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Dislocations after Total Hip-Replacement Arthroplasties*

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ABSTRACT: **In a series of 300 total hip replacements, nine (3 per cent) dislocated. Precise measurements of the orientation of the acetabular cup were made and it was found that anterior dislocations were associated with increased acetabular-component anteversion. There was no significant correlation between cup-orientation angle and posterior dislocation. The dislocation rate for cup orientation with anteversion of 15 ± 10 degrees and lateral opening of 40 ± 10 degrees was 1.5 per cent, while outside this "safe" range the dislocation rate was 6.1 per cent. Other factors that were documented include time after surgery (with the greatest risk in the first thirty days) and surgical history (with a greater risk in hips that have had prior surgery).**

Between January 1972 and June 1975, 300 total hip-replacement procedures were performed by five surgeons on the orthopaedic service of Northwestern Memorial Hospital. Dislocation of the femoral component from the acetabular cup occurred in nine patients. Five patients required a secondary operation and two had significant cardiopulmonary complications. The incidence of dislocation was 3 per cent, which is within the range reported from other centers (1 to 8 per cent) [2-8,10,13,15,16]. In order to understand this complication better, we undertook a study of our 300 cases.

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Material and Methods

Information about the patient's age, diagnosis, and acetabular-component orientation was obtained for all nine hips with dislocation and for 113 of the 291 hips in which the prosthetic components did not dislocate. Detailed study of the remaining 178 hips was not possible because the roentgenograms required could not be obtained. The detailed data on hips with dislocations are listed in Table I. The 113 non-dislocated hips had diagnoses of osteoarthritis in fifty-nine and failure of previous surgery in sixteen (nine femoral prostheses, three cup arthroplasties, three osteotomies, and one fracture nailing). The other diagnoses were rheumatoid arthritis (fourteen), ankylosing spondylitis (three), avascular necrosis (seven), congenital dislocation of the hip (six), and others (eight).

The standard technique used by the five surgeons was to approach the hip posterolaterally through a modification of the Gibson incision. The trochanter and gluteus medius muscle insertion were left intact. The capsule was incised posteriorly, usually leaving the anterior capsule intact. One surgeon, who performed 190 of the operations in the study, used Aufranc-Turner prostheses. This surgeon reattached the external rotators during closure whenever possible. The other surgeons in the study used either Aufranc-Turner or Charnley-Mueller prostheses and did not regularly reattach the external rotators.

The orientation of the radiolucent cup was determined from the elliptical appearance of the circular marker wire on precisely oriented anteroposterior postoperative roent-

TABLE I

PATIENTS WITH DISLOCATED TOTAL HIP REPLACEMENTS

Case	Age (*Yrs.*)	Sex	Diagnosis*	Time to Dislocation	Angle θ (*Deg.*)	Angle α (*Deg.*)	Direction of Dislocation
1	71	F	RS	20 days	54	25	Ant.
2	70	F	RS	23 days	54	43	Ant.
3	55	M	FA	30 days	40	31	Ant.
4	78	F	RS	9 days	42	22	Post.
5	66	M	RS	13 days	60	24	Post.
6	63	F	RS	51 days	36	26	Post.
7	35	M	RA	110 days	48	9	Post.
8	72	F	RS	$3^{1}/_{12}$ years	36	15	Post.
9	88	F	OA	6 days	60	13	?

* FA = fractured acetabulum; OA = osteoarthritis; RA = rheumatoid arthritis; and RS = revision of previous surgery.

