CAUSES OF DISLOCATION OF TOTAL HIP ARTHROPLASTY

CT STUDY OF COMPONENT ALIGNMENT

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We reviewed radiographs and CT scans of 38 total hip arthroplasties which had dislocated (36 posteriorly; 2 anteriorly) and compared the alignment of the prosthetic components with those of 14 uncomplicated arthroplasties. No difference was found between the alignment of the prosthetic components in the two groups. In the seven patients who had reoperations, the cause of dislocation diagnosed by CT was confirmed in only two cases (one retroversion of the cup and one protruding osteophyte).

Muscular imbalance rather than malposition of the components was the major factor determining dislocation. CT allows accurate measurement of cup and neck anteversion but contributes little to preoperative planning.

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There are many causes of an unstable total hip arthroplasty: incorrect positioning of the prosthetic components, multiple revisions, weakness or imbalance of the gluteal muscles or impingement of the neck of the femoral component on the anterior acetabular wall (Morrey 1992). Incorrect orientation of the acetabular component is thought to be the most important factor predisposing to hip dislocation (Fackler and Poss 1980; Dorr et al 1983; Coventry 1985; Morrey 1992) but the exact amount of anteversion of both the acetabular cup and the femoral neck cannot be reliably measured from conventional radiographs. The trigonometric method of Ackland, Bourne and Uthoff (1986) and the fluoroscopic technique of Ghelman (1979) are both of limited value in

the case of metal-backed cups. Goergen and Resnick (1975) have stressed that the reliability of such methods depends on proper centring of the hip on the radiographs.

CT, however, provides accurate information on cup and neck anteversion (Lasda et al 1978; Barmeir, Dubowitz and Roffman 1982; Mian, Truchly and Pflum 1992). We have investigated the value of CT in 38 dislocating total hip arthroplasties and compared the results in 14 uncomplicated arthroplasties.

PATIENTS AND METHODS

We reviewed the radiographs and CT scans of 38 patients with dislocated hips treated between June 1990 and September 1992. There were 18 men and 20 women; their average age was 57 years (17 to 91) and there were 19 left and 19 right hips. Dislocation had been caused by an injury in only two. The diagnosis before hip replacement was osteoarthritis in 25 patients, osteonecrosis of the femoral head in eight, rheumatoid arthritis in three, and revision for failed arthroplasty in two. One patient who presented with a dislocation and severe mental disorder was excluded from this series.

All but two of the dislocations were posterior. Only one episode of dislocation had occurred in 22 patients (58%); dislocation was recurrent in 16 (42%) (see Fig. 3). Twenty-one of the 38 dislocations had occurred less than three months after the arthroplasty.

For the primary procedure, a posterolateral approach had been used in every case with a capsulectomy as complete as possible and without osteotomy of the greater trochanter. The intended cup position was 40° of abduction and 20° of anteversion; the femoral component was anteverted 10° to 15°. The length of the prosthetic femoral neck was chosen both to correct limb-length discrepancy and to match the gluteal muscle tension. The external rotators were reattached to the greater trochanter with non-absorbable sutures. A self-locking Müller femoral prosthesis was used in 29 cases (76%), the Müller dysplasia prosthesis in five (13%) and some other design in four (11%). Twelve of the acetabular cups were cemented and 26 were uncemented (Harris-Galante acetabular components).

Radiographic and CT imaging. The first CT section was taken at the centre of the prosthetic femoral head, the second at the level of the femoral neck 1 cm above the lesser

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trochanter, and the third at the distal femur. Anteversion of the cup and the neck were compared with the natural anteversion of the acetabulum and femoral neck on the non-operated side in 35 cases.

The degree of abduction of the cup was measured, using for reference a horizontal line through the bottom edge of the teardrops as recommended by Sutherland et al (1982). The horizontal and vertical distances between the tip of the greater trochanter and the teardrop were compared before and after operation.

Eleven of the 38 patients had been operated on the contralateral side by the same surgeon. These 11 contralateral hips, which had never dislocated, were studied for comparison. Three other prosthetic hips which had never dislocated also had CT scans and were added to form a control group of 14 hips.

Statistical analysis was by Student's *t*-test for quantitative values and the chi-squared test for qualitative values.

RESULTS

The mean cup abduction was 44.5° (30 to 68°) in the dislocated hips and 43.6° in the control group. Mean cup anteversion was 24.4° (-5° to 45°) in the dislocated group and 22.3° in the control group (Fig. 1). Retroversion of the cup was found in only one case, which was in the dislocated group. The mean femoral neck anteversion was 16.5° (-30° to 37°) in the dislocated hips and 14° in the control group (Fig. 2). None of these differences was statistically significant. The mean sum of the femoral anteversion and the cup anteversion was 41° (-20° to 75°) in the dislocated group and 36.6° in the control group. The sum of acetabular and stem anteversion was not significantly related to the number of episodes of dislocation ($p < 0.75$; Fig. 3). The mean angle of anteversion of the prosthetic cups (24.4°) was greater than the anteversion angle of the osseous acetabula (5.4° ; range -25° to 24°). The anteversion angles of the two hips which dislocated anteriorly were 27° and 36° .

