Frequency and Location of Bone Cysts in Hip Osteoarthritis Patients

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Introduction

In hip osteoarthritis (OA) patients, many radiological features, such as joint space narrowing, subchondral sclerosis and formation of osteophytes and subchondral bone cysts are observed. Although there have been several reports about the formation of such bone cysts, the mechanism of cysts formation remains to be fully elucidated. To clarify the mechanism of bone cysts formation, it is essential first to find out exactly where bone cysts are located. Some Japanese researchers are propounding three-dimensional computed tomography (3D-CT) to determine the location of bone cysts. With this method, however, the results are greatly influenced by patients’ position, especially by pelvic obliquity or tilt.

The purpose of the present study was to investigate the frequency and location of bone cysts, using the 3D-CT data and a novel image analysis system.

Materials and Methods

A total of 100 patients (83 female and 17 male) with hip OA who underwent primary total hip arthroplasty (THA) were included in this study. The mean age at surgery was 65 years (range, 43-88). Bilateral hips of these 100 patients were measured. However, contralateral 15 hips which had previously been implanted with a prosthesis were excluded.

For all patients, preoperative antero-posterior radiographs of the pelvis in standing position and CT images were obtained. We evaluated the stage of hip OA (Kellgren-Lawrence grading scale, K-L grade) and the minimal joint space width (MJS) on radiographs of the pelvis. We also obtained the digital imaging and communication in medicine (DICOM) data of the pelvic CTs. We then three-dimensionally reconstructed the DICOM data using OrthoMap 3D (Stryker Inc., Kalamazoo, MI). We firstly made three orthogonal planes with reference to the anterior pelvic plane (APP) to examine the location of bone cysts in the acetabulum. In the acetabulum we divided the acetabulum into 6 areas: antero-lateral (A-L), postero-lateral (P-L), antero-central (A-C), postero-central (P-C), antero-medial (A-M), and postero-medial (P-M). Secondly, we made three orthogonal planes with reference to the plane which includes axes of the femoral neck and femoral shaft to examine the location of bone cysts in the femoral head. We divided the femoral head into 4 areas: antero-superior (A-S), antero-inferior (A-I), postero-superior (P-S), and postero-inferior (P-I). In each area, we examined the presence of bone cysts.

For statistical evaluations of the difference between groups, we used Mann-Whitney’s U test.

Results

We examined the relationship between the frequency of bone cysts and age, sex, K-L grade, and MJS.

When MJS of the hip joint was less than 2mm, the frequency of bone cysts in the acetabulum increased (p<0.05). On the other hand, in the femoral head, the frequency of bone cysts increases when MJS of the hip joint was less than 1mm (p<0.05).

In the total of 185 hips, A-L area of the acetabulum (106 hips, 57%) and A-S area of the femoral head (103 hips, 56%) exhibited the highest frequency of bone cysts.

Discussion

Although 3D-CT is very useful, it is strongly affected by the positioning of patients during the procedure. Moreover, many hip OA patients show pelvic obliquity or tilt. To eliminate these possible causes of error in this study, we therefore made independent reference planes each in the acetabulum and the femoral head.

In this study, bone cysts in the acetabulum tended to appear while MJS remained wider than that in the femoral head. Formation of subchondral bone cysts is believed to be related to stress distribution, and the stress peak is clearer on the acetabular side than the femoral head. Antero-lateral area of the acetabulum and anterior-superior area of the femoral head exhibited a high frequency of bone cysts, and these areas are thought to be susceptible to loading stress.

One noteworthy finding in this study was that subchondral bone cysts were observed in 19 of 67 hips with MJS more than 2mm, even though these hips were thought to retain sufficient articular cartilages. To reveal the cause of these cysts, we are planning to perform a finite-element model study of these hips and to investigate bone metabolism using positron-emission tomography.

Significance

Antero-lateral area of the acetabulum and anterior-superior area of the femoral head are thought to be susceptible to the loading stress, because of their high frequency of bone cysts.

References


Fig.1 Measurement of bone cysts locations on 3-D reconstructed CT
A: Planes with reference to APP
B: Planes with reference to perpendicular plane

Fig.2 MJS and numbers of hips with bone cysts
A: Cysts in the acetabulum
B: Cysts in the femoral head

Fig.3 Location of bone cysts
A: Cysts in the acetabulum
B: Cysts in the femoral head

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