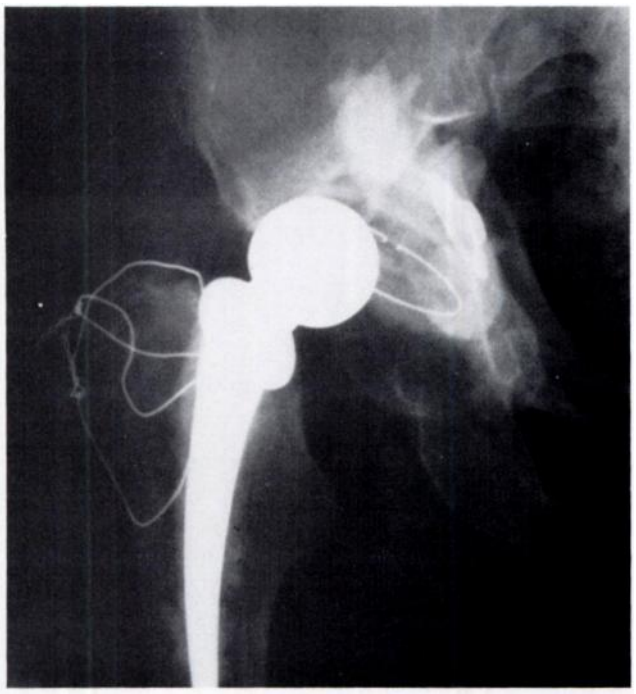

FIG. 1-A

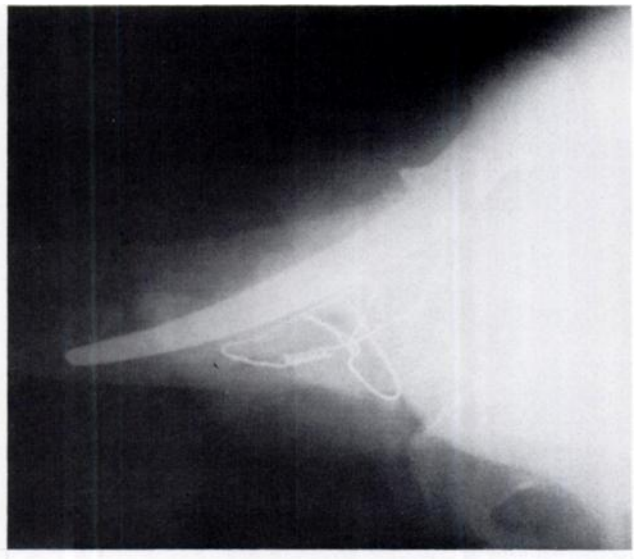

FIG. 1-B

Figs. 1-A and 1-B: Anterior dislocation of a total hip replacement.

FIG. 2-A

FIG. 2-B

Figs. 2-A and 2-B: Posterior dislocation of a total hip replacement.

genograms (Fig. 3). The lateral opening angle, θ, was measured directly. The anteversion angle, α, was calculated from the ratio between the lengths of the minor and major axes of the ellipse.

To determine whether the acetabular component was anteverted or retroverted the ellipse was closely scrutinized: anteversion was diagnosed if the lateral arc of the ellipse was more sharply defined than the medial, and vice versa.

A device with three legs and a bubble level was used to position the pelvis parallel to the film. The patient was positioned supine, as for a routine roentgenogram, and the three legs of the device were directly and firmly pressed over the anterior superior iliac spines and the symphysis pubis. The patient was instructed to reposition himself until the bubble level was horizontal. A small lead marker was placed on the patient along the midline of the body to mark the center of the x-ray beam.

A correction factor for distortion caused by the divergent x-ray beam was necessary [9]. Preliminary studies on a laboratory skeleton demonstrated that 5 degrees added to the apparent angle α yielded the true α, and that θ was correct as measured.

