



MASSACHUSETTS

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## Medical Policy

# Autografts and Allografts in the Treatment of Focal Articular Cartilage Lesions

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### Policy Number: 111

BCBSA Reference Number: 7.01.78 (For Plan internal use only)

NCD/LCD: N/A

### Related Policies

- Meniscal Allografts and Other Meniscal Implants, #[110](#)

### Policy

#### Commercial Members: Managed Care (HMO and POS), PPO, and Indemnity Medicare HMO Blue<sup>SM</sup> and Medicare PPO Blue<sup>SM</sup> Members

Fresh osteochondral allografting may be considered **MEDICALLY NECESSARY** as a technique to repair:

- Focal, full-thickness chondral defects of the knee caused by acute or repetitive trauma when other cartilage repair techniques (eg, microfracture, osteochondral autografting or autologous chondrocyte implantation) would be inadequate due to lesion size, location, or depth.
- Large (area >1.5 cm<sup>2</sup>) or cystic (volume >3.0 cm<sup>3</sup>) osteochondral lesions of the talus when autografting would be inadequate due to lesion size, depth, or location.
- Revision surgery after failed prior marrow stimulation for large (area >1.5 cm<sup>2</sup>) or cystic (volume >3.0 cm<sup>3</sup>) osteochondral lesions of the talus when autografting would be inadequate due to lesion size, depth or location.

Osteochondral allografting for all other joints is considered **INVESTIGATIONAL**.

Osteochondral autografting, using 1 or more cores of osteochondral tissue, may be considered **MEDICALLY NECESSARY**:

- For the treatment of symptomatic full-thickness cartilage defects of the knee caused by acute or repetitive trauma in individuals who have had an inadequate response to a prior surgical procedure, when **all** of the following have been met:
  - Adolescent individuals should be skeletally mature with documented closure of growth plates (eg, ≥ 15 years). Adult individuals should be too young to be considered an appropriate candidate for total knee arthroplasty or other reconstructive knee surgery (eg, ≤55 years)
  - Focal, full-thickness (grade III or IV) unipolar lesions on the weight-bearing surface of the femoral condyles, trochlea, or patella that are between 1 and 2.5 cm<sup>2</sup> in size

- Documented minimal to absent degenerative changes in the surrounding articular cartilage (Outerbridge grade II or less), and normal-appearing hyaline cartilage surrounding the border of the defect
- Normal knee biomechanics, or alignment and stability achieved concurrently with osteochondral grafting.
- Large (area >1.5 cm<sup>2</sup>) or cystic (volume >3.0 cm<sup>3</sup>) osteochondral lesions of the talus.
- Revision surgery after failed marrow stimulation for osteochondral lesion of the talus.

Osteochondral autografting for all other joints and any indications other than those listed above is considered **INVESTIGATIONAL**.

Treatment of focal articular cartilage lesions with autologous minced or particulated cartilage is considered **INVESTIGATIONAL**.

Treatment of focal articular cartilage lesions with allogeneic minced or particulated cartilage is considered **INVESTIGATIONAL**.

Treatment of focal articular cartilage lesions with decellularized osteochondral allograft plugs (eg, Chondrofix) is considered **INVESTIGATIONAL**.

Treatment of focal articular cartilage lesions with reduced osteochondral allograft discs (eg, ProChondrix, Cartiform) is considered **INVESTIGATIONAL**.

### Prior Authorization Information

#### Inpatient

- For services described in this policy, precertification/preauthorization **IS REQUIRED** for all products if the procedure is performed **inpatient**.

#### Outpatient

- For services described in this policy, see below for products where prior authorization **might be required** if the procedure is performed **outpatient**.

	Outpatient
Commercial Managed Care (HMO and POS)	Prior authorization is <b><u>required</u></b> .
Commercial PPO and Indemnity	Prior authorization is <b><u>required</u></b> .
Medicare HMO Blue <sup>SM</sup>	Prior authorization is <b><u>required</u></b> .
Medicare PPO Blue <sup>SM</sup>	Prior authorization is <b><u>required</u></b> .

#### Requesting Prior Authorization Using Authorization Manager

Providers will need to use [Authorization Manager](#) to submit initial authorization requests for services. Authorization Manager, available 24/7, is the quickest way to review authorization requirements, request authorizations, submit clinical documentation, check existing case status, and view/print the decision letter. For commercial members, the requests must meet medical policy guidelines.

To ensure the service request is processed accurately and quickly:

- Enter the facility's NPI or provider ID for where services are being performed.
- Enter the appropriate surgeon's NPI or provider ID as the servicing provider, *not* the billing group.

#### Authorization Manager Resources

Refer to our [Authorization Manager](#) page for tips, guides, and video demonstrations.

