

Impaction Bone Grafting for Treatment of Unstable Osteochondritis Dissecans (OCD) Lesions



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Abstract: Although treatment options for unstable and unsalvageable large osteochondral lesions have largely been limited to autologous chondrocyte implantation (ACI) and osteochondral allografts, isolated impaction bone grafting represents a cost-friendly alternative, with predictable outcomes comparable to other options. Furthermore, the procedure can be completed in a single stage on an elective basis. We present our technique for impaction bone grafting of unstable osteochondritis dissecans (OCD) using either cancellous autograft or allograft.

Osteochondritis dissecans (OCD) of the knee is an idiopathic subchondral bone abnormality that initially can cause pain, recurrent effusions, and mechanical symptoms. Ultimately, if neglected, OCD can lead to early osteoarthritis.¹ Although relatively uncommon, with an estimated incidence of ~1 or 10 per 100,000 adults or children, respectively, the disease can be functionally limiting, and treatment can be costly depending on the severity of the initial presentation.²⁻⁴ For stable lesions, asymptomatic lesions, or those that present in pediatric patients with open physes, the mainstay of initial management is observation and activity modification; microfracture is reserved for recalcitrant cases.⁵

Unstable lesions are identified on magnetic resonance imaging (MRI) as lesions with a surrounding linear pattern of high signal intensity, a cystic area beneath the lesion (multiple or size >5 mm), a high-signal intensity line through the articular cartilage, or a focal articular defect (Fig. 1).⁶ These characteristics portend a worse clinical outcome with nonsurgical treatment: The

OCD lesion can dissociate from the native articular surface and cause an intra-articular loose body and a large crater-like defect, both of which can subsequently accelerate the onset of osteoarthritis.³ If the osteochondral fragment is salvageable (i.e., adequate subchondral bone for fixation, lacking fragmentation and with intact articular cartilage), excellent long-term outcomes and healing rates of $\leq 100\%$ have been reported with open reduction and internal fixation (ORIF) of the fragment back to its native location.⁷

Several operative techniques have been developed to address unstable OCD lesions not amenable to repair, including osteochondral autograft transfer (OATS; Arthrex, Naples, FL), autologous chondrocyte reimplantation (ACI), osteochondral allograft, and the matrix-induced autologous chondrocyte implantation (MACI; Vericel, Cambridge, MA) sandwich technique.⁸⁻¹² These procedures are not without their limitations, however. OATS can be used only in patients with small defects (<200 mm²) because of limited available autogenous chondrocytes; ACI and osteochondral allografts are expensive and have conflicting long-term outcome data; and the MACI-sandwich technique requires a 2-stage procedure.¹³⁻¹⁵ Impaction bone grafting is a single-stage, less expensive option that has been shown to have favorable outcomes.¹⁶ Therefore, the purpose of this paper is to describe the technique of impaction bone grafting for treating unstable, large (>200 mm²) OCD lesions.

Surgical Technique

Preoperative patient assessment is critical to identify appropriate candidates for impaction bone grafting of OCD lesions. Patients who will benefit from the procedure are those relatively young but skeletally mature,

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Fig 1. Coronal T2 magnetic resonance imaging image of a right knee in a 17-year-old male with an unstable osteochondritis dissecans (OCD) lesion measuring $\sim 20 \times 16 \times 7$ mm (white arrow). Note the hyperintense signal beneath the lesion, suggesting instability.

with an unstable OCD lesion of ≥ 200 mm², and with no significant underlying pre-existing osteoarthritic changes in the rest of the articular cartilage. Associated pathology, including limb malalignment, patellar mal-tracking, meniscal pathology, or ligament tears, should be addressed at the time of the procedure.



Fig 2. Patient is positioned supine with the knee flexed over a triangle. Landmarks including the patella, patellar tendon, and tibial tubercle are marked to assist with approach.



Fig 3. A high-speed burr is used to remove the layer of sclerotic bone during defect preparation (black arrow indicates the osteochondritis dissecans lesion).

The procedure is performed with the patient under general anesthesia supplemented with a femoral regional block. The patient is positioned supine with a tourniquet applied to the proximal thigh that is inflated only if improved visualization is necessary to complete the case ([Video 1](#)). Arthroscopy is first performed to more thoroughly evaluate the lesion and, if necessary, remove loose bodies or treat other pathology. The knee is flexed over a triangle to allow access to the weightbearing portion of the femoral condyles ([Fig. 2](#)).

