Gender-Specific Knee Replacement

Overview

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 (Academy). Readers are encouraged to consider the information presented in this document and reach their own conclusions about gender-specific knees. The 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.1 Men have larger femurs than women (anterior-posterior height, transepicondylar width, height of the lateral and medial condyles).2,3 Furthermore, for the same anterior-posterior dimension of the distal femur, women have a narrower medial-lateral width.2,4 Rotatory differences exist, with the trochlear groove rotated somewhat externally relative to the epicondylar axis in females and somewhat internally in males.2

Anatomic differences in the patellofemoral joint are also present between males and females. Females have a larger Q angle,1,5,6 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].5 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 the sexes.5 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.7

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°.8 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 females as compared to males at 0° and 30° of knee flexion, and peak pressures were statistically significantly higher in women at 0°, 30° and 60° of knee flexion.8

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 that was commissioned by the National Institutes of Health (NIH) in preparation for a Consensus Conference on Total Knee Replacement in December 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 [Appendix 1]. 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, range of motion, and scores on several outcomes instruments, and it is true of the data reported in both studies that attempted to adjust for potential risk, and in non–risk-adjusted studies [Appendix 2]. Possible exceptions to this are that women may have a longer length of stay and lower death rates. 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, range of motion, and scores on several outcomes instruments, and it is true of the data reported in both studies that attempted to adjust for potential risk, and in non–risk-adjusted studies [Appendix 2]. Possible exceptions to this are that women may have a longer length of stay and lower death rates.

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**Appendix 1**

**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 tibiofemoral arthritis with minimal involvement of the patellofemoral, 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.)

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**Appendix 2**

**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 on knee arthroplasty.

Search Strategies for Question #2


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 the English language. The search identified 37 studies, none of which was 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 was 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.
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 (Tables 1 and 2).

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

The searches that we constructed to address this question are described in Appendix 2. 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.

**Additional Criteria for Question #1**

1. Study must be published after April 2003. This cutoff date was 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...
# Table 2

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Level of Evidence</th>
<th>n Females/n Males</th>
<th>Max Follow-up Duration</th>
<th>Risk Factor Adjusted for</th>
<th>Outcomes for Which Males and Females not Significantly Different</th>
<th>Outcomes for Which Males and Females Significantly Different</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jones et al</td>
<td>2003</td>
<td>III</td>
<td>162/114</td>
<td>6 mo</td>
<td>Age, comorbidities, preoperative use of walking device</td>
<td>Postsurgical WOMAC scores, postsurgical SF-36 scores</td>
<td>—</td>
</tr>
<tr>
<td>Weaver et al</td>
<td>2003</td>
<td>III</td>
<td>371/11,339</td>
<td>30 d</td>
<td>Age, race, comorbidities, Medicaid or VA supplementation, surgery duration</td>
<td>—</td>
<td>Females had more complications, longer length of stay</td>
</tr>
<tr>
<td>Fehring et al</td>
<td>2004</td>
<td>III</td>
<td>1,110/627</td>
<td>13 yr</td>
<td>Age, device-related variables, side of surgery</td>
<td>—</td>
<td>Females had lower rates of wear-related failure</td>
</tr>
<tr>
<td>Gatha et al</td>
<td>2004</td>
<td>III</td>
<td>80/55</td>
<td>?</td>
<td>Age, device-related variables, preoperative knee mobility/function</td>
<td>Range of motion</td>
<td>—</td>
</tr>
<tr>
<td>Harrysson et al</td>
<td>2004</td>
<td>III</td>
<td>30,523/15,434</td>
<td>9 yr</td>
<td>Age, year of surgery, diagnosis</td>
<td>Implant removal (for any reason), revision due to loosening</td>
<td>—</td>
</tr>
<tr>
<td>Mahomed et al</td>
<td>2004</td>
<td>III</td>
<td>82,780/42,206</td>
<td>90 d</td>
<td>Age, race, comorbidities, Medicaid or VA supplementation, geographic region, surgical or hospital volume, diagnosis</td>
<td>Manipulation under anesthesia, pulmonary embolism,</td>
<td>Females had fewer myocardial infarctions, lower pneumonia rates, lower rates of knee infection, lower additional knee surgery rates, and lower death rates</td>
</tr>
<tr>
<td>Wright et al</td>
<td>2004</td>
<td>III</td>
<td>138/60</td>
<td>11.7 yr</td>
<td>Age, BMI, diagnosis</td>
<td>Knee revisions</td>
<td>—</td>
</tr>
<tr>
<td>Himanen et al</td>
<td>2005</td>
<td>III</td>
<td>5,623/1,586</td>
<td>10 yr</td>
<td>Age, cementing, year of surgery, diagnosis</td>
<td>—</td>
<td>Females had lower rates of revision due to loosening</td>
</tr>
<tr>
<td>Solomon et al</td>
<td>2006</td>
<td>III</td>
<td>6,252/2,821</td>
<td>90 d</td>
<td>Age, surgical or hospital volume, hospital teaching status, % of patients receiving surgery in a dedicated operating room</td>
<td>—</td>
<td>Females had lower combined rate of pulmonary embolism + myocardial infarction + pneumonia + knee infection + death</td>
</tr>
<tr>
<td>Vessely et al</td>
<td>2006</td>
<td>III</td>
<td>384/361</td>
<td>15 yr</td>
<td>Age, BMI, device-related variables, diagnosis</td>
<td>Implant removal (for any reason)</td>
<td>—</td>
</tr>
<tr>
<td>Vincent et al</td>
<td>2006</td>
<td>III</td>
<td>? (Total, 268)</td>
<td>In hospital (?)</td>
<td>Age</td>
<td>Functional Independent Motor (FIM)†</td>
<td>Females had longer length of stay, higher hospital rehabilitation charges</td>
</tr>
<tr>
<td>SooHoo et al</td>
<td>2007</td>
<td>III</td>
<td>138,064/84,620</td>
<td>90 d</td>
<td>Age, race, comorbidities, Medicaid or VA supplementation, surgical or hospital volume, hospital size, hospital teaching status</td>
<td>Pulmonary embolism</td>
<td>Females had higher rates of knee infection and lower death rates</td>
</tr>
</tbody>
</table>

* The assigned levels of evidence are based on the levels for prognostic studies. All studies are level III because none was 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.”

BMI = body mass index, SF-36 = Short Form 36, VA = Veterans Administration, WOMAC = Western Ontario and McMaster Universities
that examined 10 or more knees. (This criterion is less restrictive than the analogous criterion for Question 1.)

2. No restriction on outcome. May be either intermediate or patient-oriented.

References


