Introduction: A painful lesion localized to the medial femoral condyle in the elderly was defined by Ahlbäck in 1986 as spontaneous osteonecrosis of the knee (SONK) based on its roentgenographic and pathological features (1).

The pathological examination of Stage 1 and 2 lesions, which are difficult to detect by plain radiography, is extremely important in the elucidation of SONK pathogenesis; however, a search of the published literature did not reveal any pathological studies of such early lesions. This study focused on painful SONK lesions classified by MRI and plain radiography, particularly Stage 1 and 2 lesions of SONK classified by plain radiography, to analyze their pathological features.

Materials and Methods: Twenty-three knee joints were examined in 23 patients who had been diagnosed with SONK by physical and imaging findings, and had undergone surgery including arthroscopy between July, 2000 and December, 2004. These patients consisted of 4 men and 19 women, ranging in age from 58 to 77 years (mean, 67 years).

The subjects were patients aged > about 60 years who suddenly developed symptoms without any apparent cause and had typical clinical symptoms such as pain localized in the medial femoral condyle accompanied by night pain. However, since early stage SONK lesions can not be sometimes identified by plain X-ray examination, diagnosis was made based on MRI findings in addition to clinical symptoms characteristic of SONK.

Plain radiographic images were classified as Stages 1, 2, 3, and 4 according to the classification of Koshino (2). As a result, 5, 5, 7, and 6 joints were classified as Stages 1 through 4, respectively.

The MRI criteria used for the diagnosis of SONK were described in previous reports (3, 4).

The 3-dimensional localization of the lesion was determined based on preoperative MRI images, and the site of the lesion was confirmed used sometimes in combination with X-ray fluoroscopy. In addition, under arthroscopy, bone biopsy tissue was obtained from at least 2 sites in the weight-bearing area showing changes in the articular cartilage using a bone biopsy needle (OSTYCUT; Angiomed, Karlsruhe, Germany).

All specimens were routinely stained with hematoxylin and eosin to analyze the morphological features and with tetrachrome staining to evaluate primary osteoid and newly mineralized bone formation (5). Osteonecrosis was microscopically diagnosed if both bone necrosis, as evidenced by empty lacunae that do not contain stainable osteocytes, and fat necrosis, which result from breakdown of the walls of fat cells, were confirmed. As all fractures lead to bone necrosis, necrotic regions only around the fracture line were not classified as osteonecrosis in this study (6).

We also classified SONK lesions into the three groups according to histological characteristics of Yamamoto’s classification (7).

Results: The histopathology in each stage of SONK on plain radiographs was characterized by reparative reactions as follows. In Stage 1, all 5 patients showed the features of Group I, with no evidence of antecedent osteonecrosis. Little or no reparative reaction was noted. Similarly, in Stage 2, all 5 patients showed the features of Group I, with no evidence of antecedent osteonecrosis. However, a reparative reaction mainly consisting of osteoid and immature bone formation was actively ongoing. In Stage 3, all 7 patients showed the features of Group II, with an osteonecrotic lesion confined to the area distal to the fracture line. A gap was present between an unstable osteochondral fragment and the subchondral bone, apparently representing a state of delayed union. In Stage 4, four of 6 patients showed the features of Group II, representing a state of nonunion. The remaining 2 patients were classified as having a Group III lesion, in which it was not possible to detect either a fracture or necrosis.

Discussion: MRI has contributed greatly to the diagnosis of SONK, particularly to the detection of early changes that are difficult to diagnose by plain radiography (7). The pathological examination of such Stage 1 and 2 SONK lesions, which are difficult to detect by plain radiography, is extremely important to elucidate the pathogenesis of SONK. This study is the first to investigate 10 early cases including Stage 1 lesions, and is valuable in finding that their common pathological features were subchondral fracture and repair reactions without osteonecrosis. This strongly suggests that SONK results from subchondral fracture, but not from osteonecrosis due to ischemia. Lotke et al. reported that in some patients with SONK, spontaneous resolution occurred (8). This is reasonable if the spontaneous resolution resulted from subchondral insufficiency fracture causing SONK.

When histopathologically evaluating an osteonecrotic lesion, it should be remembered that all fractures are accompanied by small necrotic regions around the fracture line (6). In the absence of the concept of subchondral insufficiency fracture at that time, the possibility cannot be excluded that small necrotic regions around the fracture line were diagnosed as osteonecrosis. We also noted empty lacunae in trabecular distal to the fracture line, and interpreted them as secondary changes associated with fracture.

The histopathological features of advanced SONK closely resemble those of delayed union or nonunion, that is, a fracture of the subchondral bone occurs first, followed by repair reactions, but the weight load and other factors impair fracture healing. Repeated movement of the fragments accounts for recurring hyperemia, and increasingly more of the bone ends undergo resorption: a crack becomes a cavity, a linear fracture becomes a gap fracture. It seems reasonable to assume that damage to ingrowing vascular tissue may result from incomplete immobilization, with resulting cartilage and fibrous tissue formation, that is, delayed union or nonunion. Thus, in a state of delayed union or nonunion, an unstable fragment distal to the fracture site becomes detached, resulting in complete loss of blood supply, leading to osteonecrosis.

This suggests that if a subchondral fracture can be diagnosed early using MRI before it results in delayed union or nonunion, remission can be expected by conservative treatment.