Intra-articular Fibrous Tissue Formation Following Ankle Fracture: The Significance of Arthroscopic Debridement of Fibrous Tissue

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Purpose: The purposes of this study were to understand the clinical consequences of arthrofibrosis following surgical reduction of ankle fractures and to examine the effectiveness of arthroscopic debridement. Methods: Subjects included 33 patients (26 males, 7 females) aged 14 to 78 years (mean, 40.2 years) who had undergone open reduction and internal fixation of ankle fractures between May 2000 and May 2003. Arthroscopic examination was performed at the time of implant removal after an average of 12.4 months (range, 6 to 43 months), and abnormal fibrous tissue, when present, was removed through arthroscopy. The mean follow-up period after arthroscopy was 43.7 months (range, 22 to 68 months). Clinical outcomes before and after arthroscopy were evaluated with the American Orthopaedic Foot and Ankle Society scale and our own functional evaluation method. Arthroscopic findings, including the degree of articular cartilage damage and the quantity of fibrous tissue, were scored on a 3-point scale. Results: Functional deterioration of the ankle joint was observed in 27% of subjects. Arthroscopy showed articular cartilage damage in 33% of patients and arthrofibrosis in 73%. In patients with functional deterioration, the rate of articular cartilage damage was 78%, and arthrofibrosis was present in all cases. Furthermore, when extensive fibrosis and impingement on the articular surface were present, 88% of patients showed impaired articular function. Arthroscopic debridement of fibrous tissue resulted in improved articular function in 89% of patients with functional deterioration of the ankle joint before arthroscopy. Conclusions: Arthrofibrosis following ankle fracture causes an unfavorable surgical outcome, and arthroscopic debridement of fibrous tissue is an effective means of improving articular function. Level of Evidence: Level IV, therapeutic case series. Key Words: Ankle arthroscopy—Ankle fracture—Evaluation—Cartilage damage—Fibrous tissue.

Intra-articular fibrous tissue formation after ankle fracture or other injury causes impingement that may lead to articular dysfunction. In ankle sprains, resection of fibrous tissue has been reported to improve articular function.1-3 It has also been reported that anatomically successful surgical reduction of ankle fractures does not always result in a clinically favorable outcome.4-6 However, no reports have described the relationship between formation of arthrofibrosis and the postoperative clinical course. Also, no reports have been written to follow up on resections of arthrofibrosis formed postoperatively for the reduction of ankle fracture. The purposes of our study were to investigate how arthrofibrosis following surgical reduction of an ankle fracture would affect clinical symptoms and to examine the effectiveness of arthroscopic debridement of fibrous tissue. Our hypothesis was that arthrofibrosis is a major cause of unfavorable surgical outcomes, and in such cases, arthroscopic debridement is an effective means of improving articular function.
METHODS

Studied subjects included 33 patients who had experienced ankle fracture and undergone open reduction and internal fixation in our institute between May 2000 and May 2003. All surgeries were performed or supervised by one of the authors (K.U.). Included were 26 male and 7 female patients aged 14 to 78 years (mean age, 40.2 years). By the American Orthopaedic Foot and Ankle Society (AOFAS) classification, the fractures were 43A in 1 case, 43B in 8, 43C in 3, 44A in 4, 44B in 10, and 44C in 7 (Table 1). In all 33 cases at the time of implant removal, arthroscopy was performed by one of the authors (K.U.) after radiography showed bone union. Full informed consent was obtained from all patients. Timing of procedures was planned with consideration of each patient’s preference, but in principle, they were performed as soon as possible after bone union in young patients, and after approximately 1 year in adults.

Arthroscopic visualization was accomplished with a 2.7-mm, 30° oblique arthroscope inserted through standard anteromedial and anterolateral portals. The period between surgical reduction of the fracture and arthroscopic examination ranged from 6 months to 43 months (mean, 12.4 months), and the follow-up period after arthroscopy was between 22 and 68 months (mean, 43.7 months). Anatomically favorable reduction was confirmed in all cases on the basis of radiographs taken at the time of arthroscopy. Clinical outcome was assessed with the AOFAS scale and our own functional assessment scale, by which pain during squatting, pain during daily activities except for squatting, and limitation of range of motion of more than 5° were evaluated in comparison with the unaffected side. On the basis of these parameters, articular function was graded on a 4-point scale (G1 to G4), as shown in Table 2.

