

# **GENDER-SPECIFIC KNEE REPLACEMENTS**

## **Technology Overview**

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## **Work Group Panel**

Joshua J. Jacobs, MD  
Rush University Medical Center  
Chicago, IL

E. Anthony Rankin, MD  
Providence Hospital  
Washington, DC

Mary I. O'Connor, MD  
Mayo Clinic  
Jacksonville, FL

Mathias P. G. Bostrom, MD  
Hospital for Special Surgery  
New York, NY

Stephen B. Trippel, MD  
Indiana University Medical Center  
Indianapolis, IN

William J. Hozack, MD  
The Rothman Institute  
Philadelphia, PA

Joseph C. McCarthy, MD  
Newton, MA

AAOS Staff:  
Charles M. Turkelson, PhD  
AAOS Research Director  
6300 N River Road Rosemont, IL 60018

## Gender-Specific Knee Replacements A Technology Overview

This Technology Overview was prepared using systematic review methodology, and summarizes the findings of studies published as of November, 2006 on gender specific knee replacements. As a summary, this document does not make recommendations for or against the use of gender specific knee replacements. It should not be construed as an official position of the American Academy of Orthopaedic Surgeons. Readers are encouraged to consider the information presented in this document and reach their own conclusions about gender specific knees

The American Academy of Orthopaedic Surgeons (Academy) has developed and is providing this *Technology Overview* as an educational tool. Patient care and treatment should always be based on a clinician's independent medical judgment given the individual clinical circumstances.

### Are There Gender Specific Knee Anatomic Differences?

Differences in bony anatomy have been well documented between male and female knees<sup>6</sup>. Men have larger femurs than women (anterior-posterior height, transepicondylar width, height of the lateral and medial condyles).<sup>1,2</sup> Furthermore, for the same anterior-posterior dimension of the distal femur, women have a narrower medial-lateral width.<sup>2,3,1</sup> Rotatory differences exist with the trochlear groove rotated somewhat externally relative to the epicondylar axis in females and somewhat internally in males.<sup>1</sup>

Anatomic differences in the patellofemoral joint are also present between males and females. Females have a larger Q angle,<sup>4,5,6</sup> larger ratio between the length of the patellar tendon and the greatest diagonal length of the patella on a lateral knee radiograph (patella alta), and a more negative congruence angle (indicating that the lowest portion of the patella is more medial relative to a line bisecting the sulcus angle).<sup>4</sup> While women have higher average Q angles as compared to men and a higher minimum Q angle, maximum values for Q angles do not differ greatly between sexes.<sup>5</sup> Of note is that men and women of the same height have similar Q angles and taller people have slightly lower Q angles. Thus the higher average Q angle in women as compared to men may be related to the larger overall height of men compared to women.<sup>7</sup>

In addition to anatomic differences, patellofemoral joint biomechanics varies between sexes. Male cadaveric specimens had greater patellofemoral contact area as compared to female specimens at knee flexion angles greater than 30 degrees.<sup>8</sup> This is logical given the larger size of the patella in males as compared to females. However, mean patellofemoral contact pressures were significantly increased in female as compared to males at 0 degree and 30 degrees of knee flexion and peak pressures were statistically significantly higher in women at 0 degree, 30 degrees and 60 degrees of knee flexion.<sup>8</sup>

Difference in soft tissue characteristics, physical activities and psychological makeup have also been discussed by some relative to sex-differences but are beyond the scope of this *Overview*.

## Findings of Published Studies

We used systematic processes to locate published studies relevant to this topic. These processes began with the framing of two Key Questions, which appear below. We next developed article inclusion/exclusion criteria, and then conducted systematic literature searches. Articles were included only if they met our *a priori* criteria. A Level of Evidence was assigned to each article included in this *Overview*.

### **Question #1: Do women have higher failure rates than men after traditional knee replacement surgery?**

To address this question, we performed a systematic review of the literature published after the issuance of an Agency for Healthcare Research and Quality (AHRQ) evidence report<sup>9</sup> that was commissioned by the National Institutes of Health (NIH) in preparation for a Consensus Conference on Total Knee Replacement in December of 2003. The AHRQ evidence report systematically reviewed the literature published between 1995 and April, 2003. We replicated the search strategies used in the AHRQ report (except that our searches were for literature published between April 1, 2003 and November, 2006, searched PubMed, and used article inclusion/exclusion criteria nearly identical to those in the AHRQ report (see Appendix I). The AHRQ systematic review concluded “There is no evidence that age, gender, or obesity is a strong predictor of functional outcomes.”

