Association Between Decreased Acetabular Bone Mineral Density and Fragility Acetabular Fractures

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INTRODUCTION: Proximal femoral fractures are among the most common fragility fractures in the elderly and are mainly caused by osteoporosis-related reductions in bone mineral density (BMD). However, recently, fragility acetabular fractures in elderly individuals following falls have been increasingly reported. Although BMD assessment using dual-energy X-ray absorptiometry (DXA) is standard for the proximal femur and lumbar spine, it is technically difficult to perform on the acetabulum due to its complex three-dimensional anatomy. The purpose of this study was to evaluate the volumetric BMD (vBMD) of the acetabulum using quantitative computed tomography (qCT) and to clarify whether a reduction in vBMD is associated with fragility acetabular fractures.

METHODS: The study included patients who sustained fractures due to falls from standing height, underwent surgical treatment, and subsequently had BMD measurements taken by DXA. 4 cases of proximal femoral fractures and two cases of fragility acetabular fractures were analyzed. Preoperative CT scans were used to assess the vBMD of the acetabulum and the proximal femur. All cases of acetabular fractures for which data could be collected were male, and because patients with corresponding proximal femoral fractures were selected based on gender and age, only one sex was included. The region of interest (ROI) for the acetabulum was defined as the area bounded superiorly by the line connecting the greater sciatic notch and the anterior inferior iliac spine, medially by the iliopubic eminence, and posteriorly by the lesser sciatic notch. The proximal femoral ROI was defined from the femoral neck to the upper margin of the lesser trochanter.(Figure1,2) A quantitative analysis was performed using Mechanical Finder ver.13, with Hounsfield unit (HU) values were converted to vBMD using a calibration phantom. First, the analysis calculated the ratio of the fractured side to the non-fractured side. Then, the non-fractured side was used as the representative value, assuming no significant bilateral differences. We hypothesized that femoral fractures are more likely to occur when femoral BMD is markedly lower than acetabular BMD. Conversely, when acetabular BMD is lower or comparable to femoral BMD, load transmission may concentrate stress on the acetabulum, thereby increasing the risk of acetabular fractures. Based on this hypothesis, we calculated the ratio of the non-fractured femur to the acetabulum and used it as an index for intergroup comparison of fracture locations. Group comparisons were performed using the Mann–Whitney U test. A p-value of less than 0.05 was considered statistically significant. Statistical analyses were conducted using SPSS.

RESULTS SECTION: The proximal femoral fracture group (n = 4) had a mean age of 74.0 years and a mean BMI of 17.0 kg/m². The acetabular fracture group (n = 2) had a mean age of 74.5 years and a mean BMI of 21.4 kg/m². It is noteworthy that none of the patients had a history of steroid use or osteoporosis treatment. In the proximal femoral fracture group, the mean vBMD of the proximal femur was 0.15 ± 0.01 mg/mm³, while the mean vBMD of the acetabulum was 0.22 ± 0.02 mg/mm³. The mean proximal femur-to-acetabulum ratio was 0.67 ± 0.12. In the acetabular fracture group, the mean proximal femoral vBMD was 0.20 ± 0.05 mg/mm³, and the acetabular vBMD was 0.24 ± 0.08 mg/mm³. The mean proximal femur-to-acetabulum ratio was 0.85 ± 0.06. No substantial lateral discrepancies were detected in either group. However, the femur-to-acetabulum ratio was found to be lower in the proximal femoral fracture group compared to the acetabular fracture group.

DISCUSSION: This study evaluated vBMD of the acetabulum and proximal femur in elderly patients with fragility fractures using qCT. Compared with the femoral fracture group, the acetabular fracture group showed relatively lower acetabular vBMD, suggesting that reduced acetabular bone quality is a potential risk factor for fragility acetabular fractures. Traditionally, fracture risk assessment has focused on femoral BMD, but our findings highlight the importance of acetabular bone quality. Future incorporation of finite element analysis (FEM) may allow evaluation of structural fragility in addition to bone density, contributing to the development of preventive strategies.

SIGNIFICANCE/CLINICAL RELEVANCE: A reduction in acetabular vBMD may be associated with fragility acetabular fractures, and a qCT-based assessment can provide valuable insights into the management of osteoporosis and the prevention of fractures.

IMAGES AND TABLES:

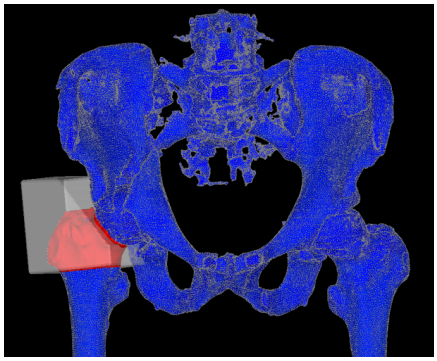

Figure 1. Three-dimensional pelvic and femoral model of a patient with right acetabular fracture. The region of interest (ROI) of the proximal femur (highlighted in red) was defined from the subcapital region to the upper margin of the lesser trochanter. Volumetric bone mineral density (vBMD) was quantified using quantitative CT (qCT).

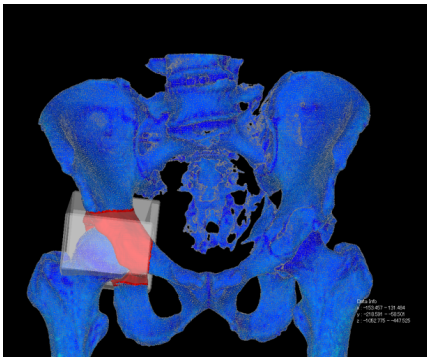

Figure 2. Three-dimensional pelvic and femoral model of a patient with left acetabular fracture. The region of interest (ROI) of the acetabulum (highlighted in red) was defined and quantified using quantitative CT (qCT).