Protrusion of anterior acetabular bone beyond the lip of the cup was found in six cases. This was due to excessive anteversion of the cup in four cases and to an anteroinferior

marginal osteophyte in two. In the two cases of anterior dislocation, the CT showed no bone protruding posteriorly.

The centre of rotation of the prosthetic joint was displaced laterally in three hips and medially in eight. The horizontal displacements were never more than 10 mm. There was no difference in the range of movement between these two groups: flexion was to 108° in the medialised hips and to 105° in the lateralised hips ($p < 0.71$); internal rotation was 22° and 19° respectively ($p < 0.55$). The mean position of the greater trochanter relative to the radiographic teardrop was not significantly different before and after arthroplasty (mean cranial displacement 0.4 mm).

Seven hips had reoperation. The preoperative CT

Fig. 1

Angle of cup anteversion in the dislocated and the control groups.

Fig. 2

Angle of neck anteversion in the dislocated and the control groups.

Fig. 3

The sum of the angles of cup and neck anteversion (instability index) and the number of episodes of dislocation showed no correlation.

Fig. 4

Diagram of Lewinnek's 'safe zone'. Eleven of the 38 hips which dislocated were in the safe zone. Paradoxically, most of the hips which dislocated posteriorly had excessive anteversion and abduction.

findings, confirmed at surgery, explained the dislocations in only two cases. In one hip there was insufficient cup anteversion and in the other an osteophyte situated at the anteroinferior part of the acetabulum was impinging on the neck of the prosthesis. The CT scan revealed no abnormality in the other five patients. In these cases the instability was due to lack of tension in the soft tissues, and the hips were rendered stable by lateralisation of the cup (using Müller rings in two cases) and lengthening of the prosthetic femoral neck. In two cases an additional polyethylene posterosuperior rim was added to the cup. In some cases, the fascia lata and the enlarged pseudocapsule were sutured to the greater trochanter to limit internal rotation. All seven patients achieved a stable hip after the reoperation.

DISCUSSION

According to Müller (1970), cup anteversion should be 10° to 15° ; Harris (1980) recommended 20° to 25° . Fackler and Poss (1980) found malposition of the cup in 44% of their 34 patients; Dorr et al (1983) found 23% malpositioned cups among 39 hips; only three of the 32 dislocated hips reported by Coventry (1985) were too retroverted (respectively 18° , 15° and 10°) but posterior dislocation occurred in 78%. Posterior dislocation is likely to occur when the cup is vertical and inadequately anteverted; two cups in our series were in this position. Lewinnek et al (1978) correlated cup anteversion and abduction and described a 'safe zone' (5° to 25° anteversion with 30° to 50° abduction) inside which the dislocation rate was very low. Eleven of our 38 hips were located in this 'safe zone': all the others were sufficiently abducted and anteverted (Fig. 4). The two hips which dislocated anteriorly were also situated out of this 'safe zone' and were too anteverted.

Femoral anteversion can be accurately measured by CT (Fig. 5), and therefore the instability index of Visser and Jonkers (1980), defined as the sum of neck and cup anteversion in the transverse plane, was easily determined. This index, however, was not found to be predictive of dislocation. We concluded that even 25° of anteversion of the cup does not preclude posterior dislocation. There was

Fig. 5

CT allows accurate measurement of prosthetic neck anteversion. On this scan of a left hip, lines are drawn along the femoral neck and between the posterior parts of the femoral condyles.

no statistical difference between the dislocated hips and the control group with respect to abduction or anteversion of the prosthetic components: malposition of the components seems not to have been the primary factor governing dislocation in our series.

Impingement of the greater trochanter on the iliac wing was misdiagnosed from the CT because the patients were scanned in the supine position with the hip extended. Protrusion of the anterior wall of the acetabulum because of excessive anteversion of the cup or the presence of osteophytes is well seen on CT (Fig. 6). These anomalies, however, were also found in hips in which no dislocation occurred. Nor did correction of these supposed causes of dislocation achieve stability during reoperation. Stability was obtained by lateralising the cup and lengthening the prosthetic neck to increase the tension in the gluteal muscles. Although the CT provided information additional to that available from the plain radiographs, this was not useful in preoperative planning.

Fig. 6

Bone protruding beyond the tip of the cup anteriorly is well shown by CT, but this anomaly was also seen in hips which did not dislocate.

The soft tissues are not well visualised by CT of prosthetic hips; remnants of the anterior capsule, on which the neck can impinge, were not revealed. Stretching of the pseudocapsule found in two of our cases at reoperation might have been demonstrated better by arthrography than by CT (Charnley 1970; Morrey 1992).

Conclusion. Dislocation in our series was seldom caused by malalignment of the components. Anterior dislocations occurred when the cup was too anteverted, but posterior dislocations were also seen despite adequate anteversion of the cup. CT is therefore of little value in a preoperative assessment after dislocation of a total hip arthroplasty.

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