Staging and Practical Issues in Complex Cases

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Introduction

Articular cartilage defects can be debilitating for patients and difficult for an orthopedic surgeon to treat. They often present in a young athletic population after injury but can also occur following chronic mechanical stress causing degeneration or alongside metabolic disorders of the subchondral bone [1]. Because articular cartilage has low regenerative potential, invasive procedure must often be performed to attempt to recreate the articular surface. If left untreated, focal chondral defects can often progress to osteoarthritis. However, many chondral defects are asymptomatic and incidentally found using advanced imaging techniques [1]. Deciding when to intervene and how to approach each individual scenario is what makes these cases challenging.

Surgeons should follow a patient-centered approach to treating cartilage defects as it is important to consider all factors involved, including the defect characteristics, imaging findings, and patient profile and goals. All of these various factors impact the appropriate management strategy that can range from non-operative treatments such as physical therapy and intra-articular injections to operative treatments such as debridement chondroplasty, microfracture, collagen scaffold-augmented microfracture, autologous chondrocyte implantation, osteochondral autograft transplant, and osteochondral allograft transplantation. Additionally, concomitant pathology such as meniscal deficiency or malalignment can predispose patients to failure or recurrence and must be addressed either concomitantly or in a staged fashion. Each therapeutic option can be successful when appropriately used. It is imperative to approach each case from all angles to determine the best option for that specific patient.

Clinical Evaluation and Chondral Defect Diagnosis

Clinical History

A thorough clinical history is critical to providing a patient-centered approach to treatment of articular cartilage lesions. Among the factors important to understand in the patient's history are duration of symptoms (acute or chronic), mechanism of injury (direct trauma, twisting, or insidious), symptom severity, symptom quality (sharp, focal, dull, or diffuse), and associated symptoms (clicking, locking, swelling, or instability). Additionally, paying attention to exacerbating

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factors, functionality, and patient habits can provide a better understanding of the patient's experience.

Patients with symptomatic cartilage lesions will typically have pain that is worse with load bearing and isolated to the compartment containing the chondral defect. Some patients will experience effusions associated with activity, but symptoms do not always correlate with severity of cartilage damage. There is currently no evidence to support the treatment of asymptomatic chondral defects, so clinical correlation with arthroscopic or radiologic findings is critical in the management of these patients.

Patient goals and performance demands are extremely useful in determining appropriate patient-centered management. Return to sport or work versus return to normal daily activities can play a pivotal role in deciding between operative or non-operative management. The authors highly recommend extensive communication between the patient and provider about the goals of therapy to provide mutual understanding and an appropriate management plan.

Physical Exam

Physical examination of the knee in a patient with a suspected cartilage defect should confirm the symptomatic presentation. Thorough examination should begin with observation of gait and any apparent gross muscular deficiencies followed by a complete assessment for pathology and specific muscle imbalances. In particular, malalignment should be assessed as it can place increased forces through a specific compartment and contribute to pathology. Malalignment may need to be addressed surgically to redistribute forces in order to increase chances of a successful outcome and prevent recurrence. Lachman, pivot shift, anterior drawer, posterior drawer, and varus and valgus stress testing should be performed because ligamentous injury and instability can often accompany cartilage damage. Assessing the knee for effusion and range of motion may help identify limitations that point to the severity of intra-articular pathology. Evaluation of the meniscus should also be performed to identify possible concomitant pathology.

Diagnostic Imaging

Imaging techniques are critical in the diagnosis and management of cartilage damage. Radiographs should be used to assess for osteoarthritis as severe osteoarthritis can be a contraindication for many cartilage restoration procedures. This may indicate the need for management via arthroplasty assuming non-operative management has been exhausted. The tibiofemoral joint should be evaluated using weight-bearing anteroposterior and flexion posteroanterior radiographs, whereas the patellofemoral joint is better evaluated with Merchant and lateral views. Weight-bearing full-length extremity radiographs are necessary to evaluate possible malalignment that may require surgical correction via an off-loading osteotomy.

Radiographs have low sensitivity for the diagnosis of focal chondral defects which makes magnetic resonance imaging (MRI) critical in the diagnosis of this pathology. In addition to evaluating the articular cartilage, MRI allows for identification of meniscus or ligamentous pathology in addition to subchondral bone involvement, osteochondritis dissecans, avascular necrosis, and fracture. The size and characterization of focal chondral defects can be evaluated with two-dimensional fat suppression and three-dimensional fast spin echo sequences, while the quality of the cartilage itself can be evaluated with gadolinium enhancement. Despite the utility of these advanced imaging techniques, the findings must be correlated with clinical symptoms, and diagnostic arthroscopy remains the gold standard for evaluation of intra-articular pathology and relating it to patient-specific complaints, symptoms, and signs present on physical examination.

