



Femoral stem size mismatch in women undergoing total hip arthroplasty

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ABSTRACT

Background: Total hip arthroplasty (THA) is a highly successful surgery with a high prevalence in women. Women have been noted to have smaller proximal femoral anatomy and decreased bone strength compared to males. The goal of our study was to define the size discrepancy in femoral stem implants between men and women using a metaphyseal fitting single taper stem.

Methods: We retrospectively reviewed the THA's performed by a single surgeon over the previous two years. Data was extracted from operative reports regarding stem size, neck length and offset, and conversion to a different type of stem. This data was reviewed with confidence intervals and a *t*-test was performed for independent samples with a $p < 0.05$ being determined significant.

Results: We analyzed the data from 276 THA's performed (129 in men, and 147 in women). Women were noted to be associated with smaller stem sizes compared to men (37.67% in women, 6.11% in men), with 7.48% of women requiring conversion to a different type of implant. There was a significant difference in mean stem size (9.21 in men, 6.70 in women, $p < 0.0001$). Women also required reduced neck options significantly more often than men (38.97% in women, 9.29% in men, $p < 0.0001$).

Conclusion: Review of femoral stem sizes reveals that current femoral stem sizing may not appropriately account for women and alternative stem options should be available if using a metaphyseal fitting single tapered stems. Future consideration should be given to more anatomic female sized femoral stems or alternative options should be available.

1. Introduction

Total hip arthroplasty (THA) is a highly utilized, and highly successful operation performed routinely in the United States. The prevalence of THA is large, with 2010 estimates accounting for approximately 5.26% of the population at age 80.¹ Rates are even higher in women, and it is estimated that there are nearly 1.4 million women with a current THA in the United States alone.¹ Current success rates vary, but revision rates are typically reported as less than 1% per year.¹ The prevalence of THA in women is notably higher, with rates as high as 6.26% in women at age 80 compared to 4.77% in men. The geometry of the proximal femur is highly variable, and women and certain Asian populations have smaller proximal femoral anatomy and decreased bone strength compared to males, and obtaining proximal fixation has been difficult at times.^{2–5}

While femoral morphology and size differ between men and women, implants do not and are unisex at this point, resulting in a sizing issue in smaller canals. This can lead to increased calcar fractures in women, especially when smaller femoral sizes are used.^{6,7} Also of note is the

significant change in femoral canal diameter that occurs in women as they age with changes in femoral canal diameter as women age. Not only is there a change in the size of the canal but there is also an associated change in morphology of the canal and a decrease in bone mineral density (BMD) which is accelerated after menopause.⁸ Since this is the age at which most women undergo THA this is pertinent to the arthroplasty surgeon.

With the need for smaller sizes of femoral components causing incrementally increased jumps between sizes compared to larger components, decreased bone mineral density and increased buckling ratio, this could lead to higher fracture rates in this population.⁸ In this study we sought to evaluate whether there was a notable mismatch in femoral component size between women and men. We also wanted to see whether female THA was skewed towards the smaller sizes and whether there were more cases that had to be altered to other stems intraoperatively.

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2. Methods

We retrospectively reviewed all THA's performed over the past 2 years by a high volume, adult reconstruction fellowship trained surgeon. Only primary THA's were evaluated. The only exclusion criteria was prior surgery to the hip or proximal femur. All cases were comprehensively templated preoperatively by both the adult reconstructive fellow on service and the attending. All cases in which a size 4 stem was templated a backup Wagner cone stem was available. Femoral stem size was recorded and the mean and standard deviation of the stem sizes were recorded as well. THA's in which alternative stems were used for sizing issues were recorded for both men and women. The femoral neck used was also recorded, with options being standard, extended offset, reduced neck standard offset, and reduced neck extended offset.

The stem used for all patients was a Zimmer M/L taper (Zimmer Biomet: Warsaw, IN). These were all implanted through a mini posterior approach. In all patients an attempt was made in order to place the smallest broach, a size 4. If unable to place the smallest broach we then converted to the Wagner cone stem at that time. The geometry and sizing of the stem is based off the coronal diameter of the stem 100 mm from the most proximal point on the medial body. For patients in which appropriate sizing could not be obtained a Zimmer Wagner cone stem (Zimmer Biomet: Warsaw, IN) was used in all cases. This stem is designed as a monoblock taper fluted stem with a five degree distal taper. This is a diaphyseal engaging stem and comes in numerous length and diameter options offering flexibility when there is difficulty obtaining proximal fixation.

This data was analyzed, femoral stem size mean was obtained and mean stem size with 95% confidence intervals was obtained. This data was then analyzed using a *t*-test for independent samples and significance was set at $p < 0.05$. This was then analyzed using a two proportion test with $p < 0.05$ being determined statistically significant.