Clinical outcomes were evaluated through discussion among multiple authors, including the senior author (K.U.), after patients were examined. Arthroscopic findings were graded according to degree of articular cartilage damage and formation of intra-articular fibrous tissue. Chondral damage was classified into 3 categories, according to the method of Hintermann et al., with slight modifications. Patients were classified according to 3 levels: A0, presenting no chondral damage; A1, chondral damage of less than 50% of the thickness of the articular cartilage; and A2, chondral damage to 50% or more of the thickness (Fig 1). Arthrofibrosis was rated B0 when undetected by arthroscopic examination, B1 when mild and presenting no evidence of impingement on the articular surface on passive motion testing of the ankle joint during arthroscopy, and B2 when extensive and presenting articular impingement during passive dorsiflexion of the ankle joint (Fig 2). Arthroscopic debridement was performed to remove fibrous tissue in cases scored B1 and B2 (Fig 3). A χ² test, 1-way analysis of variance (ANOVA), and paired t test were used for statistical analysis, with P < .05 considered significant.

RESULTS

Mean AOFAS score immediately prior to arthroscopy was 90.3 (range, 61 to 100) points; 22 cases were
rated excellent, 4 good, 7 fair, and 0 poor. On our own functional assessment scale, 22 cases were rated as G1 for articular function, 2 as G2, 7 as G3, and 2 as G4. G3 and G4 accounted for 27% of all cases. Mean preoperative range of motion for the ankle joint was 8.2° (range, 0° to 15°) for dorsiflexion and 42.9° (range, 40° to 50°) for plantarflexion, and 4 of 33 subjects had a range of motion limitation of more than 5° in comparison with the unaffected side.

Cartilage damage was rated as A0 in 22 cases, A1 in 9, and A2 in 2; the total number of cases with chondral damage was 11 (33%; Table 3). AOFAS scores based on degree of chondral damage were 96.4 (range, 64 to 100) at A0; 79.7 (range, 61 to 100) at A1; and 71 (range, 65 to 77) at A2 (P = .0008). Although G1 and G2 cases were less likely to show chondral damage, 78% of G3 and G4 cases were accompanied by chondral damage (P = .0122; Table 3).

Arthrofibrotic tissue formation was observed in 73% of patients; 9 patients were graded as B0, 16 as B1, and 8 as B2. AOFAS scores by level of arthrofibrosis were 100 at B0; 94.8 (range, 62 to 100) at B1; and 70.4 (range, 61 to 85) at B2 (P < .0001). All B0 cases showed favorable G1 articular function, whereas all G3 and G4 cases had arthrofibrosis, and 7 of 8 B2 cases (88%) were rated G3 or higher (P = .0005; Table 4).

After arthroscopy, all 9 B0 cases showed no change in clinical score and were scored at 100 points on the AOFAS scale and at G1 articular function on the basis of our own functional assessment scale. In remaining patients who underwent arthroscopic debridement of fibrous tissue, postoperative AOFAS scores were 98.7 (range, 79 to 100) in B1 cases and 91.4 (range, 61 to 100) in B2 cases. Although paired t testing of changes in AOFAS score preoperatively and postoperatively showed no significance among B1 cases (P = .1734), significant improvement was noted among B2 cases (P = .0036).

Postoperative AOFAS scores by degree of chondral damage observed at the time of arthroscopy were 99.3 (range, 85 to 100) in A0 cases, 93.3 (range, 61 to 100) in A1 cases, and 92.5 (range, 85 to 100) in A2 cases (P = .1282). Paired t testing of changes in AOFAS scores preoperatively and postoperatively showed no significant change in A0 cases (P = .1646), but significant improvement was seen in A1 and A2 cases (P = .0384 and P = .0443, respectively).

Of 16 B1 cases, articular function was improved from G3 to G1 in 1 patient and from G4 to G1 in another patient after arthroscopic debridement of fibrous tissue, but no changes were seen in G1 or G2 patients (Fig 4). Of 8 B2 cases with extensive fibrous

**TABLE 3. Correlation Between Rating Based on Functional Assessment and Rating Based on Chondral Damage**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Level</th>
<th>G1</th>
<th>G2</th>
<th>G3</th>
<th>G4</th>
<th>Total Level</th>
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<td>A0</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>9</td>
<td></td>
</tr>
<tr>
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<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Total grade</td>
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<td>2</td>
<td>7</td>
<td>2</td>
<td>33</td>
<td></td>
</tr>
</tbody>
</table>

**FIGURE 4.** Improvement in articular function in B1 cases after arthroscopic debridement of fibrous tissue.
tissue formation and articular impingement, no significant improvement in articular function was observed in a patient with G2 articular function and in 1 of 6 G3 patients; remaining G3 patients improved to G1 (4 cases) or G2 (1 case). The single B2 case with G4 articular function also improved to G1. Thus, 6 of 8 B2 patients (75%) showed improvement in articular function (Fig 5). Consequently, 8 of 9 cases with G3 or G4 articular function (89%) showed improvement in articular function after fibrous tissue had been arthroscopically debrided.

