Evaluation and Treatment of Osteochondritis Dissecans Lesions of the Knee

Alvin J. Detterline, MD
Jordan L. Goldstein, MD
John-Paul H. Rue, MD
Bernard R. Bach, Jr, MD

ABSTRACT: Osteochondritis dissecans (OCD) is a condition affecting the subchondral bone of joints with secondary effects on articular cartilage that results in pain, effusions, loose-body formation, and mechanical symptoms. Left untreated, OCD can lead to the development of degenerative arthritis secondary to joint incongruity and abnormal wear patterns. This article discusses the etiology of knee OCD lesions, clinical presentation, proper evaluation, and treatment options. Treatment of OCD may include nonoperative measures or operative procedures ranging from drilling or fixation of fragments to complex reconstruction procedures such as autologous chondrocyte implantation, osteochondral autograft, and fresh osteochondral allograft. Physicians must consider many factors, including the patient’s age and skeletal maturity, as well as size, location, and stability of OCD lesions to determine the proper course of treatment.


INTRODUCTION

Osteochondritis dissecans (OCD) is a relatively common source of knee pain in children and adolescents. Hughston et al.\(^\text{23}\) reported a prevalence of 15 to 21 cases per 100,000. Osteochondritis dissecans is an acquired condition in which the subchondral bone becomes avascular.\(^\text{23}\) If healing does not occur, this bone-cartilage complex can become loose from its osseous bed. This can cause a defect in the articular cartilage and result in loose bodies within the joint, causing pain, loss of motion, destruction of articular cartilage, and further mechanical symptoms from joint pathology. Although OCD most commonly occurs in the knee, it can affect multiple joints including the elbow, shoulder, ankle, and hip.\(^\text{39}\) Osteochondritis dissecans is typically a unilateral condition; however, it may present bilaterally.\(^\text{19}\)

ETIOLOGY

Frequently, the cause of OCD is idiopathic. Etiologic factors for OCD include trauma (either macrotrauma or repetitive microtrauma), endocrinopathies, and vascular insults. Genetic predisposition may play a role, but this is unclear. Notable in cases of OCD is whether the physis of the bone involved is open or closed. If open, the term juvenile OCD (JOCD) is used. Overlap between OCD and JOCD occurs when a lesion first presents with the physis still open and does not heal by the time of physal closure. Juvenile osteochondritis dissecans is believed to be caused by either a macrotraumatic episode or multiple microtraumatic episodes, causing continued stress to subchondral bone and resulting in subchondral stress fractures.

Similar to adult OCD, genetics, endocrine causes, ligamentous laxity (and its associated conditions), and ischemia are possible etiologic factors in JOCD.\(^\text{11,13,19,23,39}\) In 204 patients with JOCD of the knee, Cahill\(^\text{11}\) noted many
did not report a single traumatic episode, but rather noted a long history of sports and exercise. For this reason, Cahill concluded an emphasis on exercise may be a causative factor of JOCD.

Osteochondritis dissecans is seen most commonly in patients between the ages of 13 and 21 years, and the most commonly affected site is the lateral aspect of the medial femoral condyle, accounting for 70% to 80% of OCD lesions. The lateral femoral condyle is involved in only 15% to 20% of cases, and patellar involvement is even less common (5% to 10%) (Figure 1). The location of the lesion has a direct effect on the possibility of resulting degenerative changes within the knee joint. Lesions of the medial femoral condyle tend to be located anteriorly and therefore do not usually affect the tibiofemoral articular surface. However, lesions of the lateral femoral condyle tend to be more posterior along the weight-bearing portion of the tibiofemoral articulation; as a result, these lesions can cause degenerative changes within the cartilage (Figure 2). Additionally, OCD of the lateral femoral condyle generally involves a larger area than does OCD on the medial femoral condyle.

