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No Rationale for Gender Specific Femoral Stems for Total Hip Arthroplasty

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Abstract

The purpose of this study was to compare the applicability of two femoral stem systems in male and female populations via preoperative templating. The radiographs of 47 consecutive patients (94 hips) were templated using one of two stem systems by first fixing the acetabular center of rotation. Based upon templating, the result categories were: no obvious advantage of either system, System 1 preferred, System 2 preferred, neither system adequate. Preference was determined based upon having a best-fit stem choice and at least one additional length or offset option, and avoiding the extremes of the system as the best-fit choice. Significantly, there were gender differences in applicability of femoral stems. Specifically, more neck length and offset options seem to be required for females. The potential limitations of the implant systems in applicability could be overcome by adjusting the level of neck resection. Therefore, it would appear that there is a limited role for gender specific implants for total hip arthroplasty.

Keywords: *hip arthroplasty modular stem gender*

Introduction

Variations in femoral anatomy [1,2,3,4] and acetabular anatomy [5] have been partially ascribed to gender differences. Traditionally, femoral stems for THA have been designed across an entire population including both males and females. The purpose of this study was to compare the applicability of two femoral stem systems, one with modular bodies and one with a one piece stem, in male and female populations via preoperative templating.

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Methods

All patients seen during a single month who presented complaining of knee pain had screening pelvis x-rays. These x-rays formed a consecutive cohort of hips for the templating study. During templating, the acetabular component was placed in a fully medialized position at 45o of abduction. The center of rotation was marked. The femoral neck osteotomy was set at 15 mm proximal to the top of lesser trochanter, as recommended in the technique guide. Templates of equal magnification were utilized for both systems. System 1 (Figure 1a) had a double tapered wedge body design, a fixed 135o neck-shaft angle with two different offsets (6 mm difference) and two different neck lengths (4 mm difference). There were 7 head options with different lengths. System 2 (Figure 1b) had the same body design with a modular neck offering 20 different offsets/lengths and 7 different neck-shaft angles, with only

Figure 1. (a) In System 1, there are two neck length and two neck offset choices. The stem on the left is a reduced neck length, standard offset. The stem on the right has standard length and offset. (b) In System 2, multiple neck lengths and offsets can be used with any body. The neck length of the head is always +0.

Figure 2. Template Examples. (a) System 1 applicable as lateralized stem matches center of rotation of the templated acetabular component. (b) System 1 would not be applicable as the stem has too much offset to match the center of rotation of the templated acetabular component.

one head option. Neck length and offset were independent of body size for both systems. Based upon templating, the categories were: No obvious advantage of either system, System 1 preferred, System 2 preferred, Neither system adequate. Preference was determined based upon providing at least one additional length or offset option, and avoiding the extra extended offset option in System 2 based upon the risk of fracture or disassociation due to extremely high moments [6,7]. Examples of templates are depicted in Figure 2.

Fisher exact test was utilized to calculate the probability of a difference in system applicability across groups.

Results

There were 20 female patients contributing 40 hips and 27 males contributing 54 hips. The data are summarized, by gender, in Table I. Among the males, there was no obvious advantage in 20/54 hips (37%), System 1 was preferred in 11/54 hips (20.4%), System 2 was preferred in 15/54 hips (27.8%), and neither system was adequate in 8/54 hips (14.8%). In addition, System 1 could have been used in 33/54 hips (61.1%), while System 2 could have been used in 42/54 hips (77.8%). Overall, 46/54 male hips (85.2 %) could be implanted with either of these stems. There was no statistically significant advantage of one system over the other in applicability ($p = 0.13$). Among the

Table I. Neck Cut 15 mm above lesser trochanter

	Males	Females
No Advantage	20/54	17/40
System 1 Preferred	11/54	1/40
System 2 Preferred	15/54	13/40
Neither Adequate	8/54	9/40
Either Possible	46/54	31/40

Table II. Neck Cut Adjustable

	Males	Females
No Advantage	31/54	30/40
System 1 Preferred	14/54	1/40
System 2 Preferred	4/54	6/40
Neither Adequate	5/54	3/40
Either Possible	49/54	37/40

Table III. Dorr B and C Females, with adjustable neck cut

	Dorr B	Dorr C
No Advantage	15/21	11/16
System 1 Preferred	1/21	0/16
System 2 Preferred	5/21	3/16
Neither Adequate	0/21	2/16
Either Possible	21/21	14/16

females, there was no obvious advantage in 17/40 hips (42.5%), System 1 was preferred in 1/40 hip (2.5%), System 2 was preferred in 13/40 hips (32.5%), and neither system was adequate in 9/40 hips (22.5%). In addition, System 1 could have been used in 22/40 hips (55%), while System 2 could have been used in 31/40 hips (77.5%). Neither system was appropriate in 9/40 (22.5%) of the female patients. Overall, 31/40 female hips (77.5 %) could be implanted with either of these stems. There was no statistically significant advantage of one system over the other in applicability (p = 0.07).

