Cartilage Lesions

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14.1 Diagnosis

Since hyaline cartilage is not innervated, even large defects can remain completely symptomless for a long time. Chondral defects often become noticeable on the appearance of secondary symptoms like swelling, joint locking, or effusion due to synovitis. These simple and common symptoms or persistent pain could draw attention to the possibility of a cartilage defect [1].

14.1.1 History

Chondral injuries are present in 10–12 % of individuals [2]. Widuchowski et al. reviewed 25,124 knee arthroscopies to quantify the prevalence, location, and grade of the chondral lesions. Sixty percent had chondral lesions, of which 67 % were supposed to be focal. The main locations were retropatellar and medial [3]. In their series of more than 30,000 arthroscopies of the knee, Curl et al. found high-grade cartilage lesions (Outerbridge grades III and IV) in over 60 % of the patients [4]. As 14 % of osteoarthritis patients had a knee trauma in adolescence [5], medical history should particularly include past specific traumas. A knee distortion – even a couple of years ago – may lead to the source of the knee problems. Especially in athletes, full-thickness chondral defects are more common than among the general population [6]. Familiar dispositions (OCD, metabolic disorders) should also be recorded. Patients should be asked for loose-body symptoms, intermittent or activity-related pain, or swelling. Pain with prolonged sitting, kneeling, or stair climbing may indicate cartilage problems behind the patella. Previous operations, e.g., meniscal resections, ligament replacements, etc., are also important due to possible subsequent cartilage damage. Increased age, male sex, and increased surgical delay all increase the frequency and severity of articular cartilage injuries after ACL tears [7]. Twenty three percent after acute ACL injury and 54 % with chronic laxity of the ACL have chondral lesions [8].

14.1.2 Clinical Evaluation

A systematic physical examination should be performed in every patient with careful observation of gross morphology, effusion, palpation,

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range of motion assessment, stability testing, and alignment. In acute traumatic cases, up to 50 % of patients with lateral patellar dislocation show evidence of osteochondral lesions of the lateral femoral condyle, the medial patellar facet, or both [9]. These patients complain about tenderness at the insertion of the medial patellofemoral ligament at the medial epicondyle or along the medial retinaculum. In chronic cases of cartilage injuries, patients show tenderness at the joint line, limited weight bearing, or recurrent effusion.

Physical examination should focus on the following pathologies:

- Limited range of motion
- Effusion
- Instability
  - Clicking, grinding, or any other pathological sounds
  - Catching or locking
- Malalignments (valgus or varus deformities)
- Maltracking or tilt of the patella

14.2 Exploration

14.2.1 Radiological

14.2.1.1 X-Ray Examination

Cartilage cannot be seen directly in X-rays. Nevertheless, X-rays of the knee in two planes and sometimes with special techniques like patella défilé or others are still necessary, as they give useful information about posttraumatic changes and overall joint conditions [1]. In acute cases osteochondral injuries especially with large underlying bony fragments and osteochondritis dissecans lesions can be detected. By plain X-rays arthritis of the knee can be diagnosed or at least excluded. Especially X-ray evaluation under weight bearing like the Rosenberg view can help to detect joint space narrowing and other (pre) arthritic conditions. In most cases long-leg standing radiographs are mandatory for the analysis of the alignment, as axis deviation might change the therapeutic algorithm for the treatment of chondral injuries.

X-ray examination should focus on the following pathologies:

- Joint space narrowing
  - Calcification of cartilage and meniscus
- Osteophytes
- Patella maltracking or tilt
  - Malalignments (varus or valgus deformities)
  - Signs of inflammatory diseases
  - Trauma-related pathologies

14.2.1.2 Magnetic Resonance Imaging

Improvements in MRI technique continue, so that modern magnetic resonance tomographs give a detailed view of the articular cartilage itself and can help to detect even smaller articular cartilage pathologies and osteochondral injuries. MRI is also useful in detecting (osteo)chondral loose bodies and chondral fragments. Although the field intensity plays a major role in terms of image resolution and quality, in the hands of a skilled examiner, even devices with 1.5 or 1.0 tesla can bring out reasonably explicit images of the articular cartilage. However, clinicians should be aware that MRI tends to underestimate articular chondral lesion size compared to intraoperative arthroscopic findings after cartilage debridement. This should be considered when surgeons plan treatment strategies.

The main factor is the appropriate MRI sequence, which can only be chosen when the clinical objectives are precisely described.