**CLINICAL PRESENTATION**

The clinical presentation of OCD of the knee may vary depending on the severity and stability of the lesion. Minimal pain to overt mechanical symptoms such as catching, clicking, or giving way have been reported. Initially, patients may report vague, poorly localized pain around the affected condyle. Symptoms may become mechanical with time as a stable lesion (one that is still attached to the femoral condyle) becomes unstable. Furthermore, effusion may be present depending on the severity and stability of the lesion.

**PHYSICAL EXAMINATION**

The Wilson test has been used to evaluate for medial OCD lesions. This test is performed with an examiner holding a patient's foot in internal rotation with the knee flexed at 90°. The patient then extends his or her leg against resistance. The test is considered positive when the patient feels pain at approximately 30° of flexion. The discomfort is believed to result from impingement of the tibial spine against the lesion. Pain usually is relieved when the leg is allowed to come out of internal rotation. However, a full knee examination still should be performed to evaluate for any other pathology. It has been noted that patients occasionally will walk with the affected extremity externally rotated to relieve pressure on the lesion. In addition, thigh girth atrophy frequently has been noted with OCD lesions secondary to relative disuse.

**DIAGNOSTIC IMAGING**

After the physical examination has been performed, plain radiographs should be obtained. Views include weight-bearing anteroposterior and posteroanterior tunnel views (taken at 45° of knee flexion), as well as lateral and Merchant views. Comparison views in a skeletally immature individual may be useful. The purpose of plain radiographs is to localize the lesion, determine its size, and evaluate the status of the distal femoral physis. Osteochondritis dissecans lesions may or may not be visualized depending on the lesion's stage. A tunnel view best demonstrates the presence of OCD lesions because it permits better visualization of the femoral condyles, which is where most lesions are located. In some cases, a radiolucent line can be visualized between the fragment and femoral condyle; this occurs during advanced stages of the disease. It is important to obtain the tunnel view as lesions may be detected only in this view in some patients.

Often, magnetic resonance imaging (MRI) is the imaging modality of choice in the evaluation of OCD. Magnetic resonance imaging is useful in determining the size and location of a lesion not evident on plain radiographs (Figure 3). It also is helpful in evaluating the condition of the articular cartilage and subchondral bone. Of prognostic importance is the ability of MRI to assess the stability of the OCD lesion. De Smet et al described the following 4 MRI criteria on T2-weighted images for OCD lesions:

- Line of high signal intensity ≥5 mm in length between the OCD lesion and bone.
72% of unstable lesions. This finding has both prognostic and treatment value, as stable and unstable lesions have differing outcomes and surgical options.

Another available but less frequently used imaging modality is technetium bone scans. Increased blood flow on quantitative technetium scans has been believed to be indicative of healing lesions; however, some problems exist with this test. The isotopic tracer remains in the area in question for a significant length of time, which makes interpretation difficult. In addition, Paletta et al. reviewed qualitative bone scans in a small series of patients and found that increased activity predicted healing in 100% of patients with open femoral physis but not in adolescents with closing physis. Unfortunately, this latter group represents the patients in whom it is most difficult to characterize whether healing will occur with nonoperative treatment alone.

Recent advances in arthroscopy have improved the ability to diagnose, stage, and treat OCD. However, orthopedic surgeons must be careful to not be misled by an intact-appearing articular surface over a suspected OCD lesion; arthroscopy should be used in conjunction with other diagnostic modalities to gain a full picture of the problem. Guhl was the first to arthroscopically classify osteochondritis dissecans lesions using the following system:

- Category 1: intact lesions.
- Category 2: lesions with early separation.
- Category 3: partially detached lesions.
- Category 4: crater lesions with or without loose bodies.

**TREATMENT OPTIONS**

**Stable Lesions**

Stable OCD lesions do not have a propensity to displace by definition and thus can be treated more conservatively initially. They are more likely to heal spontaneously and less likely to cause further damage to the lesion or to the remaining articular cartilage. Therefore, nonoperative management may be the initial treatment of choice in addressing these lesions. If spontaneous healing does not occur even after mechanical stresses have been reduced by either restricted weight bearing or activity modification, arthroscopic-guided drilling may provide stimulation of the underlying subchondral bone to promote healing of the lesion (Figure 4).

