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Comparison of the fit and fill between the Anatomic Hip femoral component and the VerSys Taper femoral component using virtual implantation on the ORTHODOC workstation

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Abstract The purpose of this study was to evaluate differences in fit and fill between an anatomic femoral component and a straight tapered femoral component, both of which were designed for proximal fit and fill using the preoperative planning workstation of the ROBODOC system (ORTHODOC). Anatomic Hip (Zimmer) and VerSys Taper (Zimmer) femoral components were each virtually implanted into 50 femora (25 dysplastic femora and 25 anatomically normal femora) using the ORTHODOC workstation. The fit and fill of the femoral components were measured on cross-sectional images. The VerSys Taper femoral components showed significantly better fit and fill than the Anatomic Hip femoral components at the lower corner of the femoral neck cut and the middle of the femoral component in both the dysplastic femora and the anatomically normal femora. The Anatomic Hip femoral components showed significantly better fit and fill than the VerSys Taper femoral components 1 cm proximal from the femoral component tip in both dysplastic femora and anatomically normal femora. There was no significant difference in fit and fill between the two types of femoral component at the center of the lesser trochanter or 1 cm distal from the center of the lesser trochanter in either dysplastic femora or anatomically normal femora. Overall, VerSys Taper femoral components appear to provide better proximal fit and fill than Anatomic Hip femoral components in both dysplastic and anatomically normal femora.

Key words ORTHODOC · Virtual operation · Fit and fill · Femoral component · Total hip arthroplasty

Introduction

Fit and fill of a cementless femoral component in the femoral canal are important factors for stable fixation and good clinical results.[2,3,6,8,10,12] An increase in the gap between the surface of the femoral component and the host bone decreases bone ingrowth and strength of fixation.[5] It would be ideal if surgeons could precisely determine which femoral component provides the best fit and fill for each patient during preoperative planning. However, in practice, fit and fill cannot be perfectly predicted preoperatively because of the inaccuracy inherent in surgical techniques and preoperative planning techniques that use radiographs with a template.[16] Therefore, fit and fill are usually evaluated using postoperative radiographs of the patient.

ORTHODOC is a computed tomography (CT)-based preoperative planning workstation associated with the ROBODOC system (Integrated Surgical Systems, Davis, CA, USA).[1] A three-dimensional model of the femur constructed from CT-based volumetric data and a three-dimensional computer-aided design (CAD) model of a femoral component are shown in coronal, sagittal, and axial cross-sectional images, and their planes can be moved and rotated in any direction on the ORTHODOC display. During virtual implantation procedures, CAD implant models are moved and rotated within the model of the femur to determine the optimal position, type, and size of the femoral components. ORTHODOC assists surgeons preoperatively in determining the effects of femoral component designs on fit and fill in the femoral canal. The purpose of this study was to evaluate differences in fit and fill between an anatomic femoral component and a straight tapered femoral component, both of which were designed for proximal fit and fill. We also analyzed the factors affecting fit and fill of these two femoral component design types.

Materials and methods

For virtual implantation, we used preoperative CT scans of 50 femora in 43 randomized patients who underwent cementless total hip arthroplasty at the authors' hospital between September 1999 and Decem-

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Table 1. Demographics of patients used for virtual implantation

Diagnosis	No. of patients (femora)	Gender (men : women)	Age, average and range (years)
Dysplastic femora	18 (25)	3 : 15*	52 (23–73)**
Anatomically normal femora	25 (25)	15 : 10*	49 (20–79)**
Osteonecrosis of the femoral head	16 (16)	11 : 5	45 (20–79)
Rheumatoid arthritis	5 (5)	2 : 3	48 (25–75)
Primary osteoarthritis	4 (4)	1 : 1	68 (62–76)
Total	43 (50)	18 : 25	50 (20–79)

* Difference was statistically significant ($P < 0.001$; Fisher's exact test)
** Difference was not statistically significant (Mann-Whitney U-test)

ber 2000. The patient demographics are given in Table 1. Eighteen patients (25 hips) had dysplastic femora. The remaining 25 patients (25 hips) did not have dysplastic femora and were classified as having normal anatomy. Each diagnosis was made by the senior authors using an anteroposterior radiograph of the hip. All 25 dysplastic femora were classified as group I (0%–50% subluxation) or group II (50%–75% subluxation) according to the classification of Crowe et al.[4] All hips with normal anatomy were confirmed to have no subluxation of the femoral head. None of the hips had previously undergone femoral osteotomy. There was no significant difference in age between the patients with dysplastic femora and those with anatomically normal femora (Mann-Whitney U-test). There was a significant difference in the sex ratio between the patients with dysplastic femora and those with anatomically normal femora ($P < 0.001$; Fisher's exact test). This is because most of the patients with dysplastic femora were women.