Approach

A standard midline incision is used. Depending on the location of the lesion, a medial or lateral parapatellar arthrotomy is performed to gain access to the lesion. The quadriceps tendon is split proximally enough to allow for retraction of the patella and ensure adequate exposure of the entire lesion. Care should be taken to avoid iatrogenic damage to the meniscus when performing the surgical arthrotomy distally ([Video 1](#)). The amount of knee flexion required depends on the location of the lesion: OCD defects involving the posterior aspect of the femoral condyles require increased flexion.

Assessment of the Lesion

Once the lesion is exposed and accessibility is confirmed, the reparability of the lesion is assessed. The



Fig 4. Appearance after defect preparation and microfracture. In this case, a burr was used to violate the base of the osteochondritis dissecans (OCD) lesion to encourage influx of bone marrow elements. Black arrow, OCD lesion; gray arrow, patella; white arrow, patellar tendon.

surgeon should be prepared with appropriate equipment to potentially perform open reduction and internal fixation of the lesion if it appears reparable intraoperatively. The lesion is determined irreparable if the fragment is free-floating or comminuted, appears chronic with sclerotic edges, or has insufficient subchondral bone attached. If deemed not suitable for repair, the fragment is excised from the joint. Ideally, the fragment can be excised sharply in its entirety with a scalpel, but if necessary, it can be removed piecemeal with a rongeur.

Preparation of the Defect

The native bed of the OCD lesion is defined. The sclerotic bone at the base of the defect is removed. Initially, debridement is performed with curettes to remove any fibrous tissue. A high-speed burr is used to remove the layer of sclerotic bone, which can be readily appreciated by the feel and pitch of the burr (Fig. 3). Once the sclerotic bone has been removed and a bleeding base of bone is achieved, an awl or Kirschner wire is used to create a series of microfracture holes in the base of the lesion to stimulate the influx of bone marrow elements (Fig. 4).

Placement of Bone Graft

The prepared defect is filled to the level of the subchondral bone with bone graft, which is tamped into position (Fig. 5). It is essential that the bone graft only

fill the defect to the surface of the surrounding subchondral bone, as the regenerative fibrocartilage will then form superficial to this and flush with the normal articular cartilage. Cancellous autograft from the patient's proximal tibia or iliac crest or allograft cubes can be used based on surgeon and patient preference and comorbidities. Once the bone graft is adequately compacted and fills the defect, the tourniquet is deflated, and the graft is stabilized by applying downward pressure with the volar aspect of the surgeon's thumb for ~5 minutes. The bleeding that occurs acts as a glue to stabilize the graft (Fig. 6). The knee is taken through a range of motion to confirm stability of the graft material.

Postoperative Management

Postoperatively, the patient is placed into a hinged knee brace with passive range of motion exercises, continuous passive motion, and straight leg raises beginning immediately. To avoid shear stress to the developing fibrocartilage layer at the surface of the impacted bone, the patient is non-weightbearing for 6 weeks. Partial weightbearing is initiated gradually, with expectation of progression to full weightbearing by 3 months (Table 1).

Discussion

Several well-documented operative techniques have been described to address unstable OCD lesions with a



Fig 5. Bone graft is impacted into position with use of a tamp. White arrow, bone tamp; black arrow, patella.

