

Comparison of preoperative templating with postoperative assessment in cementless total hip arthroplasty

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ABSTRACT We studied how preoperative templating corresponded to the postoperative leg length in total hip arthroplasty.

On average, the preoperative predictive value of the desired corrective change in leg length was +4.9 (+4.0–+6.7) mm, while the true postoperative assessed value of the corrective change in leg length was +4.7 (+4.0–+6.3) mm. On preoperative radiographs, the ratio of the horizontal offset of a pathological side to a normal side was 95%, on average, and it increased to 96%, on average, after an operation. Preoperatively planned sizes of the acetabular cup and the femoral stem by templating showed a high rate of coincidence with the sizes used intraoperatively.

In conclusion, an accurate and careful preoperative templating can result in a balanced hip reconstruction by correcting the leg length differences and restoring the offsets.

Leg length discrepancy, which can occur after total hip arthroplasty (THA), disturbs not only hip mechanics, but also causes leg problems. Recent improvements in preoperative templating have helped to restore normal hip mechanics accurately, equalize leg length, and also to select an implant system that best fits the patient's anatomy (Capello 1986, D'Antonio 1994).

In cementless THAs, we studied the correspondence between preoperative templating and postoperative leg length and hip offset.

Patients and methods

Among cementless THAs performed from April 1992 to April 1996, we chose 96 consecutive cases of THAs with avascular necrosis of the femoral head, which has a high incidence in the Republic of Korea. We used hydroxyapatite-coated ABG hip prostheses (Anatomique Benoist Girard, Howmedica Europe, Staines, England) in all patients. 18 cases were bilateral and 78 had unilateral avascular necrosis of the femoral head. Those with bilateral necrosis had both hips operated on, but not at the same time. 74 were men and 22 women, with an average age of 47 (32–64) years.

To study the differences between preoperative templating and postoperative assessment, we determined leg length differences, the offset, sizes of the acetabular cup and the femoral stem, and the predictive value of corrective change in leg length on preoperative radiographs, using a magnification marker, and postoperative radiographs. All measurements on radiographs, made by one of the authors, were made at least twice, using a manual caliper.

Radiographs and transparent sheets

Since the transparent sheets for cementless hydroxyapatite-coated ABG hip prostheses had been manufactured with 115% magnifying power, the preoperative radiographs were magnified to 115% by using a magnification marker. The preoperative anteroposterior radiographs of both hips were taken with the femur rotated 15–20 degrees

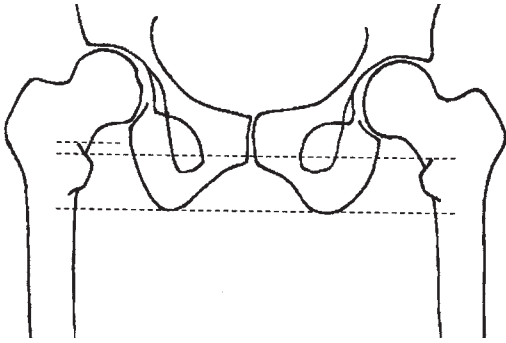


Figure 1. Leg length difference on anteroposterior radiographs of the hips. Using a line connecting the lowest part of the ischial tuberosities, the intersection of the line on both femurs will be gauged from the highest part of the lesser trochanters to measure the leg length inequality with the transparent sheet.

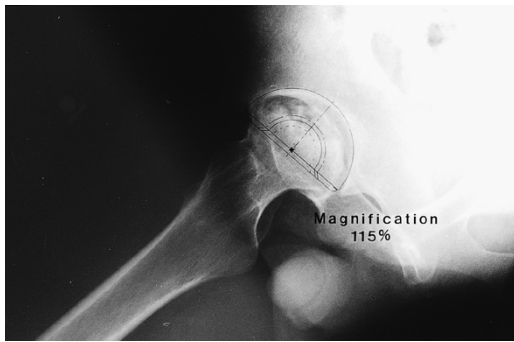


Figure 3. Accurate determination of the anteroposterior size of the acetabulum on a lateral radiograph of the hip.

internally. We used these radiographs to evaluate the true head-neck offset and femoral neck-shaft angle as accurately as possible with the devised anteroposterior transparent sheets.

Determination of leg length difference on radiographs

We drew a line on the preoperative anteroposterior radiographs of both hips across the the lowest part of both ischial tuberosities to meet both femurs (Figure 1). By measuring the distance from this line to the uppermost part of the lesser trochanters of the femurs, we determined the difference in the degree of leg length discrepancy (Harris 1982, D'Antonio 1994, Dore and Rubash 1994).

Preoperative acetabular templating

We selected the size of the acetabular cup and

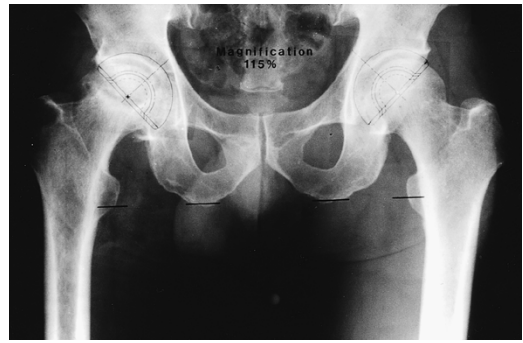


Figure 2. Anteroposterior view of hips with normal acetabular center of rotation marked through the transparent sheet on the normal and pathological hips, placing the transparent sheet just lateral to the teardrop at an inclination of 40 to 45 degrees to the superolateral acetabular rim.

