Prognostic Factors Associated with a Subchondral Insufficiency Fracture of the Femoral Head

Introduction
Subchondral insufficiency fractures of the femoral head (SIF) often occur in osteoporotic elderly patients. Patients usually suffer from acute hip pain without any obvious antecedent trauma. Radiologically, a subchondral fracture is seen primarily in the superolateral portion of the femoral head. The T1-weighted magnetic resonance (MR) images reveal a very low-intensity band in the subchondral area of the femoral head, which tends to be irregular, disconnected, and convex to the articular surface. This low-intensity band in SIF was histologically proven to correspond with the fracture line with associated repair tissue. Some cases of SIF resolve after conservative treatment, while others progress until collapse, thereby requiring surgical treatment. The prognosis of SIF patients remains unclear.

The current study investigated the risk factors that influence the prognosis of SIF based on the progression to collapse.

Materials and Methods
Twenty six hips in 26 consecutive patients diagnosed with SIF were divided into 2 groups: non-progression of a collapse group that resolved after conservative treatment (Group N: 11 cases), and progression of a collapse group that underwent surgical treatment (Group P: 15 cases). The clinical profiles, including the age, body mass index and follow-up period were examined. The following radiographic measurements of hip dysplasia were performed: sharp angle, center-edge (CE) angle, acetabular roof angle (ARA) and acetabular head index (AHI) (Figure 1).

The morphological characteristics of the low intensity band on the MR images were also examined: (A) The band length, (B) band thickness, (C) length of the weight-bearing portion, and (D) band length ratio were measured on the T1-weighted MR images in the coronal plane. The band length ratio represents the length of the fracture line relative to the length of the weight-bearing portion (Figure 2).

Results
Regarding the radiographic measurements, both the sharp angle and ARA in Group P were significantly greater than in Group N (p < 0.05, p < 0.01 respectively). In addition, the CE angle and AHI in Group P were significantly lower than in Group N (p < 0.05, p < 0.01 respectively) (Table).

Discussion
The present study demonstrated that the inadequate acetabular coverage represented by the sharp angle, CE angle, ARA and AHI may be the prognostic factors for SIF.

Because the band in SIF corresponds to the fracture line, the band length represents the extent of a subchondral fracture, and the band length ratio represents the proportion of a subchondral fracture to the weight-bearing portion of the femoral head. As shown in the present study, both the band length and the band length ratio were important for making an accurate prognosis of SIF. We assumed that the longer band in the weight-bearing portion indicates a mechanically weakened subchondral condition, which therefore causes a further collapse and the incongruity of the femoral head, eventually resulting in osteoarthritic changes.

Significance
In the current study, the prognosis of SIF varied, even though all the patients received similar conservative treatments. If the prognosis for SIF can be predicted at an early stage, it would allow the design of optimal treatments for each patient. In this investigation, inadequate acetabular coverage, the band length and band length ratio were demonstrated to be useful when selecting the optimal treatment for SIF.

Table
The results of the radiographic and MR image measurements
Group N: non-progression of the collapse group
Group P: progression of the collapse group
CE angle: center age angle, ARA: acetabular roof angle
AHI: acetabular head index