OSTEOCHONDRITIS DISSECANS OF THE KNEE

CONQUERING A CHALLENGING ENEMY

– Written by Theodorakys Marín Fermín, Venezuela, Bruno Olory, and Khalid Al-Khelaifi, Qatar

INTRODUCTION

Epidemiology and Clinical Presentation

Osteochondritis dissecans (OCD) is an osteochondral unit disease characterized by the sequestration of subchondral bone and subsequent delamination and instability of the overlying cartilage[1-3]. König was the first to coin the term in 1888 and it has become an increasing cause of knee pain among young patients, with a prevalence of 15-29 per 100,000 population[4,5]. The most commonly affected location is the lateral surface of the medial femoral condyle, followed by the lateral femoral condyle and the patella[6].

OCD diagnosis is more frequent during the second decade of life, as an incidental finding or presenting symptoms during physical activity[1]. It can be categorized as juvenile and adult OCD[7]. Symptoms include pain, joint effusion, locking or catching, and functional impairment, which can be as severe as those presenting patients waiting for a knee replacement[2,8].

Pathogenesis and Natural History

OCD pathogenesis is not entirely understood. Several factors, including biological and mechanical, have been suggested to participate in its development. Genetics, ossification center deficit, endocrine disorders, tibial spine impingement, discoid meniscus, injuries, and overuse remain under discussion as causative factors[1].

The typical evolution of the resulting osteochondral lesion is the natural filling of the defect bed with fibrocartilage, a form of cartilage constituted by collagen type I fibers. However, fibrocartilage mechanical properties lack those of hyaline cartilage[2,9]. Thus, the aim of any treatment in the management of OCD is to preserve a congruent joint with hyaline cartilage and correct alignment to avoid the progression to osteoarthritis[2]. Therefore, successful long-term treatment outcomes of this condition are of paramount importance, considering that OCD predominantly affects children and adolescents[10-12].

DIAGNOSTIC IMAGING

Plain radiographs and magnetic resonance imaging (MRI) studies are essential in diagnosing OCD (Figures 1 and 2), which can be bilateral in 15% of the patients. Anteroposterior, lateral, tunnel, and skyline views compose the battery for examination, the latter when patella involvement is suspected[6].

MRI is the definitive imaging study, as it provides the most information about the lesion, including size, volume, presence of loose bodies, and confirming radiographs findings (Figure 3). The fragment appears as a hypointense image in T1, usually extending to the trochlear notch when affecting the medial femoral condyle, with underlying bone edema. Other findings include a subchondral bone puzzle configuration and spicules corresponding to secondary ossification centers[6].

Furthermore, T2-weighted images are valuable in assessing fragment stability with high sensitivity and specificity in adults[13]. High-signal-intensity rim at the interface and extending through the articular cartilage, fluid-filled cysts underneath the lesion, and a focal defect filled with joint fluid are typical of unstable fragments[13,14].

Additionally, in juvenile OCD, it is reliable assessing the following signs when suspect fragment instability: interface rim with the same signal intensity as joint fluid, a second outer rim of T2-weighted low-signal intensity, or multiple breaks in the subchondral bone plate on T2-weighted MRI[13,15].

CONSERVATIVE MANAGEMENT: THE FIRST-LINE TREATMENT OF STABLE LESIONS

Conservative management remains the first-line treatment for small and stable lesions in young patients. Patient education about disease behavior is of paramount importance, and counseling on the importance of restricting sporting activities[16].

Conservative treatment traditionally consists of activity restriction with or without weight-bearing or immobilization, therapeutic strengthening exercises, and modalities such as external shockwave therapy[16]. A systematic review by Andriolo et al[16] revealed an overall healing rate of 61.4% in patients undergoing conservative treatment. However, high variability among the included studies was noted. They also identified several risk factors that potentially contraindicate conservative treatment, like larger lesion size, more severe stages, skeletal maturity, and older age, as well as the presence of joint effusion or locking. Moreover, according to their findings, the only restriction of sports and strenuous activities seems advantageous over further limitations.

It is advisable to limit running, jumping, squatting, or activities with repetitive and compressive stress on the affected knee until symptoms relief and imaging alterations show healing progress[16].

SURGICAL TREATMENT OPTIONS: AN INSIGHT TO THE ARMAMENTARIUM

Surgical treatment is the preferred approach for symptomatic lesions presenting with joint effusion and locking or catching of the knee[2]. The size and depth of the lesion, patient's age, activity level, and the presence of degenerative changes play a vital role in the decision-making[2,17].