Diagnostic Arthroscopy

Diagnostic arthroscopy and intra-articular debridement is the gold standard for diagnosis of chondral defects and is often the best initial step in the management. In some patients, this procedure may be therapeutic allowing for delayed treatment of the cartilage defect and other comorbidities. In other patients, arthroscopy allows for a thorough intra-articular evaluation of the ligaments, meniscus, and articular surface providing index information for definitive treatment recommendations. During arthroscopy, chondral defect size can be measured and graded based on depth and appearance according to the Outerbridge or International Cartilage Repair Society (ICRS) criteria (Table 10.1, Fig. 10.1), to best determine the appropriate management. The dimensions of the chondral defect should be measured accurately as size plays an important role in determining which treatment options are indicated and most likely to be successful [2]. However, defect size coupled with knowledge of prior treatments, patient goals and expectations, and the status of the subchondral bone will also play pivotal roles in the decision-making related to definitive treatment.

Table 10.1 Chondral defect grading criteria

Outerbridge criteria	ICRS criteria
Grade 0: Normal cartilage	Grade 0: Normal cartilage
Grade 1: Mild cartilage softening or swelling	Grade 1: Superficial lesions, soft indentation, or superficial fissures
Grade 2: Fraying or fissuring extending less than 50% of cartilage depth	Grade 2: Lesions extending less than 50% of cartilage depth
Grade 3: Partial thickness loss with focal ulceration greater than 50% of cartilage thickness	Grade 3a: Lesions extending greater than 50% of cartilage depth
Grade 4: Full-thickness chondral defect with exposed subchondral bone	Grade 3b: Lesions extending greater than 50% of cartilage depth down to calcified layer
	Grade 3c: Lesions extending greater than 50% of cartilage depth down to subchondral bone
	Grade 3d: Lesions extending greater than 50% of cartilage depth with blisters
	Grade 4: Full-thickness chondral defect extending into subchondral bone

ICRS International Cartilage Repair Society

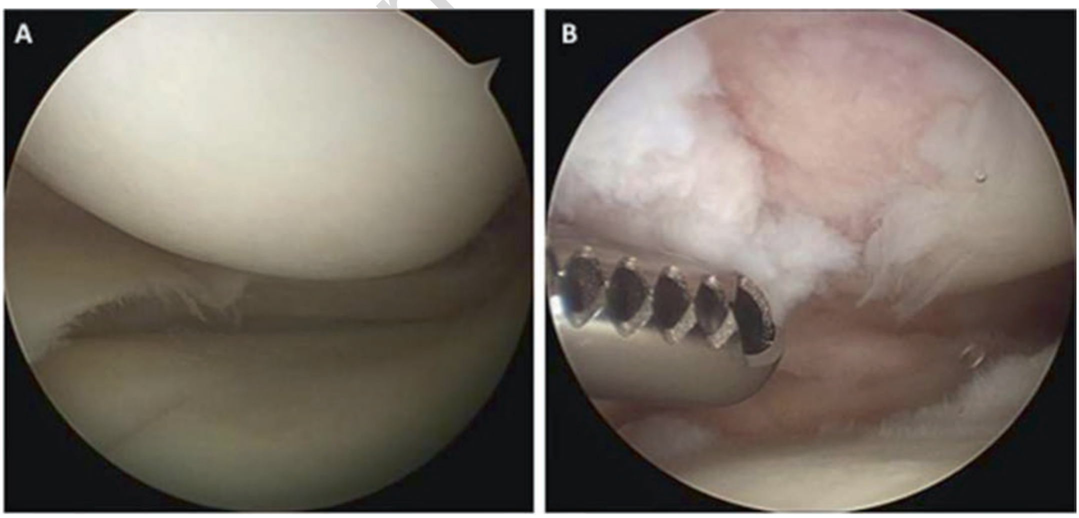

Fig. 10.1 Focal chondral defect. Intraoperative arthroscopic images during left knee arthroscopy demonstrating (**a**) normal cartilage of the medial femoral condyle and a (**b**) grade IV focal chondral defect of the patella with exposed subchondral bone

Factors Contributing to Complexity of Chondral Defect Management

The complexity of cartilage repair and restoration surgery is multifaceted and extends far beyond the technical difficulties of performing procedures such as microfracture, microfracture with collagen scaffold augmentation, autologous chondrocyte implantation (ACI), or osteochondral grafting. The factors contributing to complexity are wide ranging including patient demographics, chondral defect characteristics, and concomitant pathology (Figs. 10.2 and 10.3). In order to provide patients with the greatest chance of a successful outcome, it is necessary to incorporate all of these factors into the decision-making process.