### CPT Codes / HCPCS Codes / ICD Codes

*Inclusion or exclusion of a code does not constitute or imply member coverage or provider reimbursement. Please refer to the member's contract benefits in effect at the time of service to determine coverage or non-coverage as it applies to an individual member.*

Providers should report all services using the most up-to-date industry-standard procedure, revenue, and diagnosis codes, including modifiers where applicable.

The following codes are included below for informational purposes only; this is not an all-inclusive list.

**The above medical necessity criteria MUST be met for the following codes to be covered for Commercial Members: Managed Care (HMO and POS), PPO, Indemnity, Medicare HMO Blue and Medicare PPO Blue:**

### CPT Codes

CPT codes:	Code Description
27415	Osteochondral allograft, knee, open
27416	Osteochondral autograft(s), knee, open (e.g., mosaicplasty) (includes harvesting of autograft[s])
29866	Arthroscopy, knee, surgical; osteochondral autograft (s) (e.g., mosaicplasty) (includes harvesting of the autograft[s])
29867	Arthroscopy, knee, surgical; osteochondral allograft (eg, mosaicplasty)

### ICD-10 Procedure Codes

ICD-10-PCS procedure codes:	Code Description
0SBC0ZZ	Excision of Right Knee Joint, Open Approach
0SBC3ZZ	Excision of Right Knee Joint, Percutaneous Approach
0SBC4ZZ	Excision of Right Knee Joint, Percutaneous Endoscopic Approach
0SBD0ZZ	Excision of Left Knee Joint, Open Approach
0SBD3ZZ	Excision of Left Knee Joint, Percutaneous Approach
0SBD4ZZ	Excision of Left Knee Joint, Percutaneous Endoscopic Approach
0SQC0ZZ	Repair Right Knee Joint, Open Approach
0SQC3ZZ	Repair Right Knee Joint, Percutaneous Approach
0SQC4ZZ	Repair Right Knee Joint, Percutaneous Endoscopic Approach
0SQCXZZ	Repair Right Knee Joint, External Approach
0SQD0ZZ	Repair Left Knee Joint, Open Approach
0SQD3ZZ	Repair Left Knee Joint, Percutaneous Approach
0SQD4ZZ	Repair Left Knee Joint, Percutaneous Endoscopic Approach
0SQDXZZ	Repair Left Knee Joint, External Approach

The following ICD Diagnosis Codes are considered medically necessary when submitted with the CPT and ICD Procedure codes above if medical necessity criteria are met:

### ICD-10 Diagnosis Codes

ICD-10-CM Diagnosis codes:	Code Description
M12.561	Traumatic arthropathy, right knee
M12.562	Traumatic arthropathy, left knee
M12.569	Traumatic arthropathy, unspecified knee
M17.0	Bilateral primary osteoarthritis of knee
M17.10	Unilateral primary osteoarthritis, unspecified knee
M17.11	Unilateral primary osteoarthritis, right knee
M17.12	Unilateral primary osteoarthritis, left knee
M17.2	Bilateral post-traumatic osteoarthritis of knee
M17.30	Unilateral post-traumatic osteoarthritis, unspecified knee

M17.31	Unilateral post-traumatic osteoarthritis, right knee
M17.32	Unilateral post-traumatic osteoarthritis, left knee
M17.4	Other bilateral secondary osteoarthritis of knee
M17.5	Other unilateral secondary osteoarthritis of knee
M17.9	Osteoarthritis of knee, unspecified
M22.40	Chondromalacia patellae, unspecified knee
M22.41	Chondromalacia patellae, right knee
M22.42	Chondromalacia patellae, left knee
M23.8X1	Other internal derangements of right knee
M23.8X2	Other internal derangements of left knee
M23.8X9	Other internal derangements of unspecified knee
M93.261	Osteochondritis dissecans, right knee
M93.262	Osteochondritis dissecans, left knee
M93.269	Osteochondritis dissecans, unspecified knee
M94.261	Chondromalacia, right knee
M94.262	Chondromalacia, left knee
M94.269	Chondromalacia, unspecified knee
M94.9	Disorder of cartilage, unspecified
S83.30xA	Tear of articular cartilage of unspecified knee, current, initial encounter
S83.30xD	Tear of articular cartilage of unspecified knee, current, subsequent encounter
S83.30xS	Tear of articular cartilage of unspecified knee, current, sequela
S83.31xA	Tear of articular cartilage of right knee, current, initial encounter
S83.31xD	Tear of articular cartilage of right knee, current, subsequent encounter
S83.31xS	Tear of articular cartilage of right knee, current, sequela
S83.32xA	Tear of articular cartilage of left knee, current, initial encounter
S83.32xD	Tear of articular cartilage of left knee, current, subsequent encounter
S83.32xS	Tear of articular cartilage of left knee, current, sequela
S89.90xA	Unspecified injury of unspecified lower leg, initial encounter
S89.90xD	Unspecified injury of unspecified lower leg, subsequent encounter
S89.90xS	Unspecified injury of unspecified lower leg, sequela
S89.91xA	Unspecified injury of right lower leg, initial encounter
S89.91xD	Unspecified injury of right lower leg, subsequent encounter
S89.91xS	Unspecified injury of right lower leg, sequela
S89.92xA	Unspecified injury of left lower leg, initial encounter
S89.92xD	Unspecified injury of left lower leg, subsequent encounter
S89.92xS	Unspecified injury of left lower leg, sequela