The roentgenographic technique was used on most of the 113 patients for whom data are presented. For patients on whom it was not possible to use the technique, the av-

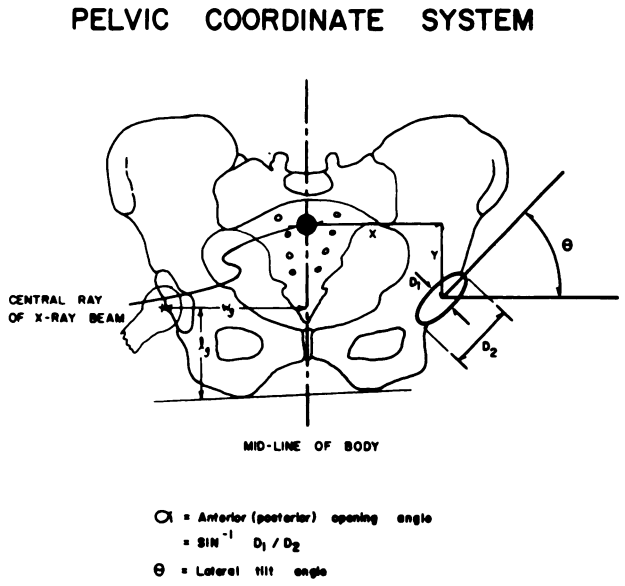

FIG. 3

In order to measure the orientation of the acetabular component, those portions of the wire marker that are obscured by the femoral component are drawn in with the aid of a draftsman's French curve. Measurement of D_1 and D_2 permit calculation of α. Angle θ is measured directly.

erage of at least three routine anteroposterior roentgenograms was used, but only when the several sets revealed reproducible measurements (±3 degrees).

The anteversion angle α corresponds to rotation around an artificial axis which projects onto an x-ray as the major axis of the marker-wire ellipse. The Aufranc-Turner cup-positioner is designed so that the surgeon can control rotation about the anatomical transverse axis [12]. The amount of rotation in this sense may be called angle ϕ. In contrast, the Charnley-Mueller positioner is designed to control angle α [14]. Angle ϕ may be calculated from the relationship $\tan\alpha = \tan\phi \cos\theta$. Angle ϕ is 3 to 6 degrees larger than the anteversion angle α for the usually recommended cup orientations.

In addition to the measurements on all nine of the dislocations, adequate data were available on 113 of the 291 hips that remained stable. The total of 122 patients was not a random sample, in that it included all nine of the dislocations. This provided more information than would have been available in a true random sample. With caution it was possible to apply the Fisher-Irwin-Yates exact test and tests on normalized variables to the available statistics [1,11].

Analysis of Data

The average age of the 122-patient study group was 63.1 years, while the average age of the nine patients with dislocations was 66.4 years, which is not significantly different. A significantly larger percentage of patients whose hips dislocated had had prior surgery on the same hip as compared with the control group. Of the nine patients whose hips dislocated, six had had prior surgery. Of the 113 patients whose hips remained stable, only fifteen had had prior surgery. This difference is significant at the 1 per cent level (Fisher exact test).

When dislocation occurred it tended to be early in the convalescent period. Six of the nine dislocations were seen within thirty days of the total hip replacement, and these dislocations occurred while the patient was in bed or walking, or during other normal activities. Two dislocations were caused by falls outside the hospital and these occurred more than thirty days after the operation. In one patient (Case 9), the hip dislocated more than three years after the operation, while she was bending over to tie her shoe. She was the only patient who had a late dislocation without significant trauma.

The relationship between the orientation of the acetabular component of the prosthesis and the dislocation (Fig. 4) shows that the three anterior dislocations (Cases 1, 2, and 3) occurred with α angles of 25 degrees or more as compared with an average of 15.6 ± 8.5 degrees for the study group. The increased angle is significantly different from that of the stable group at the 1 per cent level of statistical significance. The three hips with anterior dislocation had an average θ of 49.3 degrees, which was not significantly different from the θ of the stable group, 44.4 ± 7.5 degrees. The five posterior dislocations (Cases 4 through 9) had an average α of 19.2 degrees and an average θ of 44.4 degrees. Neither of these values were significantly different from the corresponding angles in the control group.