Demographics

The patient presenting with a focal chondral defect has many inherent factors worth considering when determining a treatment plan including age, duration of symptoms, body mass index (BMI), occupation, goals of treatment, and smoking status [3]. Among various cartilage restoration procedures, including osteochondral allografts and autologous chondrocyte implantation, younger age, particularly less than 30 years old, has been associated with better outcomes and lower rates of failure than older patients [4–6]. Additionally, one study reported that patients with a BMI >35 were four times more likely to have unsuccessful outcomes after osteochondral allograft transplantation [7]. In studies investigating the outcomes of ACI and matrix-induced ACI (MACI), longer duration of symptoms has been found to be negatively correlated with successful outcomes [8, 9]. Factors such as these are important to consider because they can help predict which patients will benefit from various forms of management.

Patient occupation or hobbies along with their goals of treatment are critical to determining the appropriate management. Some patients may be looking to avoid surgical management in which case physical therapy, nonsteroidal anti-inflammatory medications, and intra-articular joint injections with corticosteroids, viscosupplementation, or biologics may be the best course of treatment. Additionally, some patients may be professional athletes or highly active recreational athletes looking to return to sport, whereas others may simply hope to return to their normal daily activities. An athlete's joints undergo significant load-bearing stress during sport and may require a more durable treatment than nonathletes. It is important to consider all available factors to determine the best patient-centered treatment plan.

Patients are educated to understand that most treatments might lead to some residual symptoms with higher-level activities. In addition, choosing enduring solutions that can tolerate ballistic activities or collision sports such as isolated osteotomy or osteotomy with osteochondral allograft transplantation and potentially avoiding a meniscal allograft when otherwise required are a consideration at times in higher-level athletes. Ultimately, the greatest challenge is determining the least amount of surgery to encourage a satisfactory outcome and properly match the patient's expectations.

Defect Location

The location of a focal chondral defect greatly impacts the treatment decision-making process. Femoral condyle lesions are the most common types of chondral defects encountered in the knee [10]. These are followed by lesions seen in the tibial and patellofemoral compartments [10]. Given the load-bearing nature of the tibiofemoral compartment, these lesions may require more durable treatment options such as osteochondral allografts, depending on the lesion's other characteristics and the patient-specific factors. Lesions of the patella or trochlea have proven to be a difficult clinical problem due to the complex shape of the patellofemoral articular surface and often concomitant joint instability. While recent studies indicate successful outcomes with osteochondral allograft transplants, there is ongoing discussion regarding management of these lesions with osteochondral

