Comparative Measurements of Male and Female Distal Femurs During Primary Total Knee Arthroplasty

Kingsley R. Chin, MD, David F. Dalury, MD, and Richard D. Scott, MD

From the Arthroplasty Services, Brigham and Women's Hospital and Harvard Medical School, Boston, Massachusetts and John's Hopkins Medical School, Baltimore, Maryland

INTRODUCTION

Variability in the ratio of the anterior-posterior (AP) and transepicondylar (ML) dimensions of the distal femur among males and females may have implications for implant design and functional outcome after total knee arthroplasty (TKR). Current AP and ML size dimensions of standard femoral components may not optimally account for the variability between male and female osteoarthritic knees.

Only a few studies have analyzed the dimensions of the distal femur and made comparisons according to gender.[4-7] These studies have been limited because of small sample sizes and the fact that some were done on non-arthritic cadaveric femoras[5,7] that were stripped of all soft tissue. In addition, some of these studies have relied on indirect measurements using plain radiographs[4,5,7] and have not accounted for magnification.

MATERIALS AND METHODS

We prospectively determined the intra-operative measurements of the anterior-posterior and transepicondylar dimensions in a large series of consecutive osteoarthritic knees (100 male and 100 female Caucasian patients) undergoing unilateral primary TKR by two separate surgeons. All patients were skeletally mature and had no evidence of Paget's or other metabolic bone diseases. All measurements were done at the time of surgery using a sterile ruler after removing all osteophytes and after making the distal femoral cut. The distal femoral cut was 7 millimeters of bone from the more prominent distal condyle (usually medial). The transepicondylar axis (medio-lateral dimension) was measured as a transverse line drawn between the medial and lateral epicondylar prominences at the level of the distal resection. The anterior-posterior axis was measured as the distance between the anterior femoral cortex just proximal to the trochlea (usually maximal height) and the transposterior condylar axis. Measurements were obtained from the larger of the two posterior condyles.

Values for the AP, ML, and AP/ML ratio were evaluated by the Kolmogorov-Smirnov test[8] and found to deviate significantly from a normal distribution. Therefore, median values and the range are reported. AP and ML values were compared using the Wilcoxon signed-ranks test. Differences between males and females were evaluated by the Mann-Whitney U test[8]. For all comparisons, a two-tailed value of $P < 0.05$ was considered statistically significant.

RESULTS

We found that the ML dimension was greater than the AP dimension for all osteoarthritic distal femurs. Female arthritic knees were narrower on the ML dimension than their male counterparts In addition, females had a significantly greater AP/ML ratio than males.

DISCUSSION

Determining the linear dimensions of the distal femur across genders is important for several reasons. Linear measurements may identify reproducible dimensional relationships within the knee among genders. Prosthetic manufacturers can use this data to streamline their production to generate sizes that are more likely to fit most males and females. Finally, surgeons can be more aware of these size differences and make adjustments during pre-operative planning and surgery to avoid medio-lateral impingement3 and malpositioning of the prosthesis.[1,2] One rule of thumb in our practice is to cover as much bone as possible and lateralize the femoral prosthesis without metal overhang.

The AP and ML dimensions showed that all distal femurs are wider than they are tall and that females have narrower knees than males. Thus, males are more likely to have bone overhang the outer borders of the prosthesis than females. In contrast, females are more likely to have the outer borders of the prosthesis hang over the lateral and medial edges of the femoral condyles. Both scenarios are susceptible to medio-lateral impingement and decreased range of motion. This is particularly true with more conforming implant designs. Females are likely to impinge on the soft-tissues, such as the capsule or retained menisci, while males with uncovered bone, are likely to impinge on the polyethylene liner.[3] The surgeon should anticipate these possibilities before cementing the prostheses and should clear the soft tissues and excess bone from the edges of the femoral prosthesis. Centering the femoral implant on the distal femoral surface can help

Kingsley R. Chin, MD is a Clinical Fellow in Orthopaedic Surgery at Harvard Medical School.

David F. Dalury, MD is an Assistant Professor in Orthopaedic Surgery, John's Hopkins University, Baltimore, MD

Richard D. Scott, MD is a Professor in Orthopaedic Surgery at Harvard Medical School.

Address correspondence to:

Richard D. Scott, MD
Department of Orthopaedic Surgery
New England Baptist Hospital
125 Parker Hill Avenue
Boston, MA 02120

avoid excessive bony or metal overhang. Further studies are also encouraged in this area to assess how much overhang is critical to cause medio-lateral impingement in poorly fitting femoral prostheses.

CONCLUSION

Our experience suggests that males and females have comparable AP/ML ratios although most female arthritic distal femurs tend to be narrower than males. Femoral implant designs and surgical techniques should account for these differences to avoid medio-lateral overhang and possible capsular impingement. Further studies are encouraged to determine the amount of prosthetic or bony overhang that is critical to cause clinically significant impingement.

ACKNOWLEDGMENT

We thank David Zurakowski, Ph.D. for his invaluable assistance in performing the statistical analysis.

References

1. **Anouchi YS, Whiteside LA, Kaiser AD, Milliano MT.** The effects of axial rotational alignment of the femoral component on knee stability and patellar tracking in total knee arthroplasty demonstrated on autopsy specimens. 287:170-177, 1993.
2. **Arima J, Whiteside LA, McCarthy DS, White ES**: Femoral rotational alignment, based on the antero-posterior axis, in total knee arthroplasty in a valgus knee. J Bone Joint Surg 77A:1331-1334, 1995.
3. **Barnes CL and Scott RD.**:Popliteus tendon dysfunction following total knee arthroplasty. J. Arthroplasty 10:543-545, 1995.
4. **Erkman MJ, Walker PS**:A study of knee geometry applied to the design of condylar prostheses. Biomed Engineering 9:14-17, 1974.
5. **Mensch JS, Amstutz HC**: Knee morphology as a guide to knee replacement. Clin Orthop 112:231-241, 1975.
6. **Poilvache PL, Insall JN, Scuderi GR, Font-Rodriguez DE**. Rotational landmarks and sizing of the distal femur in total knee arthroplasty. Clin Orthop 331:35-46, 1996.
7. **Seedhom BB, Longton EB, Wright V, Dowson D**: Dimensions of the knee: Radiographic and autopsy study of sizes required for a knee prosthesis. Ann Rheum Dis 31:54-58, 1972.
8. **Sokal RR, Rohlf FJ**.: Biometry, 3rd ed. New York: W. H. Freeman, pp. 427-434, 1995.