Figure 1: AP X-ray of the knee a skeletally immature patient with a displaced osteochondritis dissecans lesion on the lateral femoral condyle.

Figure 2: AP X-ray of a typical lesion of osteochondritis dissecans in a teenager with closed physis on the medial femoral condyle.

Figure 3: Magnetic resonance imaging sagittal view of a patient with a big and unstable osteochondritis dissecans lesion.

Also, lesions with a higher odd for developing osteoarthritis should be considered individually[10]. The risk is notably higher in those lesions where incongruity is present, such as type III and IV lesions, according to the International Cartilage Regeneration and Joint Preservation Society (ICRS) (Table 1)[2,18].

Table 1

Grade	Description
I	*Stable lesions with a continuous but softened area covered by intact cartilage.*
II	*Lesions with partial discontinuity that are stable when probed.*
III	*Lesions with a complete discontinuity that are not yet dislocated ("dead in situ").*
IV	*Empty defects as well as defects with a dislocated fragment or a loose fragment within the bed.*

Table 1: The International Cartilage Regeneration and Joint Preservation Society osteochondritis dissecans lesion classification[18].

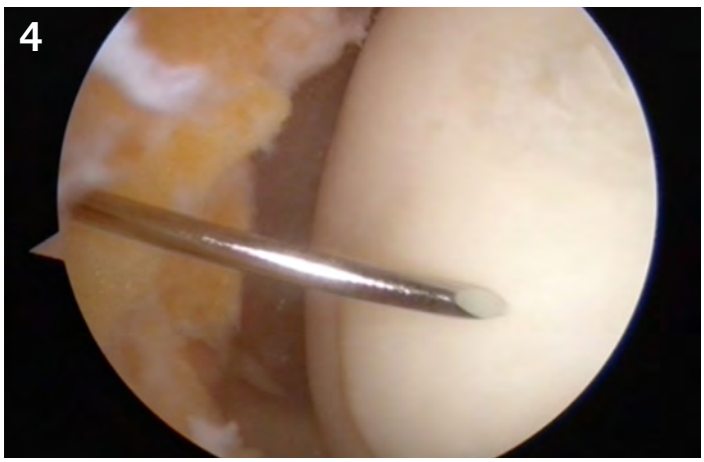
Surgical Procedures

Drilling

Drilling is advisable for stable lesions that failed conservative treatment and OCD ICRS grade I and II lesions[19]. This procedure aims to create bone channels that allow healing of the osteochondral unit above it[6]. There are two techniques, trans-articular and retro-articular drilling. Both methods are satisfactory and have shown good results[20,21]. Kirschner wires can be used for this purpose (Figure 4), with a suggested depth ranging from 18 to 20 mm, if trans-articular. Fluoroscopic control during the procedure is recommended in skeletally immature patients. Postoperatively, non-weight bearing is advisable for 4 to 6 weeks and should be followed by plain radiographs. With proper rehabilitation, patients can go back to normal sports activities within 4 to 6 months post-operatively[6].

Fragment Fixation

Fixation is the first surgical option for osteochondral fragments that are unstable or loose[6]. It has the potential to restore the native cartilage surface and can be performed open or arthroscopically with stimulation of the defect bed[2]. After assessing the stability of the lesion and confirming its instability, it is critical to debride the subchondral bone underneath the fragment (Figure 5). Moreover, if the