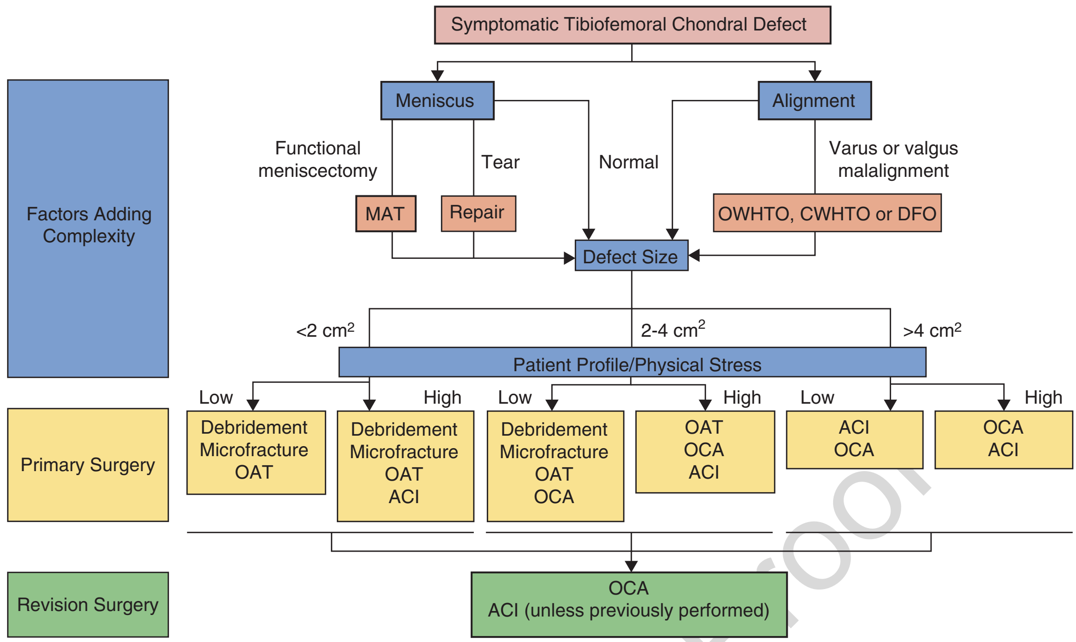

Fig. 10.2 Management of symptomatic tibiofemoral focal chondral defects. Blue represents factors that add complexity to surgical management including meniscal status, coronal plane alignment, patient profile, and, most importantly, defect size. Orange represents procedures that can be performed concomitantly or in a staged fashion to address these factors. Yellow represents primary surgical options based on all factors considered. Green represents options for surgical revision if necessary. OWHTO, opening wedge high tibial osteotomy; CWHTO, closing wedge high tibial osteotomy; DFO, distal femoral osteotomy; OAT, osteochondral autograft transplantation; ACI, autologous chondrocyte implantation; and OCA, osteochondral allograft

allografts due to the difficultly matching the shape of the articular surface [11, 12]. This leads many surgeons to prefer surface allograft transplantation (i.e., ProChondrix, AlloSource, Denver CO; Cartiform, Arthrex, Naples, FL; DeNovo NT, Zimmer/Biomet, Warsaw, IN) or cell-based therapies such as ACI or MACI for management of these lesions. As the literature documenting our real-world experience improves, knowledge of the best treatment modality for each lesion location will likely be elucidated.

Defect Size

Defect size factors into treatment decision-making because the efficacy of various treatments for chondral defects changes depending on the size of the lesion. Small lesions (<2 cm^2) can be managed successfully with an initial debridement with the possible addition of microfracture, which allows the defect to be filled with fibrocartilage. Since fibrocartilage is not as durable as innate articular cartilage, microfracture is less successful when treating larger defects [13, 14]. Depending on other patient factors such as athletic participation, osteochondral autograft may be an appropriate treatment for small defects as well. Medium-sized defects (2–4 cm^2) may have variable outcomes with microfracture treatment and may be better treated with an osteochondral allograft, osteochondral autograft, surface allograft, or even ACI/MACI because they are more durable solutions. Treatment for the largest defects is limited to osteochondral allograft transplant or ACI/MACI due to durability and defect-filling capabilities (Fig. 10.4) [6, 10]. Osteochondral autograft or mosaicplasty is often not an ideal option in these larger defects due to donor site morbidity [15]. As a result, accurate defect measurement complemented by advanced imaging and diagnostic arthroscopy is critical for appropriate surgical planning.

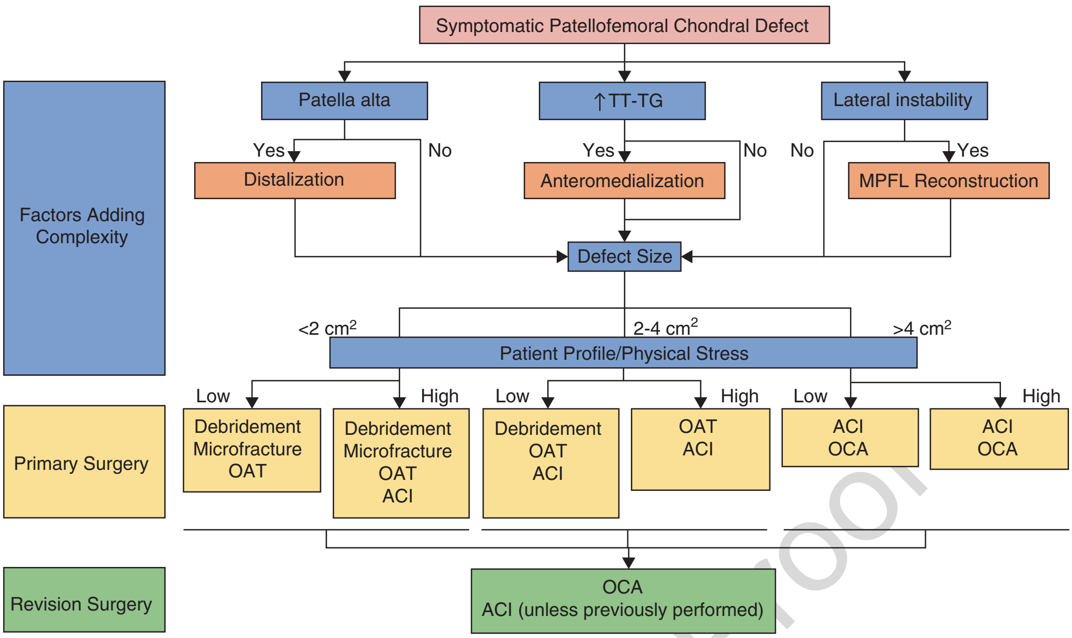

Fig. 10.3 Surgical management of symptomatic patellofemoral focal chondral defects. Blue represents factors contributing to case complexity including patella alta, tibial tubercle to trochanteric groove (TT-TG) distance, lateral instability, patient profile, and, most importantly, defect size. Orange represents procedures that can be performed to address these layers of complexity either concomitantly or in a staged fashion. Yellow represents primary surgical management options given the factors considered. Green represents options for surgical revision if necessary. TT-TG, tibial tubercle to trochanteric groove distance; MPFL, medial patellofemoral ligament; OAT, osteochondral autograft transplant; ACI, autologous chondrocyte implantation; and OCA, osteochondral allograft

