individual's genetic composition and every cell has a sex. Gender is a more complex term and can encompass the influence of a culture on an individual and an individual's perception of their identity and behavioral roles within their society. Within the scope of this article, the term sex/gender is used when potentially both sex and gender may be appropriate.

Implant Survival

Women may have a more favorable prognosis related to implant survival than men. Several large studies within the last 10 years show less favorable primary total knee implant survivorship in men than in women (Table 1). Although some studies report no gender difference, none showed a significant difference favoring improved implant survivorship in men as compared with women.

Specific etiologies of arthroplast failure may be influenced by whether the patient is male or female. MacDonald et al. [22] found a major increase in the risk of revision for men as compared with women and revision for polyethylene wear and infection was more likely in men. While showing no difference for knee revision (infection excluded), Dalury et al. [5] showed a higher rate of osteolysis between men and women (3.8% versus 1.1%).

Preoperative and Postoperative Function

Women have lower preoperative functional scores at the time of TKA than men. Three large clinical series using the Knee Society score all reported lower function in women at the time of TKA (Table 2). Lower preoperative scores have also been reported using the WOMAC [19, 22].

Specific quantitative physical functional tests provide additional evidence of a difference between men and women in physical function at the time of arthroplasty. Women demonstrate longer 6-minute walk tests [14, 25] and longer timed up-and-go tests [25]. Moreover, Petterson et al. [25] compared arthroplasty candidates with normal control subjects and found women had reduced normalized quadriceps strength, 6-minute walk test, and stair-climbing test times as compared with men in both the arthroplasty and control groups, suggesting an

Table 1. Recent literature with gender analysis: rate of revision TKA

Study	Implants used	Number of patients/ number of TKAs	Implant survival			
			Time	Men	Women	p Value
Dalury et al. [5] (2009)	Single implant (PFC)	1512/1970	10-year survival probability	97.8%	96.9%	0.96
MacDonald et al. [22] (2008)	Multiple implants	3817/5279	2- to 10-year followup revision rate	10.2%	8%	0.013
Ritter et al. [29] (2008)	Single implant (AGC)	4903/7326	10-year survival probability	99.22%	98.95%	0.4684
Roberts et al. [30] (2007)	Multiple implants	4390/4606	15-year implant survival	90%	94%	0.001
Himanen et al. [11] (2007)	Single implant (AGC)	5470/6306	10-year implant survival	93%	94%	0.01
Fehring et al. [6] (2004)	Single implant (PFC)	1287 TKAs	5- to 13-year followup	Male risk 2.8 times greater than female risk		0.0001
Rand et al. [26] (2003)	Multiple implants	8290/11,606	10-year implant survival	88%	93%	0.001

PFC = PFC[®] Sigma[™] Knee system (DePuy Orthopaedics, Inc, Warsaw, IN); AGC = AGC[®] Total Knee System (Biomet Inc, Warsaw, IN).

Table 2. Gender differences in Knee Society scores

Study	Gender	Overall preoperative score	Preoperative pain score	Preoperative functional score	Overall postoperative score	Postoperative pain score	Postoperative functional score
Dalury et al. [5]	Men	51.48	8.66	51.59	88.61	43.18	76.12
	Women	53.93	7.27	43.68	86.5	41.34	67.22
	p Value	0.056	< 0.00	< 0.001	< 0.001	0.005	< 0.001
Ritter et al. [29]	Men	41.2	10.6	45.8	87	48.5	85.8
	Women	39.8	9.5	42.4	86.9	47.2	77.5
	p Value	0.0014	0.0005	< 0.0001	0.5528	< 0.0001	< 0.0001
MacDonald et al. [22]	Men	40.55		48.67	87.85		70.76
	Women	40.17		41.33	86.66		59.98
	p Value	0.419		< 0.0001	0.013		< 0.0001

inherent gender (and also possibly sex)-based difference. However, these differences were magnified in the women undergoing arthroplasty. Finally, two studies showed, in patients with knee osteoarthritis, women had lower quadriceps normalized maximal voluntary isometric contraction than men [8, 25].