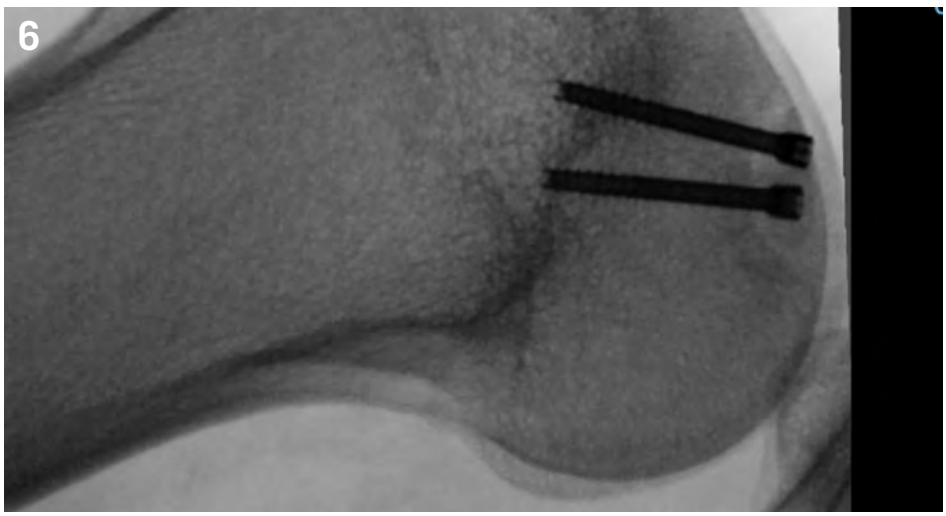


Figure 4: Trans-articular drilling of a stable lesion after careful arthroscopic examination and assessment of the stability of the diseased osteochondral unit.

Figure 5: Arthroscopic examination of ICRS grade III lesion and introducing a shaver just below the diseased osteochondral unit to debride the fibrous tissue until bleeding bone.

Figure 6: Intra-operative fluoroscopy showing the fixation of the fragment with two metallic headless screws.

subchondral bone is scarce, it is essential to bone graft the void previous to reduction and fixation of the lesion[6].

There are several available implants for this purpose, including headless screws, bioabsorbable pins, or nails[2]. Osteochondral autograft plugs harvested from non-weight bearing areas are also among the options to fix the unstable fragment. Several studies have shown the benefit of bioabsorbable and metallic screws (Figure 6)[22,23]. Among the advantages of bioabsorbable screws is that the patient does not need further surgery for hardware removal. Correspondingly, the metallic headless screws allow a better and rigid fixation for the fragment, leading to a higher healing rate (Figures 7 to 10). The patient post-operatively will be non-weight bearing for two months, and if the osteochondral fragment was fixed with a metallic screw, the patient is expected to need another surgery for its removal[6].

According to a systematic review by Leland et al[24], the rate of radiographic healing after fixation in adult OCD ranges from 67%-100%, with satisfactory improvements in Lysholm and IKDC scores. Although, the quality of literature addressing the fragment healing ability in skeletally mature patients remains scarce.

Reoperations are common complications, accounting for up to 44% of loose body removal. Chondral revision and unplanned removal of hardware are also common causes for reoperations[2].

Restorative Procedures

Restorative procedures are indicated when the reparative procedures fail or if the osteochondral unit is not repairable from the start. They depend on the size and location of the diseased cartilage.

Osteochondral Autograft Transplant (OAT) and Mosaicplasty

In OAT, a mature hyaline cartilage local graft is harvested from a non-weight bearing area of the knee and transplanted, providing immediate coverage of the defect area open or arthroscopically. Similarly, in mosaicplasty, many smaller osteochondral grafts are transplanted to fill a cartilage defect[25].

Both techniques have been widely studied and implemented, yielding satisfactory results, especially for OAT. However, as mosaicplasty has been used to treat larger defects, both are not amenable for comparison[26]. It is essential to point out that the reproduction of curved cartilage areas can be challenging, and thus, such procedures should be done by experienced surgeons[27]. Additionally, concerns exist regarding mosaicplasty as the spaces between graft plugs are filled with fibrocartilage[28].

Medium- and long-term results are satisfactory, particularly when patient selection is driven appropriately[2]. Active young males (< 40 years old) with cartilage defects < 3cm² have shown to have the best outcomes[29].

Autologous Matrix-Induced Chondrogenesis (AMIC)

AMIC is a bone marrow-stimulation augmentation procedure in which a scaffold concentrates and distributes the migrating cells, improving the healing of the cartilage defect[2,6]. Randomized controlled trials have demonstrated AMIC to have similar clinical results as bone marrow stimulation alone at a year. However, AMIC results are maintained up to 5-year follow-up with a superior filling of the defect and quantity of hyaline cartilage and only 7% failure compared to 66% in the microfracture group[30,31].

Scaffold versatility lies in the possibility to treat lesions with different sizes and shapes and the lack of need for highly specialized laboratory settings, standing out as a single-stage procedure[2]. Furthermore, newer techniques remove the need to violate the subchondral bone in the form of bone marrow aspirate concentrate[32].