The above **medical necessity criteria MUST** be met for the following codes to be covered for Commercial Members: Managed Care (HMO and POS), PPO, Indemnity, Medicare HMO Blue and Medicare PPO Blue:

### CPT Codes

CPT codes:	Code Description
28446	Open osteochondral autograft, talus (includes obtaining graft[s])

### ICD-10 Procedure Codes

ICD-10-PCS procedure codes:	Code Description
0QQL0ZZ	Repair Right Tarsal, Open Approach
0QQM0ZZ	Repair Left Tarsal, Open Approach
0QQL3ZZ	Repair Right Tarsal, Percutaneous Approach

0QQM3ZZ	Repair Left Tarsal, Percutaneous Approach
0QQL4ZZ	Repair Right Tarsal, Percutaneous Endoscopic Approach
0QQM4ZZ	Repair Left Tarsal, Percutaneous Endoscopic Approach

The following ICD Diagnosis Codes are considered medically necessary when submitted with the CPT and ICD Procedure codes above if medical necessity criteria are met:

## ICD-10 Diagnosis Codes

ICD-10-CM Diagnosis codes:	Code Description
M93.271	Osteochondritis dissecans, right ankle and joints of right foot
M93.272	Osteochondritis dissecans, left ankle and joints of left foot
M93.279	Osteochondritis dissecans, unspecified ankle and joints of foot
M94.271	Chondromalacia, right ankle and joints of right foot
M94.272	Chondromalacia, left ankle and joints of left foot
M94.279	Chondromalacia, unspecified ankle and joints of foot
M94.8X7	Other specified disorders of cartilage, ankle and foot
S99.911A	Unspecified injury of right ankle, initial encounter
S99.911D	Unspecified injury of right ankle, subsequent encounter
S99.911S	Unspecified injury of right ankle, sequela
S99.912A	Unspecified injury of left ankle, initial encounter
S99.912D	Unspecified injury of left ankle, subsequent encounter
S99.912S	Unspecified injury of left ankle, sequela
S99.919A	Unspecified injury of unspecified ankle, initial encounter
S99.919D	Unspecified injury of unspecified ankle, subsequent encounter
S99.919S	Unspecified injury of unspecified ankle, sequela

## Description

### Articular Cartilage Lesions

Damaged articular cartilage can be associated with pain, loss of function, and disability, and can lead to debilitating osteoarthritis over time. These manifestations can severely impair an individual's activities of daily living and quality of life. The vast majority of osteochondral lesions occur in the knee with the talar dome and capitulum being the next most frequent sites. The most common locations of lesions are the medial femoral condyle (69%), followed by the weight-bearing portion of the lateral femoral condyle (15%), the patella (5%), and trochlear fossa.<sup>1</sup> Talar lesions are reported to be about 4% of osteochondral lesions.<sup>2</sup>

### Treatment

There are 2 main goals of conventional therapy for patients who have significant focal defects of the articular cartilage: symptom relief and articular surface restoration.

First, there are procedures intended primarily to achieve symptomatic relief: debridement (removal of debris and diseased cartilage) and rehabilitation. Second, there are procedures intended to restore the articular surface. Treatments may be targeted to the focal cartilage lesion, and most such treatments induce local bleeding, fibrin clot formation, and resultant fibrocartilage growth. These marrow stimulation procedures include microfracture, abrasion arthroplasty, and drilling, all of which are considered standard therapies.

### Microfracture

Microfracture is an arthroscopic procedure in which a small pick creates a network of holes at the base of the articular cartilage lesion, allowing blood into the injured area to form clots and subsequent fibrocartilage growth. Mithoefer et al (2009) examined the efficacy of the microfracture technique for articular cartilage lesions of the knee in a systematic review.<sup>3</sup> Twenty-eight studies (N=3122 patients) were selected; 6 studies were randomized controlled trials. Microfracture was found to improve knee function in all studies

during the first 24 months after the procedure but the reports on durability were conflicting. Solheim et al (2016) reported on a prospective longitudinal study of 110 patients and found that, at a mean of 12 years (range, 10-14) after microfracture, 45.5% of patients had poor outcomes, including 43 patients who required additional surgery.<sup>4</sup> The size of the lesion has also been shown to affect outcomes following marrow stimulation procedures.