Women have lower functional scores after TKA than men (Table 2). Although the final overall knee score was slightly lower for women in all three major studies and reached statistical significance in two, the difference in final overall scores of approximately 1 to 3 points may not be clinically important. However, when only the functional component of the knee scores was analyzed, the final functional scores were lower for women than for men by approximately 9 to 11 points; these likely reflect clinically important differences.

With use of the WOMAC outcome measure, results in two studies differed. MacDonald et al. [22] found a difference favoring men in final WOMAC scores (men, 71.9; females, 69.6; $p = 0.001$) and functional scores (men, 70.6; women, 67.9; $p = 0.001$). However, Lingard et al. [19] found no difference in functional scores at 1 and 2 years after surgery between men and women despite the preoperative WOMAC scores being the strongest predictor of the postoperative WOMAC functional score.

The degree of improvement in postoperative scores generally favored women in some studies [22, 29] but not all [5]. However, the data consistently show women do not reach the same final functional level as men [5, 22, 29]. For example, in the Ritter et al. [29] study of 4903 patients, the mean Knee Society functional score at 5 years for men was 85.8 versus 77.5 for women. Analyzing function (walking, stairs, and rising from a chair) and need for a walking aid, Singh et al. [32] showed women had poorer function and higher dependence on walking aids than men at both 2 and 5 years after TKA (2 years, 4701 patients; 5 years, 2935 patients) even after adjusting for preoperative limitation, demographics, and comorbidities.

Preoperative and Postoperative Pain

Women have worse pain than men both before and after arthroplasty. In large studies with prospectively collected data, this difference in pain is consistent (Table 2) [19, 22, 29]. Using followup questionnaires to patients in a large clinical database, Singh et al. [31] analyzed the 2- and 5-year pain ratings of patients after primary TKA (2 years, 5290 patients; 5 years, 2602 patients). Two years after arthroplasty, approximately 36% more women than men were likely to have moderate to severe pain. At 5 years, there was no improvement, with approximately 37% more women having this level of discomfort than men. After adjusting for preoperative pain level and age, women were still more likely to have moderate to severe pain at 2 years after arthroplasty; however, no difference was seen at 5 years. The authors concluded the risk of moderate to severe pain after TKA was greater in female patients, younger patients, and patients with worse preoperative pain.

Several investigators have studied whether pain after TKA can be predicted. Although no difference between men and women was observed in a smaller study of 116 patients, Brander et al. [4] found patients with greater preoperative pain to have both greater postoperative pain and worse function. Preoperative depression and anxiety were associated with heightened pain at 1 year. One in eight patients reported moderate to severe pain at 1 year, with no clinical or radiographic abnormality identified. In a followup study of 83 of these patients [3], those with heightened and unexplained pain at 1 year improved over several years and nearly all reported being satisfied with their arthroplasty 5 years after the procedure. Preoperative pain and depression still predicted lower Knee Society functional scores, but anxiety, although associated with pain at 1 year, did not affect the 5-year outcome.

Preoperative pain catastrophizing reportedly predicted pain at 6 months after TKA in a study of 140 patients [28].

Pain catastrophizing was defined as the patient's belief that their pain will progress and that they are helpless to deal with it. Of note, although approximately 20% of the patients in this study had symptoms of major depression and an additional 20% had symptoms of anxiety disorder, pain catastrophizing was the only clear predictor of pain at 6 months. Whether women undergoing TKA are more likely to catastrophize regarding pain is unclear.

Sex-related differences in the pain mechanisms may influence outcomes. In a small study of patients with knee osteoarthritis undergoing TKA, Lundblad et al. [21] showed women had lower sensation thresholds and pain thresholds than men. Pain at rest and lower preoperative pain threshold were associated with postoperative pain at rest.