The most widely used MRI cartilage-sensitive sequences are fast spin echo (FSE) and 3D fat-suppressed gradient echo (GRE). T2-weighted FSE sequence is accurate in detecting intrachondral pathologies and tissue structure abnormalities and has some additional advantages: high-spatial resolution images, low artifact sensitivity, and short scan time. 3D GRE sequences highlight cartilage surface and thickness; they are characterized by higher out-of-plane resolution and contrast-to-noise resolution than 2D images and allow for volume measurements [10, 11]. Magnetic resonance arthrography can reveal minimal fibrillation or fractures of the articular

surface, and it is particularly useful in defining the integrity of the interface between native cartilage and repair tissue. Other isotropic 3D-GRE-based acquisitions have been recently developed [12]: fast low-angle shot (FLASH), volumetric interpolated breath-hold examination (VIBE), and sampling perfection with application optimized contrast using different flip angle evolutions (SPACE). They can potentially be promising in cartilage imaging, providing high-resolution images of the cartilage and the surrounding tissues, with a voxel (volumetric picture element) size inferior to 0.5 cm^3 for 1.5 Tesla.

MR imaging should focus on the following pathologies:

- Characteristics of the cartilage defect (size, depth, localization)
- Status of the subchondral plate
- Pathologies of the subchondral bone (OCD, edema, bone bruise)
- Secondary pathologies (meniscal tears, ACL ruptures, etc.)

Even if some of those questions will nevertheless be answered during later arthroscopy, MRI remains a useful tool for a detailed therapy planning and enables assessment of the joint status and subchondral structures.

14.2.2 Arthroscopy

Diagnostic arthroscopy is indicated on suspicion of an articular cartilage defect or in persistent, unclear disorders of the knee [13]. It is accepted as the most accurate and reliable method to assess chondral injury size, depth, surface appearance, and location in order to determine therapeutic options. Only arthroscopy enables a direct view of the cartilage surface and palpation of its stiffness with a probe hook. Softening of the articular cartilage and partial delamination can be discovered that way. However, the evaluation of the cartilage quality stays subjective and depends on the surgeon's experience. Objective methods, e.g., near-infrared spectroscopy (NIRS) [14] for intraoperative cartilage evaluation or navigated defect size assessment [15], have not become daily routine in arthroscopy. The probe hook with its defined length can be used for the assessment of the defect size. However, it has been shown that especially smaller defects and inexperienced surgeons are factors that make an overestimation of the cartilage lesion size more likely [16]. However, arthroscopic examination of the knee by experienced surgeons is the gold standard for exact determination of the defect characteristics and is essential in terms of differential diagnosis and classification of a cartilage lesion.

14.3 Rating

14.3.1 Classification

A couple of classifications have been published for the grading of articular cartilage defects, and a few of them are in clinical use. In 1961 Outerbridge et al. introduced the first classification, initially developed to describe cartilage defects behind the patella [17].

- Outerbridge Grade I: Softening and swelling
- Outerbridge Grade II: Fragmentation/fissuring <1/2 in.
- Outerbridge Grade III: Fragmentation/fissuring >1/2 in.
- Outerbridge Grade IV: Erosion with exposed subchondral bone

To address some deficiencies of the existing classification systems, the International Cartilage Repair Society (ICRS) developed a clinical evaluation system [18]. By dividing the articular surface into 21 femoral, 18 tibial, three trochlear, and nine retropatellar zones, it is possible to map chondral lesions precisely. Direct measurement of the size and depth of the defect is also performed and scored. So the International Cartilage Repair Society (ICRS) offers a sophisticated but still pragmatic classification that is increasingly recommended for use [13].

Basically, ICRS distinguishes between osteochondritis dissecans (OCD) lesions and (post) traumatic cartilage defects.

Isolated cartilage defects are classified as follows:

- Grade 0: Normal.
- Grade I: Nearly normal. Superficial lesions, soft indentation (A), and/or superficial fissures and cracks (B).
- Grade II: Abnormal. Lesions extending down to <50 % of cartilage depth.
- Grade III: Severely abnormal. Cartilage defects extending down to >50 % of cartilage depth (A) as well as down to the calcified layer (B) and down to but not through the subchondral bone (C). Blisters are also included in this grade as subgroup (D).
- Grade IV: Severely abnormal. Defects include the subchondral plate (A) and also the adjacent cancellous bone (D) (Fig. 14.1).