The femoral components used for virtual implantation were Anatomic Hip femoral components (Zimmer, Warsaw, IN, USA) and VerSys Taper femoral components (Zimmer). Anatomic Hip femoral components are asymmetrical anatomic femoral components with a posteriorly bowed proximal body and a cylindrical distal portion; they are manufactured in right hip and left hip versions (Figs. 1A, 2A, 3A). VerSys Taper femoral components are straight tapered femoral components that have two variations of the proximal metaphysis: standard metaphysis (STD) and large metaphysis (LM) (Figs. 1B,C, 2B, 3B). Anatomic Hip femoral components and VerSys Taper femoral components both have a circumferential proximal porous coating, and both are designed for proximal fit and fill. Virtual implantation of Anatomic Hip femoral components and VerSys Taper femoral components were performed on the ORTHODOC workstation. The present study involved 50 hips. Total hip arthroplasty using the VerSys Taper femoral component was performed in nine hips. Total hip arthroplasty using implants other than the Anatomic Hip femoral component and the VerSys Taper femoral component was performed in the remaining 41 hips. In all nine hips treated using the VerSys Taper femoral component, there was 100% agreement between the preoperatively planned type and size of the implants and the actual type and size used intraoperatively. Thus, it appears that the accuracy of preoperative planning using ORTHODOC is very high.

Virtual implantation of femoral components was performed as follows. The center of the femoral head was marked until a circle encompassed the femoral head contour on the coronal, sagittal, and axial views of the workstation display. The femur was reoriented on the workstation to obtain the coronal plane that passed through the head center and the proximal femoral medullary axis. Then the sagittal plane through the medullary axis was obtained. Femoral components of the maximum size that would not overream the endosteal cortical bone were selected and virtually implanted into the femoral canal to achieve maximum proximal medial fit.[1,9] We then chose the variation of the proximal metaphysis (STD or LM) that would provide the best fit and fill in the proximal metaphysis for tight proximal fixation of the femoral component. The neck cut level was not determined at first but was finally determined based on the position of the femoral component for the best fit and fill. Each virtual implantation was discussed by two of the senior authors until a consensus was obtained.

After the femoral component was implanted, the canal fill ratio and the canal fit ratio were calculated from the cross-sectional images at the following five levels (Fig. 4): the lower corner of the femoral neck cut (level 1); the center of the lesser trochanter (level 2); 1 cm distal from the center of the lesser trochanter (level 3); the middle of the femoral component (level 4); and 1 cm proximal from the femoral component tip (level 5). The canal fill ratio was defined as the ratio of the stem area to the total medullary cavity area at each cross-sectional level. The canal fit ratio was defined as the ratio of the length of the stem–endosteal contact to the total endosteal length, at each cross-section level. A distance of less than 1 mm between the femoral component surface

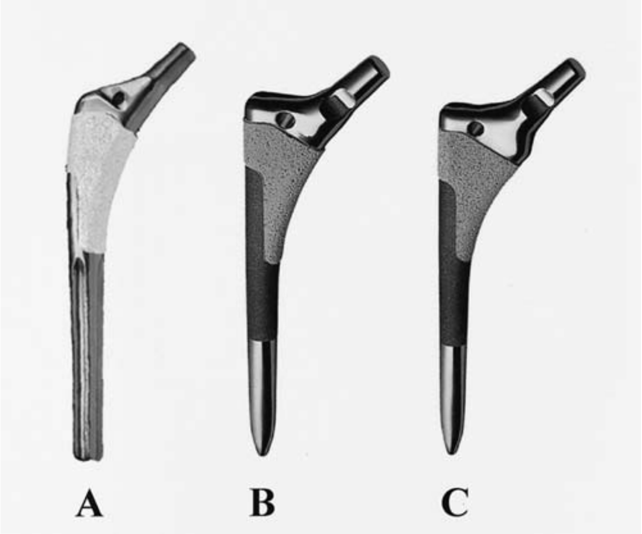

Fig. 1. *A*, Anatomic Hip femoral component; *B*, VerSys Taper femoral component with standard metaphysis (STD); *C*, VerSys Taper femoral component with large metaphysis (LM)

and the endosteal line was defined as contact. Differences in femoral component size between the Anatomic Hip femoral components and the VerSys Taper femoral components were evaluated for each femur. The femoral component seating level was defined as the vertical distance between the superior border of the greater trochanter and the lower corner of the femoral neck cut (level 1) (Fig. 4). Femoral component seating levels of the Anatomic Hip femoral components and the VerSys Taper femoral components were compared for each femur to determine which femoral component can be implanted lower in the same femur. A larger femoral component seating level corresponded to lower implantation of the femoral component. VerSys Taper STD femoral components and VerSys Taper LM femoral components were implanted in the same femora in which VerSys Taper LM femoral components had been selected to investigate the effect of the difference in size of the proximal metaphysis.