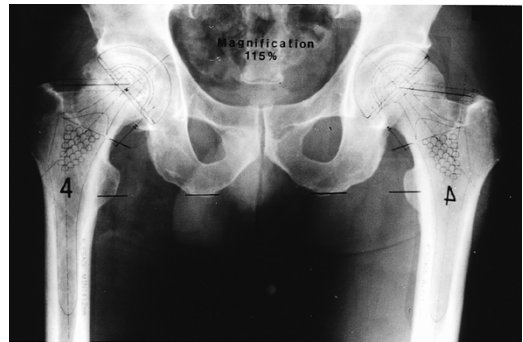


Figure 4. Templating on an anteroposterior radiograph of the hips, first on the normal side and then transposing the plan to the pathological hip.

marked the acetabular center of rotation by placing the acetabular transparent sheet on a preoperative anteroposterior radiograph and a lateral radiograph to determine the mediolateral and anteroposterior size of the acetabulum (Figures 2 and 3).

Preoperative femoral templating

We determined the implant size of the femoral stem by placing the femoral transparent sheet over the normal proximal femur on a preoperative anteroposterior radiograph of both hips (Figure 4).

After selecting the femoral stem size, the overlay transparent sheet on the normal hip was used to determine the level of the neck resection that would best reproduce the normal neck-shaft angle and offset in the patients. By being able to move the neck resection level in a proximal or distal direction, and with the offset possibilities of the hip

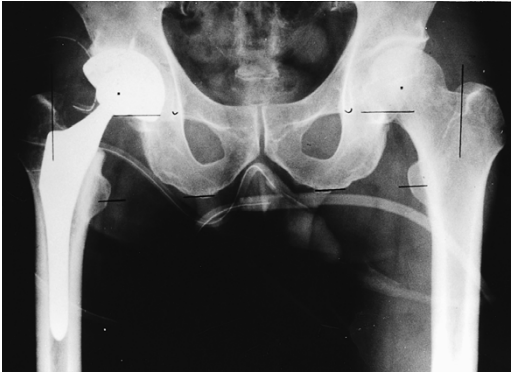


Figure 5. A postoperative radiograph showing a balanced hip reconstruction.

system being evaluated, the offset could usually be duplicated closely. Once this was done, the level of the neck resection was marked on the femoral neck and measured from the highest part of the lesser trochanter. This plan for resection was then transposed to the pathological hip using the same femoral neck resection measured from the upper—most part of the lesser trochanter. We also marked the center of the prosthetic head (Figure 4).

Comparison of the preoperatively planned value with the postoperative actual value of the corrective change in leg length

We compared the leg length difference measured on preoperative anteroposterior radiographs with the preoperatively planned value of the corrective change in leg length difference, planned before surgery, caused by the alteration in the length of the neck and the center of the acetabular cup by using the transparent sheet. We also compared the preoperatively planned value with the actual corrective change in leg length on postoperative radiographs (Figure 5).

Results (Table)

On the preoperative anteroposterior radiograph of each hip, the sick limb was, on average, 5.6 (-22 to -2.2) mm shorter, and on the postoperative radiograph, the

limb on which the operation had been performed was, on average, 3.1 (-3.9 to +10.2) mm longer.

We divided the patients into two groups: one required unilateral THA, and the other required bilateral THA. In the unilateral THA group, the mean preoperative leg length difference was 6.4 (-22 to -2.2) mm, while the mean postoperative leg length difference was 2.1 (-3.9 to +10.2) mm. Before the operation, the sick limb was, on average, 6.4 mm shorter; after the operation, the sick limb became, on average, 2.1 mm longer. In the bilateral THA group, the preoperative leg length difference was, on average, 2.6 (-7.0 to -2.2) mm, while the postoperative leg length difference was 7.4 (3.6 to 10.2) mm. Before the operation, the sick limb scheduled for the operation was, on average, 2.6 mm shorter; after the operation, it became, on average, 7.4 mm longer.

By comparing the preoperatively planned value with the actual value of the corrective change in the leg length difference, the average change in postoperative leg length that had been planned before surgery was a 4.9 (4.0 to 6.7) mm lengthening of the sick limb. However, the actual average change in postoperative leg length was a 4.7 (4.0 to 6.3) mm lengthening of the sick limb.