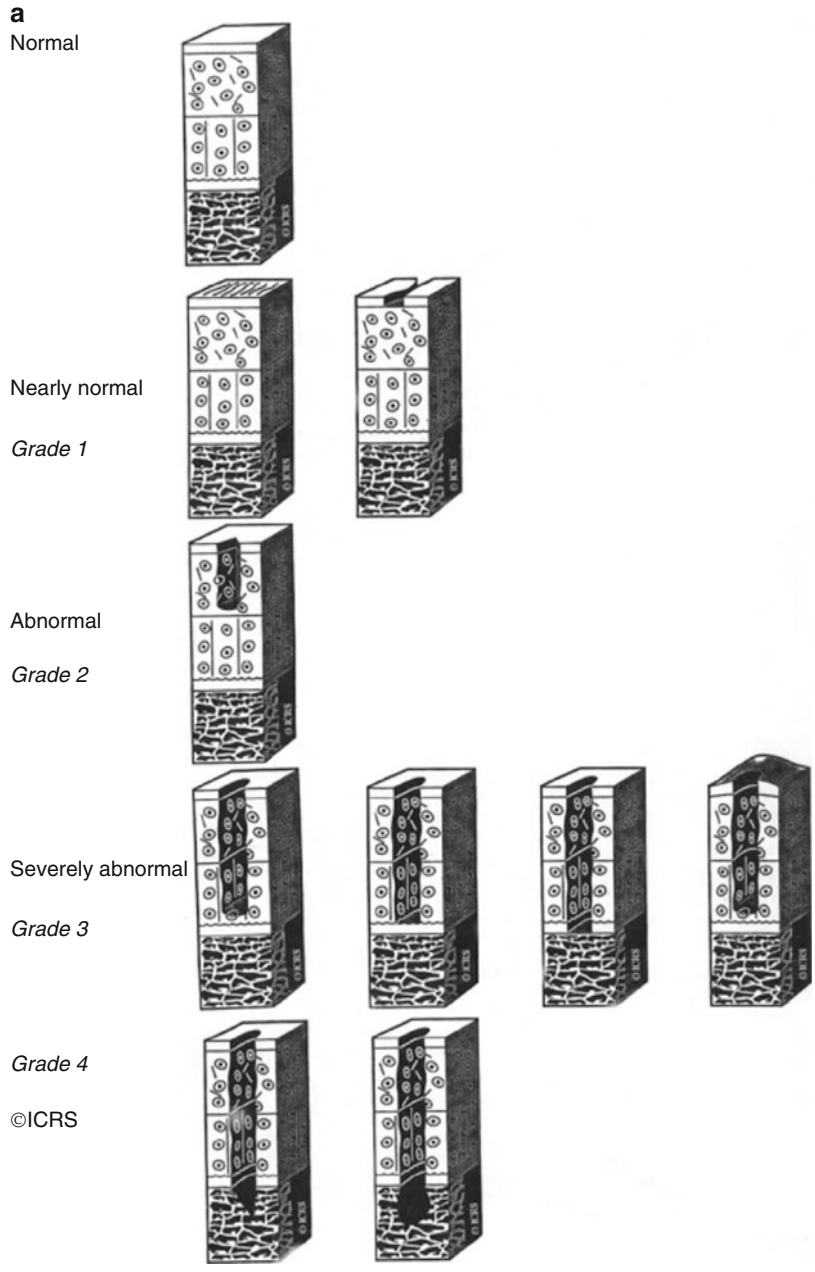
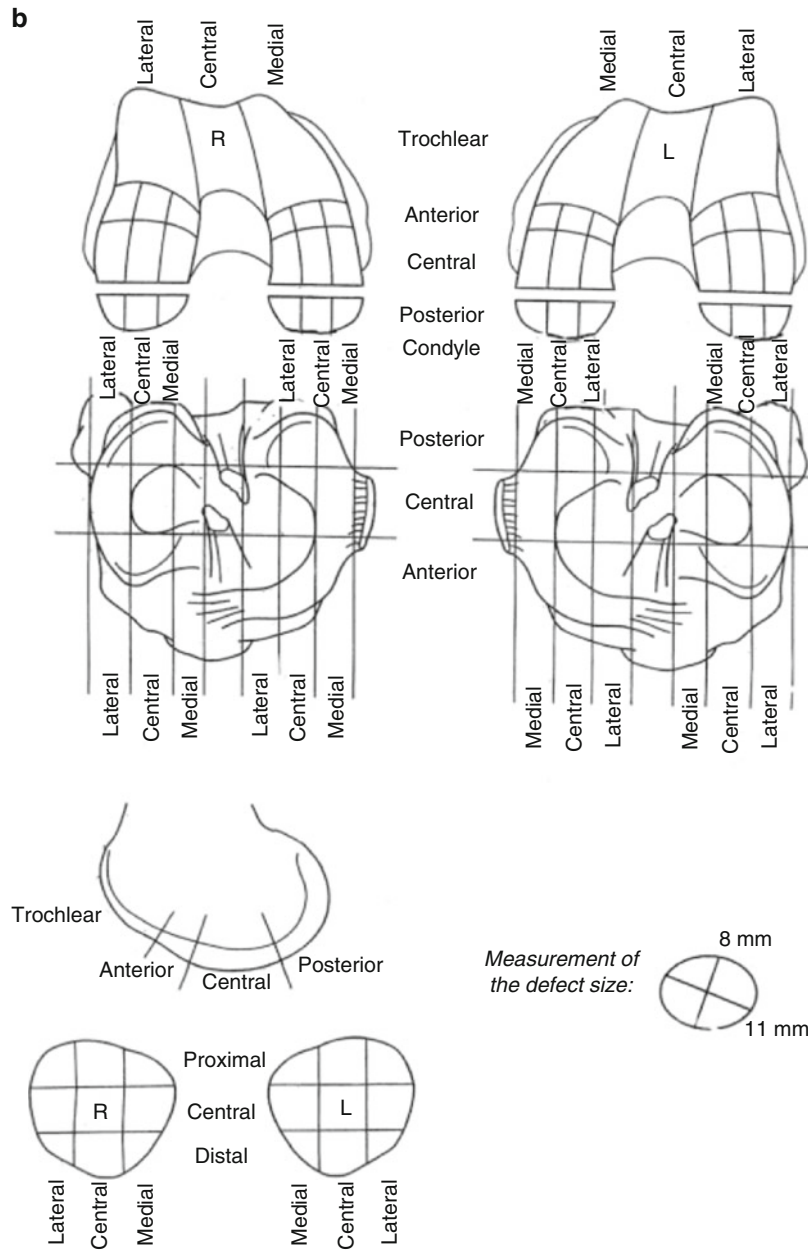