Our searches identified 1,777 articles. Of these, 66 articles were retrieved as potentially meeting our inclusion criteria, and 24 were ultimately included. The data published subsequent to the AHRQ report do not consistently show differences between men and women in most of the outcomes of tricompartmental total knee replacement surgery. This is true regardless of whether a study examined revision rates, reoperation rates, range of motion, and scores on several outcomes instruments, and is true of the data reported in both studies that attempted to adjust for potential risk, and in non-risk adjusted studies (See Appendix II). Possible exceptions to this are that women may have a longer length of stay and lower death rates than men; results that are consistent between the two studies that examined these outcomes. However, in general, published studies have not attempted to replicate the results of other published studies, none of the studies we included were specifically designed to evaluate gender differences, and they were not of high quality (see Appendix III).

### **Question #2: Do gender-specific knee replacement increase the rates of successful knee replacement surgery in women?**

The searches we constructed to address this question are described in Appendix II. These searches did not identify any clinical studies that directly addressed this question.

As noted above, this document is not intended to convey any official AAOS position on gender specific knees. We provide this *Technology Overview* as a service to our members in an effort to help them identify and evaluate the available published literature on this topic. We hope that our summary will assist physicians in providing the best possible care to their patients.

AAOS would like to have feedback from its members on this *Technology Overview*. To provide your feedback, please visit <http://research.aaos.org/surveys/Tech-Feedback.htm>.

## APPENDIX I: Inclusion/Exclusion Criteria

We used the following criteria to determine whether studies should be included in this systematic review:

1. Article must be a full report and not a meeting abstract. Meeting abstracts do not contain sufficient information to allow for complete evaluation of study design and conduct. Further, many abstracts are never published as full reports.
2. Article must be published in English. Translation costs are prohibitive.
3. Study must be of humans.
4. Article must present results in quantitative fashion.
5. Studies of unicondylar knee replacements are excluded. Unicondylar knee replacements have 1) a more specific indication ie, unicompartmental tibio-femoral arthritis with minimal involvement of the patello- femoral and 2) different patient demographics, primarily male population, low activity, minimal deformity, and good range of motion. Additionally, indications for unicondylar replacements appear to be in a transition phase. Surgeons have only recently gained experience with this reportedly less invasive procedure. Thus it is too early to adequately assess outcomes. (NOTE: This criterion is taken from the AHRQ systematic review).

### *Additional Criteria for Question #1*

1. Study must be published after April, 2003. This cutoff date is used because we updated the searches described in the AHRQ evidence report.
2. Study must examine more than 100 knees
3. Studies may be either experimental (RCTs) or quasi-experimental (non-randomized, controlled studies, before and after studies)

### *Additional Criteria for question #2:*

1. Include any study of any design that examined 10 or more knees. (This criteria is less restrictive than the analogous criterion for Question 1)
2. No restriction on outcome. May be either intermediate or patient-oriented.

## APPENDIX II: Databases Searched and Search Strategies

### Search Strategies for Question #1

To obtain information for Question #1, we searched PubMed using the search strategies of the previous AHRQ report<sup>9</sup> on knee arthroplasty.

### Search Strategies for Question #2

To identify studies for Question #2, we searched PubMed, EMBASE, and CINAHL.

Our PubMed search strategies were:

("Sex Characteristics"[MeSH] OR "Sex Factors"[MeSH] OR gender[Text Word] OR "gender differences"[Text Word]) AND ("Arthroplasty, Replacement, Knee"[MeSH] OR "Knee Prosthesis"[MeSH] OR "knee replacement"[All Fields] OR "knee implant"[All Fields] OR (TKAR[All Fields] OR "prosthesis design"[MeSH Terms] AND ("knee"[MeSH Terms] OR "knee injuries"[MeSH Terms] OR "knee joint"[MeSH Terms]))) AND English[lang] AND "humans"[MeSH Terms]

This search identified 222 studies, none of which reported results of studies that employed gender specific knees.

Our search strategies for EMBASE: were

(gender.mp. or "GENDER AND SEX"/) AND (knee replacement.mp. or Knee Arthroplasty/) limited to English language.

The search identified 37 studies, none of which were of gender specific knee replacements.

Our search strategies for CINAHL were:

(knee replacement.mp. or exp Arthroplasty, Replacement, Knee/) AND gender.mp.

The search identified 33 studies, none of which were of gender specific knee replacements.

We also searched for ongoing and recently completed clinical studies at <http://www.clinicaltrials.gov/>. This search did not identify any studies on gender specific knee replacements.