### **Abrasion and Drilling**

Abrasion and drilling are techniques to remove damaged cartilage. Instead of a drill, high-speed burrs are used in the abrasion procedure.

Fibrocartilage is generally considered to be less durable and mechanically inferior to the original articular cartilage. Thus, various strategies for chondral resurfacing with hyaline cartilage have been investigated. Alternatively, treatments of very extensive and severe cartilage defects may resort to complete replacement of the articular surface either by osteochondral allotransplant or artificial knee replacement.

### **Osteochondral Grafting**

Autologous or allogeneic grafts of osteochondral or chondral tissue have been proposed as treatment alternatives for patients who have clinically significant, symptomatic, focal defects of the articular cartilage. It is hypothesized that the implanted graft's chondrocytes retain features of hyaline cartilage that are similar in composition and property to the original articulating surface of the joint. If true, the restoration of a hyaline cartilage surface might restore the integrity of the joint surface and promote long-term tissue repair, thereby improving function and delaying or preventing further deterioration.

Both fresh and cryopreserved allogeneic osteochondral grafts have been used with some success. However, cryopreservation decreases the viability of cartilage cells, and fresh allografts may be difficult to obtain and create concerns regarding infectious diseases. As a result, autologous osteochondral grafts have been investigated as an option to increase the survival rate of the grafted cartilage and to eliminate the risk of disease transmission. Autologous grafts are limited by the small number of donor sites; thus, allografts are typically used for larger lesions. In an effort to extend the amount of the available donor tissue, investigators have used multiple, small osteochondral cores harvested from non-weight-bearing sites in the knee for treatment of full-thickness chondral defects. Several systems are available for performing this procedure: the Mosaicplasty System (Smith & Nephew), the OATS (Osteochondral Autograft Transfer System; Arthrex), and the COR and COR2 systems (DePuy Mitek). Although mosaicplasty and autologous osteochondral transplantation may use different instrumentation, the underlying mode of repair is similar (ie, use of multiple osteochondral cores harvested from a non-weight-bearing region of the femoral condyle and autografted into the chondral defect). These terms have been used interchangeably to describe the procedure.

Preparation of the chondral lesion involves debridement and preparation of recipient tunnels. Multiple individual osteochondral cores are harvested from the donor site, typically from a peripheral non-weight-bearing area of the femoral condyle. Donor plugs range from 6 to 10 mm in diameter. The grafts are press fit into the lesion in a mosaic-like fashion into the same-sized tunnels. The resultant surface consists of transplanted hyaline articular cartilage and fibrocartilage, which is thought to provide "grouting" between the individual autografts. Mosaicplasty or autologous osteochondral transplantation may be performed with either an open approach or arthroscopically. Osteochondral autografting has also been investigated as a treatment of unstable osteochondritis dissecans lesions using multiple dowel grafts to secure the fragment. While osteochondral autografting is primarily performed on the femoral condyles of the knee, osteochondral grafts have been used to repair chondral defects of the patella, tibia, and ankle. With osteochondral autografting, the harvesting and transplantation can be performed during the same surgical procedure. Technical limitations of osteochondral autografting are difficulty in restoring concave or convex articular surfaces, the incongruity of articular surfaces that can alter joint contact pressures, short-term fixation strength and load-bearing capacity, donor-site morbidity, and lack of peripheral integration with peripheral chondrocyte death.

Reddy et al (2007) evaluated donor-site morbidity in 11 of 15 patients who had undergone graft harvest from the knee (mean, 2.9 plugs) for treatment of osteochondral lesions of the talus.<sup>5</sup> At an average 47-

month follow-up (range, 7-77), 5 patients were rated as having an excellent Lysholm Knee Scale score (95-100 points), 2 as good (84-94 points), and 4 as poor ( $\leq 64$  points). The reported knee problems were instability in daily activities, pain after walking 1 mile or more, slight limp, and difficulty squatting. Hangody et al (2001) reported that some patients had slight or moderate complaints with physical activity during the first postoperative year but there was no long-term donor-site pain in a series of 36 patients evaluated 2 to 7 years after autologous osteochondral transplantation.<sup>6</sup>

