

Osteochondritis dissecans of the knee

Anatomy & Pathophysiology

BONY ANATOMY

- The medial femoral condyle is larger and projects farther posteriorly and distally than the lateral femoral condyle [10].
- The lateral femoral condyle projects farther anteriorly and is wider in the medial-lateral direction than the medial femoral condyle [10].
- The sulcus terminalis is a small ridge on the lateral femoral condyle just distal to the intercondylar notch that separates the patellofemoral and tibiofemoral articular surfaces [10].
- The trochlear groove separates the femoral condyles anteriorly and constitutes the patellofemoral articulation [10].
- The intercondylar notch is of variable width and is the site of attachment of the cruciate ligaments [10].
- The medial tibial plateau is larger than the lateral plateau and is concave in its frontal and sagittal planes [10].
- The lateral tibial plateau is smaller and more circular than the medial plateau, concave in the frontal plane, and convex in the sagittal plane [10].
- The patella is the largest sesamoid bone in the body with an average thickness of 2.5 cm [10].
- The patellar articular surface contains a vertical central ridge that separates the broader lateral facet from the medial facet, and a smaller, more medial facet called the odd facet [10].
- The posterior slope of the tibial plateau averages 10.7° in the medial plateau and 7.2° in the lateral plateau [14].
- The medial compartment has a large surface area containing a convex femoral condyle and concave tibial plateau [14].
- The lateral compartment has a smaller surface area than the medial compartment and contains a convex femoral condyle and convex lateral plateau in the sagittal plane [14].
- The fibular head is located a mean of 1.5 cm distal to the joint line, with a range of 6 to 32 mm [14].

VASCULAR ANATOMY

- The blood supply to the knee is formed from an anastomosis around the knee derived from the descending geniculate artery, medial and lateral superior geniculate arteries, medial and lateral inferior geniculate arteries, middle geniculate artery, and anterior tibial recurrent arteries [10].
- The middle geniculate artery supplies both the anterior and posterior cruciate ligaments [10].
- The inferior geniculate arteries pass deep to their respective collateral ligaments [10].
- The blood supply of the patella is derived from the geniculate artery complex with some contribution from the anterior tibial recurrent artery, primarily existing in the middle to inferior portions of the patella [10].
- The middle genicular artery courses anteriorly in the median septum to nourish the tissues of the intercondylar notch of the femur [24].

LIGAMENT ANATOMY

- The anterior cruciate ligament (ACL) travels from the medial border of the lateral femoral condyle to its insertion site anterolateral to the medial tibial spine [4].
- The ACL prevents anterior translation and rotation of the tibia on the femur [4].
- The posterior cruciate ligament (PCL) prevents posterior subluxation of the tibia on the femur [4].
- The PCL runs from the lateral aspect of the medial femoral condyle to the posterior aspect of the tibia, just below the joint line [4].
- The medial collateral ligament has superficial and deep portions that stabilize the knee to valgus stresses [4].
- The lateral collateral ligament runs from the lateral femoral condyle to the head of the fibula and is the main stabilizer against varus stress [4].
- The popliteofibular ligament is present in 90% of knees and runs from the tendon of the popliteus muscle to the styloid on the posterior fibular head [4].
- The ACL is composed of 90% type I collagen and 10% type III collagen [10].
- The mean length of the ACL is 33 mm and the mean midsubstance width is 11 mm [10].
- The femoral attachment of the ACL is a semicircular area on the posteromedial aspect of the lateral femoral condyle, measuring 20 mm long and 10 mm wide [10].
- The tibial attachment of the ACL is a broad, irregular, oval-shaped area measuring 30 mm long and 10 mm wide, located slightly medial and anterior to the midline between the medial and lateral tibial spinous processes [10].
- The PCL has an average length of 38 mm and a mean diameter at the midpoint of 13 mm [22].
- The PCL arises from the lateral aspect of the medial femoral condyle and inserts onto the posterior tibia [22].
- The PCL has two distinct bundles defined by their insertion on the femur: an anterolateral (AL) bundle and a posteromedial (PM) bundle [22].
- The AL bundle of the PCL is larger and comprises 85% of the PCL's cross-sectional area [22].