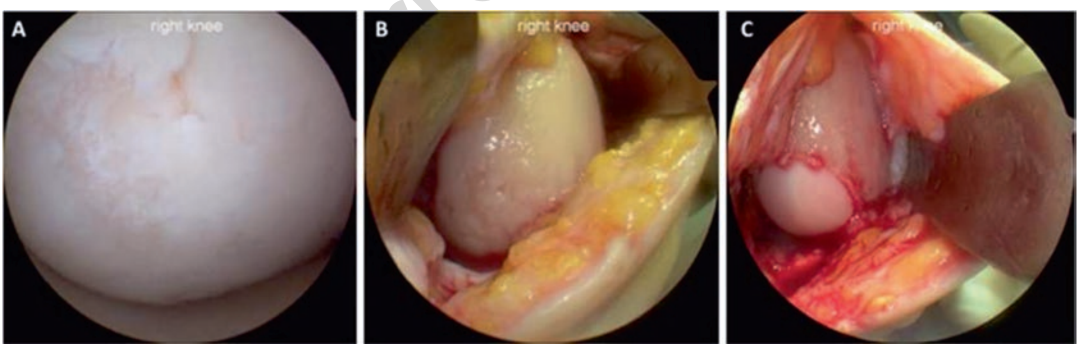

Fig. 10.4 Osteochondral allograft for treatment of large focal chondral defect. (**a**) Right knee arthroscopic intraoperative images of a large area (>4 cm^2) of grade III/IV chondral changes of the medial femoral condyle. (**b**) The same cartilage damage after arthrotomy prior to treatment. (**c**) Large defect of the medial femoral condyle treated with an osteochondral allograft

Bipolar Disease

Bipolar articular cartilage lesions are defined as lesions of reciprocal cartilage surfaces such as the medial tibia and medial femoral condyle or the patella and trochlea. This poses a unique clinical challenge because inadequate treatment can lead to accelerated development of osteoarthritis and definitive treatment options limited to arthroplasty [16]. The management of bipolar chondral defects has been investigated with several treatment options. Gomoll et al. reported significant clinical improvement and no difference in the outcomes between patellofemoral unipolar and bipolar chondral defects treated with ACI [17]. Osteochondral allograft transplantation has been investigated in both the tibiofemoral and patellofemoral bipolar lesions as it provides a location-matched reconstruction of the articular cartilage and subchondral bone. Success rates for bipolar osteochondral allograft transplants range from 40 to 53% with failure rates up to 46% [16]. Bipolar OCA in the patellofemoral joint has a lower failure rate than in the tibiofemoral, likely due to the load-bearing nature of the tibiofemoral joint [16]. Patients with grafts that survive, however, show significant clinical improvement. The high failure rates complicate management of these lesions because the patient is at elevated risk of not improving and being subjected to additional surgery.

Meniscal Deficiency

The meniscus and articular cartilage have a symbiotic relationship that cannot be ignored when managing chondral defects (Fig. 10.5). Intra-articular changes, particularly increased contact pressures and cartilage degeneration over time, have been well documented in the literature when patients are meniscal deficient [18, 19]. If a repairable meniscus tear is present at the time of surgery, the meniscal repair should be performed as part of a combined procedure. If cartilage procedures are performed in patients who are meniscal deficient, those increased contact pressures are applied to the implanted chondrocyte, graft, or developing fibrocartilage which may complicate the outcome. It is therefore critical that a thorough evaluation of the meniscus is performed during preoperative planning to determine if a meniscal allograft transplant is necessary in addition to the cartilage procedure.