**APPENDIX III: Evidence Tables****Table 1 Gender-Related Results of non-Risk Adjusted Studies**

Author	Year	Level of Evidence	n females/ n males	Follow-up Duration	Outcomes for which male and females not significantly different	Outcomes for which males and females significantly different
Brander <sup>10</sup>	2003	III*	64/52	12 Months	Post-operative pain	
Kennedy <sup>11</sup>	2003	III	500/312	5 Years	Change in Knee Society Score	
Ritter <sup>12</sup>	2003	III	2798/1954	7 Years		Females had less flexion
Aderinto <sup>13</sup>	2004	III	198/171	5 Years	Fixed flexion de- formity**	
Dalury <sup>14</sup>	2004	III	288/176	2 Years	Heterotopic Os- sification	
Kim <sup>15</sup>	2004	III	644/337	?	Knee stiffness	
Parvizi <sup>16</sup>	2004	III	61/105	15.1 Years		Females had lower revision rate
Wright <sup>17</sup>	2004	III	138/60	11.7 Years	Revision rate	
Chatterji <sup>18</sup>	2005	III	80/64	1-2 Years	Oxford Knee Score Change in sports activity	
Laskin <sup>19</sup>	2005	III	59/41	2.4 Years	Range of motion	
Capeci <sup>20</sup>	2006	III	129/124	34 Months	Femoral component asymmetry Patellar component asymmetry	Tibial component asymme- try different between gen- ders, but direction of differ- ence not reported
Meneghin <sup>21</sup>	2006	III	439/281	5.1 Years		Females exhibited greater decrease in Insall-Salvati ratio
Robertsson <sup>22</sup>	2006	III	?	?	Revision rate	
Vessely <sup>23</sup>	2006	III	384/361	15 Years	Revision rate	

\*The assigned levels of evidence are based on the levels for prognostic studies. All studies are Level III because none were based on testing hypotheses developed *a priori*, and because none adjusted for potentially important risk factors. All studies except the study by Brander et al. and the study by Dalury et al. were retrospective. Whether there was attrition in these two studies is not clear.

\*\*Fixed flexion deformity was greater in males at one week post-surgery, but not at other times.

**Table 2 Gender-Related Results of Risk Adjusted Studies**

Author	Year	Level of Evidence	n females /n males	Max Follow-up Duration	Risk Factor Adjusted for	Outcomes for which male and females not significantly differ-	Outcomes for which males and females significantly different
Jones <sup>24</sup>	2003	III	162/114	6 months	Age, comorbidities, preoperative use of walking device	Postsurgical WOMAC scores, postsurgical SF-36	
Weaver <sup>25</sup>	2003	III	371/11339	30 Days	Age, race, comorbidities, Medicaid or VA supplementation, surgery duration,		Females had more complications, longer length of stay
Fehring <sup>26</sup>	2004	III	1110/627	13 Years	Age, device-related variables, side of surgery		Females had lower rates of wear-related failure
Gatha <sup>27</sup>	2004	III	80/55	?	Age, device-related variables, preoperative knee mobility/function	Range of motion	
Harrison <sup>28</sup>	2004	III	30523/15434	9 years	Age, year of surgery, diagnosis	Implant removal (for any reason), revision due to	
Mahomed <sup>29</sup>	2004	III	82,780/42,206	90 days	Age, Race, comorbidities, Medicaid or VA supplementation, geographic region, surgical or hospital volume, diagnosis	Manipulation under anesthesia, pulmonary embolism,	Females had fewer myocardial infarctions, lower pneumonia rates, lower rates of knee infection, lower additional knee surgery rates,
Wright <sup>17</sup>	2004	III	138/60	11.7 Years	Age, BMI, diagnosis	Knee reoperations	
Himannen <sup>30</sup>	2005	III	5623/1586	10 years	Age, cementing, year of surgery, diagnosis		Females had lower rates of revision due to loosening
Solomon <sup>31</sup>	2006	III	6,252/2821	90 days	Age, surgical or hospital volume, hospital teaching status, % of patients receiving surgery in a dedicated OR		Females had lower combined rate of pulmonary embolism + myocardial infarction + pneumonia + knee infection + death
Vessely <sup>23</sup>	2006	III	384/361	15 years	Age, BMI, device-related variables, diagnosis	Implant removal (for any reason)	
Vincent <sup>32</sup>	2006	III	? (Total=268)	in hospital (?)	Age	FIM™**	Females had longer length of stay, higher hospital rehabilitation charges
SooHoo <sup>33</sup>	2007	III	138,064/84620	90 days	Age, Race, comorbidities, Medicaid or VA supplementation, surgical or hospital volume, hospital size, hospital teaching status	Pulmonary embolism	Females had higher rates of knee infection and lower death rates

\* The assigned levels of evidence are based on the levels for prognostic studies. All studies are Level III because none were based on testing hypotheses developed *a priori*. There is, therefore, a potential for Type I errors. All studies except the study by Jones et al. were retrospective. Whether there was attrition in this study is not clear. None of the studies attempted to validate the regression models on which they reported.

\*\*The FIM™ Score "estimates performance during tasks that can be broadly categorized as activities of daily living, mobility, and cognitive domains"

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