Zimmer® Gender Solutions™ Hip Technology

Solutions designed to fit the unique anatomies of men and women
While no two hips are alike, there are distinct differences between male and female hip anatomies. Zimmer gender-related hip research has identified these differences, and hip implant systems are being designed to address them. It isn’t a matter of simply adding sizes, but of designing implants with proportional geometry and head center locations that improve fit and function in total hip arthroplasty (THA) by accommodating these anatomic differences.

The science of gender-based THA

Clinical experience supported by anthropometric data shows important differences between men and women in head center location, as well as the size and shape of the medullary canal. With traditional hip implant systems, these differences can make size selection and head center placement a challenge.

Radiographs show some of the anatomical differences between the average male femur and average female femur, including the head center location, as well as the size and shape of the medullary canal.
THA has been shown by numerous long-term outcome studies to significantly improve quality of life through pain relief, increased range of motion, and improved stability of the hip joint.\(^3\) It is one of the most successful surgical procedures.\(^4\) However, there continue to be areas of improvement through better outcomes, reduced complications, and implant design.

**Traditional solutions**

Surgeons often have to make intraoperative adjustments to fit traditional implants to each patient. These adjustments may involve the resection of additional healthy bone or altering the implant version or vertical positioning, which may affect implant fit and adversely affect range of motion, joint stability, or leg length.

**Clinical needs**

Zimmer has reviewed data from clinical and anthropometric studies to determine the range of patient anatomies that must be accommodated to optimize fit and function for both male and female THA patients. Through this research, Zimmer has identified these specific needs in total hip systems.

- There is a need for implants with shorter head height dimensions.
- There is a need for implants with wider variation in neck shaft angle.
- There is a need for implants with shorter head offset dimensions.
- There is a need for femoral implant options that allow complete restoration of hip joint anteversion.
- There is a need for uncemented implants that provide a natural fit within the larger canals of patients with osteoporosis without increasing the risk of patient dissatisfaction from complications such as stress shielding, femoral fracture, and thigh pain.

**The solution**

Implant systems designed to accommodate the variations in both male and female anatomies help the surgeon address gender differences—in essence, creating a more natural fit. The goal of Zimmer Gender Solutions Hip Technology is to provide the surgeon with more options for variable patient anatomies by striving to address:

- The issues of head height, offset, and version independently, such that an adjustment to one does not affect the others.
- The variation in male and female anatomies by offering a broad range of head center options.
- The issues associated with increased canal width, and mismatch between the diaphysis and metaphysis.

**HEAD CENTER DATA**

This chart shows the trend of smaller head heights and offsets in the female population compared with the male population.\(^\text{i}\)
Inherent head center variations

Anthropometric data shows two distinct patterns in head center location and version; one applies predominantly to women and the other to men. These differences may explain why instability is up to four times more prevalent in female patients.\(^6\) Data analysis involving head height, offset, and version demonstrates that to appropriately restore hip joint geometry and kinematics, each group must be considered independently.

**Women tend to have less head height and offset.**

On average, the head height and offset in women tend to be less than in men.\(^5\) These differences represent more than one prosthetic head/neck length. Furthermore, women experience more variation in head height via varus and valgus neck angles.\(^5,9,10\) Femoral head center location is important because traditional implants often don’t easily accommodate the shorter head heights and offsets in women.\(^11,12\) This can increase surgical complexity, raising the risk of leg length discrepancy,\(^13\) lateral hip pain,\(^14\) impingement,\(^15\) and dislocation.\(^6\)–\(^8\)

**Comparison of average male and female femurs shows that females exhibit shorter head heights and offsets than males.**

- The average head height is 6.6mm less in females than in males (p<0.01).\(^5\)
- Excessive head height may lead to leg length discrepancy, which is one of the most common complaints among THA patients.\(^13\)

**Average male head height and offset**

**Average female head height and offset**

- The average head offset is 3.9mm less in females than in males (p<0.01).\(^5\)
- Excessive offset may lead to an “overstuffed” joint and lateral hip pain, which are more commonly found in females.\(^14\)

\(^*\) There is no statistically significant difference between average male and female canal size in this patient population.
Version differs between men and women.

