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Comparison the of Radiographic and Clinical Results Between Conservative and Conventional Femoral Components in Total Hip Arthroplasty

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Abstract： The aim of this study was to compare the radiographic and clinical results after Mayo–stem and conventional femoral component replacements. Seventy–nine total hip arthroplasties were performed in young patients, utilizing conservative hip prostheses developed at the Mayo clinic. We compared the anteroposterior radiographs of 74 control hips who underwent conventional femoral replacement, with 79 hips who had Mayo－stem replacement. We measured the femoral offset, %FO, and valgus angle of the component. In comparison to the conventional femoral component, the Mayo－stem had decrease in femoral offset, %FO and an increase in the valgus angle after implantation. In conclusion, the Mayo－stem is considered to be a suitable femoral component for young patients because the proximal femoral bone can be conserved and the incidence of thigh pain is low, but a weakening of the abductor muscle may ensue after the implantation of this type of femoral prosthesis. It is therefore necessary to pay attention to the stem position during implantation.

Key words：Total Hip Arthroplasty, Conservative Hip Replacement, Femoral Offset, Radiographic and Clinical Results

Introduction

Total hip arthroplasty（THA）has become one of the most successful standard procedures in orthopedic surgery. With the increasing frequency of this modality in young and active patients, bone preserving procedures are therefore becoming more important. Mayo conservative hip prosthesis（Mayo–stem）was developed at the Mayo clinic with the goals preventing pain, reducing the resection of the proximal femur at the initial surgery, and preventing stress shielding. However, it seems to be difficult to place the Mayo－stem in a neutral alignment because of its small size. The aim of this study was to compare the radiographic and clinical results after Mayo－stem and conventional femoral component（Versys－stem）replacements（Fig. 1）.

Patients and Methods

From January 2000 to June 2004, the Mayo–stem was used in 89 hip joints of 72 patients who visited our department（Group M）（19 men and 53 women）. As a control, the Versys－stem was used in 86 hip joints of 82 patients over the same period（Group C）（12 men and 70 women）. Of these, any patients in whom a direct lateral approach was employed and those in whom conversion to THA was required following femoral neck osteotomy were excluded. In addition, patients who were followed for less than 12 months postoperatively were also excluded. Subsequently, there were 67 Group M patients who underwent a total of 79 arthroplasties（18 men and 49 women）and 73 Group C patients

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who underwent a total of 74 arthroplasties (10 men and 63 women). In Group M, the patients were younger than 65 years of age at the time of surgery, and radiographs showed the canal flare indices were either of normal type (>3.0) or champagne-flute type (cortical bone was maintained).[1] In all patients, the same surgeon (M. N.) performed the surgery employing either the translateral or posterolateral approach. The same design of uncemented acetabular cup (Zimmer, Trilogy) of 26 mm head was used in both groups.

The average age of the subjects at the time of surgery in Group M was 50.9 years (range : 33-64 years) and Group C, 65.4 years (range : 43-86

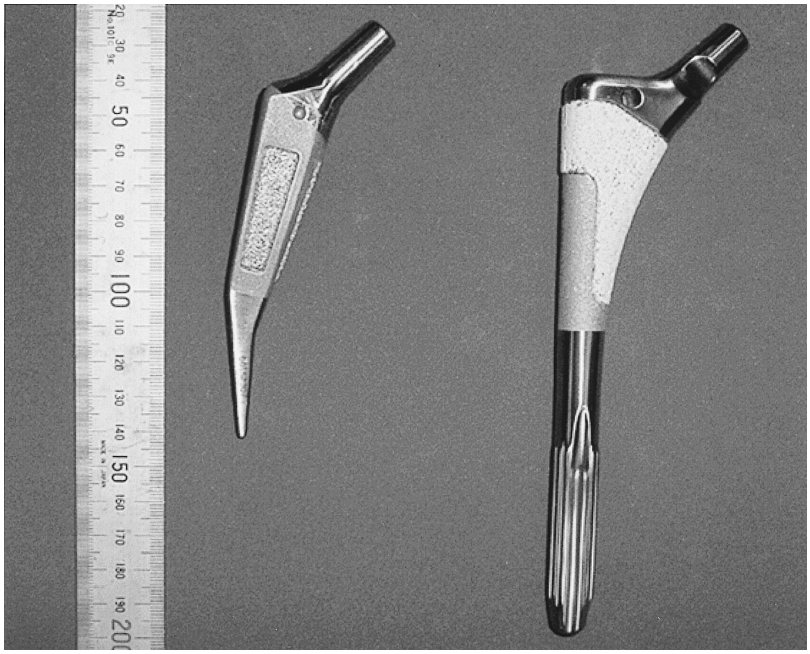


Fig. 1. The left picture shows the Mayo-stem, while the right picture shows the Versys-stem. The Mayo-stem is tapered in the anteroposterior and mediolateral directions and is designed to achieve initial fixation through multiple contact points in the proximal medullary cavity.