To study the effects of proximal femoral canal geometry, the lateral curvature of the proximal femur and femoral anteversion were assessed on the workstation display. The lateral curvature of the proximal femur was assigned an α angle, according to the method of Noble et al.[11] The α angle of the femur was defined as the angle of the intersection of the anterior bow of the diaphysis and the posterior bow of the proximal metaphysis. Femoral anteversion was measured using the single-slice CT method.[14] Femoral anteversion was defined as the angle of the intersection of the line passing through the midpoints of the neck at the medial and lateral edges of the central portion of the neck just below the femoral head and the tangent to the posterior condyles. All measurements were performed by one of the authors in a blinded fashion.

Areas of the Anatomic Hip (12 mm) and VerSys Taper STD femoral components (12 mm and 13 mm) on cross-sectional images perpendicular to the femoral component axis at the following levels were measured to study differences in femoral component designs. When determining the levels of the cross-sectional images, the prosthesis collar was assigned a value of 0 mm. The cross-sectional images were made at 10-mm intervals below the prosthesis collar (Fig. 5). Distances of 0, 20, 30, 60, and 120 mm from the prosthesis collar were designated levels 1 to 5, respectively.

The paired *t*-test, the Mann-Whitney U-test, the Wilcoxon signed-rank test, and Fisher's exact test were used for statistical analysis. Differences were considered significant when P was <0.05.

Results

Canal fill ratios

VerSys Taper STD femoral components were used in 36 femora and VerSys Taper LM femoral components in 14 femora. With the VerSys Taper femoral components, the average canal fill ratios were highest at level 4 and lowest at level 1 (Fig. 6). With the Anatomic Hip femoral components, average canal fill ratios were highest at level 5 and lowest at level 1. In all patients the VerSys Taper femoral components had significantly higher canal fill ratios than the Anatomic Hip femoral components at level 1 (paired *t*-test, $P < 0.001$) and level 4 ($P < 0.0001$), whereas the Anatomic Hip femoral components had significantly higher canal fill ratios than the VerSys Taper femoral components at level 5 ($P < 0.0001$). There was no significant difference in the canal fill ratio between component types at level 2 or 3 (Fig. 6). There were no significant differences in canal fill ratio between the dysplastic femora and the anatomically normal femora.

Canal fit ratios

VerSys Taper STD femoral components were used in 36 femora and VerSys Taper LM femoral components in 14 femora. The canal fit ratio was lower than the canal fill ratio at each level (Fig. 7). However, the highest and lowest average canal fit ratios were obtained at the same levels as the highest and lowest average canal fill ratios for both the Anatomic Hip (levels 5 and 1, respectively) and the VerSys Taper (levels 4 and 1, respectively)

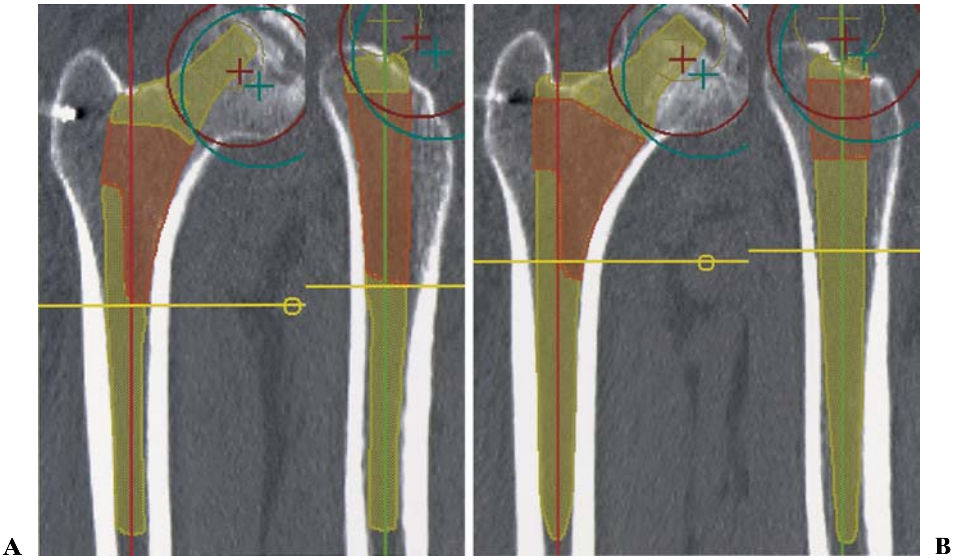

Fig. 2. Comparisons of the two femoral components used in this study. **A** Anteroposterior and lateral views of the Anatomic Hip femoral component. **B** Anteroposterior and lateral views of the VerSys Taper femoral component with large metaphysis