- The PCL inserts onto a midline depression on the tibia, 10 to 15 mm below the level of the medial and lateral tibial plateaus [22].
- The AL bundle of the PCL occupies the superolateral aspect of the tibial footprint, with the PM bundle occupying the inferomedial aspect of the intercondylar fossa [22].
- Meniscomfemoral ligaments are present in at least one form in 93% of knees [22].
- The meniscomfemoral ligaments connect the posterior horn of the lateral meniscus to the intercondylar notch [22].

MENISCI

- The menisci are C-shaped fibrocartilaginous disks that provide shock absorption, increase congruency between joint surfaces, enhance joint stability, and aid in distribution of synovial fluid [4].
- The medial meniscus is firmly attached to the joint capsule along its entire peripheral edge [4].
- The lateral meniscus is attached to the anterior and posterior capsule, but there is a region posterolaterally where it is not firmly attached [4].
- The medial meniscus has less mobility than the lateral meniscus and is more susceptible to tearing when trapped between the femoral condyle and tibial plateau [4].
- The lateral meniscus is larger than the medial meniscus and carries a greater share of the lateral compartment pressure than the medial meniscus carries for the medial compartment [4].
- The menisci are crescent-shaped, fibrocartilaginous structures with a triangular cross section [14].
- The menisci consist of type I collagen fibers arranged obliquely, radially, and vertically [14].
- The vascular supply of the menisci is derived from the geniculate arteries, which penetrate into 20% to 30% of the peripheral medial meniscus and 10% to 25% of the peripheral lateral meniscus [14].
- The medial meniscus is crescent-shaped and attaches more anteriorly and posteriorly [14].
- The lateral meniscus has a circular shape, covers a larger proportion of the tibial plateau, and has an anterior attachment adjacent to the tibial insertion of the ACL [14].

PATHOPHYSIOLOGY OF OSTEOCHONDritis DISSECANS

- Histologic findings in osteochondritis dissecans (OCD) suggest a failure of ossification secondary to ischemia of the developing cartilage in the epiphysis [9].
- OCD lesions are classically located on the medial femoral condyle, though they may occur in the lateral condyle or the trochlea [9].
- In a large epidemiologic study of OCD lesions in adults, the most common location for lesions was the ankle rather than the knee [1].
- Men had a higher incidence of OCD lesions than women and were more likely to have a lateral femoral condyle lesion [1].
- Juvenile OCD of the knee is a result of failure of the blood supply to growth cartilage and osteochondrosis [15].

- Histologic changes in juvenile OCD lesions are identical to osteochondrosis seen in animals and represent failure of epiphyseal cartilage canal blood supply with ischemic chondronecrosis [15].
- Multiple single-nucleotide polymorphisms may be associated with a genetic basis for OCD [1].
- Vitamin D3 deficiency was associated with high-grade OCD lesions in a review of mostly an adult population [1].
- Patients with OCD had larger tibial spines compared to a control group, whereas intercondylar height was not statistically different [16].
- Playing basketball or soccer was statistically significant for the presence of a trochlear OCD lesion, suggesting repetitive patellofemoral loading may play a role in disease pathogenesis [17].
- Baseball and softball catchers presented at an earlier age and had more posterior femoral condylar involvement compared with noncatchers [18].
- 14.5% of patients with symptomatic discoid lateral meniscus also had a lateral femoral condyle OCD lesion [1].
- Males, younger patients (age 5 to 11 years), and type C meniscal shifts seen on MRI were risk factors for lateral condyle OCD concurrent with discoid lateral meniscus [1].
- Age seems to be a risk factor for instability, with older children more likely to have unstable lesions [9].
- The presence of an underlying high-signal intensity line between the lesion and underlying bone, a cystic area, or a focal articular defect on MRI indicates instability [9].
- MRI alone should not be used to determine lesion stability, as recent studies have reported less specificity and sensitivity than previously thought [9].
- OCD of the knee in children with open physes usually heals when treated with cast immobilization or protected weight bearing [9].
- Lesions with increased size, associated swelling, and mechanical symptoms are less likely to heal [9].
- Specific indications for operative treatment of OCD in children include prolonged pain without evidence of healing during a 6-month period, an unhealed lesion in which symptoms persist after physal closure, a sclerotic lesion in the crater (unstable lesion), and a troublesome loose body [9].
- In skeletally mature individuals, surgery is necessary to evaluate the lesion and implement treatment [9].
- Up to 12 months of conservative treatment might be successful if cyst-like lesions are less than 1.3 mm in length as seen on MRI [9].
- OCD of the knee usually is unilateral and may be painful [9].
- There are no specific physical findings diagnostic of OCD of the knee [9].
- Patients with OCD may complain of pain or mechanical symptoms [9].
- MRI is a highly sensitive method for detection of OCD and can aid in determining if a lesion is stable or unstable [9].
- OCD in children should not be confused with anomalous ossification centers, which may be present in both condyles and in both knees [9].