A comparison of the size of the acetabular cup that we had planned to use in preoperative templating with the one actually used showed a coincidence rate of 58% and a difference in size of only 2

Measurements used to compare preoperative templating with postoperative assessments

Factors	Preoperative	Postoperative
Leg length difference (mm) ^a		
Unilateral (78 cases)	-6.4 (-22– -2.2)	+2.1 (-3.9– +6.6)
Bilateral (18 cases)	-2.6 (-7.0– -2.2)	+7.4 (+3.6– +10.2)
All hips	-5.6 (-22– -2.2)	+3.1 (-3.9– +10.2)
Amount of correction of leg length difference (mm)	+4.9 (+4.0– +6.7)	+4.7 (+4.0– +6.3)
Total hip system		
Coincidence rate (%)		
Cup		58
Stem		79
Femoral offset		
Difference (mm) ^a	2.1 (1.8–3.1)	1.6 (0.1–2.6)
Ratio (%) ^b	95.3 (88–99)	96.3 (89–99)

^a Difference calculated by subtracting the value of the sick limb from that of the contralateral limb

^b The ratio of the sick limb to the contralateral limb

mm in the remaining cases. As regards the femoral stem, the coincidence rate was 79% with a size difference of only 1 unit in the remaining cases.

Although the measurements of the offset were done preoperatively, it was difficult to make the limbs equal in length and maintain the offset at the same time. On preoperative radiographs, the average ratio of the offset of the sick limb to the contralateral limb was 95 (88–99)%, and it increased to 96 (89–99)% after the operation.

Discussion

Preoperative planning for THA is an integral part of adult hip joint reconstruction. Deyerle's (1967) article on the preoperative planning of unipolar prosthesis called the planning "silhouette surgery". A 30-year-long history has shown the importance of preoperative planning (Capello 1986, D'Antonio 1994, Dore and Rubash 1994). In the past, preoperative templating was done merely to make the legs equal in length and to determine the size of a prosthesis. Today, it is important to try to restore normal mechanics of the hip joint, determine the anatomical center of the acetabulum and normalize the relation between the pelvic bone and femur as much as possible.

Charnley (1979) advocated an intraoperative comparison of the lengths of the extremities by palpating the medial malleoli through surgical drapes. Various devices have been described to measure the change in leg length intraoperatively (Knight 1977, Hoikka et al. 1991, Bose 2000). In our view, intraoperative measurement of the leg length is not so accurate as preoperative radiographic measurements and templating. However, we measured the leg length and its change intraoperatively to see crudely whether the leg length had changed and to compare it with the preoperative measurement.

Many studies show that a difference in leg length directly affects the clinical outcome (Giles and Taylor 1981, Friberg 1983, Moseley 1987, Visuri 1987). A discrepancy in leg length is therefore regarded as important. Shortening of an operated leg can impair abduction and increase the likelihood of dislocation. On the other hand, overlengthening can cause sciatic nerve palsy, low back pain, and shorten the longevity of the prosthesis (Visuri

1987). Because leg length discrepancy in THA can also increase the probability of low back pain and aseptic loosening of a prosthesis, its correction must be taken into consideration (Giles and Taylor 1981, Friberg 1983).

Some authors have reported postoperative lengthening of 15 mm or more (Williamson and Reckling 1978, Love and Wright 1983). Turula et al. (1986) studied the leg length discrepancy in 55 cases of THAs and found that the average radiographic difference in leg length was 8.7 mm in cases of unilateral THAs, 11.6 mm in cases of bilateral THAs, and differed considerably from clinical measurements. Woolson (1990), studying a consecutive series of 84 patients undergoing primary THAs, showed that the average radiographic difference in leg length was 2.8 mm. Egli et al. (1998) reported that the mean postoperative radiographic difference was 0.2 ± 0.1 cm in 100 consecutive primary THAs, using preoperative planning. They also reported that the agreement between planned and actually used components was 92% on the femoral side and 90% on the acetabular side. In our study, the mean preoperative difference in leg length was 6.4 (-2.2 to -2.2) mm in the unilateral THA group, while the mean postoperative difference was 2.1 (-3.9 to 10.2) mm. In the bilateral THA group, the preoperative difference was, on average, 2.6 (-2.2 to -7.0) mm, while the postoperative difference was 7.4 (3.6 to 10.2) mm. However, a postoperative difference in leg length of 7.4 (3.6 to 10.2) mm in the bilateral THA group will be corrected by the operation on the other hip. In comparison with the results of other studies, our findings showed a marked reduction in the leg length discrepancy. In our study, the corrective change in leg length planned by preoperative templating was, on average, +4.9 (4.0 to 6.7) mm, we therefore planned a 4.9 (4.0 to 6.7) mm lengthening, and the actual corrective change in leg length measured postoperatively was +4.7 (4.0 to 6.3) mm. Hence the leg length of the sick limb which had been operated on, was increased by 4.7 (4.0 to 6.3) mm. The difference was therefore only 0.2 mm. A comparison of the relation between the size of the acetabular cup that we planned to use in preoperative templating and the one actually used, showed a coincidence rate of 58% and size difference of only 2 mm in the remaining cases.

Our postoperative correction of the offset was not very successful. We agree that it is important to obtain not only a normal leg length but also to normalize the mechanics in THA. However we used the ABG prostheses in all patients with the same 132° neck-stem angle and varying ball/neck lengths. We think this is the reason why our results with offsets were not very successful and believe that this is the limitation of our study.

No competing interests declared.

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