Autologous Chondrocyte Implantation (ACI) and Matrix-Assisted Autologous Chondrocyte Implantation (MACI)

ACI has shown good clinical results and better durability when compared to microfractures[17]. It is a two-stage procedure in which chondrocytes are harvested from a local non-weight bearing zone of the knee and cultured in highly specialized laboratories for a second procedure involving its implantation in the lesion site with or without a scaffold[17].

Conservative management remains the first-line treatment for small and stable lesions.

The characteristics of the new cartilage have been reported to be better than those observed in other bone marrow stimulation procedures[33]. Techniques involving chondrocyte implantation are the preferred method of choice in treating ICRS grade IV full-thickness cartilage injuries and those involving subchondral bone. The latter may benefit from bone grafting and double-layer implementation, the so-called sandwich technique[34].

In a systematic review by Sacolick et al[17] comprising nine studies, they found that patient-reported outcomes after ACI in OCD were significantly better, with negligible complication and failure rates. The lesion size and age of the patient revealed contrasting differences. Outcomes were better in the young population undergoing surgery, contrasting to adults, where surgery was the preferred approach with less satisfactory results.

Costs of restorative procedures are still their main limitation; despite the gathered evidence, its widespread implementation has not been feasible[35-37]. Nevertheless, technical developments have allowed

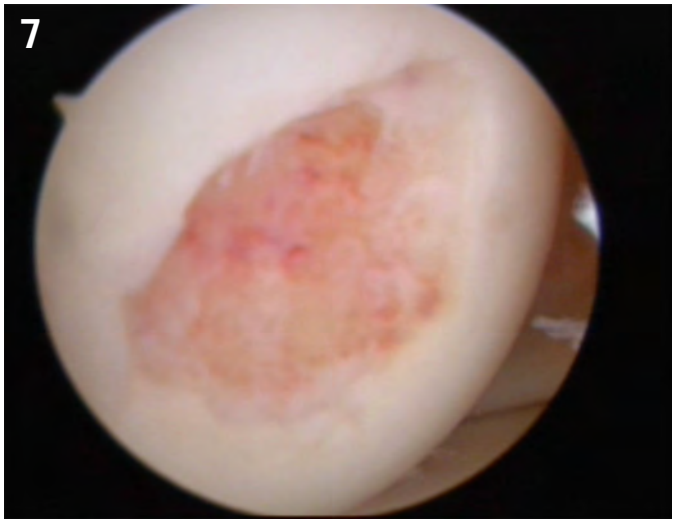


Figure 7: Intra-operative arthroscopic view of a full-thickness lesion at the femoral condyle.

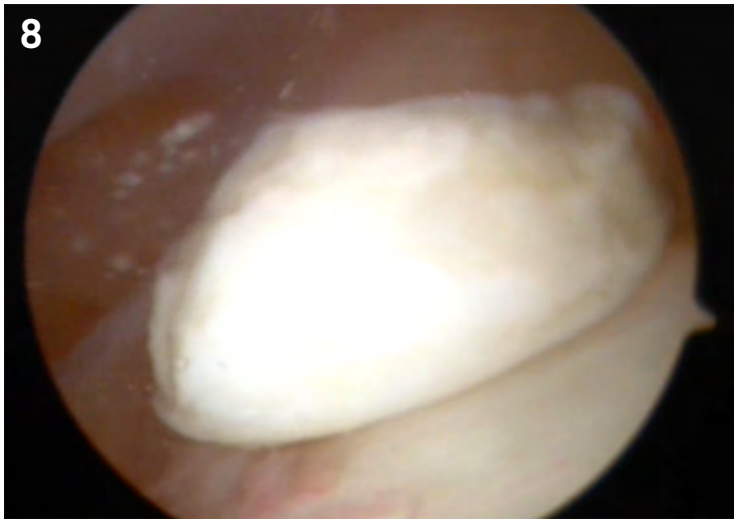


Figure 8: Intra-operative arthroscopic picture showing the detached fragment.