- Comparison radiographs of the affected and unaffected knees are advised to distinguish OCD from anomalous ossification centers [9].
- MRI findings seem to be different for anomalous ossification centers and OCD [9].
- Whether the lesion is drilled, excised, curetted, replaced and pinned, or bone grafted depends on the size, stability, and weight-bearing nature of the lesion, which can be determined only at surgery [9].

Classification

- MR contrast arthrography (MRA) has been utilized in the evaluation of osteochondritis dissecans [2].
- The value of MR imaging in determining lesion stability and the presence of articular cartilage defects in osteochondritis dissecans of the knee has been established [3].
- MR criteria for the stability of osteochondritis dissecans in the knee and ankle have been reassessed [3].
- Radiographic and MR findings can be used to predict the outcome of untreated osteochondritis dissecans of the femoral condyles [3].
- Wilson's sign has been revisited in the context of osteochondritis dissecans [3].
- Stage-I osteochondritis dissecans can be distinguished from normal variants of ossification in the knee in children [3].
- The arthroscopic classification and treatment of osteochondritis dissecans of the capitellum has been described [3].
- Internal fixation of unstable Cahill type-2C osteochondritis dissecans lesions of the knee in adolescent patients has been reported [3].

Clinical Presentation

EPIDEMIOLOGY AND DEMOGRAPHICS

- In a large epidemiologic study of osteochondritis dissecans (OCD) lesions in adults, the most common location for lesions was the ankle rather than the knee [7].
- In a large epidemiologic study of osteochondritis dissecans (OCD) lesions in adults, men had a higher incidence of lesions than women [7].
- In a large epidemiologic study of osteochondritis dissecans (OCD) lesions in adults, men were more likely to have a lateral femoral condyle lesion [7].

ASSOCIATED RISK FACTORS AND PATHOGENESIS

- In patients with symptomatic discoid lateral meniscus, 14.5% also had a lateral femoral condyle OCD lesion over a 15-year study period [8].
- Males, younger patients (age 5 to 11 years), and type C meniscal shifts seen on MRI were risk factors for lateral femoral condyle OCD concurrent with discoid lateral meniscus [8].

- Multiple single-nucleotide polymorphisms may be associated with a genetic basis for juvenile osteochondritis dissecans [9].
- Histologic changes in juvenile OCD lesions of the knee represented failure of epiphyseal cartilage canal blood supply with ischemic chondronecrosis, identical to osteochondrosis seen in animals [15].
- Patients with OCD had larger tibial spines compared to a control group, while intercondylar height was not statistically different [16].
- Playing either basketball or soccer was statistically significant for the presence of a trochlear OCD lesion, suggesting repetitive patellofemoral loading may play a role in disease pathogenesis [17].
- Children and adolescent baseball/softball catchers presented at an earlier age and had more posterior femoral condylar involvement compared with noncatchers [18].