Filling defects with minced or particulated articular cartilage (autologous or allogeneic) is another single-stage procedure being investigated for cartilage repair. The Cartilage Autograft Implantation System (Johnson & Johnson) harvests cartilage and disperses chondrocytes on a scaffold in a single-stage treatment. The Reveille® Cartilage Processor (Exactech Biologics) has a high-speed blade and sieve to cut autologous cartilage into small particles for implantation. BioCartilage® (Arthrex) consists of a micronized allogeneic cartilage matrix that is intended to provide a scaffold for microfracture. DeNovo NT® Graft (Natural Tissue Graft) is produced by ISTO Technologies and distributed by Zimmer. DeNovo NT consists of manually minced cartilage tissue pieces obtained from juvenile allograft donor joints. The tissue fragments are mixed intraoperatively with fibrin glue before implantation in the prepared lesion. It is thought that mincing the tissue helps both with cell migration from the extracellular matrix and with fixation.

A minimally processed osteochondral allograft (Chondrofix®; Zimmer) is now available. Chondrofix is composed of decellularized hyaline cartilage and cancellous bone; it can be used “off the shelf” with pre-cut cylinders (7-15 mm). Multiple cylinders may be used to fill a larger defect in a manner similar to autologous osteochondral transplantation or mosaicplasty.

ProChondrix® (AlloSource) and Cartiform® (Arthrex) are wafer-thin allografts where the bony portion of the allograft is reduced. The discs are laser etched or porated and contain hyaline cartilage with chondrocytes, growth factors, and extracellular matrix proteins. ProChondrix is available in dimensions from 7 to 20 mm and is stored fresh for a maximum of 28 days. Cartiform is cut to the desired size and shape and is stored frozen for a maximum of 2 years. The osteochondral discs are typically inserted after microfracture and secured in place with fibrin glue and/or sutures.

Autologous chondrocyte implantation is another method of cartilage repair involving the harvesting of normal chondrocytes from normal non-weight-bearing articular surfaces, which are then cultured and expanded in vitro and implanted back into the chondral defect. Autologous chondrocyte implantation techniques are discussed in medical policy #374.

## Summary

### Description

Osteochondral grafts are used to repair full-thickness chondral defects involving a joint. In the case of osteochondral autografts, 1 or more small osteochondral plugs are harvested from non-weight-bearing sites, usually from the knee, and press fit into a prepared site in the lesion. Osteochondral allografts are typically used for larger lesions. Autologous or allogeneic minced cartilage, decellularized osteochondral allograft plugs, and reduced osteochondral allograft discs are also being evaluated as a treatment of articular cartilage lesions.

### Summary of Evidence

#### Knee Lesions

For individuals who have full-thickness articular cartilage lesions of the knee who receive an osteochondral autograft, the evidence includes randomized controlled trials (RCTs), systematic reviews of RCTs, and longer-term observational studies. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. Several systematic reviews have evaluated osteochondral autografting for cartilage repair in the short- and mid-term. Compared with abrasion techniques (eg, microfracture, drilling), there is evidence that osteochondral autografting decreases failure rates and improves outcomes in patients with medium-size lesions (eg, 2-6 cm<sup>2</sup>) when measured at longer follow-up. This is believed to be due to the higher durability of hyaline cartilage compared with fibrocartilage from abrasion techniques. There appears to be a relatively narrow range of lesion size for which osteochondral autografting is most effective. The best results have also been observed with lesions on the femoral condyles, although treatment of lesions on the trochlea and patella may also improve outcomes. Correction of malalignment is

important for the success of the procedure. The evidence suggests that osteochondral autografts may be considered an option for moderate-sized, symptomatic, full-thickness, chondral lesions of the femoral condyle, trochlea, or patella. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have full-thickness articular cartilage lesions of the knee when autografting would be inadequate due to lesion size, location, or depth who receive a fresh osteochondral allograft, the evidence includes case series and systematic reviews of case series. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. Due to the lack of alternatives, this procedure may be considered a salvage operation in younger patients for full-thickness chondral defects of the knee caused by acute or repetitive trauma when other cartilage repair techniques (eg, microfracture, osteochondral autografting, autologous chondrocyte implantation) would be inadequate due to lesion size, location, or depth. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

