Partial fractures around the knee: bone bruise and fractures.

Prof. Romain Seil, MD, PhD
Definition

**Bone bruise**

- Alteration of bone marrow signal intensity
- ≠ bone marrow lesion (bone on bone stress in OA)
- ≠ stress-related bone marrow edema
Bone bruise

- Alteration of bone marrow signal intensity
- ≠ bone marrow lesion (bone on bone stress in OA)
- ≠ stress-related bone marrow edema
Definition

**Bone bruise**

- Alteration of bone marrow signal intensity
- ≠ bone marrow lesion (bone on bone stress in OA)
- ≠ stress-related bone marrow edema

- Bone marrow edema
- Stress fracture
- Osteonecrosis
**Bone bruise**

- First description in 1989  
  *Mink JH, Deutsch AL, Radiology 1989*

- 37-100% of all ACL tears  
  *Lee K, Radiology 1999*

- Inferior sensitivity in pediatric population  
  *Lee K, Radiology 1999; Snearly WN, Radiology 1996*

- Resolves over time: first 6 weeks after injury most important  
  *Graf BK, AJSM 1993*
Visualization

**MRI sequences**

- Lower signal intensity in T1-weighted sequences
- Higher signal intensity in T2-weighted sequences
- Fat suppression
- Short tau inversion recovery (STIR) sequences
Direct impact loading ± shear stress

Bone contusion: hemorrhage & edema $\rightarrow$ water concentration

Alterations of loadbearing properties of subchondral bone $\rightarrow$ cartilage changes (Faber KJ, AJSM 1999)

Cartilage contusion $\rightarrow$ chondrocyte damage; $\uparrow$ cartilage oligomeric protein (COMP) (Fang C, JOR, 2001; Koelling S, Arthritis Res Ther 2006; Johnson DL, Radiology 1989)

Soft tissues and i.a. effusion predominant!
Severity

LFC bone bruising volume:
- none/minimal <4%
- mild 4%-9.75%
- moderate 9.8%-17%
- severe >18%

LTP bone bruising volume:
- none/minimal <8%
- mild 8%-16%
- Moderate 17%-38%
- severe >39%

Bisson L, AJSM 2013
**Brittberg & Winalski classifications**

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial</td>
<td>Just beneath subchondral bone</td>
</tr>
<tr>
<td>Shallow</td>
<td>Extends up to 1/3d of the distance from articular surface to physeal scar</td>
</tr>
<tr>
<td>Deep</td>
<td>Extends from 1/3d-2/3ds of the distance to physeal scar</td>
</tr>
<tr>
<td>Extensive</td>
<td>Extends from 2/3ds of the distance to the physeal scar but not beyond</td>
</tr>
<tr>
<td>Generalized</td>
<td>Extends beyond the physeal scar</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Intensity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>Signal intensity less than muscle</td>
</tr>
<tr>
<td>Moderate</td>
<td>Signal intensity equal to muscle</td>
</tr>
<tr>
<td>Severe</td>
<td>Signal intensity brighter than muscle</td>
</tr>
</tbody>
</table>
Correlation with injury mechanism

Forceful valgus

Correlation with injury mechanism

Forceful valgus

Convex lateral tibial plateau

Spheric lateral femoral condyle

Correlation with injury mechanism

- Quadriceps pull IR tibia → ACL#
- Reflex reposition IR femur

ACL

Localization

✧ Lateral compartment:

1. weight bearing portion of LFC (94%) → lateral notch sign
2. posterolateral tibial plateau (91%) → kissing impaction fracture

✧ Medial compartment:

3. posteromedial tibial plateau → contre-coup injury with tibial reduction
4. medial femoral condyle
 Localization

✧ Lateral compartment:

1 - weight bearing portion of LFC (94%) → lateral notch sign
2 - posterolateral tibial plateau (91%) → kissing impaction fracture

✧ Medial compartment:

3 - posteromedial tibial plateau → contre-coup injury with tibial reduction
4 - medial femoral condyle
Lateral femoral notch sign

- Depression of > 2 mm in depth of condylotrochlear sulcus
- 26% of ACL injured patients
- 40% association with lateral meniscus tear
- High risk pivoting sports

Herbst E, KSSTA 2014
Kissing impaction fracture

✧ Frightens the patient
✧ Rarely problematic
“Contre-coup” injury

Kaplan PA, Radiology 1992

ACL + meniscosynovial lesion

• « Meniscosynovial »
• « Meniscocapsular »
• « Ramp » lesion
• systematic posterior arthroscopy:
  → Intercondylar approach
  → knee @ 90° of flexion
  → 30° (70°) arthroscope

Hamberg P, JBJS 1983
Seil R, OTSR 2009
Bollen SR, JBJS-B, 2010
Liu X, AJSM 2011
Sonnery-Cottet, AJSM 2014
Location of Bone Bruises and Other Osseous Injuries Associated With Acute Grade III Isolated and Combined Posterolateral Knee Injuries

Andrew G. Geeslin,* BS, and Robert F. LaPrade,‡ MD, PhD
Investigation performed at the University of Minnesota, Department of Orthopaedic Surgery, Minneapolis, Minnesota

Background: Bone bruises on magnetic resonance imaging (MRI) are common in patients with acute knee ligament injuries and have been well described for injuries involving the anterior and posterior cruciate ligaments and the medial collateral ligament. These have not yet been described in detail for posterolateral corner injuries.