Investigations

RADIOGRAPHY

- Plain radiographs are appropriate initial imaging studies for most knee conditions because they allow the assessment of traumatic injury, arthritis, patellofemoral alignment, osteochondral injury, bone neoplasm, and surgical implants [7].
- Radiographic studies help confirm the clinical diagnosis of a joint disorder determined using the patient's history and physical examination [7].
- Imaging studies for the knee should include at least two perpendicular views: AP and lateral [7].
- Weight-bearing AP (extension) views are used to assess cartilage loss from the distal femur and tibial plateau [7].
- Weight-bearing PA (Rosenberg; flexion) views are used to assess cartilage loss from the posterior femur and tibial plateau [7].
- Patellofemoral views are used to assess patellofemoral alignment (tilt/subluxation), patellar and trochlear morphology, osteochondral injury, and patellofemoral arthritis [7].
- The notch view is used to assess posterior femoral cartilage, notch width, and osteophytes [7].
- For osteochondral defects, radiography may identify subchondral radiolucency, which is most common in the medial femoral condyle [7].
- Radiographic evaluations are essential when diagnosing an OCD lesion of the knee and elbow [30].
- Supine AP knee radiographs are most frequently used but do not adequately estimate the joint space width [31].
- Plain frontal radiographs of the knee may not accurately display the actual joint space due to different cartilage wear patterns, meniscal integrity, or variances in tibial slopes [31].
- A 45° standing flexion view was introduced to improve evaluation of the joint space [31].
- The fixed flexion view (FFV) technique uses a fixed X-ray irradiation angle of 10° caudal direction with the limb position fixed relative to the cassette [31].

- The Lyon Schuss view (LSV) uses the same posture as the FFV but requires fluoroscopic adjustment of the irradiation angle relative to the medial tibial plateau [31].
- The Lyon Schuss view is more accurate for measuring the actual joint space width than the FFV [31].
- The radiation exposure dose for the Lyon Schuss view is higher than for the FFV [31].
- Positioning for the Lyon Schuss view is more complex and time-consuming than for the FFV [31].
- Goniometer readings of long limb alignment or measured on an FFV correlated well with the angle measured on long limb radiographs [31].

MAGNETIC RESONANCE IMAGING (MRI)

- Advanced radiographic imaging studies may help assess overall limb alignment and further delineate intra-articular and extra-articular soft tissues, including cartilage, menisci, ligaments, tendons, muscles, and nerve and vascular structures [7].
- Increasing strength of the magnetic field (measured in Tesla units) increases the resolution of images [7].
- An injected contrast agent (intravenous or intra-articular) may help delineate specific tissues of interest in MRI [7].
- MRI may identify the degree of articular cartilage injury (chondrosis, full-thickness cartilage loss), the presence of associated bone marrow edema, and the location (medial condyle, lateral condyle, trochlea, patella; anterior, posterior) [7].
- Important aspects of OCD lesions may be better seen with MRI [30].
- MRI is the most useful study for differentiating osteonecrosis from other conditions such as osteochondritis dissecans, transient osteoporosis, bone bruises, or occult fractures [33].
- Bone edema on MRI is a common feature of OA, osteonecrosis, cartilage injury, and transient regional osteoporosis [33].
- Serpentine lesions within a well-demarcated border is a specific finding on MRI for osteonecrosis [33].
- MRI is grossly overused in the arthritic patient population [28].
- If the joint space is significantly narrowed on radiograph, then MRI is not indicated [28].
- MRI is used when osteonecrosis is suspected [28].

COMPUTED TOMOGRAPHY (CT)

- Computed tomography provides a three-dimensional study performed with ionizing radiation that provides enhanced bone detail [7].
- Imaging in the axial, sagittal, and coronal planes may help visualize fracture lines and displacement, osteolytic lesions around joint arthroplasty, and cortical disruption in cases of infection or neoplasia [7].
- Three-dimensional reconstructions may help with preoperative planning for complex intra-articular fractures, multiplanar osteotomy for limb malalignment, and reconstitution of bone loss in joint arthroplasty [7].

- Axial plane imaging of the hip and knee can help assess the rotational alignment of components of a total knee arthroplasty in cases of patellar maltracking [7].
- Three-dimensional CT with remodeling is used for preoperative planning for reconstruction associated with dysplasia, post-trauma planning, and complex total knee arthroplasty (TKA) planning [28].

NUCLEAR MEDICINE

- Nuclear medicine involves labeled radionuclide injection followed by delayed imaging of gamma radiation [7].
- Areas of increased radionuclide concentration appear bright or “hot” on nuclear medicine imaging [7].
- Nuclear medicine provides a nonspecific study that does not define the etiology of an abnormality but rather the presence of an abnormality that may correlate with a clinical concern [7].
- Increased radionuclide activity in bone may be a normal postoperative finding for up to 6 to 12 months after a fracture repair or arthroplasty [7].
- Technetium-99 (Tc-99) is a radionuclide that may help identify infection, neoplasia, occult fracture, bone healing, active phases of heterotopic ossification, implant loosening, or failure of osseointegration [7].
- Gallium-67 (Ga-67) is a radionuclide that may help differentiate between aseptic and septic prosthetic loosening [7].
- 24 to 72 hours are needed for a complete Gallium-67 study [7].

