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Gender Issues in Total Hip Arthroplasty: Length, Offset, and Osteoporosis

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Total hip arthroplasty is a highly successful operation, yet outcomes in women tend to be inferior to those in men. Many differences have been hypothesized to account for these outcomes. Anatomic differences between the male and female hip are important variables with significant impacts on appropriate reconstruction of leg length and offset. In addition, osteoporosis is significantly more prevalent in the female population, further impacting the anatomic differences. We present a classification system describing six female femoral subtypes and discuss the importance of recognizing gender differences in reconstructive hip surgery.
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Total hip arthroplasty (THA) is among the most successful procedures in orthopedics,[1] yet there is literature suggesting outcomes are inferior in female compared with male patients.[2] Several issues require special attention when considering THA in the female patient. Reconstruction of leg length and offset can be challenging, particularly in the short female. In addition, the presence of osteoporosis in many female patients introduces a challenging variable to the successful implantation of a THA, particularly when using a cementless stem.

Studies have found lateral trochanteric pain, leg length discrepancy, and intraoperative femoral fracture occurs more commonly in females.[3-6] Morrey[7] found dislocation rates to be up to four times higher in females. While the reasons for these differences have not been fully elucidated, several authors have presented compelling evidence supporting an anatomic difference between the female and male hip.

Dorr and coworkers[8] identified three femur types (A, B, and C) based on plain radiographs and identified demographic, histomorphometric, and biochemical factors associated with the different types. The type A femurs were defined as having thick diaphyseal cortices, a narrow diaphyseal canal, and a funnel-shaped proximal femur. The type C femurs were defined as having thinned cortices with almost complete loss of the medial and posterior cortices and a wide diaphyseal canal, resulting in the characteristic stovepipe femur. The type C femurs were found to have both structural and cellular compromise. Ninety percent of the type A femurs were found in males while 70% of the type C femurs were found in females.

In addition to differences in anatomy, osteoporosis is much more common in women. Approximately 80% of the nearly 45 million Americans with osteoporosis are women and, in one study, 25% of postmenopausal white women scheduled to undergo THA met World Health Organization guidelines for osteoporosis with a *t* score less than -2.5.[9] The presence of osteoporosis is frequently associated with an increased risk of complications during THA. Stress shielding and thigh pain have both been found to have a higher incidence in women with poor bone quality.[10,11] In most men and in women without osteoporosis, the intraosseous dimensions of the femur increase proportionally with the extraosseous dimensions (Fig. 1). As osteoporosis progresses, the intraosseous anatomy begins to change relative to the extraosseous anatomy (Fig. 2). The femoral canal enlarges without the normal proportional increase in the extraosseous geometry. In addition, the metaphyseal width remains relatively constant as the canal width increases. The resulting changes secondary to osteoporosis result in a proximal–distal femoral mismatch.

The design of most current cementless implants is based on the notion that the extraosseous dimensions of the femur increase proportionally with the intraosseous dimensions. Therefore, as the diaphyseal dimensions of the implant increase, the metaphyseal width and neck length increase accordingly. For most patients this tenet is successful, but for many women and patients with osteoporosis the aforementioned proximal–distal mismatch requires an implant that is oversized proximally to accommodate the enlarged diaphyseal canal. The use of a larger stem with its coexistent larger metaph-

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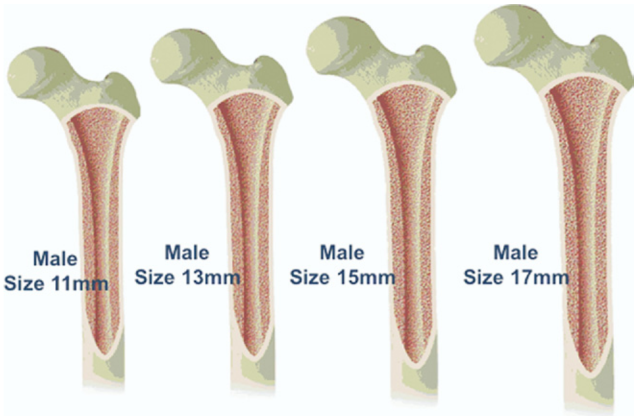

Figure 1 Intraosseous dimensions are proportional to extraosseous dimensions. (Color version of figure is available online.)

yseal portion causes the implant to be seated proudly, resulting in inappropriate increases in leg length and offset (Fig. 3). To accommodate the differences found in the female femur, surgeons may make intraoperative adjustments, such as a lower neck cut (Fig. 4). Despite these adjustments, it still may not be possible to appropriately reconstruct leg length and offset.