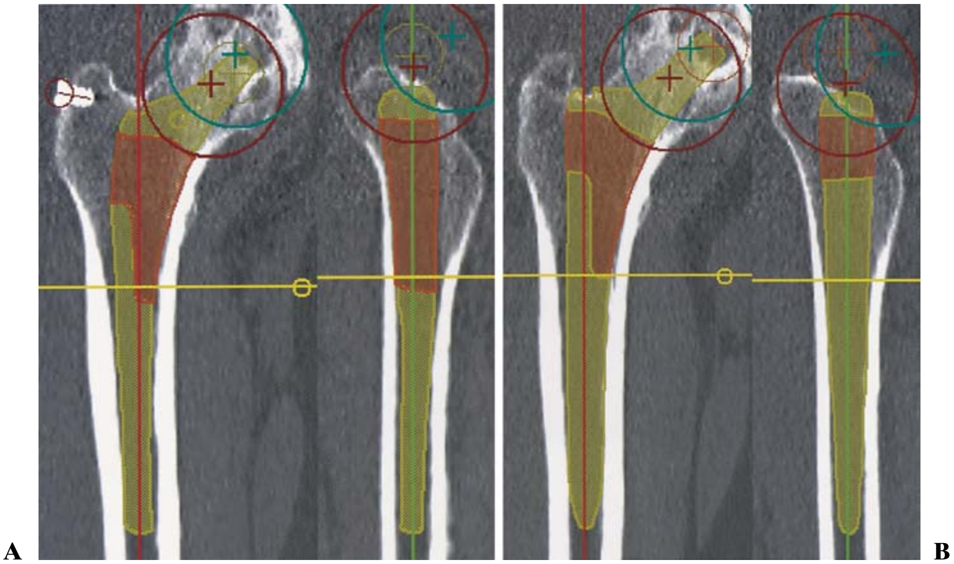

Fig. 3. Comparisons of the two femoral components used in this study. **A** Anteroposterior and lateral views of the Anatomic Hip femoral component. **B** Anteroposterior and lateral views of the VerSys Taper femoral component with standard metaphysis

femoral components. In all patients, the VerSys Taper femoral components had significantly higher canal fit ratios than the Anatomic Hip femoral components at level 1 (paired *t*-test, $P < 0.001$) and level 4 ($P < 0.0001$), whereas the Anatomic Hip femoral components had significantly higher canal fit ratios than the VerSys Taper femoral components at level 5 ($P < 0.0001$) (Fig. 7). There was no significant difference in canal fit ratios between component types at level 2 or 3. There were no significant differences in canal fit ratio between the dysplastic femora and the anatomically normal femora.

Size and seating levels of the Anatomic Hip and VerSys Taper femoral components

The mean size of the Anatomic Hip femoral components was 12 mm, whereas that of the VerSys Taper femoral components was 13 mm. The distribution of size of the Anatomic Hip and VerSys Taper femoral components are shown in Fig. 8. The largest VerSys Taper femoral component that can be implanted in a given femur is significantly larger than the largest Anatomic Hip femoral component that can be implanted in the same femur (Wilcoxon signed-rank test, $P < 0.0001$).

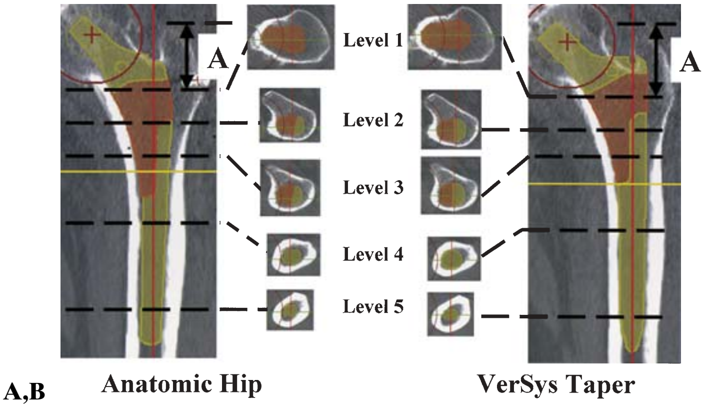

Fig. 4. The five levels at which cross-sectional images were used to calculate the canal fill ratio and the canal fit ratio. Femoral component seating level (*A*) was defined as the vertical distance between the superior border of the greater trochanter and the lower corner of the femoral neck cut