Table 1. Patient Demographics and Procedure Data

	Group M (Mayo)	Group C (Versys)	p value
No. of hips	79	74	
Age (yr)	50.9 (33-64)	65.4 (43-86)	p<.0001
Sex (male/female)	18/49	10/63	p=.0041
Body-mass index (kg/m^2)	23.4 (16.6-38.4)	23.8 (15.8-36.4)	ns
Preoperative Diagnosis			
Osteoarthritis of the hip due to acetabular dysplasia	54	64	
Osteonecrosis	25	3	
Primary osteoarthritis	—	3	
Traumatic arthritis	—	1	
Rheumatoid arthritis	—	1	
CPPD	—	2	
Surgical Approach			
Translateral/Posterolateral	53/26	45/29	ns
Femoral Neck Component (mm)	5.7 (0-10.5)	5.1 (0-10.5)	ns

ns : not significant
CPPD : Calcium Pyrohosphate Deposition Disease

years). The subjects in Group M were significantly younger ($p<0.001$). The average preoperative BMI for Group M was 23.4 kg/m^2 (range : 16.6 −38.4 kg/m^2) and Group C, 23.8 kg/m^2 (range : 15.8 − 36.4 kg/m^2), with no significant intergroup difference. The preoperative diagnosis in Group M was osteoarthritis of the hip due to acetabular dysplasia in 54 hips and osteonecrosis in 25 hips, and in Group C, osteoarthritis of the hip due to acetabular dysplasia in 64 hips, osteonecrosis in 3 hips, primary osteoarthritis of the hip in 3 hips, traumatic arthritis in 1 hip, Calcium Pyrohosphate Deposition Disease (CPPD) in 2 hips and Rheumatoid arthritis (RA) in 1 hip. In Group M, the translateral approach was employed in 53 hips and the posterolateral approach in 26 hips, and in Group C, the translateral approach was employed in 45 hips and the posterolateral approach in 29 hips. The average length of the femoral neck component during surgery for Group M was 5.7 mm (range : 0 − 10.5 mm) and Group C 5.1 mm (range : 0 − 10.5 mm), with no significant intergroup difference.

Clinical assessment

The clinical assessment was based on Harris hip scores, and the scores before surgery and at the final follow − up were compared between Groups M and C. The intra − operative and post − operative complications and thigh pain at the final follow−up were also compared.

Radiographic assessment

Each femoral component was radiographically assessed using anteroposterior radiographs that were taken before surgery, immediately after surgery and at the final follow − up. Measurements were taken from standardized post − operative anteroposterior radiographs of the pelvis centered on the symphysis pubis, with the patient lying in the supine position. The neck shaft angle for the Mayo − stem is 132 degrees and that of the Versys −stem 135 degrees. Femoral offset and valgus angle of the femoral component were measured using Laughed and colleagues' methods before and after surgery, and the results were compared between Groups M and C.[2] Valgus angle was defined as the angle formed by the femoral bone axis and the femoral component axis. The femoral offset ratio (%FO) was calculated by dividing the femoral offset by the distance between the rotation centers of the bilateral femoral heads and then multiplying by 100 after surgery.[3] Furthermore, using radiographs taken at the final follow − up, the presence or absence of subsidence (>2 mm) and radiolucent line (>2 mm) were ascertained. Radiolucent lines were assessed according to the method of Gruen and colleagues.[4]

Statistical analysis

Either the Chi − square or Mann − Whitney U test was used to compare Groups M and C with the level of significance set at $p<0.05$. Correlations were assessed using Pearson's correlation coefficients and the relationship between femoral offset and valgus angle was analyzed. With the Mayo − stem, the relationship of the postoperative Harris hip scores to femoral offset and valgus angle was ascertained.