### **Ankle Lesions**

For individuals who have primary full-thickness articular cartilage lesions of the ankle less than 1.5 cm<sup>2</sup> who receive an osteochondral autograft, the evidence includes observational studies and systematic review of these studies. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. A systematic review found similar improvements in outcomes following microfracture and autologous osteochondral transplantation. Another systematic review found that autologous osteochondral transplantation reduces pain and improves function in patients with osteochondral lesions of the talus, including lesions less than 1.5 cm<sup>2</sup>; most included studies performed autologous osteochondral transplantation as a secondary procedure. Given the success of marrow stimulation procedures for smaller lesions (<1.5 cm<sup>2</sup>) and the increase in donor-site morbidity with graft harvest from the knee, current evidence does not support the use of autologous osteochondral transplantation as a primary treatment for smaller articular cartilage lesions of the ankle. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have large (area >1.5 cm<sup>2</sup>) or cystic (volume >3.0 cm<sup>3</sup>) full-thickness articular cartilage lesions of the ankle who receive an osteochondral autograft, the evidence includes a RCT and several observational studies. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. A RCT in patients with large lesions found similar efficacy for autologous osteochondral transplantation, marrow stimulation, and arthroplasty at 2-year follow-up. Longer-term results were not reported in the RCT. However, observational studies with longer-term follow-up (4-5 years) have shown favorable results for patients with large or cystic lesions receiving osteochondral autograft transplantation. Limitations of the published evidence preclude determining the effects of the technology on health outcomes. Studies on the standard treatment for ankle lesions, marrow stimulation, have reported positive outcomes for patients with small lesions of the ankle (<1.5 cm<sup>2</sup>), but have generally reported high failure rates for patients with large (>1.5 cm<sup>2</sup>) lesions. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have osteochondral lesions of the ankle that have failed primary treatment who receive an osteochondral autograft, the evidence includes 2 nonrandomized comparative trials and several case series. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. The best evidence for revision autologous osteochondral transplantation comes from a nonrandomized comparative study that found better outcomes with autologous osteochondral transplantation than with repeat marrow stimulation. This finding is supported by case series that have indicated good-to-excellent results at mid-term and longer-term follow-up with revision autologous osteochondral transplantation. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have primary full-thickness articular cartilage lesions of the ankle less than 1.5 cm<sup>2</sup> who receive a fresh osteochondral allograft, there is little evidence. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. Because microfracture is effective as a primary treatment for lesions less than 1.5 cm<sup>2</sup> and autologous osteochondral transplantation is effective as a



revision procedure, use of allograft for small primary cartilage lesions has not been reported. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have large (area  $>1.5 \text{ cm}^2$ ) or cystic (volume  $>3.0 \text{ cm}^3$ ) cartilage lesions of the ankle when autografting would be inadequate, who receive a fresh osteochondral allograft, the evidence includes a small number of patients in a RCT and systematic reviews of mainly case series. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. The majority of patients in the RCT were patients with revision osteochondral lesions, so conclusions about the few patients with primary lesions could not be made. The systematic reviews of case series reported improvements in ankle scores and decreases in pain scores, though 25% of patients needed additional surgery and 13% experienced either graft nonunion, resorption, or symptom persistence in 1 systematic review. A recent systematic review compared allografts and autografts for osteochondral lesions of the talus, and found that talar osteochondral transplant using allografts was associated with higher rates of failure and revision compared with autografts at midterm follow-up. For particularly large lesions, marrow stimulation techniques have been found to be ineffective, and obtaining an adequate volume of autograft may cause significant morbidity. For these reasons, osteochondral allografts may be a considered option for large lesions of the ankle. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have revision osteochondral lesions of the ankle when autografting would be inadequate, who receive a fresh osteochondral allograft, the evidence includes a RCT. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. Most of the patients in the RCT had failed a prior microfracture. The RCT found that outcomes were statistically similar with osteochondral allografts compared with autografts. However, failure rates due to nonunion were higher in patients in the allograft group compared with patients in the autograft group. For particularly large lesions, marrow stimulation techniques have been found to be ineffective, and obtaining an adequate volume of autograft may cause significant morbidity. For these reasons, osteochondral allografts may be a considered option for revision of large lesions of the ankle. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

### **Elbow Lesions**

For individuals who have full-thickness articular cartilage lesions of the elbow who receive an osteochondral autograft, the evidence includes a meta-analysis of case series. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. Osteochondritis dissecans of the elbow typically occurs in patients who play baseball or do gymnastics. Although the meta-analysis suggested a benefit of osteochondral autographs compared with debridement or fixation, RCTs are needed to determine the effects of the procedure with greater certainty. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

### **Shoulder Lesions**

For individuals who have full-thickness articular cartilage lesions of the shoulder who receive an osteochondral autograft, the evidence includes a case series. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. Evidence on osteochondral autografting for the shoulder is very limited. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

