Predictive value of magnetic resonance imaging in avascular necrosis following talar fractures

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ABSTRACT
Ischemic bone necrosis following talar fractures is a problematic complication and its early diagnosis is important. Patients with Hawkins Type II and III talar fractures received internal fixation using titanium alloy screws, and chronological bone changes were observed with Magnetic Resonance Imaging (MRI). With the Type II patient, Hawkins’ sign was radiographically confirmed 2 months after the surgery. Furthermore, there were no changes of MR images for 2 years and a good clinical outcome was obtained. However, in the Type III patient, Hawkins’ sign was negative and MRI revealed a low signal-intensity band on the talus 2 months after the surgery and then necrosis was radiographically confirmed; pain appeared 10 months later. These 2 cases suggest that MRI is a useful means for detecting bone necrosis with talar fractures in the early post-operative period.

Key words: talus, fracture, MRI, radiography, Hawkins’ sign

INTRODUCTION
Talar fractures occur rarely, but once they happen, development of subsequent ischemic bone necrosis should be monitored carefully.1–3 Bone necrosis is suspected when Hawkins’ sign is radiographically negative during 6 and 12 weeks after the fracture.3 However, diagnosis of bone necrosis in the early disease period is difficult to make with radiography alone. MRI is known to depict ischemic changes in bone tissues, and this has been shown in patients with femoral head necrosis.4 Therefore, MRI was expected to be applicable in making the diagnosis of bone necrosis following talar fractures. In the present study, clinical courses of patients with Hawkins Type II or III talar fractures after the internal fixation using titanium alloy were monitored by using MRI, and the usefulness of MRI in making early diagnosis of ischemic bone necrosis was examined.

MATERIALS AND METHODS
Subjects were 2 patients with talar fractures of Hawkins Type II (a 39-year-old female) and Hawkins Type III (a...
24-year-old female). Osteosynthesis of fractured bones was done using titanium alloy Herbert bone screws, and the post-operative courses were monitored by MRI at 2, 4, and 8 months after the surgery, radiographically and clinically for 2 years. T1-weighted MR images with 5-mm thick slices were obtained using a 1.5 Tesla superconducting MRI equipment (made by Shimadzu, Kyoto, Japan) and the spin echo method (TE: 500 msec, TR: 20 msec).

RESULTS

In the 39-year-old female with Hawkins Type II talar fracture (Fig. 1), radiograms 2 months after the surgery depicted Hawkins’ sign, i.e., subchondral bone atrophy on the upper part of the pulley of the talus (Fig. 2). Post-operative MR images were normal, the screw and fracture line depicted at a low signal intensity, while the weight-bearing portion of the talus was depicted as a homogenous high-intensity area, and there were no abnormalities (Fig. 3). During the 2 years post-operative follow-up period, the patient did not develop pain, and no necrotic changes were detected on radiograms.

In the 24-year-old male with Hawkins Type III talar fracture (Fig. 4) and who received osteosynthesis 10 days after injury, the talus was dislocated posteromedially but continued to the fractured medial malleolar surface of the talus with the deltoid ligament. Two months after the surgery, Hawkins’ sign was not radiographically observed (Fig. 5), while MRI revealed a low signal-intensity band pattern on the middle of the talus. The band pattern became more apparent 4 months after the surgery, but there was no expansion of the area surrounded by the band. Eight months after the surgery, the area surrounded by the band was depicted at a low intensity by MRI (Fig. 6), and tomograms showed osteosclerotic changes on the same area (Fig. 7). The patient developed walking pain on the lateral side of the ankle joint 10 months after the surgery, and it continued until the end of the 2-year monitoring period.

Figure 1  Radiograms of the 39-year-old female at the first examination after talar fracture. (a) Anteroposterior view. (b) Lateral view. Hawkins Type II fracture.
Figure 2  Two months after surgery. (a) Hawkins’ sign (arrows) radiographically observed. (b) Lateral view.

Figure 3  MR images of Hawkins Type II talar fracture. (a) Two months after surgery. (b) Four months after surgery. There were no abnormal pictures showing bone necrosis on the weight bearing area of the talus.
Figure 4  Radiograms of the 24-year-old male at the first examination after talar fracture.  
(a) Anteroposterior view. (b) Lateral view. Hawkins Type III fracture.

Figure 5  Two months after the surgery. No Hawkins’ sign.
**Figure 6** MR images of Hawkins Type III talar fracture. (a) A low signal-intensity band appeared 2 months after the surgery. (b) The band became clear 4 months after the surgery but the area surrounded by the band did not expand. (c) The area inside the band became a homogenous low intensity area 8 months after surgery.

**Figure 7** The area inside the band showed sclerotic change and collapse.
DISCUSSION

Ischemic necrosis following talar fractures occurs when nutrient vessels to the talus are damaged and the blood supply to the talus is cut off. The degree of the vessel damage varies according to the severity of dislocation, and damage of nutrient vessels is thought to be severer in Hawkins Type III fractures than in Type II fractures. This was also shown in our 2 cases, i.e., the patient with Hawkins Type II fracture did not develop bone necrosis whereas the patient with Hawkins Type III fracture did. In the case with Type III fractures, necrosis occurred only on the lateral side. This could be attributable to the maintenance of deltoid ligament with which nutrient vessels to the medial side of the talus would be protected.

In the Type III patient who developed bone necrosis, a band pattern was distinguished on MR images 2 months after the surgery. In the other studies, this band pattern was shown to be an early sign of femoral head necrosis, confirmed to be a specific change in bone necrosis and reported to appear in an early disease period, e.g., 6 weeks after kidney transplantation and 4 weeks after traumatic osteonecrosis of femoral head. An animal experiment indicated that the band pattern appeared 4 weeks after the occurrence of bone necrosis. Therefore, even in talar fractures, the band pattern could appear 4 weeks after the injury. In the Type III patient, the area inside the band did not expand, and it changed to a homogenous low intensity area 8 months after the surgery. The authors regarded this change as a repair reaction to the necrotic tissues. In addition, it was also quite important that the area inside the band did not expand. This shows that the necrotic area is measurable even at an early disease period, and with this information, future collapse becomes predictable.

In the current 2 cases, MR images were normal when Hawkins’ sign was positive, whereas the band pattern occurred when the sign was negative. This supports the usefulness of Hawkins’ sign, and MRI is thought to be more useful because it allows the evaluation of the size of the necrotic area.

It is also reported that metallic materials used for internal fixation affect MR images in various degrees. The present study utilized titanium alloy screws, which produced only minor artifacts on MR images and allowed chronological monitoring of bone changes. Recently, a new fixation technique using absorbptive polylactic acid has become available, and these materials would be worthwhile treating the talar fracture.

REFERENCES