In an attempt to further understand the differences between the male and female hip, the senior author undertook an anatomic study to evaluate the relationship of canal width to head height and offset in a series of 300 patients (unpublished data). Using standardized digital radiographs, the measurements were made with a semiautomated digital software package. These data revealed that, for a given metaphyseal width, female patients had significantly less head height compared with the male patients. When evaluating offset, the data revealed that, for a given canal width, female patients had significantly less offset compared with the male patients. Mahfouz and coworkers[12] have confirmed these findings in a report on sex differences in adult femurs. Again they found that females have less offset and lower head heights compared with males. These differences were also statistically significant. In summary, females generally have smaller metaphyses, lower head heights, and less femoral offset when considering canal diameter as the independent variable.

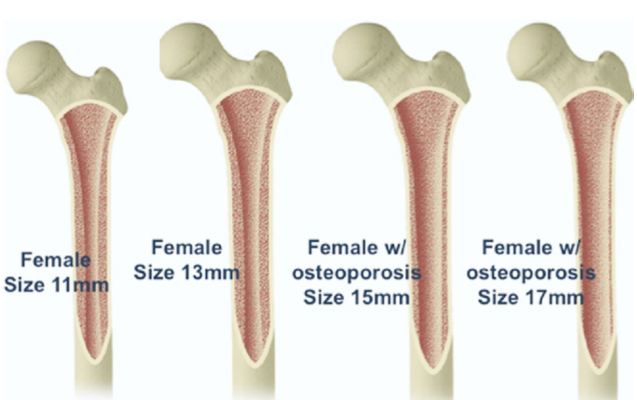

Figure 2 Osteoporosis leads to disproportionate changes in intraosseous dimension.

Figure 3 Proximal–distal mismatch prevents full seating of implant. (Color version of figure is available online.)

In the analysis of these data it became evident that the female hip is less predictable and more variable than the male hip. In addition, it became clear that the female hip is more than just a "small male" hip. In an attempt to further analyze these differences and to help guide the surgeon when considering a THA in female patients, we developed a classification system for the female hip. The system includes six subtypes and is based on stature, neck–shaft angle, relative canal diameter, head height/offset, and the presence of osteoporosis. The six subtypes will be outlined below and are summarized in Table 1.

Type 1

The type 1 femurs are found in the tall woman with a normal neck–shaft angle of approximately 135°. They may or may not have osteoporosis and have normal-sized canals (11-16 mm). The metaphysis, head height, and offset are progressive, in that they enlarge proportionally with the canal diameter. These patients can be treated with any implant available and are skeletally the most similar to men.

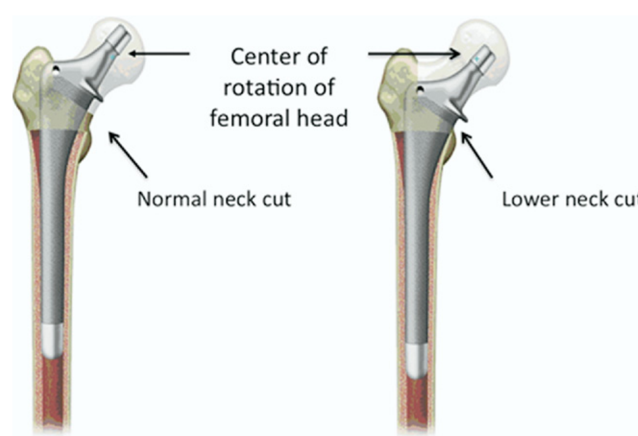

Figure 4 Lower neck cut may not restore length and offset. (Color version of figure is available online.)