3. Results

After exclusions which consisted only of previous hip surgery, we reviewed the results of 275 THA performed. There were 146 THAs performed in women and 129 in men. For women of the 146 THA, ten (6.85%) had to be converted to a different prosthesis for difficulty placing the smallest broach in an acceptable position. There were no fractures or intraoperative complications. Mean stem size in women was 6.70 (95% confidence interval 6.70 ± 0.41). Size 4 stems, the smallest size available, accounted for 22.60% of the stems used and size 5 stems accounted for an additional 15.07%. Graphical analysis of the distribution of femoral stems in women (Fig. 1) shows a skew towards the smaller sizes. Reduced necks were also used in 26.46% of the femoral stems in women, and a distribution of the different neck used is shown in Fig. 2.

In the 129 THA's performed in men, none had to be converted to an

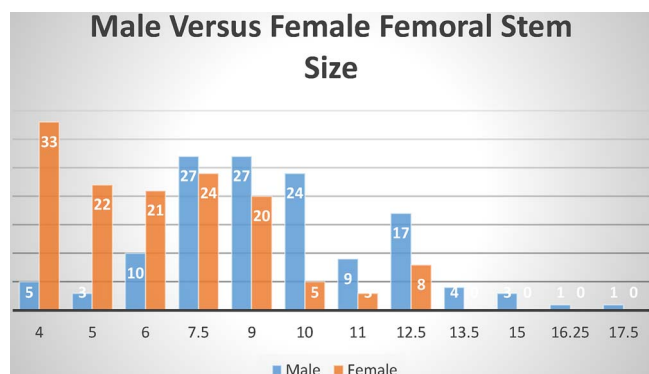


Fig. 1. Graphical analysis of femoral stem sizes inserted between males and females.

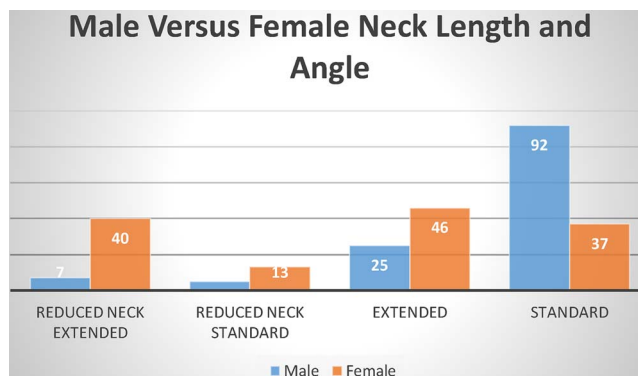


Fig. 2. Graphical analysis of femoral neck length and angle inserted between males and females.

alternative prosthesis and the standard metaphyseal fitting, single taper stem was able to be used in all cases. The mean stem size used in men was 9.21 (95% confidence interval 9.35 ± 0.485). The most common stem sizes used were size 9 and 10 stems, accounting for 20.61% of the total femoral stem use in men. Size 4 stems were only used in 3.82% of men and size 5 stems only accounted for an additional 2.29%. Fig. 1 shows a graphical analysis of the femoral stem size distribution in men. Reduced neck options were only used in 9.29% of men and graphical analysis of the femoral neck used is displayed in Fig. 2. Comparing data in femoral stem size between men and women, there was a significant difference in femoral stem size between men and women ($p < 0.0001$). The need for reduced neck femoral stem options were also evaluated and there was a significant increased need for a reduced femoral neck noted in women ($p = 0.0009$) (Figs. 3 and 4).

All cases were followed post-operatively and a minimum of one year follow up was recorded in all patients. They were followed both clinically and radiographically for any complications. There were no cases of fracture requiring revision in any patient, male or female. There were no cases of subsidence noted and all patients showed radiographic evidence of osseus integration at one year. One male patient had an infection requiring revision, there were no revisions in the female cohort.

4. Discussion

In our study we sought to identify a population in which the standard single taper metaphyseal fitting stem using current sizes available may have a size mismatch. We found that reduced neck lengths were required in 26.46% of our female patients and 6.85% required conversion to a different type of stem. Also of note is that 37.66% of the femoral stems used were one of the smallest two sizes available with this system. This requires the need for alternative femoral stem implants being available when implanting in these smaller women, and surgeon recognition that this could be problematic.

Intra-operative femur fracture with cementless components ranges in the literature from 0.1%–11%.⁹ This has been noted to be higher in women using cementless components.^{10–12} Higher rates of fracture and higher revision rates have also been found using smaller stem sizes with other implants.⁶ Computed tomography (CT) measurements of the proximal femur have shown a narrower aspect of female proximal femoral anatomy and female femurs were also significantly smaller than that of male proximal femurs.⁷ This study also confirmed that patients with an intraoperative femur fracture had a narrower femur and a smaller size of stem than those without fracture. Although single wedge stems such as the one used in this study have a lower incidence of fracture than dual tapered stems used in other studies, this still does not mitigate the problems associated with smaller stem sizes and fracture.¹³

Issues seen with fracture may be multifactorial, and may partially account for why none were seen in this study. Having a readily available alternate stem which the surgeon was familiar with made

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