**Nonoperative Treatment.** Nonoperative treatment initially is considered for younger patients, especially the skeletally immature, who have evidence of stable lesions on both physical examination and radiographic imaging. Nonoperative treatment should not be considered for unstable lesions or loose bodies regardless of patient age.
because of the risk of further damage to the unstable fragment or the surrounding articular cartilage. Nonoperative treatment may range from activity modification to limitation of weight bearing. Patients should be restricted to a point at which they are no longer symptomatic. Physical therapy with emphasis on range of motion and strengthening exercises can be initiated as symptoms improve. Prolonged immobilization and restricted weight bearing can lead to increased stiffness, muscle atrophy, and cartilage degeneration, and thus is not considered appropriate treatment. The duration of nonoperative treatment is unclear but probably should not be continued beyond 6 months without strong evidence of significant clinical or radiographic healing.

The results of nonoperative treatment vary depending on patient age and the location of the lesion. Yoshiida et al reported on 51 knees that were diagnosed and treated before skeletal maturity. After mean follow-up of 11.5 years, they found an overall 81% good clinical outcome with conservative treatment consisting of restriction of sporting activities without immobilization or change in weight-bearing status. However, the location of the lesion did affect the success rate; they reported only a 55% good clinical outcome in lesions located on the intercondylar medial condyle compared with 89% on the lateral condyle and 100% on the inferocentral me-
radiographic healing in 30 skeletally immature knees at an average of 4.4 months, and Aglietti et al. and Bradley and Dandy reported 95% and 82% radiographic healing, respectively.

In studies that included skeletally mature patients, those with closed physis tended to have poorer results. Anderson et al reported 18 of 20 immature knees had radiographic evidence of healing, whereas only 2 of 4 mature knees had a similar finding. In their study on 51 adolescent knees, Flynn et al. found transarticular drilling was effective in 83% of patients with open physis compared with only 75% with closed physis. They identified nonclassic lesion location, multiple lesions, and underlying medical conditions as factors associated with inadequate healing.

Thus, drilling is an effective treatment option for stable OCD lesions, especially in patients with open physis who tend to have greater healing potential. Care should be taken not to dislodge the stable fragment when approaching the lesion either from a transarticular or transphyseal approach. Postoperatively, patients should remain touch-down weight bearing for 4 weeks to allow for fragment healing to occur and then slowly progress to unrestricted activity by 4 to 6 months provided patients remain asymptomatic.

**Unstable Lesions**

*Nonoperative Treatment.* In general, nonoperative treatment of unstable OCD lesions is not recommended. Conservative management places an unstable but salvageable lesion at risk for further fragmentation and an unsalvageable lesion at risk for creating a loose body with the potential to cause greater damage to the remainder of the articular surface (Figure 4).
Operative Treatment. Regardless of age, patients with clinical or radiographic evidence of unstable OCD lesions should be treated with operative intervention. An unstable OCD lesion should be classified as either salvageable or unsalvageable. A salvageable lesion is one that has the potential for healing to the remainder of the subchondral bone and recreating a congruous articular surface. In these cases, the OCD is usually a flap lesion in which the osteochondral fragment is only partially displaced from its subchondral bed. An unsalvageable lesion is one that either cannot be fixed to its subchondral bed because of fragmentation or would result in an incongruous articular surface because of excessive gapping between the fragment and the remainder of the articular surface. In either case, the goal of operative intervention is to restore an even articular surface with either the native fragment in a salvageable lesion or a reconstructive or reparative option for an unsalvageable lesion.