Patient Satisfaction

In two contemporary studies of patient satisfaction, no difference in satisfaction after TKA between men and women was identified. Using a satisfaction questionnaire to ask for (1) overall satisfaction, (2) satisfaction regarding pain reduction, and (3) satisfaction regarding improved function, Bourne et al. [2] studied 1703 primary TKAs and found 19% were very dissatisfied, dissatisfied, or neutral about their outcomes. The strongest predictors of dissatisfaction were expectations not being met, a low 1-year WOMAC score, preoperative pain at rest, and a postoperative complication requiring hospitalization. In a smaller study of 253 patients, Noble et al. [24] utilized a validated self-administered survey instrument consisting of 55 multiple-choice questions related to symptoms, function, and degree of overall satisfaction. They found 75% of patients were satisfied or very satisfied with their arthroplasty and patient satisfaction was primarily determined by patients' expectations and not their absolute level of postoperative function.

Discussion

The influence of a patient's sex/gender on results after TKA remains an important question, particularly given the higher incidence of knee osteoarthritis in women. The purpose of this review was to identify potential differences between men and women with respect to (1) implant survival, (2) function, (3) pain relief, and (4) patient satisfaction after TKA. While such specific outcomes are influenced by multiple factors, the inclusion of large clinical series (> 1000 TKA) in this study strengthens the ability to determine whether the patient's sex/gender impacts a particular result.

There are a number of limitations to the literature and this review. The analysis focused on clinical series with greater than 1000 implants. Such studies are typically retrospective reviews of prospectively collected data with limitations associated with such databases. Studies with smaller patient numbers may still have significant findings. Second, a formal meta-analysis was not performed. Third, these studies did not explore the potential role of gender in the decision to proceed with TKA and when such a decision was made relative to a patient's duration of symptoms.

The role of sex/gender in implant survival is not clear. Current studies either show implant survival to be favorable to women or show no difference. No studies found an implant survival advantage to men. Of note, however, is that in two studies of the PFC[®] Sigma[™] Knee System (DePuy Orthopaedics, Inc, Warsaw, IN), Dalury et al. [5] found no gender difference, whereas Fehring et al. [6] identified the revision risk to be 2.8 times greater for men than women. Although the sterilization process used for the polyethylene inserts in the Dalury et al. [5] study was not detailed, the use of inserts sterilized in air with gamma irradiation may have influenced the revision rates in the Fehring et al. [6] study. The newly formed American Joint Replacement Registry may help provide data needed to answer the question of sex/gender influence on implant survival. If men have a higher failure rate than women, then strategies should be developed to identify patient attributes related to this higher failure rate and mitigating factors under the control of the surgeon and patient.

Sex/gender influences function both before and after TKA. Women have lower functional scores before surgery and at followup than men. Although women have at least the same improvement after surgery as men, they do not reach the same final level of function. Women do not "catch up" to men [18]. Petterson et al. [25] have suggested women undergoing TKA may be more adversely affected by osteoarthritis than men and women may have more advanced disease at the time of arthroplasty. While muscle atrophy resulting from disuse and pain before knee arthroplasty clearly influences quadriceps function, research suggests neural inhibition of full quadriceps activation, also referred to as arthrogenic muscle inhibition [27], affects women to a greater degree than men [8, 25] and may be an important factor in the etiology of sex differences in knee function in patients with osteoarthritis.

Sex/gender influences pain after TKA. In large studies, women have more pain both before and after arthroplasty (Table 2). Women had both lower sensation and pain thresholds than men after TKA [21]. Moreover, in a small study of only six men and six women with knee osteoarthritis, positron emission tomography imaging of the brain showed arthritic pain is processed in areas of the brain concerned with emotion and fear [15]. Certainly pain is

complex and a detailed analysis of sex and gender differences in pain is beyond the scope of this article. However, psychosocial factors appear to play a role in pain after arthroplasty, particularly pain catastrophizing. Preoperative pain, depression, and anxiety may also influence pain, particularly within the first year after surgery. Additional research is needed in this area and more clinical attention directed to the emotional state of the patient undergoing TKA.

Sex/gender influence on patient satisfaction after TKA, based on limited studies, showed no difference. Understanding and meeting patients' expectations regarding TKA may be the most important factor in a good outcome from the perspective of the patient. Although data clearly show women have lower functional scores than men after surgery, excellent function does not always equate to high patient satisfaction with the procedure [24]. Preoperative education can be effective in modifying inappropriate patient preoperative expectations [23].

