

特発性大腿骨頭壊死症において壊死境界域の骨密度が高いと

その後圧潰する可能性がある

High bone mineral density in the boundary before collapse might proceed subsequent collapse: A preliminary report

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無症候の Stage 2 症例の CT を用いて、境界域の BMD 測定ならびに応力解析を行った。CT 撮影から 3 ヶ月以内に圧潰した 9 例ではその他の 10 例に比して外側境界域の BMD 値が有意に高く、同部位の応力値も有意に高かった。圧潰前の stage において、外側境界域の BMD 値が高くなるとかかる応力は高くなり、圧潰発生に関連することが示唆された。

1. 研究目的

We hypothesize that femoral head collapse occurs at the sclerotic lateral boundary of the necrotic femoral head in osteonecrosis of the femoral head (ONFH)^{1, 2)}. However, the degree of reparative change at the boundary before the collapse and its relationship with the subsequent collapse onset is still unclear. This study aims to assess whether the bone mineral density (BMD) around the sclerotic boundary before collapse is related to the subsequent collapse.

2. 研究方法

We reviewed 225 patients diagnosed with atraumatic ONFH in our institution from November 2016 to May 2021. Inclusion criteria were: 1) diagnosed with JIC stage 2 ONFH based on x-ray, CT, and MRI; 2) classified as JIC type C1 or C2 based on coronal MRI; 3) without a dysplastic hip joint. Finally, 19 hips of 19 patients (17 males, and 2 females) were included in this study, with a mean age of 44 (SD 14, range 20 - 74) years, a mean body mass index of 22 (SD 3, range 17 - 26) kg/m². Regarding the etiology,

6 patients reported a steroid intake history, 1 patient reported an alcohol abuse history, and 12 patients were diagnosed as idiopathic ONFH. In addition, 7 hips in 7 patients were classified as JIC type C1, and 12 hips in 12 patients were classified as JIC type C2. According to whether the subsequent collapse occurs within 3 months after the CT examination before the collapse, we divided the hips into 2 groups: Subsequent-collapse (+) group (n = 9), and Subsequent-collapse (-) group (n = 10).

Using CT data in DICOM format, we constructed the finite element models (FEMs). Each of the FEMs was composed of the pelvis, the cartilage, and the proximal femur. BMD of the sclerotic boundary and the necrotic region was assessed. Then, the BMD ratio was calculated as BMD of the sclerotic boundary divided by BMD of the necrotic region. Equivalent stress and shear stress at the lateral sclerotic boundary was assessed. The receiver operating characteristic (ROC) curve was used to assess the predicting value of BMD and BMD ratio for collapse onset in pre-collapse stage ONFH.

3. 研究結果

The demographic data of patients, including sex, age, BMI, etiology, and JIC type, is not significantly different between groups.

BMD of the sclerotic boundary in the Subsequent-collapse (+) group was significantly higher than that of the Subsequent-collapse (-) group ($p = 0.0313$). BMD of the necrotic lesion was not significantly different between groups ($p = 0.3282$). BMD ratio of the Subsequent-collapse (+) group was significantly higher than that of the Subsequent-collapse (-) group ($p = 0.0031$). Stress value of the sclerotic boundary in Subsequent-collapse (+) group was significantly higher than that of Subsequent-collapse (-) group (equivalent stress, $p = 0.0071$; shear stress, $p = 0.0143$). In addition, BMD ratio shown a good predicting value for subsequent femoral head collapse onset in pre-collapse stage ONFH (AUC = 0.97, Cutoff value = 1.48).

4. 考察

The femoral head collapse has been reported to occur at the lateral sclerotic boundary in ONFH^{1, 2)}. Using FEM analysis, stress concentration at the sclerotic boundary has also been observed^{3, 4)}. However, the influence of the reparative process on the femoral head collapse onset remains unclear. In this study, we preliminarily investigated the influence of the degree of the sclerotic change around the boundary on subsequent collapse onset. Our results demonstrated that BMD in the sclerotic boundary region is significantly increased during the reparative process, which is associated with the subsequent collapse onset.

5. 結論

BMD around the boundary region before collapse is associated with subsequent collapse onset in ONFH.

6. 研究発表

1. 論文発表
なし
2. 学会発表
なし

7. 知的所有権の取得状況

1. 特許の取得
なし
2. 実用新案登録
なし
3. その他
なし

8. 参考文献

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