Results

The average duration of postoperative follow−up for Group M was 28.2 months (range : 15 − 56 months) and Group C 30.2 months (range : 12 − 65 months).

The average preoperative Harris hip score for Group M was 52.2 points (range : 13 − 87 points), which significantly improved to 93.6 points (range : 71–100 points) postoperatively. For Group C, the average preoperative Harris hip score was 44.7 points (range:9–80 points), which significantly improved to 91.0 points (range:63–100 points) postoperatively. As for intraoperative complications, a fissure fracture of the proximal femur (Vancouver classification : Type A fracture) occurred in six Group M hips (7.6%) and one Group C hip (1.3%), and cerclage wires were used ($p=0.065$).[5] In one Group M hip, aseptic loosening occurred 14 months after surgery and revision THA was performed. Subsidence occurred two weeks after surgery in one Group C hip, and revision THA was performed. Thigh pain was reported in one Group M hip (1.3%) and nine Group C hips (12.2%) ($p=0.0064$). None of the patients had either postoperative pulmonary embolism, infection or dislocation.

Table 2. Clinical results

	Group M (Mayo)	Group C (Versys)	p value
No. of hips	79	74	
Duration of postoperative follow-up (months)	28.2 (12-56)	30.2 (12-65)	ns
Harris Hip score (points)			
Pre-operative	52.2 (13-87)	44.7 (9-80)	p=.0092
Post-operative	93.6 (71-100)	91.0 (63-100)	ns
Complications			
Intra-operative fracture (%)	6 (7.6)	1 (1.3)	ns
Pulmonury embolism (%)	0 (0)	0 (0)	
Infection (%)	0 (0)	0 (0)	
Dislocation (%)	0 (0)	0 (0)	
Revision-THA (%)	1 (1.3)	1 (1.3)	
Thigh pain (%)	1 (1.3)	9 (12.2)	p=.0064

ns : not significant
THA : Total hip arthroplasty

Table 3. Radiographic Results

	Group M (Mayo)	Group C (Versys)	p value
No. of hips	79	74	
Preoperative femoral offset (mm)	35.5 (12-65)	33.9 (10-65)	ns
Postoperative femoral offset (mm)	40.8 (22-55)	43.4 (30-61)	p=.0054
Postoperative %FO (%)	20.6 (11-32)	22.0 (16-30)	p=.0278
Valgus Angle (degree)	4.3 (−6-18)	−1.0 (−6-2)	p<.0001
Subsidence >2 mm (%)	2 (2.5)	1 (1.3)	ns
Radiolucent line >2 mm (%)	3 (3.8)	1 (1.3)	ns

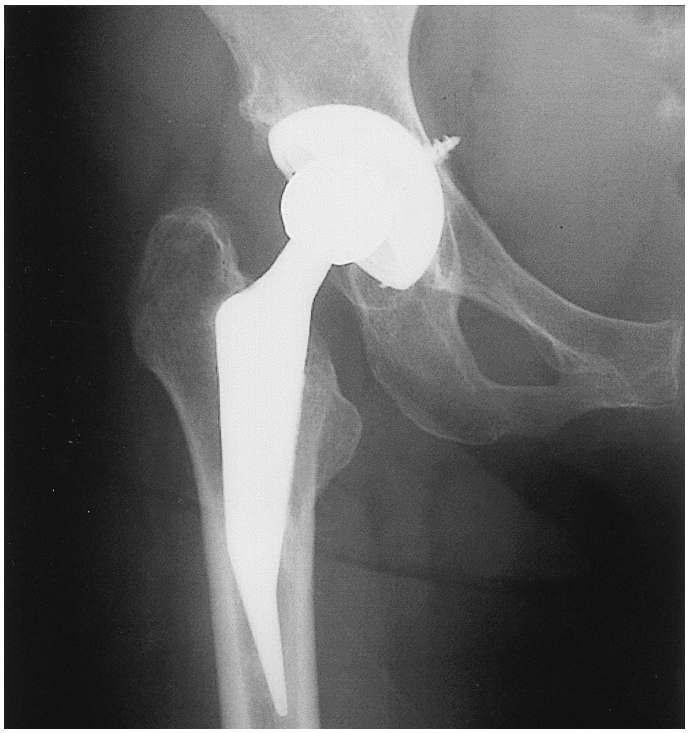
%FO:The femoral offset ratio was calculated by dividing the femoral offset by the distance between the rotation centers of the bilateral femoral heads and then multiplying by 100 after surgery.
Valgus Angle : Valgus angle was defined as the angle formed by the femoral bone axis and the femoral component axis. Radiolucent lines were seen in Zones 1-2 for Group M and Zones 1 and 7 for Group C.