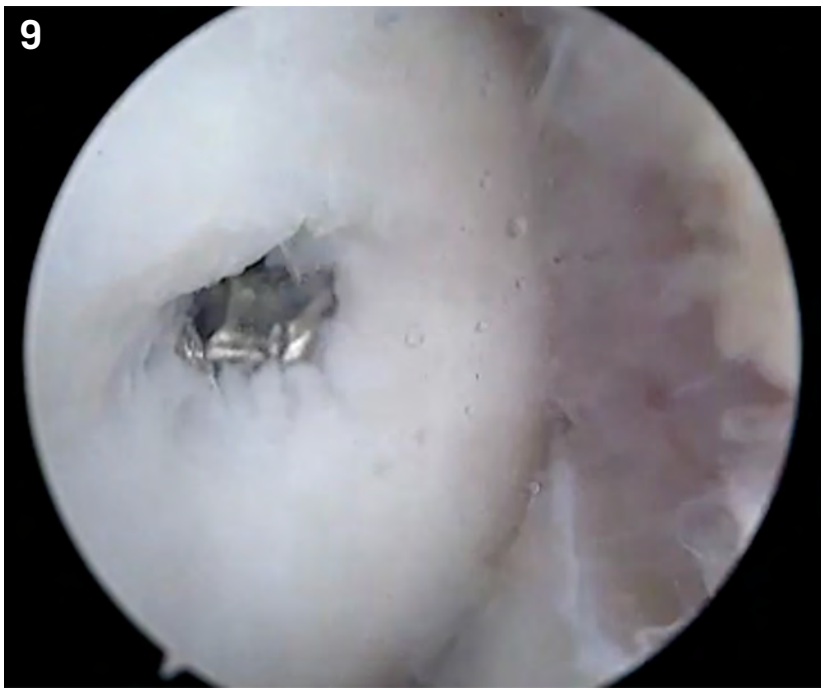


Figure 9: Intra-operative arthroscopic fixation of the detachment fragment to its bed after debridement with two metallic screws.

Figure 10: X-ray showing screws' position just below the open physis in a skeletally immature patient.

Image: Osteochondritis dissecans can be a devastating disease to young athletes. A picture from Aspire Academy where Aspetar Hospital is providing medical care for their young athletes (illustration).

translating the same principles to fast isolation protocols from local cartilage donating areas to allow chondrocyte implantation in a single-stage procedure, allowing comparable results to ACI at a lower cost[38,39].

Osteochondral Allograft

Allograft tissue is also an available option to be considered in larger defects and cartilage revision procedures, yet more as fresh allografts in which superior chondrocyte viability is expected[2,40,41]. It enables the replacement of a pathologic osteochondral unit by competent, viable, and congruent cartilage regardless of its size[3].

Long-term follow-up clinical studies have demonstrated satisfactory outcomes using osteochondral allograft in treating OCD. Sadr et al[42] and Murphy et al[43] case series reported graft survivorship in more than 90% of patients at ten years, with high satisfaction and only 8% of graft failure.

Limitations to this procedure lie in the availability of tissue and government regulations on human tissues. Also, size matching, congruence, viability, and host-donor compatibility are to be considered. Thus, the successful implementation of this technique is limited to a few countries[3].

TAKE HOME MESSAGGE

OCD is a disease of the young population that restricts their activity and leads to undesirable outcomes if not treated or diagnosed early[10-12]. It should be suspected whenever the patient presents to the clinic with knee swelling or mechanical symptoms and not be overlooked[8].

Conservative treatment is the first-line treatment, especially in skeletally immature patients, and surgeons should be vigilant in their follow-up. Also, restricting activities in young patients is difficult, but the patient's family should be involved while this discussion happens in the clinic. Size, location, and bone edema are to be considered when managing activity restriction. Sports activity cessation and a quadriceps-strengthening program is the recommended conservative approach based on the available evidence and should be maintained for six months or upon resolution of primary radiological findings[16].

The final goal of treating this disease is maintaining hyaline cartilage to prevent osteoarthritis in the future[10]. History taking, physical examination, and Imaging modalities can help differentiate between different grades of the disease. The ultimate goal is to give the fragment the chance to heal by drilling or fixing it back to its anatomic position[24,44-47]. If the previous plans failed, surgeons should be familiarized with other restorative procedures. Then, the decision should be based on the size, depth, and location of the diseased fragment.

References
Available at www.aspetar.com/journal

Theodorakys Marín Fermín, M.D.
Orthopaedic Surgeon
Hospital Universitario Periférico de Coche
Caracas, Venezuela

Bruno Olory, M.D.
Orthopaedic Surgeon
Aspetar Orthopaedic and Sports Medicine Hospital
Doha, Qatar

Khalid Al-Khelaifi M.D., F.R.C.S.C.
Orthopaedic Surgeon
Aspetar Orthopaedic and Sports Medicine Hospital
Doha, Qatar

Contact: khalid.alkhelaifi@aspetar.com