Radiological factors affecting joint space narrowing after transtrochanteric anterior rotational osteotomy for stage 3 osteonecrosis of the femoral head

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INTRODUCTION
Osteonecrosis of the femoral head (ONFH) often occurs in young and middle-age adults. The natural history of ONFH generally involves a progressive femoral head collapse and secondary osteoarthritic changes, which often requires surgical treatments. Since necrotic lesion is generally localized in the anterosuperior aspect of the femoral head, transtrochanteric anterior rotational osteotomy (ARO) had been developed as one of the joint preserving procedure. To date, several studies demonstrated the long term efficacy of ARO for ONFH. Several authors reported that postoperative intact ratio is one of the important factors correlated with radiological outcome after ARO. Sugioka et al reported a success rate of 93% from ARO when the postoperative intact ratio exceeded 36%. Miyashita et al reported the minimum postoperative intact ratio necessary to prevent the progression of collapse of the femoral head after ARO was 34%. On the other hand, some cases treated by ARO gradually develop joint space narrowing without progressive collapse.

In this study, we investigated factors that correlate with the development of joint space narrowing without progressive collapse of the femoral head after ARO.

METHODS
We reviewed 43 hips in 39 patients with a minimum period of 3 years after ARO for the treatment of ON. The subjects comprised 30 men and 9 women with a mean age of 42 years (range, 23-61 years) at the time of surgery. The etiology of osteonecrosis was corticosteroids in 23 hips, alcohol abuse in 16, corticosteroids plus alcohol abuse in 3 and the consequence of trauma in 1. Clinical assessment was performed based on the Harris Hip Score (HHS) at preoperative and final follow-up. According to the classification of the Japanese Investigation Committee of Health, labor and Welfare, thirty-five hips were in stage 3A, eight in stage 3B. Localization of the necrotic lesion was type C1 in 13 hips, type C2 in 30. The following factors were investigated radiologically: the extent of necrotic lesion, the development of joint space narrowing, and the postoperative intact ratio. All radiographic evaluations were assessed by using the Image J (NIH image, USA). On the basis of postoperative radiographs, 43 hips were divided into 2 groups (Joint space narrowing group: JSN group, Non-Joint space narrowing group: non-JSN group). The age, BMI, follow-up period, preoperative HHS, extent of necrotic lesion and postoperative intact ratio were compared between two groups using the log-rank test. Fisher’s exact probability test or chi-square test was used with regard to sex, operated side, stage, type, contralateral condition, contralateral treatment, and etiology of ONFH. A multivariate analysis was performed using a logistic regression model. The P values less than 0.05 were considered to be significant.

RESULTS
The mean preoperative HHS was 60.7 points (33 to 79), which improved to 87.9 (51 to 100) at the final follow-up (p < 0.001). Examination of the postoperative radiographs assigned 6 hips to JSN group and 37 to non-JSN group. There was a significant difference in the preoperative HHS between two groups (P = 0.013). The rates of stage 3A was significantly higher in the non-JSN group than those in the JSN group (P = 0.033). In non-JSN group, the postoperative intact ratio was significantly higher than in JSN group (P = 0.002). Two of JSN group were converted to THA at a mean of 6.5 years (6 and 7) after the operation. Of the 43 hips, 41 (95.3%) had remained intact without conversion to THA at the final follow-up.

A multivariate analysis between two groups demonstrated that the postoperative intact ratio was an independent predictor of the development of joint space narrowing after ARO (Table I). The cut-off point of the postoperative intact ratio (Figure 1) to prevent the joint space narrowing was 39.2% (sensitivity 100%, specificity 83.8%). A Kaplan-Meier survival curves are shown in figure 2. There were significant differences between 2 groups using the log-rank test.

DISCUSSION
Several studies have reported that the postoperative intact ratio is one of the important factor influencing the radiological outcome after transtrochanteric rotational osteotomy. Recently, Zhao G et al reported that the minimum ratio necessary to prevent both the progression of collapse and joint space narrowing after the transtrochanteric curved varus osteotomy was 41.9%. The outcome of present study demonstrated that postoperative intact ratio is one of the determining factors for joint space narrowing without progressive collapse after ARO, approximately 40% or more postoperative intact ratio is desirable to prevent long term joint space narrowing.

REFERENCES

SIGNIFICANCE
The present study demonstrated that postoperative intact ratio is one of the determining factors for joint space narrowing without progressive collapse after ARO, approximately 40% or more postoperative intact ratio is desirable to prevent long term joint space narrowing.

Table 1. The results of multivariate analyses using a logistic analysis.

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<thead>
<tr>
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<th>likelihood ratio</th>
<th>P-values</th>
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<tbody>
<tr>
<td>Postoperative intact ratio</td>
<td>3.511</td>
<td>0.016</td>
</tr>
<tr>
<td>Stage</td>
<td>3.749</td>
<td>0.053</td>
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<tr>
<td>Contralateral treatment</td>
<td>6.767</td>
<td>0.080</td>
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<tr>
<td>Extent of necrotic lesion</td>
<td>1.965</td>
<td>0.161</td>
</tr>
<tr>
<td>Preoperative HHS</td>
<td>0.546</td>
<td>0.460</td>
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Figure 2. Kaplan-Meier survival curve with 95% confidence interval (CI) shows the radiological survival rate according to the intact ratio. The end point is the time when the joint space narrowing is observed.