The average preoperative femoral offset for Group M was 35.5 mm (range : 12-65 mm) and Group C 33.9 mm (range:10-65 mm), and there was no significant intergroup difference (p=0.191). The average postoperative femoral offset for Group M was 40.8 mm (range : 22-55 mm) and Group C 43.4 mm (range:30-61 mm), and there was a significant intergroup difference (p=0.0054). The average valgus angle for Group M was 4.3° (range : −6-18 °) which was significantly greater than Group C −1.0 °(range : −6-2 °) (p<0.0001) (Fig. 2). The average postoperative %FO for Group M was 20.6% (range : 11-32%) and Group C 22.0% (range : 16-30%), and there was a significant intergroup difference (p=0.0278). Radiographs taken at the final follow-up showed subsidence (>2 mm) in two Group M hips (2.5%) and one Group C hip (1.3%) and a radiolucent line (>2 mm) in three Group M hips (3.8%) and one Group C hip (1.3%). Subsidence was seen in the patients in whom cerclage wires were not used. Radiolucent lines were seen in Zones 1-2 for Group M and Zones 1 and 7 for Group C. There was a strong negative correlation between the postoperative femoral offset and valgus angle (r=−0.59, p< 0.0001). However, in Group M, the postoperative Harris hip scores did not correlate with postoperative femoral offset or valgus angle.

Discussion

The Mayo-stem is a cementless system that was developed in the 1980's for use in young and active patients with a favorable bone quality to minimize

(a) THA using a Mayo－stem was performed in a 48 year－old woman with avascular osteonecrosis.



(b) Postoperatively, the femoral offset was 30 mm, %FO 15.5% and valgus angle 13°. At 56 months after surgery, the Harris hip score was 99 points, and there was no stem loosening, subsidence or thigh pain.

Fig. 2.

bone loss.[6] The Mayo－stem is tapered in the anteroposterior and mediolateral directions and is designed to achieve initial fixation through multiple contact points in the proximal medullary cavity. Relatively favorable short－term and mid－term results have been reported.[7) 8)] In the present study, the average Harris hip score was 93 points, and the clinical results were favorable when compared to the conventional stem. Thigh pain is a recognized problem after cementless primary THA. The incidence of thigh pain reported in the literature ranges from 1.9–40.4% .[9)] In the present study, the incidence of thigh pain for the Mayo－stem and was significantly less than for the Versys－stem.

When compared to the conventional straight－type stem, we believe that it is more difficult to insert the Mayo－stem in a neutral alignment. Subsequently, we radiographically assessed the femoral component alignment of the Mayo－stem and Versys－stem. The postoperative femoral offset for the Mayo－stem was significantly smaller than that for the Versys－stem. In addition, the postoperative valgus angles for the Mayo－stem and Versys–stem, respectively, and as a result, the Mayo－stem was placed in a more valgus position. There was a significant negative correlation between femoral offset and valgus angle, thus confirming that valgus insertion leads to a smaller femoral offset. Mcgrory et al. reported that the femoral offset and abductor lever arm correlated positively with range of abduction and objective strength of hip abductors.[10)] Hence, with the Mayo－stem, valgus stem insertion lowers the offset and may weaken the abductor muscle. There was no significant correlation between the smaller femoral offset and clinical results in the present study. In other words, a smaller femoral offset did not negatively affect clinical results. In our previous study, the quality of the reconstruction of %FO≥20% was found to be crucial to achieve desirable abductor function after THA.[3)] The postoperative %FO for the Mayo－stem, although it was significantly smaller than that for Versys－stem. In addition, the Mayo－stem patients were younger than 65 years of age and active and the average duration of follow－up was short (28.2 months).

In the present study, in comparison to the conventional femoral component, the Mayo–stem demonstrated a decrease in the femoral offset and an increase in the valgus angle after implantation.

Although the proximal bone can be conserved and the incidence of thigh pain is low, a weakening of the abductor muscle and intra－operative fracture may ensue after the implantation of this type of femoral prosthesis. It is therefore necessary to pay attention to the stem position during implantation.

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