Fragment Excision. One treatment option that has been used for unstable OCD lesions is simple fragment excision (Figure 5). This usually can be done arthroscopically, and if mechanical symptoms are present, fragment excision can provide excellent initial pain and symptom relief. However, because OCD lesions typically occur in a young patient population, one must consider the long-term effects of an uneven articular surface in the development of premature osteoarthritis.

Wright et al.13 reviewed 17 patients who underwent OCD fragment excision at an average follow-up of 8.9 years. Sixty-five percent of patients had a fair or poor result, and 15 of 17 had radiographic changes ranging from early to severe joint-space narrowing. They postulated longer follow-up in a young patient group (average age = 26 years at time of excision) would lead to even poorer outcomes. Similarly, Anderson and Pagnani2 looked at 20 lesions treated with excision at an average follow-up of 9 years and found 75% of patients had either a fair, poor, or failed result.

Thus, even the intermediate follow-up of fragment excision for the treatment of OCD lesions is less than encouraging, and even poorer results can be anticipated after longer follow-up. Fragment excision simply prevents future propagation of the cartilage injury and does not attempt to restore the normal articular congruity of the knee. It should not be used alone unless patients have a low functional demand status or are unwilling to commit to the extensive postoperative rehabilitation protocol necessary with other procedures that attempt to recreate joint congruity.

Fragment Fixation. In cases in which the OCD lesion is salvageable, in situ fixation offers the advantage of preserving native hyaline cartilage. This frequently can be approached arthroscopically (Figure 6) to avoid the added morbidity of an open procedure (Figure 7). Stable flaps are gently debrided until a congruous articular surface is obtained. In cases of unstable or displaced flaps, the bony bed is debrided free of granulation tissue and sclerotic bone to allow for adequate reduction of the fragment. If bone defects are identified, iliac crest autograft can be used as an augment to support the reduced fragment and
prevent subsidence. Marrow stimulation through tran-
articulat drilling often is used to promote an aggressive
healing response.

The fragment is secured via fixation with cannulated
screws, Kirschner wires, Herbert screws, or biodegradable
rods (Figure 8). The advantage of screw fixation is that it
applies compression to the fragment to promote union;
thus, we recommend Herbert screw fixation. In cases of
metallic implants, a second procedure may be required
to remove the fixation after radiographic signs of healing
have occurred if the implants are not well buried below
the articular surface. However, we recommend removal
of metallic hardware to prevent the risk of loosening or
backing out of screws, which may lead to articular car-
tilage damage. Postoperatively, patients are treated with
touchdown weight bearing for 6 to 8 weeks, with return
to unrestricted activity reserved until clinical and radi-
ographic signs of fragment union are apparent.

The results from in situ fixation generally have been
rather good because if union is obtained, native hyaline
cartilage is preserved, injury propagation is prevented,
and joint congruity is obtained. Anderson et al. 19 reported
16 of 17 knees treated with open arthroscopy, curettage,
autologous bone grafting, and Kirschner wire fixation had
evidence of radiographic union, and 11 of the 17 knees
had a good or excellent clinical result at 5 to 7 years of
follow-up. Lindholm et al. 20 reported good or excellent
results in 15 of 20 patients treated with autologous cortical
bone peg fixation at 5 years of follow-up. Gillespie and
Day 21 reported good or excellent results in 16 of 17 pa-
patients at an average follow-up of 3.2 years. However,
autologous bone peg fixation does have the added downside
of donor-site morbidity.

With arthroscopic techniques, even better results have
been reported. In skeletally mature patients treated with in-
situ fixation via biodegradable pins, Dervin et al. 16 report-
ed 8 of 9 knees had radiographic signs of union and 7 of 9
had good or excellent results at 33 months of follow-up. In
their study, Cugat et al. 15 reported 93% good or excellent
results in 15 knees treated with arthroscopically placed
cannulated screws. In this case, however, a second opera-
tion for screw removal was required. Johnson et al. 22 re-
viewed 35 knees treated with metallic compression screw
fixation. They reported 94% were thought to be healed at
second-look arthroscopy for screw removal (8 weeks).
They also reported 84% good or excellent results at an
average follow-up of 3.3 years. On the basis of these reports
with encouraging results, in situ fixation should be used if
possible to restore articular congruence and preserve na-
tive hyaline cartilage.