After arthroscopy, improved range of motion was observed in 1 case (5° gain for dorsiflexion). In the remaining 32 patients, range of motion did not change, and mean range of ankle motion at final evaluation was 8.2° (range, 6° to 15°) for dorsiflexion and 42.9° (range, 40° to 50°) for plantarflexion.

At the end of the study, mean AOFAS score was 97.3 points (range, 61 to 100); 29 cases were rated excellent, 3 good, 1 fair, and 0 poor. On our own functional assessment scale, 29 cases were rated as G1, 3 as G2, and 1 as G3; none were rated as G4.

Neither the degree of cartilage damage nor formation of arthrofibrosis was significantly correlated with fracture type (P = .3705 and .5353, respectively). No arthroscopy-associated complications such as damage to the superficial peroneal nerve, infection, or reflex sympathetic dystrophy were observed. Histopathologically, the removed fibrous tissue consisted of synovial tissue with extensive fibrosis.

DISCUSSION

The principal findings of the current study were that a correlation was found between joint function and formation of arthrofibrosis after surgical reduction of ankle fractures, that formation of arthrofibrosis was observed at high rates in cases of poor ankle function, and that function was improved by removal of fibrous tissue. Limitations of this study include the fact that the surgeon was also one of the clinical outcome evaluators. However, we believe that an objective evaluation was attained through discussion with the other authors.

Various rating systems have been used for classification of articular function after ankle fracture, including the Burwell-Charnley criteria, the Olerud and Molander Ankle Score, and the AOFAS scale. In the Japanese lifestyle, squatting is a common daily activity, and difficulty in squatting presents a great limitation during everyday life. Thus, in addition to using the AOFAS scale, we developed our own rating scale by focusing on the activity of squatting. This scale categorizes postfracture ankle joint functionality into 4 grades.

Reportedly, patients with ankle fractures do not always show favorable clinical progress after surgical reduction. Ankle pain in motion or restricted range of motion persisted in 27% of cases in this study. Chondral damage at the time of fracture has been described as causing unfavorable clinical results. Cartilage damage was observed in 73.2% of patients who underwent arthroscopy at the time of open internal fixation in the report of Takao et al., and in 79.2% of cases by Hintermann et al. Loren et al. reported that 63% of patients had cartilage damage larger than 5 mm by arthroscopy. In our study, chondral damage was observed in 33% of cases, which was less frequent than in these reports. Arthroscopic examination was performed after a mean interval of 12.4 months post fracture in this series, suggesting that cartilage damage incurred at the time of fracture may have healed later. However, we did not observe chondral lesions at the time of initial surgery; therefore, we cannot conclude that the lower incidence of chondral damage in our study was due to healing. Another report showed that chondral damage was present in only 20% of patients at the time of fracture. Further studies are required to compare chondral damage at the time of initial surgical reduction with that at the time of implant removal.

An association between articular function and chondral damage has been reported; our results showed that 78% of patients with articular dysfunction after surgery had chondral damage, thereby confirming previous reports.

Recently, a few studies have shown impingement of fibrous tissue in patients with sustained pain after ankle fracture. However, no relationship between the incidence of intra-articular fibrosis and clinical consequences after surgical reduction of ankle fracture has been reported. Our research was undertaken to
address this point. Because removal of implants after fracture surgery is essentially routine in Japan, even when no implant-related complications occur, we considered the addition of relatively less invasive procedures like arthroscopy to be a reasonable solution. With informed consent, arthroscopy was performed on all patients in this study.

After surgical reduction of ankle fracture, fibrous tissue formed in 73% of all cases. Remnants of ruptured ligaments and fibrosis of synovial membranes are reportedly involved in the pathogenesis of arthrofibrosis.31 This report is consistent with pathologic findings attained in the present study. Our study also showed a strong correlation between the formation of arthrofibrosis and clinical symptoms. All patients with poor articular function had arthrofibrosis, and 88% of those with articular impingement of fibrous tissue, as confirmed through arthroscopy, showed poor articular function. In addition, clinical scores in these patients were markedly improved after arthroscopic debridement of fibrous tissue, and this improvement was shown even in those patients with chondral damage in the ankle joint. These findings strongly suggest that formation of fibrous tissue is a major cause of poor clinical outcomes. We conclude that arthrofibrosis causes unfavorable outcomes, and that arthroscopic debridement of fibrous tissue is an effective means of improving articular function after ankle fractures have been surgically reduced.

REFERENCES