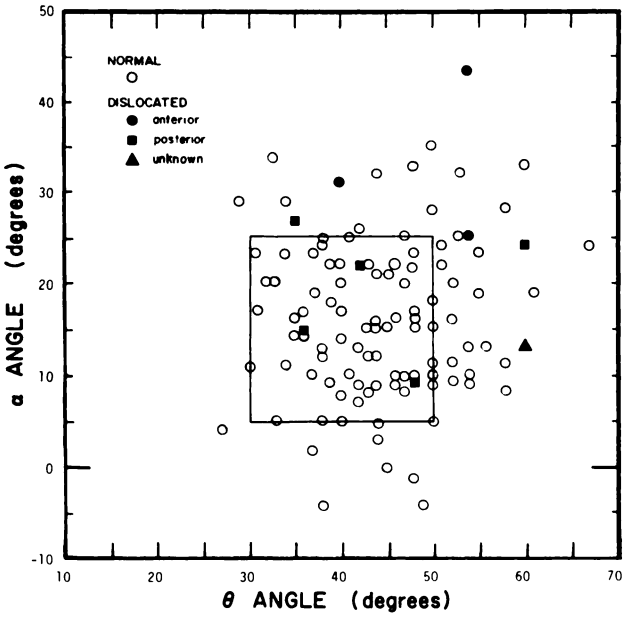

FIG. 4

A scatter-diagram summary of the orientation of the acetabular components.

When all nine dislocations were considered together, there seemed to be a tendency for the dislocations to be associated with large deviations from the average angles. This suggests that there is a relatively safe range of orientations for the cup. A number of such ranges were investigated, and the range of $\theta = 40 \pm 10$ degrees and $\alpha = 15 \pm 10$ degrees proved most satisfactory. This range is a practical one, because it is sufficiently large to allow the sur-

geon reasonable leeway in the placement of the acetabular cup and is such that it allows adequate motion in the implanted prosthesis. The difference between the dislocation rate within this safe region and outside it is statistically significant ($p<4.5$ per cent). A projection of the data from the study group to the entire group of 300 patients shows that the predicted dislocation rate will be 1.5 per cent when acetabular-component orientation is within the safe range versus 6.1 per cent when safe orientation is not achieved.

The effect of shifts in the position of the acetabulum was studied as regards medial-lateral and superior-inferior translocations. The shifts did not correlate with dislocation. An attempt was made to correlate the treatment of the initial dislocation with the final result, and we discovered no simple relationship between time in traction or casts and subsequent stability in this group of nine dislocations.

Discussion

Our data on the incidence of dislocation are similar to those reported by others, as mentioned, and the tendency of this complication to occur early in convalescence also has been noted previously. Of 929 patients followed by Nicholson for three months, twenty had dislocations (2.1 per cent), and of 580 patients followed for twenty-four months, only five had dislocations (0.09 per cent). After twenty-four months the dislocation rate fell still further (one of 295).

Our study suggests that the position of the acetabular cup relative to the body's axis is important, and in particular, that anterior dislocation is associated with anteversion. We expected that decreased anteversion would lead to posterior dislocation, and that an increased lateral opening angle would lead to superior or iliac dislocation, but our clinical studies did not support either of these hypotheses.

In one study[5], half of the dislocations were associated with retroversion of the acetabular component of between 7 and 10 degrees. All of these dislocations were posterior. None of the acetabular components in the present series were retroverted more than 4 degrees. We therefore infer that while excessive retroversion may lead to posterior dislocation, safe orientation of the acetabular component will not necessarily prevent such dislocations.

Acetabular-component orientation has been shown in this study to be a significant factor in avoiding dislocations. It is not the only factor, as demonstrated by the fact that the most experienced surgeon in this study had only one dislocation in 190 cases (0.5 per cent). He did not place a significantly greater number of acetabular cups within the safe range than did the other surgeons. He attributed his success to a number of factors, such as adjustment of soft-tissue tension to achieve clinical stability at the time of surgery and avoiding adduction for six weeks after surgery. Such elements could not be measured with satisfactory precision, even though clinical experience indicates their importance in minimizing the risk of dislocation.

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