Bone Bruise in Patients with Acute Patella Dislocation

Masanori Terauchi, Kazuhisa Hatayama and Kenji Takagishi

We investigated the biomechanical significance of bone bruises in patients with patella dislocation. Thirty-four patients with acute dislocation of the patella were studied. Redislocations were excluded. There were 11 men and 20 women with a mean age of 18 years at the time of injury. Bone bruises were noted at the periphery of the lateral femoral condyle in 22 patients (65%) and in 10 cases (29%) at the medial patellar facet. The sulcus angle in patients with bone bruises at the lateral femoral condyle was significantly greater and tibiofemoral rotation at the knee was significantly smaller than in patients without bone bruises. In knees with small tibiofemoral rotation, a large lateral displacement force applied into the knee joint is needed to displace the patella. The flat femoral trochlea groove, however, can not reduce the force, resulting in hard impaction between the medial patella facet and the lateral femoral condyle producing bone bruises. (Kitakanto Med J 2009; 59: 329~332)

Key Words: Patella dislocation, Bone bruise, external rotation

Introduction

Mink and Deutsch clarified bone bruising of the knee on magnetic resonance imaging (MRI). T-1 weighted images showed a geographic and nonlinear area of signal loss involving the subcortical bone. On T-2 weighted images, most of the lesions showed an increased signal intensity. These images represent a localized area of acute hemorrhage or edema and are secondary to microfracture of the adjacent medullary trabeculae. This clinical entity has been well described in patients with associated anterior cruciate ligament injuries and medial collateral injuries. However, there are few reports on bone bruise in patients with acute dislocation of the patella, and only the prevalence of this signal was reported. The biomechanical significance of bone bruise in patella dislocation thus remains uncertain.

Patella dislocations are often associated with lesions caused by a significant tangential load that is transmitted through the cartilage and subchondral bone between the patella and femur. The distribution of bone bruising may reflect the severity of the load applied during patella dislocation and relocation.

Anatomic predisposition to dislocation of the patella, such as abnormalities of the sulcus angle of the patellofemoral joint, high-riding patella, malalignment of the lower extremity, has been recognized. We examined the relationship between bone bruising and anatomical predisposition in patients with acute patella dislocation. Our purpose was to define the biomechanical significance of bone bruising on acute dislocation of the patella.

Patients and Methods

Thirty-four consecutive patients with acute dislocations of the patella were seen at our institute between 1996 and 2000. The diagnosis was based on the history of a laterally-displaced patella, tenderness of the medial capsule and a positive apprehension test. Redislocations were excluded. There were 11 men and 20 women with a mean age of 18 years (range, 9 to 37) at the time of injury.

MRI was performed within 2 weeks after the initial injury in all 34 patients. MR imaging was obtained with a 1.5-T unit (Toshiba, Visart). Coronal, sagittal and axial T1-and T2*–weighted images were acquired. A repetition time (TR) of 420 msec
and echo time (TE) of 15 msec were used for T1-weighted images, and TR of 500 msec, TE of 15 msec and flip angle (FA) of 30° were used for T2*-weighted images.

All patients also underwent a standard radiographic series consisting of A–P, lateral and tangential views with the knee flexed at 30°. The sulcus angle indicated by Brattström was measured as an index of femoral trochlear dysplasia. The ratio between the length of the patella tendon (LT) and the diagonal length of the patella (LP) was calculated according to Insall & Salvati to determine the height of the patella.

Relative external rotation of the tibia in relation to the femur was calculated using CT scan to evaluate tibiofemoral rotational alignment. The patients were required to lie in the supine position with the hip and knee joint extended during the CT scan. A frontal scanogram of the knee was made to select the distal femoral condyles (mid patellar point) and proximal tibial condyle (1–2 cm distal to the articular surface), and sections were made at these 2 levels. Thereafter, the CT images at these levels were overshadowed. The angle formed by the posterior border of the proximal tibia with the line connecting the posterior sides of the medial and lateral patellar condyle was defined as the external rotation angle of the knee joint (Fig. 1).

We compared the above parameters between two groups: patients with bone bruises and those without bone bruises, using the Student's t-test.

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![Fig. 1](image_url) The external rotation angle. The CT images at the levels of the distal femoral condyles and proximal tibial condyle were overshadowed. The angle formed by the posterior side of the proximal tibia with the line connecting the posterior sides of the medial and lateral condyles was measured.

**Results**

Bone bruises were noted at the periphery of the lateral femoral condyle in 22 patients (65%), and bone bruises were present in the medial patellar facet in 10 cases (29%). There was no bone bruising in the lateral patellar facet. All patients with bone bruising in the medial patellar facet also had bone bruising in the lateral femoral condyle.