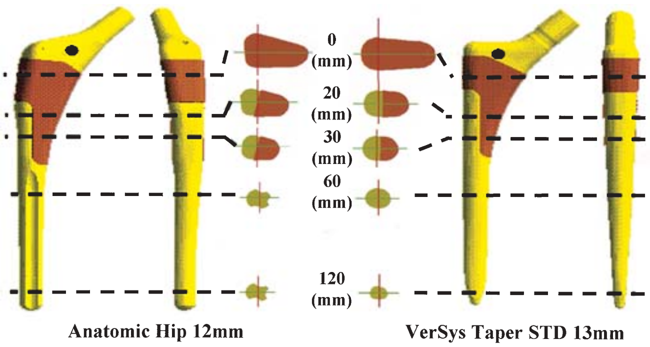

Fig. 5. Areas of the 12-mm Anatomic Hip and 13-mm VerSys Taper STD femoral components were measured on cross-sectional images perpendicular to the femoral component axis to study differences between these femoral component designs

The mean ± standard deviation (SD) seating level of the Anatomic Hip femoral components was 34.6 ± 6.5 mm, whereas that of the VerSys Taper femoral components was 36.2 ± 5.8 mm. The VerSys Taper femoral components were seated significantly lower than the Anatomic Hip femoral components (paired *t*-test, $P < 0.01$).

Effect of variations (STD and LM) of the proximal metaphysis of the VerSys Taper femoral components

There were 14 femora in which the VerSys Taper LM femoral components were selected. In the 14 femora in which both the VerSys Taper STD and VerSys Taper LM femoral components were virtually implanted, both components were 13 mm (mean). The distribution of size for the VerSys Taper STD and VerSys Taper LM femoral components is shown in Table 2. There was no significant difference in size between the two prostheses (paired *t*-test). The mean ± SD seating level of the VerSys Taper STD femoral components was 38.4 ± 5.8 mm, whereas that for the VerSys Taper LM femoral components was 36.7 ± 6.1 mm. There was no significant difference in seating level between the two prostheses (paired *t*-test).

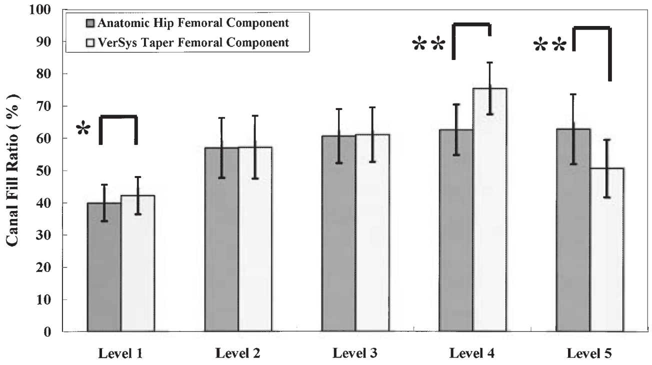

Fig. 6. Canal fill ratios for all 50 femora with the Anatomic Hip femoral components and the VerSys Taper femoral components. Averages and error bars are shown for each level. Asterisks indicate statistically significant differences (paired *t*-test: $^*P < 0.001$; $^{**}P < 0.0001$)

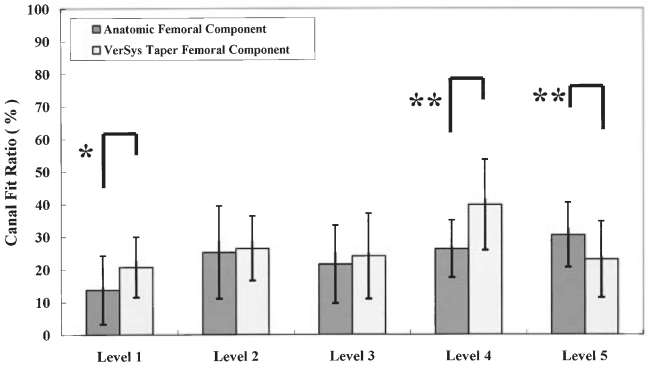

Fig. 7. Canal fit ratios for all 50 femora with the Anatomic Hip femoral components and the VerSys Taper femoral components. Averages and error bars are shown for each level. $^*P < 0.001$; $^{**}P < 0.0001$ (paired *t*-test)

