Original articles

CT image evaluation of the internal rotation limit prior to bony impingement after total hip arthroplasty

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Abstract This study evaluated the internal rotation limit prior to bony impingement of the proximal femur on the pelvis after total hip arthroplasty (THA). Reconstructed computed tomography (CT) images of 90° hip flexion were used to simulate the internal rotation limit against safety limits measured intraoperatively. Ninety joints in 86 subjects (12 men and 74 women) underwent THA for the treatment of secondary coxarthrosis. The correlation between the internal rotation limit prior to the bony impingement intraoperatively and the simulated internal rotation angle on the reconstructed CT image was statistically significant. We provide a new method to simulate the internal rotation limit prior to bony impingement based on postoperative CT.

Key words Bony impingement · Total hip arthroplasty · Dislocation · Computed tomography

Introduction

Dislocation is one of the most serious complications after total hip arthroplasty (THA). The postoperative dislocation rate of THA has been reported to be between 0.6% and 7%.1,3,5,10,11,18,20–22 Multiple surgeries, malpositioning of components, impingement, and decreased muscle tonus are some of the factors contributing to dislocation after THA.2,4,9,12,13,17 Bony impingement of the proximal femur on the pelvis is one of the factors contributing to dislocation.3,4

In the posterolateral approach, the posterior structure can be removed surgically, and because orientation of the cup is difficult, posterior dislocations are reported more frequently than with other approaches.2,21,22 There are no reports on the range of movement for internal rotation (IR) with a hip flexion of 90° after THA, probably because guidance is given to avoid excessive flexion and IR movements as contraindicated leg positions. For this reason, the purpose of our study was to provide a new method to simulate the IR limit prior to bony impingement of the proximal femur on the pelvis with a hip flexion of 90° after THA using reconstructed computed tomography (CT) images.

Materials and methods

Ninety joints in 86 subjects (12 men and 74 women) were subjected to primary THA. The hip diagnoses were osteoarthritis in 73, osteonecrosis in 11, and rheumatoid arthritis in 2. The patients' average age was 62 years (range, 40 to 84), their average weight was 51.7 kg, and their average height was 151 cm. The operations were performed consecutively between May 1998 and June 2000 by the same surgeon (M.M.) or a trainee under his supervision using a posterolateral approach and a lateral positioner. The implant used was the Perfix stem (Kyocera, Kyoto, Japan) with a 28-mm-diameter alumina head, a 13-mm-diameter neck at the base, and a head/neck ratio of 2.15. The acetabular side had an ABS (alumina-bearing-surface) cup. The ABS cup was flat in all cases and had no marginal lips (Fig. 1). The oscillation angle of the implant was 120°. The short external rotators were detached with the posterior capsule, reattached after placement of the implant, and finally restored using complete posterior capsular and muscular repair.6,16 Two days after surgery, patients were permitted weight-bearing as tolerated, with weight-bearing activities encouraged as soon as possible. No postoperative complications due to posterior dislocation were observed.

Computed tomography (CT) scans (GE HiLight Scanner, GE Medical Systems, Milwaukee, WI, USA) were employed for this study. The area of the hip joint from the anterior superior iliac spine to below the lesser trochanter and several 3-mm slices through the distal
femoral condyles were scanned to obtain 3-mm-thick transverse slices spaced 3 mm apart. The CT radiographs were scanned into a personal computer using an image scanner at a resolution of 150 dpi. Using NIH Image 1.61, proximal sections were reconstructed from 27 cross-sectional slices as follows.

**Concept**

We represented the most anterior part of the greater trochanter as the closest point to the pelvis during internal rotation at 90° of hip flexion and neutral adduction/abduction. We then measured the IR limit prior to bony impingement of the proximal femur on the pelvis from reconstructed CT images.

**Concrete steps**

1. We reconstructed a frontal plane passing through the center of the femoral head (Fig. 2).

2. We reconstructed another frontal plane to the center of the femoral head at a distance where we predicted the most anterior portion of the greater trochanter would be when a hip flexion of 90° was performed (Fig. 3). This distance is identical to the vertical separation between the center of the femoral head and the most anterior part of the greater trochanter.

3. These two reconstructed frontal sections were superimposed (Fig. 4).

4. We measured the horizontal distance between the center of the femoral head of the prosthesis and the most anterior part of the greater trochanter as well as the anteroposterior distance by superimposition on the cross-sectional CT (Fig. 5).

5. On the superimposed frontal plane, we marked a point (Fig. 6a) that was the same distance from the center of the femoral head as the distance measured in step 4. This point is the destination of the most anterior portion of the greater trochanter when a hip flexion of 90° is performed (Fig. 6b), projected on the reconstructed frontal plane.

6. Taking the center of the femoral head as the center of rotation, a straight line joining the center of the femoral head with this point was rotated to measure the IR limit up to bony impingement (Fig. 6a).

7. We corrected the measured IR limit using a CT image taken through the distal femoral condyles for the respective leg position.

Intraoperatively, after placement of the implant, the IR limit prior to impingement was measured with a goniometer, before the short external rotators and the iliotibial ligament were repaired, at 90° of hip flexion and neutral adduction/abduction, which are positions thought to cause posterior dislocation. We forced the IR until subluxation occurred because of intercalated soft tissues between the greater trochanter and the iliac wall. The IR limit was defined as the angle between the axis of the tibia and the horizontal plane. We excluded