Fig. 14.1 ICRS classification system for cartilage lesions (**a**) and localization (**b**)

Fig. 14.1 (continued)



In the ICRS classification system, OCD is divided into four categories [18]:

- OCDI: Stable continuity, softened area covered by intact cartilage
- OCD II: Partial discontinuity, stable on probing
- OCD III: Complete discontinuity, "dead in situ," not dislocated
- OCD IV: Dislocated fragment, loose within the bed or empty defect

More than 10 mm in depth is B subgroup (Fig. 14.2).

For the juvenile OCD lesions, Hefti et al. (1999) introduced a MRI classification system [19]:

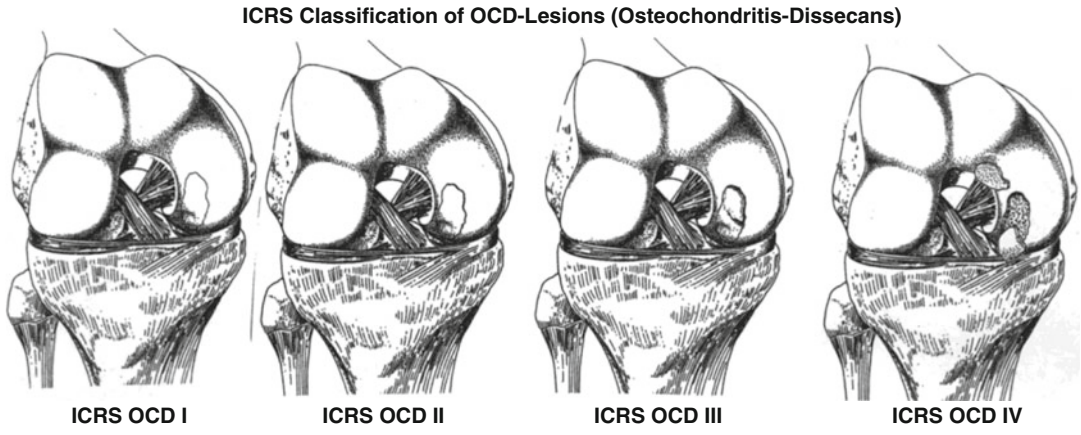


Fig. 14.2 ICRS classification of OCD lesions

- Stage 1: Small change of signal without clear margins of fragment.
- Stage 2: Osteochondral fragment with clear margins but without fluid between fragment and underlying bone.
- Stage 3: Fluid is visible partially between fragment and underlying bone.
- Stage 4: Fluid is completely surrounding the fragment, but the fragment is still in situ.
- Stage 5: Fragment is completely detached and displaced (loose body).

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