For the 14 femora virtually implanted with both variations of the VerSys Taper femoral components, the VerSys Taper LM femoral components had significantly higher canal fill ratios than the VerSys Taper STD femoral components at level 1 (paired *t*-test, $P < 0.05$), whereas the VerSys Taper STD femoral components had significantly higher canal fill ratios than the VerSys Taper LM femoral components at level 4 (paired *t*-test, $P < 0.05$) (Fig. 9). In the 14 femora virtually implanted with both variations of VerSys Taper femoral components, the VerSys Taper LM femoral components had significantly higher canal fit ratios than the VerSys

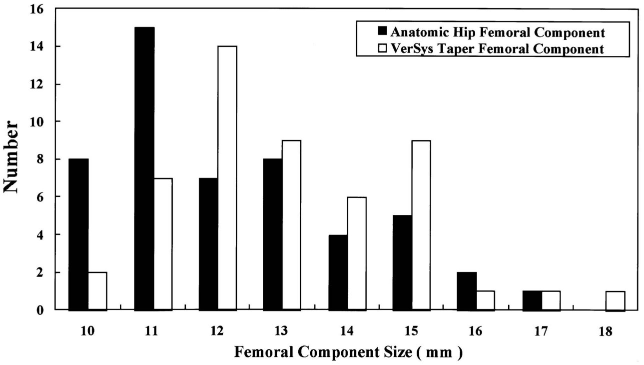

Fig. 8. Distribution of the size of the Anatomic Hip femoral components and the VerSys Taper femoral components

Table 2. Comparison of size between STD and LM VerSys Taper femoral components

Femoral component size (mm)	No. of femora	
	STD (n = 14)	LM (n = 14)
10	0	0
11	0	0
12	9 (64%)	9 (64%)
13	2 (14%)	3 (21%)
14	1 (7%)	0
15	0	1 (7%)
16	2 (14%)	1 (7%)
17	0	0
18	0	0

STD, standard metaphysis; LM, large metaphysis

Taper STD femoral components at level 1 (paired *t*-test, $P < 0.0001$), whereas the VerSys Taper STD femoral components had significantly higher canal fit ratios than the VerSys Taper LM femoral components at level 4 (paired *t*-test, $P < 0.05$) (Fig. 10).

α Angle and femoral anteversion

Measurements of the α angle and femoral anteversion are shown in Table 3. The α angle and femoral anteversion were both significantly greater in dysplastic femora than in anatomically normal femora (α angle, $P < 0.01$; femoral anteversion, $P < 0.0001$). The α angle significantly correlated with femoral anteversion (Pearson's correlation coefficient, $P < 0.0001$).

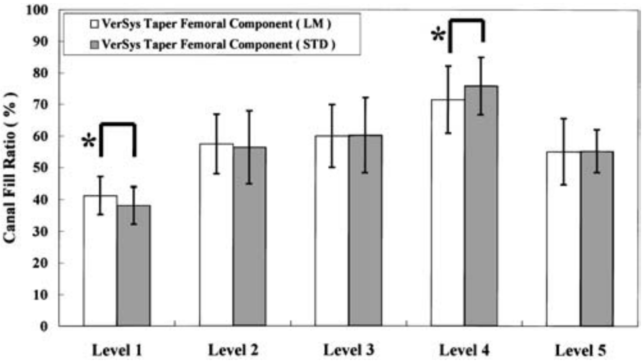

Fig. 9. Canal fill ratios for the 14 femora virtually implanted with both the VerSys Taper STD femoral components and the VerSys Taper LM femoral components. Averages and error bars are shown for each level. *$P < 0.05$ (paired *t*-test)

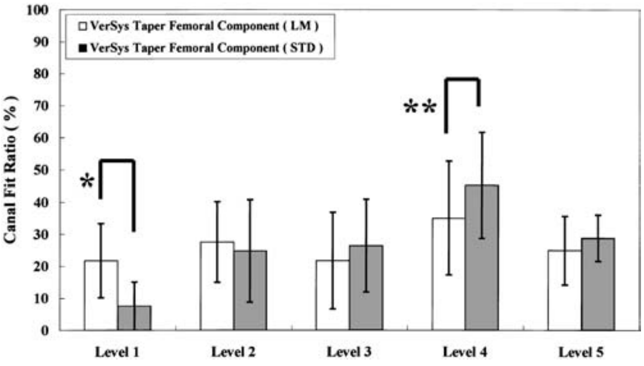

Fig. 10. Canal fit ratios for the 14 femora virtually implanted with both the VerSys Taper STD femoral components and the VerSys Taper LM femoral components. Averages and error bars are shown for each level. *$P < 0.0001$; **$P < 0.05$ (paired *t*-test)