The average LT/LP ratio for 34 patients was 1.14±0.15. The average sulcus angle was 138.7±5.70. The average of the external rotation angle was 45°±4.72. Table 1 presents the results of the angular measurements in the patients with bone bruises at the femur and those without bone bruising. The sulcus angle in patients with bone bruises at the lateral femoral condyle was significantly greater than that in patients without bone bruising. The external rotation angle in patients with bone bruising at lateral femoral condyle was significantly smaller than that in patients without bone bruising. LT/LP ratio in patients with bone bruises in the lateral femoral condyle showed no significant difference between the two groups.

Table 2 presents the results of the angular measurements in patients with bone bruising at the patella and those without bone bruises. The results of the patella were similar to those of the femoral condyle. Knees with a flat femoral trochlear groove and small femorotibial rotation tended to be associated with bone bruises at the patella during patella dislocation and relocation.

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<th>Table 1 Relationship between bone bruising at the femoral condyle and angular measurement.</th>
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<td>With bone bruise</td>
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**Discussion**

There are a few reports on bone bruising in patients with acute dislocation of the patella. Sally et al. studied twenty-three patients with patella dislocation, reporting bone bruises at the peripheral of the lateral femoral condyle in 87% of the patients and at the medial patellar facet in 30% of the patients. Lance et al. reported that the lateral femoral condyle contained an abnormal signal intensity, low on T1-weighted and high on T2-weighted images in 82% of the patients, and a similar abnormal signal intensity in the medial facet in 41% of the patients. Kirsch et al.
reported that contusion of the lateral femoral condyle was noted in 21 of 26 patients (81%) and contusion of the bone marrow of the patella in 5 (19%). These rates were comparable with our results. These contusions presumably represent trabecular microdisruption, and they characteristically occur within the medial patellar facet and lateral femoral condyle.

Acute patella dislocation and relocation results in major compression and shear forces at the articular surfaces, particularly of the patella and lateral femoral condyle. Kirsch et al.\textsuperscript{11} accounted for the contusions of the lateral femoral condyle and the patella by the mechanism of patella dislocation. As a result of lateral displacement forces, the patella is pulled out of the trochlea and over the lateral femoral condyle. When the patella slides back tangentially over the surface of the lateral femoral condyle, the medial patellar facet impacts against the lateral femoral condyle, producing trabecular microfracture or osteochondral injury or both, which are seen on MR images as bone marrow contusion or fracture.

It has become apparent that changes of bone marrow can occur with the initial injury, dependent upon the severity of bone injury.\textsuperscript{7} In this study, we found that bone bruises were seen more frequently in the knees with the combination of small femorotibial rotation and large sulcus angle. So we recognized two factors determining the magnitude of impact load between the medial patellar facet and lateral femoral condyle during the patella dislocation and relocation.

The degree of tibiofemoral rotation was considered a factor deciding the lateral displacement force required to dislocate the patella. Knees with small femorotibial rotation require a large lateral displacement force to dislocate the patella. In contrast, knees with a large femorotibial rotation can show dislocation of the patella with a small lateral displacement force. The sulcus angle was considered to counteract the displacing force during dislocation. A flat femoral trochlear groove can not reduce the lateral displacement force during dislocation. In contrast, a deep femoral trochlear groove can reduce the force. Knees with small femorotibial rotation need large lateral displacement force to displace the patella, however flat femoral trochlear groove can not reduce the displacing force, which results in the medial patellar facet impacting against the lateral femoral condyle hard when the patella recoils back into the trochlear groove.

Iwano et al.\textsuperscript{21} reported that 28% of patients with patrofemoral osteoarthritis alone had a history possibly indicating dislocation or subluxation of the patella. In contrast, none of their patients with combined patrofemoral and femorotibial osteoarthritis had such a history. This suggests that dislocation of the patella is the prime cause of patellofemoral osteoarthritis.

Mäenpää et al.\textsuperscript{22} studied the long term results of patients with acute patellar dislocation with respect to subsequent degenerative changes in the patellofemoral joint. They reported that patients with stable patella had a higher incidence of arthritic change in the patellofemoral joint, and defined a stable patella as one with no recurrence of dislocation. They proposed that the unstable patella with factors predisposing to recurrence requires little force to dislocate and therefore seems to be less prone to arthritis.

We observed that knees with small femorotibial rotation and a flat femoral trochlear groove sustained a high impact load during patella relocation. These results suggest that the patella which is stable in femorotibial rotation but unstable in the femoral trochlear groove tends to develop osteoarthritic change after patellar dislocation. Knees with these characteristics should thus undergo operative treatment to prevent redislocation and further damage to the patellofemoral joint.

**References**