Malalignment

Joint malalignment can occur within either the tibiofemoral joint in the form of varus or valgus deformity or the patellofemoral joint with patella maltracking or upstream version abnormalities. Varus or valgus deformity creates an unbalanced distribution of body weight that places increased stress on the medial or lateral compartment, respectively. If malalignment is not addressed, the patient is predisposed to having failure of their cartilage procedure either due to the absence of sufficient symptom reduction or due to catastrophic failure of the cartilage resurfacing procedure [20]. It can be corrected surgically to off-load the joint at the time of cartilage treatment with either a distal femoral osteotomy or high tibial osteotomy (Fig. 10.6). Patellar instability or maltracking becomes particularly problematic during knee flexion such as squatting or climbing stairs of the knee when contact pressures between the patella and trochlea increase. Different factors effecting patellar loading such as patella alta and lateral positioning of patella associated with an increased tibial tubercle to trochanteric groove/posterior cruciate ligament distance can be treated with tibial tubercle distalization or tibial tubercle anteromedialization. At times, the patient may also have recurrent lateral patellar instability, which is managed by medial patellofemoral ligament (MPFL) reconstruction and associated surgery as indicated. The senior author (B.J.C) prefers to treat malalignment as a combined procedure, but it can also be managed in a staged fashion. The advantages of realignment alone are that it is very durable and can tolerate high-level athletic activities without concerns for graft compromise. The disadvantage is that it simply may not be "enough" surgery to satisfy a patient's objectives and each surgery comes with muscle debilitation and the risk of excessive scar formation as well as interfering with "life."

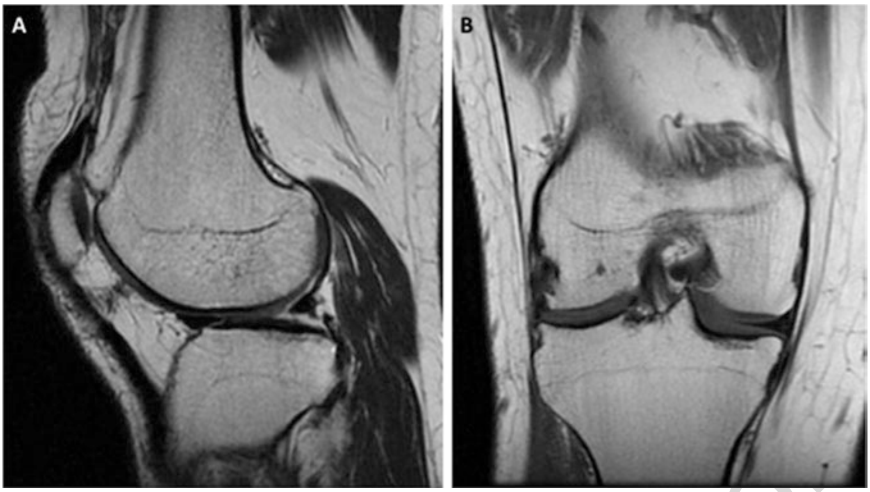

Fig. 10.5 Meniscus deficiency requiring meniscal allograft transplant. (**a**) T2-weighted sagittal plane MRI of the right knee showing the lateral tibial plateau, lateral femoral condyle, and anterior and posterior horns of the lateral meniscus. (**b**) T1-weighted coronal plane MRI of the right knee showing meniscal deficiency in the lateral compartment