Cross-sectional areas of femoral components

Area measurements for the Anatomic Hip and VerSys Taper femoral components taken from the cross-sectional images are shown in Table 4. On cross-sectional images located 0–40 mm below the prosthesis collar (corresponding to levels 1–3), the area of the 12-mm Anatomic Hip femoral component was larger than that of the 12-mm VerSys Taper femoral component. On the cross-sectional image located at the prosthesis collar (corresponding to level 1), the area of the 12-mm Anatomic Hip femoral component was smaller than that of the 13-mm VerSys Taper femoral component. The mean ± SD vertical distance between the lower corner of the femoral neck cut (level 1) and the center of the lesser trochanter (level 2) was 21.7 ± 5.4 mm for the Anatomic Hip femoral component and 20.2 ± 5.0 mm for the VerSys Taper femoral component. The cross-sectional image located 20 mm below the prosthesis collar was therefore designated as corresponding to the center of the lesser trochanter (level 2). On the cross-sectional images located 20–30 mm below the prosthesis collar (corresponding to levels 2 and 3), the area of the 12-mm Anatomic Hip femoral component was equivalent to that of the 13-mm VerSys Taper femoral component. On the cross-sectional image lo-

Table 3. α Angle and femoral anteversion

Diagnosis	No. of femora	α Angle[a] (degrees)	Femoral anteversion[a] (degrees)
Dysplastic femora	25	30.5 (18–48.2)*	38.1 (18.5 to 75.7)**
Male	3	21.3 (18.3–23.5)	28.0 (19.9–33.3)
Female	22	31.8 (18.0–48.2)	39.5 (18.5–75.7)
Anatomically normal femora	25	21.6 (−6.2–41.0)*	22.4 (2.8–43.7)**
Male	15	21.1 (−6.2–41.1)	21.6 (11.0–43.7)
Female	10	22.4 (7.8–38.7)	23.9 (2.8–35.3)
Total	50	26.0 (−6.2–48.2)	30.6 (2.8–75.7)
Male	18	21.1 (−6.2–31.1)	22.7 (11–33.6)
Female	32	28.9 (7.8–29.4)	35.4 (2.8–35.0)

*Differences were statistically significant ($P < 0.01$; unpaired *t*-test); **differences were statistically significant ($P < 0.0001$; unpaired *t*-test)

[a] Values are averages (range)

Table 4. Cross-sectional area of femoral components

Level of cross-sectional images[a] (mm)	Area of cross-sectional images (mm^2)		
	Anatomic Hip (12mm)	VerSys Taper (12mm)	VerSys Taper (13mm)
0	422	402	452
10	347	337	373
20	288	239	289
30	221	185	218
40	179	154	181
50	142	135	148
60	111	124	136
70	104	107	126
80	95	104	118
90	87	86	105
100	78	82	96
110	75	66	75
120	75	32	58

[a] Cross-sectional images were made at 10-mm intervals below the prosthesis collar assigned a value of 0mm

cated 60mm below the prosthesis collar (corresponding to level 4), the area of the 12-mm Anatomic Hip femoral component was smaller than that of the 12-mm VerSys Taper femoral component. On the cross-sectional image located 120mm below the prosthesis collar (corresponding to level 5), the area of the 12-mm Anatomic Hip femoral component was larger than those of the 12- and 13-mm VerSys Taper femoral components.

Discussion

The advantages of CT scans over conventional roentgenography include decreased distortion due to patient position, increased accuracy without magnification errors, and three-dimensional information. Linking CT data to the ORTHODOC workstation can help a surgeon evaluate effects of femoral component design and femoral canal geometry on fit and fill preoperatively. This is helpful not only when selecting the proper femoral component for optimal fit and fill but also when developing new designs for cementless femoral components. Preclinical testing of new femoral components for adequacy of fit and fill can be performed using postmortem bones in laboratory experiments,[11,13] but virtual implantation can save a great deal of time and cost. There are still many unresolved issues regarding the design and size of femoral components. Because so many types of femoral components are available and because reliable data regarding outcome can only be obtained after femoral components have been in place for 15 years, useful prospective studies are rare. This is why we chose to perform virtual implantation using CT data and the ORTHODOC workstation. Virtual implantation on the ORTHODOC workstation can clearly show the effects of the femoral component design on fit and fill.