On average, females have greater femoral anteversion than males.\textsuperscript{5,15-17} If natural femoral and acetabular anteversion angles are not replicated, the risk of implant-on-implant impingement is increased.\textsuperscript{15} This leads to a greater risk of dislocation\textsuperscript{6,18,19} an issue that affects women 2–4 times more often than men.\textsuperscript{2,8} With traditional implant systems, if the anteversion is not restored adequately with the placement of the acetabular component, the surgeon is limited in the amount of anteversion adjustment that is possible with the femoral implant.

- Research consistently shows differences in femoral version between men and women.\textsuperscript{5,16,17} One study found
  - Mean anteversion for males: 5°
  - Mean anteversion for females: 9°

- Recognizing these anatomical differences, researchers and clinicians have recommended between 10° and 15° greater combined anteversion in female patients than in male patients.\textsuperscript{16,20}

\textbf{The solution}

\textit{Zimmer Gender Solutions} Hip Technology will strive to address the issues of head height, offset, and anteversion independently, such that an adjustment to one does not affect the others. In combination with a broad range of head centers, this will offer the surgeon greater options in addressing specific patient anatomies.
Internal changes in femoral anatomy

Research shows that anatomical changes occur in the hip as a woman ages, while the typical male hip remains essentially unchanged. Osteoporosis is a key clinical factor in these changes, affecting the size and shape of the medullary canal and causing a sizing mismatch within traditional implant systems. Since approximately 80% of patients diagnosed with osteoporosis are women, the associated complications of this mismatch are more common in women.

The Dorr Type C Femur

Changes in canal size and shape correlate with the Dorr Type C femur, which exhibits a stove pipe canal shape. Women have a higher incidence of Dorr Type C femurs.

Changing canal size

Internal and external dimensions of the femur increase proportionally in the male population. But with osteoporotic remodeling, the medullary canal becomes wider, while the outer geometry of the femur remains the same.

Dorr Type A
36% of all femora
90% male/10% female

Dorr Type B
33% of all femora
65% male/35% female

Dorr Type C
31% of all femora
30% male/70% female

Females make up the majority of Dorr Type C femora, exhibiting bone loss in the diaphysis of the bone and thinner cortical walls. Osteoporosis is a key clinical factor in these changes.
The clinical implications include:

- Thinning of the cortical walls,\(^9,22\) which increases the risk of complications, such as pulmonary emboli when cementing the femur.\(^24\)

- The need for a larger implant to fill the diaphysis.

- The larger implant has more head height and more offset, potentially resulting in leg length and offset discrepancies.\(^11,13\)

- As the stem diameter increases, so does the stem stiffness, which may increase the risk of proximal fracture,\(^25\) postoperative thigh pain, stress shielding, and proximal bone resorption.\(^26,27\)

**Changing canal shape**

Although osteoporosis increases the width of the diaphysis, the width of the metaphysis remains relatively unchanged.\(^9,22\) Traditional uncemented implants are sized proportionally (so that as the diameter of an implant increases, there is a corresponding increase in the metapheal dimension). The sizing of traditional implants provides adequate fit and fill for most male femurs, but may be too large proximally for the osteoporotic femur.\(^28\)

The clinical implications include:

- Implants that fit the enlarged diaphysis of the stove pipe femur are too large proximally\(^9,26,29\) and impinge on the proximal femur causing the implant to seat proud.\(^11\)

- The implant seating proud causes excess lengthening of the leg.\(^11,13\)

- The surgeon may try to adjust by making a lower neck cut, but this may sacrifice quality bone stock and increase OR time, and does not necessarily ensure that joint kinematics will be adequately restored.

**The solution**

*Zimmer Gender Solutions* Hip Technology will strive to address the issues associated with increased canal width, and mismatch between the diaphysis and metaphysis, with the goal of offering the surgeon greater options in addressing specific patient anatomies.
THA is a highly successful surgery with great clinical outcomes.\textsuperscript{1-3} Zimmer is committed to improving implant designs to optimize surgeon and patient satisfaction. \textbf{Zimmer Gender Solutions} Hip Technologies are designed to fit the unique anatomies of men and women.

\textbf{References}


5. Data from Mohamed Mahfouz, PhD, University of Tennessee Center for Musculoskeletal Research. Femoral Bone Atlas.