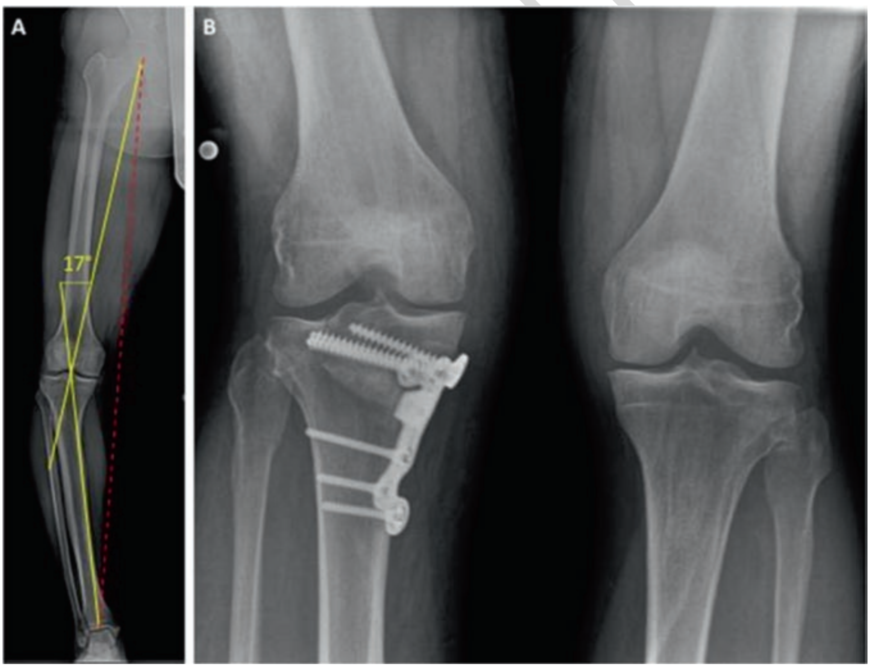

Fig. 10.6 Coronal malalignment corrected by opening wedge high tibial osteotomy. (**a**) Standing weight-bearing anteroposterior radiograph of the right knee demonstrating varus deformity causing excessive mechanical stress on the medial compartment. Yellow lines indicate the anatomic axes of the femur and tibia, while the red dashed line indicates the mechanical axis of the right lower extremity. Patient was calculated to have 17° of varus deformity. (**b**) Postoperative skier's view radiograph showing the varus deformity corrected by opening wedge high tibial osteotomy

Complex Cases

Meniscal Deficiency with Femoral Condyle Defect

As described above, meniscus evaluation is essential when determining an appropriate management plan in patients with a femoral condyle defect due to the symbiotic relationship between the meniscus and articular surface. In patients with a symptomatic femoral condyle defect who have had a prior ipsilateral subtotal meniscectomy, a meniscal allograft transplant (MAT) is indicated in addition to the cartilage procedure to reduce the contact pressures on the treated cartilage site. Multiple MAT techniques have been described including the bridge-in-slot, bone plug, dovetail, and soft-tissue only techniques, but the senior author (B.J.C.) prefers the bridge-in-slot technique for both medial and lateral MAT. Treatment of the cartilage defect should be determined by the same algorithm as an isolated cartilage defect, primarily based on defect size and expected stress. Small defects (<2 cm^2) can be managed with debridement or microfracture (with or without adjunct scaffolds and biologics such as BioCartilage (Arthrex, Inc., Naples, FL), while medium sized (2–4 cm^2) will likely require surface treatment with cartilage allografts (Cartiform, ProChondrix, and DeNovo NT), OATS, or OCA, and large defects (>4 cm^2) are likely best treated with OCA or ACI/MACI.

Combined MAT and cartilage restoration procedures have been well described in the literature with excellent, reliable outcomes. When done in combination, MAT is performed first to prevent iatrogenic damage to a newly restored cartilage surface. The senior author (B.J.C.) prefers an open arthroscopic technique when performing MAT, whereas the cartilage restoration procedure is then performed using the appropriate technique for the indicated treatment (i.e., arthroscopic for MFX or ACI versus open for OCA). A systematic review evaluating six studies with a total of 110 patients at mean follow-up of 36 months who underwent combined MAT and cartilage restoration/repair surgery found outcomes similar to those for isolated cartilage restoration/repair except for a higher reoperation rate [21]. The clinical outcomes measured by combinations of Lysholm, KOOS, IKDC, Tegner, Modified HSS, and SF-36 scores improved significantly, and the overall failure rate was 12% [21]. Overall, surgical management of femoral condyle chondral defects with concomitant MAT provides predicable successful outcomes for management of this combined pathology.

Chondral Defect with Ligamentous Injury

Incidental findings of cartilage defects are common at the time of planned knee ligament reconstruction, but they add complexity to the patient's management. When determining the appropriate treatment plan, it is critical to determine if the chondral defect is symptomatic. In the setting of an acute ligamentous injury, chondral defects are presumed to be asymptomatic and typically treated with a simple debridement. However, in a chronic ligamentous injury, chondral defects are more likely to be symptomatic resulting from the inherent joint instability. As the time between ligamentous injury and surgical management increases, the frequency and severity of pain and cartilage or meniscus pathology tend to increase [22–24]. When managing a chronic ligamentous injury, therefore, it is typically preferred to perform a combined procedure to also definitively address the chondral defect according to the typical algorithm.

Chondral Defect with Malalignment

Within the tibiofemoral joint, varus and valgus deformity in the knee place increased mechanical stress on the medial and lateral compartments, respectively. Varus deformity can be corrected with opening wedge high tibial osteotomy (OWHTO) to off-load the medial compartment, while valgus deformity can be corrected with closing wedge high tibial osteotomy (CWHTO), distal femur osteotomy (DFO), or proximal lateral opening tibial varus osteotomy [25] to off-load the lateral compartment. The patellofemoral joint can be off-loaded with a Fulkerson modified Maquet (anterior) or Fulkerson (anteromedial) tibial tubercle osteotomy. Patients with uncorrected malalignment have less successful clinical outcomes after cartilage procedure [26]. This has made concomitant cartilage and realignment procedures increasingly popular, especially in comparison to less desirable alternatives such as unicompartmental arthroplasty in the young patient.