In conclusion, further research is needed to better understand the differences between men and women influencing outcomes in TKA. Strategies need to be developed to identify any patient who is at higher risk of implant failure, suboptimal postoperative function, and incomplete pain relief. New approaches to treat these patients are required to improve outcomes. Finally, more focus on understanding patients' expectations and aligning them with realistic results may improve patient satisfaction.

Acknowledgment I thank Kelly Viola for her assistance with manuscript preparation.

References

1. Anderson JG, Wixson RL, Tsai D, Stulberg SD, Chang RW. Functional outcome and patient satisfaction in total knee patients over the age of 75. *J Arthroplasty*. 1996;11:831–840.
2. Bourne R, Chesworth B, Davis AM, Mahomed N, Charron K. Patient satisfaction after total knee arthroplasty: who is satisfied and who is not? *Clin Orthop Relat Res*. 2010;468:57–63.
3. Brander V, Gondek S, Martin E, Stulberg SD. Pain and depression influence outcome 5 years after knee replacement surgery. *Clin Orthop Relat Res*. 2007;464:21–26.
4. Brander VA, Stulberg SD, Adams AD, Harden RN, Bruehl S, Stanos SP, Houle T. Predicting total knee replacement pain: a prospective, observational study. *Clin Orthop Relat Res*. 2003;416:27–36.
5. Dalury DF, Mason JB, Murphy JA, Adams MJ. Analysis of the outcome in male and female patients using a unisex total knee replacement system. *J Bone Joint Surg Br*. 2009;91:357–360.
6. Fehring TK, Murphy JA, Hayes TD, Roberts DW, Pomeroy DL, Griffin WL. Factors influencing wear and osteolysis in press-fit condylar modular total knee replacements. *Clin Orthop Relat Res*. 2004;428:40–50.
7. Felson DT, Zhang Y, Hannan MT, Naimark A, Weissman BN, Aliabadi P, Levy D. The incidence and natural history of knee osteoarthritis in the elderly. The Framingham Osteoarthritis Study. *Arthritis Rheum*. 38:1500–1505.
8. Fitzgerald JD, Orav EJ, Lee TH, Marcantonio ER, Poss R, Goldman L, Mangione CM. Patient quality of life during the 12 months following joint replacement surgery. *Arthritis Rheum*. 2004;51:100–109.
9. Hanna FS, Teichtahl AJ, Wluka AE, Wang Y, Urquhart DM, English DR, Giles GG, Cicuttini FM. Women have increased rates of cartilage loss and progression of cartilage defects at the knee than men: a gender study of adults without clinical knee osteoarthritis. *Menopause*. 2009;16:666–670.
10. Hawker GA, Wright JG, Coyte PC, Williams JJ, Harvey B, Glazier R, Badley EM. Differences between men and women in the rate of use of hip and knee arthroplasty. *N Engl J Med*. 2000;342:1016–1022.
11. Himanen AK, Belt EA, Lehto MU, Hamalainen MM. A comparison of survival of moulded monoblock and modular tibial components of 751 AGC total knee replacements in the treatment of rheumatoid arthritis. *J Bone Joint Surg Br*. 2007;89:609–614.
12. Johnson AJ, Costa CR, Mont MA. Do we need gender-specific total joint arthroplasty? *Clin Orthop Relat Res*. 2010. DOI 10.1007/s11999-011-1769-2.
13. Jones CA, Voaklander DC, Johnston DW, Suarez-Almazor ME. Health related quality of life outcomes after total hip and knee arthroplasties in a community based population. *J Rheumatol*. 2000;27:1745–1752.
14. Kennedy DM, Hanna SE, Stratford PW, Wessel J, Gollish JD. Preoperative function and gender predict pattern of functional recovery after hip and knee arthroplasty. *J Arthroplasty*. 2006;21:559–566.
15. Kulkarni B, Bentley DE, Elliott R, Julian PJ, Boger E, Watson A, Boyle Y, El-Deredy W, Jones AK. Arthritic pain is processed in brain areas concerned with emotions and fear. *Arthritis Rheum*. 2007;56:1345–1354.
16. Kurtz S, Ong K, Lau E, Mowat F, Halpern M. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. *J Bone Joint Surg Am*. 2007;89:780–785.
17. Kurtz SM, Lau E, Ong K, Zhao K, Kelly M, Bozic KJ. Future young patient demand for primary and revision joint replacement: national projections from 2010 to 2030. *Clin Orthop Relat Res*. 2009;467:2606–2612.
18. Lavernia C, D'Apuzzo M, Rossi MD, Lee D. Is postoperative function after hip or knee arthroplasty influenced by preoperative functional levels? *J Arthroplasty*. 2009;24:1033–1043.
19. Lingard EA, Katz JN, Wright EA, Sledge CB. Predicting the outcome of total knee arthroplasty. *J Bone Joint Surg Am*. 2004;86:2179–2186.
20. Losina E, Walensky RP, Kessler CL, Emrani PS, Reichmann WM, Wright EA, Holt HL, Solomon DH, Yelin E, Paltiel AD, Katz JN. Cost-effectiveness of total knee arthroplasty in the United States: patient risk and hospital volume. *Arch Intern Med*. 2009;169:1113–1121; discussion 1121–1122.
21. Lundblad H, Kreicbergs A, Jansson KA. Prediction of persistent pain after total knee replacement for osteoarthritis. *J Bone Joint Surg Br*. 2008;90:166–171.
22. MacDonald SJ, Charron KD, Bourne RB, Naudie DD, McCalden RW, Rorabeck CH. The John Insall Award. Gender-specific total knee replacement: prospectively collected clinical outcomes. *Clin Orthop Relat Res*. 2008;466:2612–2616.
23. Mancuso CA, Graziano S, Briskie LM, Peterson MG, Pellicci PM, Salvati EA, Sculco TP. Randomized trials to modify patients' preoperative expectations of hip and knee arthroplasties. *Clin Orthop Relat Res*. 2008;466:424–431.