CLINICAL ASSESSMENT CONTEXT

- Physical examination along with radiographic or advanced imaging findings must be used concomitantly to determine the source of each patient’s symptoms and to determine appropriate surgical intervention when nonsurgical measures have failed [6].
- Assessment of the joint must combine physical examination along with radiographic (including full-length alignment views) and MRI findings [34].
- Assessing the potential instability of an OCD lesion is key to early treatment [30].

Treatment

NON-OPERATIVE MANAGEMENT

- In children with open physes, osteochondritis dissecans of the knee usually heals when treated with cast immobilization or protected weight bearing [9].
- Nonoperative treatment should always be considered in patients with open physes [9].
- Specific indications for operative treatment in children include prolonged pain without evidence of healing during a 6-month period [9].
- Specific indications for operative treatment in children include an unhealed lesion in which symptoms persist after physeal closure [9].

- Specific indications for operative treatment in children include a sclerotic lesion in the crater (unstable lesion) [9].
- Specific indications for operative treatment in children include a troublesome loose body [9].
- Up to 12 months of conservative treatment might be successful in skeletally mature individuals if cyst-like lesions are less than 1.3 mm in length as seen on MRI [9].
- Nonsurgical measures for articular cartilage injuries include activity modification, weight loss, nonsteroidal anti-inflammatory drugs (NSAIDs), corticosteroid injections, and physical therapy [6].

OPERATIVE MANAGEMENT

- The choice of surgical procedure (drilling, excision, curettage, replacement/pinning, or bone grafting) depends on the size, stability, and weight-bearing nature of the lesion [9].
- If gross instability is present in children, results are generally better after operative than after conservative treatment [9].
- Lesions with increased size, associated swelling, and mechanical symptoms are less likely to heal with nonoperative treatment [9].
- Arthroscopic débridement is a surgical option for articular cartilage injuries in the knee [6].
- Osteochondral grafting is a surgical option for articular cartilage injuries in the knee [6].
- Realignment osteotomy is a surgical option for articular cartilage injuries in the knee [6].
- Knee arthroplasty is a surgical option for articular cartilage injuries in the knee [6].
- Débridement and chondroplasty are recommended for symptomatic articular cartilage lesions [35].
- Displaced osteochondral fragments can sometimes be replaced and secured with small recessed screws or absorbable pins [35].
- Marrow-stimulating techniques include microfracture, drilling, and abrasion arthroplasty [35].
- Marrow-stimulating techniques involve perforation of the subchondral bone after removal of the “tidemark” cartilage, with eventual clot formation and fibrocartilaginous repair tissue [35].
- Marrow-stimulating techniques result in Type I collagen with inferior wear characteristics [35].
- Good clinical results in small defects (<2 to 3 cm²) are obtained in 60% to 80% of patients undergoing marrow-stimulating techniques [35].
- Osteochondral autograft transfer (OAT) or mosaicplasty can be used to address medium-sized lesions (2–3 cm²) that include subchondral bone loss [35].
- Lateral trochlea and medial trochlea are acceptable harvest locations for osteochondral autografts [35].
- Complications of osteochondral autograft transfer include donor site morbidity [35].
- Osteochondral allograft transplant utilizes cadaveric donor plugs [35].
- Osteochondral allografts can be used for larger lesions (≥ 4 cm²), especially with bone loss [35].
- Main concerns with osteochondral allografts include the small risk of disease transmission and chondrocyte viability [35].