Hypothesis: Acute grade III posterolateral corner (PLC) injuries are often accompanied by bone bruises located in the medial compartment.

Study Design: Case series; Level of evidence, 4.

Methods: One hundred two patients with acute grade III PLC knee injuries and MRI scans within 6 weeks of injury were prospectively identified. Images were reviewed for the location of bone bruises, which were defined as areas with high signal intensity adjacent to the joint surface on fat-suppressed, T2-weighted sequences.

Results: Overall, 83 patients had at least 1 bone bruise and 56 patients had a bone bruise of the anteromedial femoral condyle. Tibial plateau fractures were found in 19 knees, with 12 in the anteromedial quadrant. Isolated PLC injuries were found in 28 patients; of this group, 18 had at least 1 bone bruise with 17 located in the anteromedial femoral condyle. Seventy-four patients sustained a combined ligamentous injury; 65 of these had at least 1 bone bruise on MRI and 39 had a bone bruise on the anteromedial femoral condyle. In patients with a combined injury to the PLC and anterior cruciate ligament (38), anteromedial femoral condyle bruises were seen in 19 patients and posteromedial tibial plateau bruises in 11.

Conclusion: Medial compartment bone bruises, most commonly of the anteromedial femoral condyle, were frequently found in patients with both acute isolated and combined PLC injuries. Thus, the presence of an anteromedial femoral condyle bone bruise should increase the level of suspicion of a concurrent PLC knee injury. In addition, we believe that the presence of a posteromedial tibial plateau bone bruise may be a secondary sign of a potential combined PLC injury in the setting of anterior cruciate ligament tear.

Keywords: posterolateral knee; fibular collateral ligament; bone bruise; knee instability

Bone bruises have been reported to be trabecular microfractures that result from traumatic injuries to the bone. These lesions have also been referred to as occult posttraumatic osteochondral lesions. Bone bruises are characterized by increased signal intensity on fat-suppressed, T2-weighted magnetic resonance images and are believed to represent areas of hemorrhage, edema, or infarction due to a direct impact on the bone or compressive forces from opposing articulating osseous surfaces. Defining the incidence and location of bone bruises on MRI scans of patients can aid in the understanding of the mechanism of injury and may serve as an indirect sign of associated injuries.

Bone bruises associated with an acute tear of the anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), and medial collateral ligament (MCL) have been well described. Specifically, the classic bone bruise location for a patient with an ACL tear is the anterior or middle aspect of the lateral femoral condyle and the posterolateral tibial plateau. For an MCL tear, the classic bone bruise location is the lateral compartment, and for PCL tears bone bruises have been reported to be dispersed about the knee. However, the location of bone bruises has not yet been described in detail for posterolateral corner injuries.

If BB of PM tibial plateau
→ Consider ACL + PLC injury

Geeslin AG & LaPrade R, AJSM 2010
Hyperextension

Hyperextension injury

Anterior BB

Check PCL / PLC
PCL/PLC

Correlation with injury mechanism

A) Femoral Bone Bruise Incidence and Location

B) Tibial Bone Bruise Incidence and Location

55% BB on posteromedial FC

Geeslin AG & LaPrade R, AJSM 2010
More important if **noncontact** vs. contact ACL injury

More common and severe in **young men**

Lateral: associated with lateral **meniscus tears**

Medial meniscus tears associated with increased severity of lateral tibial plateau bruise

**Not associated with symptoms/pain** at the time of index anterior cruciate ligament reconstruction

*Dunn WR, AJSM 2010; Bisson L, AJSM 2013*  
*Viskontas DG, AJSM 2008*
Natural history

- Lack of evidence
- Poorly understood
- Variable healing patterns
- Short-, mid-, long-term consequences
Natural history

Short-term consequences
Mid-term consequences

12-2011

♂ 27 years, isolated ACL tear
Mid-term consequences

Subchondral bone cyst

05-2012
4 months post ACL-R

♂ 27 years, isolated ACL tear
Mid-term consequences

09-2012
3 months post OATS

♂ 27 years,
isolated ACL tear
Natural history

**Long-term consequences**

Majority of lesions resolve

- Bretlau T, *KSSTA* 2002
- Costa-Paz M, *Arthroscopy* 2001
- Hanypsiak BT, *AJSM* 2008

66 % persistent changes after 1 & 6 years

- Cartilage thinning
- Subcortical sclerosis
- Osteochondral defects
- Cortical impaction

- Faber KJ, *AJSM* 1999

ACL tear @ 21

♂ 31 y.
**Ligament injury & associated bone bruise:**

→ BB related to injury mechanism
→ Extent of BB reflects injury severity
→ LATERAL SIDE: THINK ACL
→ MEDIAL SIDE: THINK POSTEROLATERAL CORNER
→ Rarely direct clinical consequences
**Ligament injury & associated bone bruise:**

→ Little research, many questions remain

→ Unknown effect on:
  - long term knee function
  - outcomes after ACL/ligament injury
  - posttraumatic OA
17th ESSKA Congress

4-7 May 2016
Barcelona, Spain

www.esska-congress.org

ESSKA President
Matteo Denti (Italy)

Congress President
Joan C. Monllau (Spain)

Scientific Chairman
Roland Becker (Germany)
Gino M. Kerkhoffs (Netherlands)
Pablo E. Gelber (Spain)

Organiser & Contact
Intercongress GmbH
esska@intercongress.de