

# Orthopedic Surgical Options for Joint Cartilage Repair and Restoration



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## KEYWORDS

- Articular cartilage • Microfracture • Osteochondral • Autograft • OAT • Allograft
- Autologous chondrocyte implantation (ACI) • Juvenile particulated

## KEY POINTS

- Articular cartilage has limited intrinsic healing ability. The goal of surgical intervention is joint preservation through cartilage repair or restoration.
- Bone marrow stimulation, whole-tissue transplantation, and cell-based strategies are broad treatment concepts for these injuries. Technique variations exist within each division.
- Substantial differences often exist among interventions regarding the size of injury that can be addressed, anatomic location, technical considerations, cost, and expectations. These differences warrant transparent discussion with patients about specific goals of treatment and require at least a basic understanding of available surgical options.

## INTRODUCTION

Articular surface injuries present a common and challenging problem for the musculoskeletal physician. This difficulty is secondary to the complex structure of articular cartilage and its limited natural capacity for regeneration.<sup>1–3</sup> Furthermore, these injuries frequently occur in a younger patient population with potential for significant effects on quality of life.<sup>4</sup> Many nonoperative treatment modalities are widely used and typically considered first-line management, though this depends on the size, location, and other injury characteristics. For persistently symptomatic or larger articular injuries, surgical intervention often can provide substantial improvement in symptoms and functional capacity.<sup>1</sup>

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Surgical options for chondral and osteochondral injury range from procedures traditionally considered primary or reparative to traditionally secondary or restorative. These procedures include open reduction and internal fixation, bone marrow stimulation, whole-tissue transplantation, and cell-based strategies.<sup>5</sup> The purpose of these techniques is surface reconstitution, with the ideal goal of mature, organized, hyaline cartilage. Some interventions achieve this better than others.

Many of these techniques are performed arthroscopically or with arthroscopic assistance. Vast research has been reported on this broad and evolving field, much of which is from the knee literature. Earlier interventions have naturally received more attention and rigorous study than more recent ones. Many newer developments remain in the early stages of determining indications and long-term outcomes, some with little support for efficacy. Accordingly, reviews of more recently developed interventions are more superficial, though with anticipation of what their potential may hold.

Evaluation of outcomes has been largely through comparative studies of various surgical methods, as the natural history of articular lesions remains poorly defined.<sup>2</sup> In addition, a paucity of randomized controlled trials has made robust comparisons between techniques statistically challenging, and results must be interpreted in this context.<sup>5-8</sup>

With an increasingly large area of injury, arthritic severity, or advancing age, definitive management often is arthroplasty or arthrodesis. There are exceptions to this with the capabilities of bulk osteochondral allografting. As arthroplasty and arthrodesis are considered neither reparative nor restorative, their role is not included in this review.

Of note, considerations of periarticular biomechanical factors, such as malalignment adjacent to the injured joint and soft-tissue deficiencies (meniscus, labrum, and so forth) are extremely important. Although outside the scope of this article, these can strongly influence whether joint salvage will be successful or predicted to fail and must always receive careful consideration in surgical decision-making. These procedures may be performed in a staged or concomitant fashion. Independent of whether these complicating factors are present, transparent discussion between the physician and patient regarding goals is required. This discussion allows review of evidence-based outcomes and provides insight into specific expectations of this typically younger, physically active population.

## INDICATIONS

Considering the several joints most commonly affected by chondral injuries and their differing anatomic structure, function, and weight-bearing demands, this injury group represents a heterogeneous population. However, broad, generalized indications for chondral and osteochondral interventions may be inferred from this vast body of investigation. These indications are largely extrapolated from knee literature, though frequently applied to other joints, serving as their framework. Most investigators agree that indications include patient age ranging from skeletal maturity (depending on the procedure) to 40 to 50 years, well-preserved adjacent cartilage surfaces with minimal or no surrounding signs of osteoarthritis, noninflammatory arthritis, focal full-thickness cartilage defects (Modified Outerbridge or International Cartilage Repair Society [ICRS] grade 3 or 4), and patient ability and willingness to participate in a rigorous postoperative physical therapy regimen<sup>2,3,9,10</sup> (**Table 1**). Defect depth and area guide the decision on surgical technique. A joint-specific example of such considerations for the knee is shown in **Table 2**. More than one defect may be surgically treated, though outcomes have not been as successful if the lesions are “bipolar” or “kissing (present in the same area, on opposing surfaces of the joint).”<sup>3,11,12</sup>

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