The results of combined osteotomy and cartilage surgery have been shown to reliably provide symptomatic relief and improved functional status. A recent systematic review of 18 studies by Kahlenberg et al. compiled a total of 827 patients who underwent combined HTO and cartilage repair or restoration surgery with at least 2-year follow-up. They reported clinical improvement and a complication rate of 10.3%. The rate of conversion to arthroplasty was 6.3% with a range of mean time from HTO to conversion of 4.9–13.0 years [27]. Overall, the recent literature supports concomitant HTO and cartilage surgery for this pathology with reliably successful outcomes.

Meniscus Injury, Chondral Defect, and Malalignment

Meniscus injury is known to predispose patients to the development of cartilage injury [18, 19]. When meniscal deficiency is combined with malalignment, the increased stress on the medial or lateral compartment can lead to severe, rapid cartilage degeneration. Traditionally, meniscal-deficient patients with chondral defects and concomitant malalignment were thought to be contraindicated for MAT because the malalignment would prove to cause excess stress on the treated compartment. However, recent literature reports encouraging results in patients with this combined pathology undergoing distal femoral or high tibial osteotomy, MAT, and OCA.

Harris et al. reported on a cohort of 18 patients at mean 6.5-year follow-up who underwent combined distal femoral or high tibial osteotomy, MAT, and OCA. Their patients showed significant clinical improvement by IKDC, Lysholm, and KOOS scores. Additionally, while there was a 55.5% reoperation rate, the revision rate and rate of conversion to arthroplasty were both 5.6% [28]. Previously, Gomoll et al. reported on a cohort of seven patients in which they showed significant clinical improvement and six of seven patients were able to return to unrestricted activities [29]. Despite the high reoperation rate, these results suggest that this triad of meniscal deficiency, malalignment, and femoral condyle chondral defect can be successfully managed without conversion to arthroplasty.

The senior author (B.J.C.) prefers to manage this triad with a combined procedure. The MAT is performed first due to the significant varus or valgus stress required for graft passage, placement, and fixation. Additionally, this prevents the possibility of iatrogenic injury to the treated articular surface. The cartilage procedure and realignment osteotomy can then be performed in the surgeon's order of preference. If ACI/MACI is the indicated cartilage treatment, however, it should be performed last to avoid disruption of the type I-III collagen or periosteal patch used to cover the implanted chondrocytes.

Failed Prior Cartilage Restoration

Patients presenting with a recurrence of symptoms after a failed prior cartilage repair or restoration procedure present a unique challenge to the surgeon because the treatment options are limited. In the management of these patients, it is essential to investigate the reason for failure which could be untreated malalignment, strenuous patient activities, or improper rehabilitation so that appropriate adjustments can be made at the time of revision. Choice of revision treatment is dependent on the all of the same factors as the initial management, in addition to the type of index procedure performed. Revision treatment for the femoral condyle for a small defect after microfracture, for example, can be managed with OATS, while a large defect would be better managed with OCA. For the patella, revision of defects treated with microfracture can be managed successfully with ACI/MACI or OCA. However, failed ACI/MACI of the patellofemoral joint should be managed with OCA. It is generally accepted that OCA is the best option for a salvage procedure when managing focal chondral defects [30–32]. ACI can also be used as a revision technique, but it has been shown to have a 3–5% higher failure rate than when used as a primary treatment [33, 34].

The outcomes of revision cartilage repair, especially with OCA, are reliably successful long term. Gracitelli et al. investigated the outcomes of OCA after failed microfracture surgery compared to OCA as the index procedure and found no difference in outcomes or failure rates between the two groups, although those with prior failed microfracture had a higher reoperation rate [30]. Additionally, a subsequent study by Gracitelli et al. investigated outcomes of revision OCA after failed microfracture, OAT, or ACI. They reported a 16% failure rate at a mean time of 2.6 years, but overall survivorship was 87.8% and 82% at 5-year and 10-year follow-up, respectively. Their cohort showed significant clinical improvement and 89% satisfaction after their revision procedure [31]. These results are encouraging for patients requiring revision surgery as conversion to arthroplasty can be delayed or possibly avoided.

Conclusion

The orthopedic surgeon has several options available for the treatment of symptomatic focal chondral defects. Many factors contribute to the complexity of managing chondral defects and must be considered. When deciding the appropriate therapeutic method whether operative or nonoperative, it is critical that a thorough assessment of the patient's medical history, demographics, goals of treatment, symptoms, defect characteristics, imaging findings, and concomitant pathology is performed. Concomitant pathology such as meniscal deficiency, coronal malalignment, ligamentous injury, and patellar instability must be addressed in either as staged or combined procedures to avoid failure or symptom recurrence. When appropriately used, cartilage repair or restoration procedures can provide successful outcomes even in the most complex cases.

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