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

We retrospectively studied 25 consecutive patients diagnosed to have SIF between June 2002 and July 2009 at our institution. The follow-up period extended from the time of the first attendance to the latest follow-up. All patients were initially administered conservative treatments, which consisted of anti-inflammatory drugs and the avoidance of weight bearing for 6 to 8 weeks.

We evaluated the progression of the collapse at 12 months after the first attendance. We regarded more than a 2 mm progression of the collapse as a progression of the collapse in comparison to the radiographs obtained at first attendance.

(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).

Results

At the time of the first attendance, 21 of 25 subjects showed some degree of collapse in the femoral head. Fifteen of 25 patients showed a progression of the collapse, and all patients underwent surgery. On the other hand, 10 of the 25 patients showed no progression of the collapse, and all of these patients pain was resolved after conservative therapy.

The T1-weighted MR images showed serpiginous, irregular, and discontinuous low-signal-intensity bands in all cases. (A) The band length in patients with the progression of the collapse was 22.5 mm, while the band length in patients without progression of the collapse was 13.4 mm. The band length in patients with the progression of the collapse was significantly higher than that in patients without a progression of the collapse (p < 0.05; Table). (B) No significant differences were seen in the band thickness, and similarly, (C) no significant differences were seen in the length of the weight-bearing portion. (D) The band length ratio in patients with progression of the collapse (59.8%) was also significantly higher than in patients without a progression of the collapse (40.9%; p < 0.05).

Discussion

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, the extent of a subchondral fracture and the ratio to the femoral head were both 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.

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 preliminary investigation, both the band length and band length ratio were demonstrated to be useful when selecting the optimal treatment for SIF.

Table The results of the MR image measurements

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Non-progression of the collapse</th>
<th>Progression of the collapse</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Band length (mm)</td>
<td>13.4 (7.6–19.3)</td>
<td>22.5 (17.7–27.3)</td>
<td>0.031</td>
</tr>
<tr>
<td>Band thickness (mm)</td>
<td>1.8 (1.5–2.1)</td>
<td>1.8 (1.5–2.0)</td>
<td>0.978</td>
</tr>
<tr>
<td>Length of weight-bearing portion (mm)</td>
<td>34.8 (33.3–36.2)</td>
<td>35.2 (34.0–36.4)</td>
<td>0.637</td>
</tr>
<tr>
<td>Band length ratio (%)</td>
<td>40.9 (29.8–52.0)</td>
<td>59.8 (50.8–68.9)</td>
<td>0.016</td>
</tr>
</tbody>
</table>

mean (95% confidence intervals)