Appendix 2

Overview

Gender-Specific Knee Replacements: A Technology Overview

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J Am Acad Orthop Surg 2008;16:63-67

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.[6] 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/

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.)

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[9] 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 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.

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[9] 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

Table 1

Gender-Related Results of Non–Risk-Adjusted Studies

Study	Year	Level of Evidence	n Females/ n Males	Max Follow-up Duration	Outcomes for Which Males and Females Not Significantly Different	Outcomes for Which Males and Females Significantly Different
Brander et al[10]	2003	III*	64/52	12 mo	Postoperative pain	—
Kennedy et al[11]	2003	III	500/312	5 yr	Change in Knee Society Score	—
Ritter et al[12]	2003	III	2,798/1,954	7 yr	—	Females had less flexion
Aderinto et al[13]	2004	III	198/171	5 yr	Fixed flexion deformity†	—
Dalury and Jiranek[14]	2004	III	288/176	2 yr	Heterotopic ossification	—
Kim et al[15]	2004	III	644/337	?	Knee stiffness	—
Parvizi et al[16]	2004	III	61/105	15.1 yr	—	Females had lower revision rate
Wright et al[17]	2004	III	138/60	11.7 yr	Revision rate	—
Chatterji et al[18]	2005	III	80/64	1-2 yr	Oxford Knee Score Change in sports activity	—
Laskin[19*]	2005	III	59/41	2.4 yr	Range of motion	—
Capeci et al[20]	2006	III	129/124	34 mo	Femoral component asymmetry Patellar component asymmetry	Tibial component asymmetry different between genders, but direction of difference not reported
Meneghin et al[21]	2006	III	439/281	5.1 yr	—	Females exhibited greater decrease in Insall-Salvati ratio
Robertsson et al[22]	2006	III	?	?	Revision rate	—
Vessely et al[23]	2006	III	384/361	15 yr	Revision rate	—

* 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 and because none adjusted for potentially important risk factors. All studies except the study by Brander et al[10] and the study by Dalury and Jiranek[14] were retrospective. Whether there was attrition in these two studies is not clear.

† Fixed flexion deformity was greater in males at 1 week postsurgery but not at other times.

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

Gender-Related Results of Risk-Adjusted Studies

Study	Year	Level of Evidence	n Females/n Males	Max Follow-up Duration	Risk Factor Adjusted for	Outcomes for Which Males and Females not Significantly Different	Outcomes for Which Males and Females Significantly Different
Jones et al[24]	2003	III	162/114	6 mo	Age, comorbidities, preoperative use of walking device	Postsurgical WOMAC scores, postsurgical SF-36 scores	—
Weaver et al[25]	2003	III	371/11,339	30 d	Age, race, comorbidities, Medicaid or VA supplementation, surgery duration	—	Females had more complications, longer length of stay
Fehring et al[26]	2004	III	1,110/627	13 yr	Age, device-related variables, side of surgery	—	Females had lower rates of wear-related failure
Gatha et al[27]	2004	III	80/55	?	Age, device-related variables, preoperative knee mobility/function	Range of motion	—
Harrysson et al[28]	2004	III	30,523/15,434	9 yr	Age, year of surgery, diagnosis	Implant removal (for any reason), revision due to loosening	—
Mahomed et al[29]	2004	III	82,780/42,206	90 d	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, and lower death rates
Wright et al[17]	2004	III	138/60	11.7 yr	Age, BMI, diagnosis	Knee revisions	—
Himanen et al[30]	2005	III	5,623/1,586	10 yr	Age, cementing, year of surgery, diagnosis	—	Females had lower rates of revision due to loosening
Solomon et al[31]	2006	III	6,252/2,821	90 d	Age, surgical or hospital volume, hospital teaching status, % of patients receiving surgery in a dedicated operating room	—	Females had lower combined rate of pulmonary embolism + myocardial infarction + pneumonia + knee infection + death
Vessely et al[23]	2006	III	384/361	15 yr	Age, BMI, device-related variables, diagnosis	Implant removal (for any reason)	—
Vincent et al[32]	2006	III	? (Total, 268)	In hospital (?)	Age	Functional Independent Motor (FIM)†	Females had longer length of stay, higher hospital rehabilitation charges
SooHoo et al[33]	2007	III	138,064/84,620	90 d	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 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[24] 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.

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