Unsalvageable Lesions

Unfortunately, articular congruity cannot be restored
in all cases secondary to fragment comminution or de-
struction. Because of the generally young age of the OCD
patient population, there is significant concern for the de-
velopment of premature osteoarthritis in an incongruous
knee joint, and newer techniques have been developed to
combat this difficult problem. These techniques vary from
reparative techniques aimed at creating fibrocartilaginous
fill in the chondral defect to restorative techniques that
attempt to recreate normal articular hyaline cartilage.
Re-
parative techniques such as microfracture and autologous
chondrocyte implantation address only chondral lesions
and do not solve the problem of subchondral bone loss,
whereas restorative techniques (osteochondral grafting)
allow both chondral and bony deficits to be addressed.

Microfracture. Microfracture is a marrow-stimulating
technique in which an arthroscopic awl is used to create
small perforations in the subchondral bone. Pluripotent
stem cells from the bone marrow are released into the
chondral defect, which can then differentiate and create
a fibrocartilage cap. 40 The use of this technique for the
treatment of OCD lesions is selective. The underlying
subchondral bony bed may not be preserved in unsalvage-
able OCD lesions, and thus microfracture may not be in-
dicated in lesions with significant bone loss. In addition,
fibrocartilage has been shown to have inferior wear prop-
erties compared with native hyaline cartilage 9 and thus
may degenerate over a shorter period of time than normal
articular cartilage in such a young patient population. In
cases of larger lesions, degeneration may occur even more
rapidly.

No published studies have looked at the use of micro-
fracture specifically for the treatment of OCD. There
are numerous studies available that report varying success
rates in patient populations of mixed etiologies. For ex-
ample, in a prospective cohort study, Mithoefer et al. 15 re-

Figure 7. Intraoperative photograph showing an unstable
lateral femoral condyle osteochondritis dissecans lesion
with open reduction and internal fixation using mul-

ported good or excellent clinical results in 67% of 48 patients at a minimum of 2 years of follow-up. Furthermore, in 24 patients who had follow-up MRI, they reported 54% patients had good repair tissue fill of the chondral defect and 29% had moderate fill. Unfortunately, long-term results are needed to establish the efficacy of microfracture in the select group of OCD patients with no significant bone loss in whom the treatment may be indicated.

Autologous Chondrocyte Implantation. As with microfracture, autologous chondrocyte implantation is a technique that relies on the presence of an intact subchondral bony bed and should not be used for OCD lesions with significant bone loss unless bone grafting also is performed. The technique is a 2-stage procedure whereby a small sample of normal hyaline cartilage is harvested arthroscopically from a nonweight-bearing portion of the knee. Those chondrocytes then are cultivated in a laboratory. A second procedure, involving an arthrotomy, is required to harvest a periosteal flap from the tibia to seal the debrided chondral defect and allow the chondrocytes to be injected into a contained space.8 The goal of autologous chondrocyte implantation is to fill the chondral defect with more hyaline-like cartilage than would be achieved with microfracture to provide a more resilient cartilage fill.

There are conflicting reports in the literature regarding the histologic composition of the cartilage produced from autologous chondrocyte implantation. Britberg et al8 found hyaline-like cartilage in 11 of 15 patients treated with autologous chondrocyte implantation. Meanwhile, Knutsen et al30 reported no significant histologic difference in a randomized trial comparing autologous chondrocyte implantation with microfracture. Therefore, the theoretical advantage of creating a more durable articular surface with autologous chondrocyte implantation remains controversial.