We then changed the level of the neck cut to a position that could accommodate either of the stem systems, with no neck resection less than 5 mm above the lesser trochanter. These data are summarized in Table II. Among the males, there was no obvious advantage in 31/54 hips (57.4%), System 1 was preferred in 14/54 hips (25.9%), System 2 was preferred in 4/54 hips (7.4%), and neither system was adequate in 5/54 hips (9.3%). In addition, System 1 could have been used in 49/54 hips (90.7%), while System 2 could have been used in 44/54 hips (81.5%). Overall, 49/54 male hips (90.7 %) could be implanted with either of these stems. Importantly, the availability of System 2 did not increase the applicability of the stem family for THA (p=0.31). Among the females, there was no obvious advantage in 30/40 hips (75%), System 1 was preferred in 1/40 hip (2.5%), System 2 was preferred in 6/40 hips (15%), and neither system was adequate in 3/40 hips (7.5%). In addition, System 1 could have been used in 35/40 hips (87.5%), while System 2 could have been used in 37/40 hips (92.5%). Overall, 37/40 female hips (92.5 %) could be implanted with either of these stems. Again, the addition of System 2 slightly increased the utility of this stem family, but not significantly (p=0.38).

Because women are purported to have larger diameter canals (so-called Dorr B and C bone), we next assessed the applicability of the stem systems as a function of bone geometry. Among the female patients, there were 3 Dorr A femurs, 21 Dorr B femurs and 16 Dorr C femurs. The templating data are summarized in Table III. With flexible neck level resections, among the Dorr B hips, there was no obvious advantage in 15/21 hips (71.4%), System 1 was preferred in 1 hip (4.7%), System 2 was preferred in 5/21 hips (23.8%), and neither system was adequate in 0/21 hips. In addition, System 1 could have been used in 19/21 hips (90.4%), while System 2 could have been used in 21/21 hips. The enhanced modularity of System 2 increased the utility of this product line for 10% of the female Dorr B hips, but there was no statistical significance in applicability (p=0.12). Among the Dorr C hips, there was no obvious advantage in 11/16 hips (68.8%), System 1 was preferred in 0/16 hips, System 2 was preferred in 3/16 hips (18.8%), and neither system was adequate in 2/16 hips (12.5%). In addition, both systems could have been used in 14/16 hips (87.5%). In Dorr C femurs, the enhanced modularity of System 2 did not increase the applicability (p=0.80).

Discussion

Bone atlas and CT scan data suggests that women have larger canals, relatively shorter necks, more varus necks, greater anteversion [2,3,4], less acetabular abduction and more acetabular anteversion [5]. As a result, it has been suggested that a gender specific implant is needed to adequately address such gender-related anatomical variations when considering cementless femoral stems in THA [8]. Significantly, there appear to be gender differences in applicability of femoral stems. Whether these differences translate into poorer outcomes is debatable [9,10].

According to this study, with a fixed level of neck resection, more neck length and offset options seem to be required for female patients. However, by individualizing the level of neck resection, fewer stem options would be required to reconstruct most hips. Similarly, center of rotation of the acetabular component can be adjusted to overcome shortcomings in available stem sizes, although biomechanically, that may be less desirable. With appropriate preoperative planning, it would be expected that an experienced surgeon should be able to successfully perform THA regardless of patient gender, obviating the need for gender specific implants.

Increased stem modularity has also recently been implicated in pain and bone loss due to increased crevice corrosion [11]. Further, there have been several reports of modular neck disassociation and fracture [6,7], requiring additional surgeries with all of their associated morbidity. In these reports, excessive offset has been one associated factor with both modes of modular neck failure. In this study, we specifically avoided the extremes of the product line, thereby likely reducing the risk of such failures. Nevertheless, recent data compels the surgeon to use caution when planning a hip arthroplasty with enhanced modularity stems.

There are some limitations of this study. We did not account for appropriateness of stem as a function of variation in anteversion. In addition, this study included both normal and arthritic hips, which may affect the results. Further investigation is necessary to determine the role of neck-shaft angle, bone quality and adjustment of neck osteotomy height on stem design and patient outcome as a function of gender. Nevertheless, it would seem that no single stem product line can account adequately for all the anatomical variations encountered in routine arthroplasty practice, further underscoring the importance of preoperative templating and planning when choosing an implant.

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