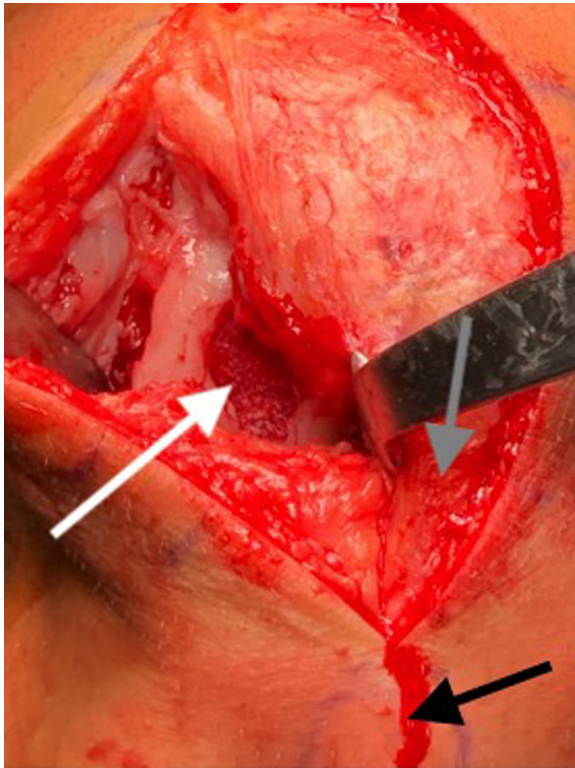


Fig 6. Final appearance with bone graft tamped into place. White arrow, final appearance of OCD lesion with bone graft in place; black arrow, tibial tubercle; gray arrow, patellar tendon.

nonsalvageable osteochondral fragment. In cases with a small residual defect size ($<200 \text{ mm}^2$), OATS has been performed with favorable outcomes but is relatively ineffective in larger lesions, owing to the limited amount of available autogenous cartilage present.¹⁷ Donor site morbidity is also a concern, especially with larger lesion sizes.¹⁸ ACI and osteochondral allografts have been used to address larger lesions with nonsalvageable fragments, although neither procedure has emerged as the gold standard secondary to cost, unknown viability of implanted chondrocytes, limited shelf-life, potential for disease transmission, and multiple or unpredictable surgery dates and delays.^{16,19-23}

In 2005, Bartlett et al.¹² described a 2-stage procedure, the MACI sandwich technique, which involved bone grafting the OCD defect with cancellous autograft or allograft and harvesting chondrocytes in the first stage, followed by a second-stage for reimplantation of the autologous chondrocytes. Subsequently, Gallo et al.¹⁶ reported favorable results of using only the impaction bone grafting aspect of the procedure and never returning for chondrocyte reimplantation. This approach was adopted, in part, due to the marked symptomatic improvement of patients after the impaction bone grafting alone and their desire to not proceed with the anticipated second stage. Of the 7 patients in the cohort, only 3 required additional surgery: 1 to debride

Table 1. Pearls and pitfalls

Pearls	Pitfalls
Be prepared to perform open reduction internal fixation if the lesion appears reparable intraoperatively.	Plunging the knife too deeply when performing the arthrotomy during the approach can lead to iatrogenic meniscal injury.
Address associated pathology, including limb malalignment, patellar maltracking, meniscal pathology, or ligament tears, concurrently at the time of impaction bone grafting.	Overpacking the defect should be avoided because of potential overgrowth of the fibrocartilaginous layer and recurrent pain symptoms.
After the defect is prepared, microfracturing the base of the defect with a burr, awl, or Kirschner wires allows influx of bone marrow elements into the base of the defect.	Failure to debride the sclerotic layer of bone at base of the lesion can hinder healing of bone graft to native bed.
If a tourniquet is used during the procedure, ensure that it is let down immediately after the bone graft is placed in the defect. The bleeding that occurs acts as a glue to stabilize the graft.	Early weightbearing before 6 weeks postoperatively can disrupt the developing fibrocartilage surface layer.

surface overgrowth, 1 who underwent an osteochondral allograft owing to persistent symptoms, and 1 who underwent OATS owing to a recurrent injury 10 years after impaction bone grafting. The remainder did not require a secondary procedure after an average follow-up of 55.4 months, had good/excellent International Knee Documentation Committee results, and had complete MRI fill of the cartilaginous defect with $<50\%$ of surface irregularity. Additionally, Johnson et al.²⁴ reported their results with impaction bone grafting for unstable OCD and osteonecrosis cartilage defects, but they strictly used autograft (no allograft). Of the OCD cohort, all patients demonstrated clinical improvement with long-term follow-up (Table 2).

Overall, there is still no gold standard for treating large, unstable, unsalvageable OCD lesions, but impaction bone grafting (with autograft or allograft) provides a cost-friendly option that can be performed as a single-stage surgery on a specific date with predictable results.

Table 2. Advantages and disadvantages

Advantages	Disadvantages
Lower cost	Does not restore native surface anatomy or restore the hyaline cartilage surface
Single-stage surgery	
Can be used to address larger lesions ($>200 \text{ mm}^2$)	
Surgery can be scheduled in advance	

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