- Osteochondral allografts are ideally used within 14 to 28 days of donor death [35].
- Autologous chondrocyte implantation (ACI) is a two-stage process involving biopsy of the patient's articular cartilage, ex vivo expansion, and subsequent implantation into the defect [35].
- ACI allows for the creation of type II collagen-rich hyaline-like cartilage with minimal type I collagen or fibrocartilage [35].
- ACI is indicated for medium-sized to larger chondral lesions without bony defects [35].
- Complications related to ACI include chondrocyte overgrowth, periosteal flap hypertrophy, and the morbidity of the second surgical procedure [35].
- Condylar lesions undergoing cartilage restoration techniques demonstrate superior outcomes compared with patellofemoral lesions [35].
- For smaller lesions, microfracture, OAT, and ACI have similar recovery periods and functional results [35].
- Variable long-term results are observed following microfracture in high-demand patients [35].
- Age, lesion size, patient's desired activity level, alignment, meniscal integrity, and ligamentous stability must be taken into consideration in selection of the appropriate treatment option for focal cartilaginous lesions [35].
- Concomitant osteotomies to correct malalignment should be considered in the management of focal cartilaginous lesions [35].
- Diffuse chondral damage is a relative contraindication to microfracture, chondrocyte implantation, and osteochondral transfer [35].
- Particulated juvenile cartilage allograft remains investigational [35].
- Retroarticular drilling without bone grafting is a treatment option for stable juvenile osteochondritis dissecans of the knee [3].
- Antegrade drilling is a treatment option for osteochondritis dissecans of the knee [3].
- Bioabsorbable lag screw fixation is a treatment option for knee osteochondritis dissecans in the skeletally immature [3].
- Extraarticular drilling is a treatment option for stable osteochondritis dissecans in the skeletally immature knee [3].
- Extraarticular, intra-epiphyseal drilling is a treatment option for osteochondritis dissecans of the knee [3].
- Lesion fixation using bioabsorbable pins is a treatment option for unstable osteochondritis dissecans of the knee [8].
- Extra-articular retrograde drilling is a treatment option for juvenile osteochondritis dissecans of the knee [8].
- Arthroscopic preparation and internal fixation is a treatment option for an unstable osteochondritis dissecans lesion of the knee [8].
- Retro-articular drilling and bone grafting is a treatment option for juvenile knee osteochondritis dissecans [8].
- The AO hook fixation system is a treatment option for knee osteochondritis dissecans [8].

- Compressive fixation of osteochondritis dissecans fragments with Herbert screws is a treatment option [2].
- Arthroscopic use of the Herbert screw is a treatment option for osteochondritis dissecans of the knee [2].
- Treatment with cannulated screws is a historical treatment option for osteochondritis dissecans [2].
- Autogenous osteochondral grafts (mosaicplasty) are used in the treatment of unstable osteochondritis dissecans lesions of the knee [3].
- Biodegradable rods are used in the treatment of adult osteochondritis dissecans of the knee [3].
- Osteochondral allografts are used in the treatment of osteonecrosis of the knee [2].

Complications

- In a large epidemiologic study of OCD lesions in adults, men had a higher incidence of lesions than women [7].
- In a large epidemiologic study of OCD lesions in adults, men were more likely to have a lateral femoral condyle lesion [7].
- Over a 15-year study period, 14.5% of patients with symptomatic discoid lateral meniscus also had a lateral femoral condyle OCD lesion [8].
- Males are a risk factor for lateral femoral condyle OCD concurrent with discoid lateral meniscus [8].
- Younger patients (age 5 to 11 years) are a risk factor for lateral femoral condyle OCD concurrent with discoid lateral meniscus [8].
- Type C meniscal shifts seen on MRI are a risk factor for lateral femoral condyle OCD concurrent with discoid lateral meniscus [8].
- Histologic changes in juvenile OCD lesions detected in pediatric cadaver knee specimens were identical to osteochondrosis seen in animals [15].
- Juvenile OCD lesions represent failure of epiphyseal cartilage canal blood supply with ischemic chondronecrosis [15].
- Patients with OCD had larger tibial spines compared to a matched control group [16].
- Intercondylar notch height in patients with OCD was not statistically different from that in the control group [16].
- Playing basketball was statistically significant for the presence of a trochlear OCD lesion [17].
- Playing soccer was statistically significant for the presence of a trochlear OCD lesion [17].
- Children and adolescent baseball/softball catchers presented at an earlier age than noncatchers with OCD lesions [18].
- Children and adolescent baseball/softball catchers had more posterior femoral condylar involvement compared with noncatchers [18].

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