### **Knee, Ankle, Elbow, or Shoulder Lesions**

For individuals who have full-thickness articular cartilage lesions of the knee, ankle, elbow, or shoulder who receive autologous or allogeneic minced or particulated articular cartilage, the evidence includes a small RCT and small case series. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. The evidence on autologous minced cartilage includes a small RCT. The evidence on allogeneic juvenile minced cartilage includes a few small case series. The case series have suggested an improvement in outcomes compared with preoperative measures, but there is also evidence of subchondral edema, nonhomogeneous surface, graft hypertrophy, and delamination. For articular cartilage lesions of the knee, further evidence, preferably from RCTs, is needed to evaluate the effect on health outcomes compared with other procedures. There are fewer options for articular cartilage lesions of

the ankle. However, further study in a larger number of patients is needed to assess the short- and long-term effectiveness of this technology. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have full-thickness articular cartilage lesions of the knee, ankle, elbow, or shoulder who receive decellularized osteochondral allograft plugs, the evidence includes small case series. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. The case series reported delamination of the implants and high failure rates. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have full-thickness articular cartilage lesions of the knee, ankle, elbow, or shoulder who receive reduced osteochondral allograft discs, the evidence includes small case series. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. A prospective case series assessed ProChondrix for treatment of articular cartilage lesions of the knee and found sustained positive results out to a mean follow-up of 2.5 years, with a low failure rate. However, larger prospective studies with longer follow-up are necessary to further elucidate the safety and efficacy of reduced osteochondral allograft discs. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

## Policy History

Date	Action
6/2024	Annual policy review. References updated. Policy statements unchanged.
9/2023	Policy clarified to include prior authorization requests using Authorization Manager.
6/2023	Annual policy review. Minor editorial refinements to policy statements; intent unchanged.
6/2022	Annual policy review. Description, summary, and references updated. Policy statements unchanged.
5/2022	The word “focal” under Osteochondral Fresh Allografting section was added for clarity.
5/2021	Annual policy review. Description, summary, and references updated. Policy statements unchanged.
6/2020	Annual policy review. Description, summary, and references updated. Policy statements unchanged.
5/2019	Annual policy review. Description, summary, and references updated. Policy statements unchanged.
9/2018	Annual policy review. Policy revised to add “or particulated” to the investigational policy statements on minced cartilage. Prior Authorization Information reformatted. Effective 9/1/2018.
1/2018	Clarified coding information.
12/2017	Annual policy review. New medically necessary indications described. Clarified coding information. Effective 12/1/2017.
2/2017	Annual policy review. First medically necessary statement clarified. Investigational indications clarified. 2/1/2017
8/2015	New references added from Annual policy review.
11/2014	Annual policy review. New medically necessary indications described. Coding information clarified. Effective 11/1/2014.
5/2014	Updated Coding section with ICD10 procedure and diagnosis codes, effective 10/2015.
12/2013	Annual policy review. New investigational indications described. Effective 12/1/2013. Removed inpatient procedure code 81.49 as it does not pertain to the policy.
11/2011-4/2012	Medical policy ICD 10 remediation: Formatting, editing and coding updates. No changes to policy statements.
6/2011	Medical Policy Group – Orthopedics, Rehabilitation and Rheumatology. No changes to policy statements.

7/2010	Medical Policy Group – Orthopedics, Rehabilitation Medicine and Rheumatology. No changes to policy statements.
8/1/2009	New policy effective 8/1/2009 describing ongoing non-coverage.
7/2008	Medical Policy Group - Orthopedics. No changes to policy statements.
7/2007	Medical Policy Group - Orthopedic/Rheumatology. No changes to policy statements.
7/2006	Medical Policy Group - Orthopedic/Rheumatology. No changes to policy statements.