There have been two philosophies regarding the best design for achieving proximal fit and fixation.[7] One favors the anatomic design, such as Anatomic Hip femoral components. The second favors the tapered design, such as VerSys Taper femoral components. Both of these prostheses have been designed by Zimmer. Comparison of the two prostheses therefore can help clarify differences in fit and fill between anatomic and tapered designs.

In the present study, differences in proximal shape (Anatomic Hip, posteriorly bowed and anatomically shaped; VerSys Taper, straight tapered) and distal shape (Anatomic Hip, cylindrical; VerSys Taper, tapered) were the focus of the analysis. In all patients, the VerSys Taper femoral components had significantly higher canal fill and fit ratios than the Anatomic Hip femoral components at the lower corner of the femoral neck cut (level 1) and at the middle of the stem (level 4), whereas the Anatomic Hip femoral components had significantly higher canal fill and fit ratios than the VerSys Taper femoral components 1 cm proximal from the femoral component tip (level 5). The mean size of the Anatomic Hip femoral components was 12 mm, whereas that of the VerSys Taper femoral components was 13 mm. The VerSys Taper femoral components were seated significantly lower than the Anatomic Hip femoral components. At the prosthesis collar (corresponding to level 1), the cross-sectional area of the 12-mm Anatomic Hip femoral component was smaller than that of the 13-mm VerSys Taper femoral component. This is consistent with the finding that, at level 1, the canal fill and fit ratios of the VerSys Taper femoral components were significantly higher than those of the Anatomic Hip femoral components. At 20–30 mm below the prosthesis collar (corresponding to levels 2 and 3), the cross-sectional area of the 12-mm Anatomic Hip femoral component was equivalent to that of the 13-mm VerSys Taper femoral component. This is consistent with the lack of significant difference in canal fill and fit ratios between these component types at levels 2 and 3. Thus, the difference in shape between the Anatomic Hip and VerSys Taper femoral components did not affect fit or fill at the center of the lesser trochanter or 1 cm distal from the center of the lesser trochanter, but it apparently resulted in poorer fit and fill for the Anatomic Hip femoral component at the lower corner of the femoral neck cut. At 60 mm below the prosthesis collar (corresponding to level 4), the cross-sectional area of the 12-mm Anatomic Hip femoral component was smaller than that of the 13-mm VerSys Taper femoral component. This is consistent with the finding that, at level 4, the canal fill and fit ratios of the VerSys Taper femoral components were significantly higher than those of the Anatomic Hip femoral components. At 120 mm below the prosthesis collar (corresponding to level 5), the cross-sectional area of the 12-mm Anatomic Hip femoral component was larger than that of the 13-mm VerSys Taper femoral component. This is consistent with the finding that, at level 5, the canal fill and fit ratios of the VerSys Taper femoral components were significantly lower than those of the Anatomic Hip femoral components. Thus, the difference in shape between the Anatomic Hip and VerSys Taper femoral components apparently resulted in better fit and fill for the VerSys Taper femoral component at the middle of the femoral component and poorer fit and fill for the VerSys Taper femoral component near the femoral component tip. Overall, the VerSys Taper femoral component appears to have better proximal fit and fill than the Anatomic Hip femoral component.

In the 14 femora in which both VerSys Taper STD and VerSys Taper LM femoral components were virtually implanted, the VerSys Taper LM femoral components had significantly higher canal fill and fit ratios than the VerSys Taper STD femoral components at the lower corner of the femoral neck cut (level 1), whereas the VerSys Taper STD femoral components had significantly higher canal fill and fit ratios than the VerSys Taper LM femoral components at the middle of the femoral component (level 4). The larger flare geometry of the proximal portion of the VerSys Taper LM femoral components may contribute to significantly higher canal fill and fit ratios at level 1 in some cases. The lower seating of the VerSys Taper STD femoral components may contribute to significantly higher canal fill and fit ratios at level 4, which may result in shorter limb length on the operated side.

The fit and fill of a femoral component to the femoral canal depend on the geometry of the femur. Therefore, we investigated fit and fill in both dysplastic and anatomically normal femora. The VerSys Taper femoral component had better proximal fit and fill in both dysplastic and anatomically normal femora. The morphological characteristics of the dysplastic femora are an increased α angle and femoral anteversion, which are thought to be due to axial canal torsion arising within the diaphysis between the lesser trochanter and the isthmus.[15] Therefore, it appears that rotational adjustment of the VerSys Taper femoral component resulted in fit and fill in the dysplastic femora equal to that of the anatomically normal femora.

In conclusion, the VerSys Taper femoral component appears to provide better proximal fit and fill than the Anatomic Hip femoral component in both dysplastic and anatomically normal femora.

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