Osteoarthritis is the most common chronic illness in the US and is a major cause of functional disability and compromised quality of life in older patients.1 The need for total hip and knee arthroplasty is projected to continue to increase significantly over the next few decades2 and may become a significant public health issue.

Improving our knowledge of sex and gender differences in osteoarthritis is critical to improving treatments. (The Institute of Medicine describes sex as the “classification of living things, generally male or female, according to their reproductive organs and functions assigned by the chromosomal complement,” and gender as “a person’s self-presentation as male or female, or how that person is responded to by social institutions on the basis of the individual’s gender presentation.”)3 The overall prevalence of osteoarthritis is higher in women compared with men,1 but is influenced by anatomical location. Women have a higher risk of osteoarthritis of the knee and hand, while men have a greater risk of cervical spine disc degeneration.4 While estrogen receptors are found in human articular cartilage, the role of sex hormones in the development of osteoarthritis is not clear. More research is needed to understand the influence of genetics and sex-linked hormones on the development and progression of osteoarthritis.

**Anatomical and Physiological Differences**

Women are not little men. We are all aware that anatomic differences exist between the sexes. Quantitative three-dimension magnetic resonance imaging (MRI) has shown cartilage thickness of the distal femur to be less in women than in men. It is unclear, however, whether this contributes to the higher incidence of knee osteoarthritis in women.5 Moreover, the shapes of the distal femur and proximal tibia differ between men and women. Men have larger femurs than women, and for the same anterior–posterior dimension women have a narrower medial–lateral width.6 The trochlear groove is somewhat externally rotated relative to the epicondylar axis in females and somewhat internally rotated in males.6 The height of the anterior lateral and medial prominences of the trochea are larger in men, but this is related to the overall larger size of the femur in males.

Patellofemoral symptoms are more common in women than in men. The role of anatomical differences in the development of symptoms is unclear. Females have a higher average Q angle7–11 and more patella alta.9 However, in patients with chondromalacia patella or recurrent patellar subluxation, both males and females had patella alta, a more shallow femoral sulcus, and an increased congruence angle (indicating that the lowest portion of the patella was more medial relative to the trochlear groove) compared with normal controls.9

Differences in patellofemoral joint biomechanics exist between males and females. Female cadaver specimens had significantly increased patellofemoral contact pressures at 0 and 30 degrees of knee flexion and higher peak pressures at 0, 30, and 60 degrees of flexion compared with male specimens.12 Furthermore, females showed a greater change in contact pressure relative to vastus medialis load: with increased load the patellofemoral contact pressures showed a greater decrease compared with males.

Some total knee arthroplasty implant manufacturers have modified implant designs based on this anthropometric data (Gender Solutions, Zimmer, Warsaw, Indiana; Triathlon Knee System, Stryker, Mahwah, New Jersey). Data indicating that such design changes will impact clinical outcomes are, to the author’s knowledge, lacking. In a large study of patients undergoing bilateral total knee arthroplasty, component sizing was based on pre-operative templating and intra-operative sizing measurements.13 Of the 269 patients, 18 (6.7%) had femoral components that differed in size from the right knee to the left knee. No statistical difference was found in post-operative knee score, pain, function, range of motion, or complications with these patients. Certainly, larger studies are needed with perhaps more sensitive clinical measurement tools to determine if sex-based, anatomically based implant designs translate into a better clinical outcome.

**Risk Factors and Prevention**

Obesity is a known risk factor for the development of knee osteoarthritis in several populations.14–18 Furthermore, weight reduction reduces the risk for development of symptomatic knee osteoarthritis in women.19 The rising incidence of obesity in the US, patient education focused on the importance of weight loss to prevent the development of disabling knee osteoarthritis is critical.

The risk of undergoing hip arthroplasty for osteoarthritis is also increased in obese individuals. The Copenhagen Osteoarthritis Study showed that the...
risk of undergoing hip arthroplasty was influenced by the patient’s body mass index (BMI) at the onset of the study. While obese patients are at higher risk for developing hip and knee osteoarthritis, obesity does not appear to adversely affect outcome of joint replacement surgery.