24. Noble PC, Conditt MA, Cook KF, Mathis KB. The John Insall Award. Patient expectations affect satisfaction with total knee arthroplasty. *Clin Orthop Relat Res.* 2006;452:35–43.
25. Petterson SC, Rasis L, Bodenstab A, Snyder-Mackler L. Disease-specific gender differences among total knee arthroplasty candidates. *J Bone Joint Surg Am.* 2007;89:2327–2333.
26. Rand JA, Trousdale RT, Ilstrup DM, Harmsen WS. Factors affecting the durability of primary total knee prostheses. *J Bone Joint Surg Am.* 2003;85:259–265.
27. Rice DA, McNair PJ. Quadriceps arthrogenic muscle inhibition: neural mechanisms and treatment perspectives. *Semin Arthritis Rheum.* 2010;40:250–266.
28. Riddle DL, Wade JB, Jiranek WA, Kong X. Preoperative pain catastrophizing predicts pain outcome after knee arthroplasty. *Clin Orthop Relat Res.* 2010;468:798–806.
29. Ritter MA, Wing JT, Berend ME, Davis KE, Meding JB. The clinical effect of gender on outcome of total knee arthroplasty. *J Arthroplasty.* 2008;23:331–336.
30. Roberts VI, Esler CN, Harper WM. A 15-year follow-up study of 4606 primary total knee replacements. *J Bone Joint Surg Br.* 2007;89:1452–1456.
31. Singh JA, Gabriel S, Lewallen D. The impact of gender, age, and preoperative pain severity on pain after TKA. *Clin Orthop Relat Res.* 2008;466:2717–2723.
32. Singh JA, O'Byrne M, Harmsen S, Lewallen D. Predictors of moderate-severe functional limitation after primary total knee arthroplasty (TKA): 4701 TKAs at 2-years and 2935 TKAs at 5-years. *Osteoarthritis Cartilage.* 2010;18:515–521.
33. Srikanth VK, Fryer JL, Zhai G, Winzenberg TM, Hosmer D, Jones G. A meta-analysis of sex differences prevalence, incidence and severity of osteoarthritis. *Osteoarthritis Cartilage.* 2005;13:769–781.