There also are conflicting reports in the literature regarding the efficacy of autologous chondrocyte implanta-
tion in patients with mixed etiologies. However, in their study, Peterson et al. examined the results of autologous chondrocyte implantation treatment specifically for OCD lesions at 2 to 10 years of follow-up. Sixty percent of the 58 patients treated had juvenile-onset OCD and the average age at surgery was 26.4 years. The average lesion size was 5.7 cm. After mean follow-up of 5.6 years, 91% of patients had a good or excellent clinical result. In addition, 22 patients underwent second-look arthroscopy, which confirmed the excellent macroscopic appearance of the cartilage at the repair site. Thus, autologous chondrocyte implantation remains an encouraging treatment option for OCD lesions without significant bone loss. Long-term studies are required to evaluate its longevity.

**Osteochondral Autograft.** Osteochondral autografts involve the transfer of an intact hyaline cartilage-subchondral bone complex from a non-weight-bearing portion of the knee to the OCD defect. The osteochondral plugs are usually press-fit into the defect. In cases of larger lesions, multiple plugs may be harvested to fill the defect in a mosaic-like pattern (mosaicplasty). The advantages of osteochondral autograft transplantation include a single-stage procedure that is performed arthroscopically, the use of hyaline cartilage with its superior mechanical properties to fibrocartilage, and the ability to address both subchondral bone loss and articular cartilage defects. The disadvantages to the procedure include donor-site morbidity from the intercondylar notch or lateral trochlea where the osteochondral plugs are taken, size mismatching, and the limited surface area available for harvesting.

The use of osteochondral autografts for the treatment of OCD lesions was first described in 1985 by Yamashita et al., who reported clinical success in 2 patients with slight irregularities seen at the graft site on plain radiographs. Since then, more encouraging results have been reported but no studies have looked specifically at the use of osteochondral autografts for the treatment of OCD. Hangody et al. described 91% good or excellent clinical result in 57 patients with >3 years of follow-up. In a later follow-up study, Hangody and Fules described their 10-year experience with 831 osteochondral autografts in which they reported good or excellent results in 92% of patients with femoral condylar lesions; only 3% of these patients had donor-site pain. They also noted 69 of 83 patients followed arthroscopically had congruent joint surfaces and histologic survival of the transplanted cartilage. Marccoli et al. reported on 13 patients with a femoral defect >1.5 cm² treated with an osteochondral autograft. After mean follow-up of 61.5 months, 12 of the 13 patients were able to resume their previous activity levels and demonstrated radiographic signs of graft integration. Although long-term results have yet to be reported, autologous osteochondral transplantation presents an interesting and exciting treatment option for the treatment of OCD lesions with both cartilage and bone loss; however, more studies are needed to assess its efficacy for the treatment of OCD.

**Osteochondral Allograft.** In cases of large OCD lesions (>2.5 cm²) in which the amount of autologous graft might not be sufficient, the use of an osteochondral allograft is an option. The advantage of an allograft is the ability to create an exact size match for the lesion without compromising the donor site. Its disadvantages include cost, graft availability, and cell viability, as well as the potential for disease transmission.

Similar to autologous osteochondral grafts, encouraging results have been reported in the literature. Garrett reported on a series of patients with OCD who were treated with osteochondral allografts. Sixteen of 17 patients were asymptomatic at 3.5 years. Similarly, Bugbee reported a 93% clinical success rate (116 of 125 patients) at 4 years of follow-up in patients with femoral lesions of varying etiologies. In cases of OCD, osteochondral allografts are reserved for the treatment of adult patients with large lesions that have both bone and articular cartilage loss.

**CONCLUSION**

Orthopedists must include OCD lesions in the differential diagnosis of adolescents and adults who present with acute and subacute knee pain. Patient workup should include physical examination, radiographic imaging, and consideration of possible knee arthroscopy. The treatment options for OCD are varied, and the factors determining which course to follow include patient age and skeletal maturity, as well as the size, location, and stability of the lesion.

**REFERENCES**

Osteochondritis Dissecans Lesions