The relationship between exercise and the development of hip and knee osteoarthritis has been studied by many investigators with variable results. Lane and colleagues found that recreational physical activities prior to menopause in white women 65 years of age and older from four regions of the US increased the risk of radiographical and symptomatic hip osteoarthritis. However, in a follow-up study by these authors, women who had mild hip joint space narrowing were unlikely to show radiographical progression over eight years. Using the Framingham cohort, no association was found between recreational, habitual exercise in middle age and the development of knee osteoarthritis. However, in former elite female runners and tennis players, higher rates of radiographical hip and knee osteoarthritis were reported. In men, some studies report a higher risk of hip osteoarthritis in individuals with high or moderate levels of physical activity, whereas other reported no increased risk of hip osteoarthritis in former elite and recreational runners aged 50–65 years.

Prior knee injury is a risk factor for the development of knee osteoarthritis. Anterior cruciate ligament (ACL) injury increases the risk of development of knee osteoarthritis in both sexes and women have a higher risk for ACL injury. Troubling data from Sweden on 84 women (age 26–40 years) who had sustained an ACL injury 12 years earlier showed that 75% had symptoms that substantially affected their quality of life and 42% had symptomatic radiographical knee osteoarthritis. With the increase in sports participation by young women, physicians may see an increase in post-injury osteoarthritis in this patient cohort, for whom treatment will most likely prove challenging.

Developmental dysplasia of the hip has long been recognized as a risk factor for the development of hip osteoarthritis and is more common in women than men in the US. Some degree of underlying hip dysplasia may be present in 20–40% of patients undergoing total hip arthroplasty. While patients with severe dysplasia and hip subluxation are at predictable risk for premature osteoarthritis, individuals with mild dysplasia are at unpredictable risk. Patients with mild acetabular dysplasia may not be at higher risk for developing hip osteoarthritis. In the Rotterdam study of adults aged 55 years and older, the association between dysplasia and hip osteoarthritis was independent of age, sex, BMI, and follow-up time. The Copenhagen Osteoarthritis Study concluded that the risk of a patient undergoing hip arthroplasty was not influenced by hip dysplasia.

The influence of post-menopausal estrogen in the development or progression of osteoarthritis in women has also been investigated with differing conclusions. In a study performed in the UK, post-menopausal estrogen use had a non-significant protective effect on the development of osteoarthritis. In a longitudinal study of white women in Southern California, however, women who used post-menopausal estrogen were more likely to have hip and hand osteoarthritis than women not taking estrogen even with adjustment for age, BMI, exercise, smoking, and onset of menopause.

Clinical Presentation and Results

Gender appears to influence when patients present to orthopaedic surgeons for consultation. In a Canadian study, women were found to have a higher prevalence of hip and knee arthritis, worse symptoms, and greater disability, yet were less likely to have undergone arthroplasty. After adjusting for patient willingness to undergo arthroplasty for severe osteoarthritis of the hip and knee, 5.3 per 1,000 women and 1.6 per 1,000 men were surgical candidates. The authors concluded that arthroplasty was underutilized by both genders, but the degree of underuse was three times greater in women. Of note is that studies of other surgical procedures such as coronary artery bypass grafting and renal transplantation suggest that these procedures are also performed less often in women than they should be.

While data show that women present later in the course of their disease than men, the National Institutes of Health (NIH) consensus panel and the Agency for Healthcare Research and Quality (AHRQ) evidence-based report on total knee arthroscopy did not find sex to be a strong predictor of functional outcome following total knee arthroscopy, based on current measurement tools. Canadian data looking at waiting time for hip arthroplasty, however, showed with logistical regression models that the odds of achieving a better than expected functional outcome after surgery decreased by 8% for each month on the waiting list.

Conclusion

Sex and gender differences exist in hip and knee osteoarthritis. Women have a higher burden of disease yet underutilize hip and knee arthroplasty. Further research is needed to understand sex and gender differences in the pathophysiology, prevention, and treatment of osteoarthritis, as well as in the education of patients regarding treatment. 

---