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## References

1. Durur-Subasi I, Durur-Karakaya A, Yildirim OS. Osteochondral Lesions of Major Joints. *Eurasian J Med.* Jun 2015; 47(2): 138-44. PMID 26180500
2. Fortin PT, Balazsy JE. Talus fractures: evaluation and treatment. *J Am Acad Orthop Surg.* 2001; 9(2): 114-27. PMID 11281635
3. Mithoefer K, McAdams T, Williams RJ, et al. Clinical efficacy of the microfracture technique for articular cartilage repair in the knee: an evidence-based systematic analysis. *Am J Sports Med.* Oct 2009; 37(10): 2053-63. PMID 19251676
4. Solheim E, Hegna J, Inderhaug E, et al. Results at 10-14 years after microfracture treatment of articular cartilage defects in the knee. *Knee Surg Sports Traumatol Arthrosc.* May 2016; 24(5): 1587-93. PMID 25416965
5. Reddy S, Pedowitz DI, Parekh SG, et al. The morbidity associated with osteochondral harvest from asymptomatic knees for the treatment of osteochondral lesions of the talus. *Am J Sports Med.* Jan 2007; 35(1): 80-5. PMID 16957009
6. Hangody L, Kish G, Módis L, et al. Mosaicplasty for the treatment of osteochondritis dissecans of the talus: two to seven year results in 36 patients. *Foot Ankle Int.* Jul 2001; 22(7): 552-8. PMID 11503979
7. Zamborsky R, Danisovic L. Surgical Techniques for Knee Cartilage Repair: An Updated Large-Scale Systematic Review and Network Meta-analysis of Randomized Controlled Trials. *Arthroscopy.* Mar 2020; 36(3): 845-858. PMID 32139062
8. Gracitelli GC, Moraes VY, Franciozi CE, et al. Surgical interventions (microfracture, drilling, mosaicplasty, and allograft transplantation) for treating isolated cartilage defects of the knee in adults. *Cochrane Database Syst Rev.* Sep 03 2016; 9(9): CD010675. PMID 27590275
9. Magnussen RA, Dunn WR, Carey JL, et al. Treatment of focal articular cartilage defects in the knee: a systematic review. *Clin Orthop Relat Res.* Apr 2008; 466(4): 952-62. PMID 18196358
10. Pareek A, Reardon PJ, Macalena JA, et al. Osteochondral Autograft Transfer Versus Microfracture in the Knee: A Meta-analysis of Prospective Comparative Studies at Midterm. *Arthroscopy.* Oct 2016; 32(10): 2118-2130. PMID 27487736
11. Harris JD, Cavo M, Brophy R, et al. Biological knee reconstruction: a systematic review of combined meniscal allograft transplantation and cartilage repair or restoration. *Arthroscopy.* Mar 2011; 27(3): 409-18. PMID 21030203
12. Hangody L, Kish G, Kárpáti Z, et al. Arthroscopic autogenous osteochondral mosaicplasty for the treatment of femoral condylar articular defects. A preliminary report. *Knee Surg Sports Traumatol Arthrosc.* 1997; 5(4): 262-7. PMID 9430578
13. Hangody L, Kish G, Kárpáti Z, et al. Mosaicplasty for the treatment of articular cartilage defects: application in clinical practice. *Orthopedics.* Jul 1998; 21(7): 751-6. PMID 9672912
14. Hangody L, Vásárhelyi G, Hangody LR, et al. Autologous osteochondral grafting--technique and long-term results. *Injury.* Apr 2008; 39 Suppl 1: S32-9. PMID 18313470
15. Solheim E, Hegna J, Oyen J, et al. Osteochondral autografting (mosaicplasty) in articular cartilage defects in the knee: results at 5 to 9 years. *Knee.* Jan 2010; 17(1): 84-7. PMID 19666226

16. Solheim E, Hegna J, Øyen J, et al. Results at 10 to 14 years after osteochondral autografting (mosaicplasty) in articular cartilage defects in the knee. *Knee*. Aug 2013; 20(4): 287-90. PMID 23482060
17. Marcacci M, Kon E, Delcogliano M, et al. Arthroscopic autologous osteochondral grafting for cartilage defects of the knee: prospective study results at a minimum 7-year follow-up. *Am J Sports Med*. Dec 2007; 35(12): 2014-21. PMID 17724094
18. Astur DC, Arliani GG, Binz M, et al. Autologous osteochondral transplantation for treating patellar chondral injuries: evaluation, treatment, and outcomes of a two-year follow-up study. *J Bone Joint Surg Am*. May 21 2014; 96(10): 816-23. PMID 24875022
19. Nho SJ, Foo LF, Green DM, et al. Magnetic resonance imaging and clinical evaluation of patellar resurfacing with press-fit osteochondral autograft plugs. *Am J Sports Med*. Jun 2008; 36(6): 1101-9. PMID 18337357
20. Kunze KN, Ramkumar PN, Manzi JE, et al. Risk Factors for Failure After Osteochondral Allograft Transplantation of the Knee: A Systematic Review and Exploratory Meta-analysis. *Am J Sports Med*. Apr 2023; 51(5): 1356-1367. PMID 35049404
21. Merkely G, Ogura T, Ackermann J, et al. Clinical Outcomes after Revision of Autologous Chondrocyte Implantation to Osteochondral Allograft Transplantation for Large Chondral Defects: A Comparative Matched-Group Analysis. *Cartilage*. Apr 2021; 12(2): 155-161. PMID 30897940
22. De Caro F, Bisicchia S, Amendola A, et al. Large fresh osteochondral allografts of the knee: a systematic clinical and basic science review of the literature. *Arthroscopy*. Apr 2015; 31(4): 757-65. PMID 25660010
23. Chui K, Jeys L, Snow M. Knee salvage procedures: The indications, techniques and outcomes of large osteochondral allografts. *World J Orthop*. Apr 18 2015; 6(3): 340-50. PMID 25893177
24. Nielsen ES, McCauley JC, Pulido PA, et al. Return to Sport and Recreational Activity After Osteochondral Allograft Transplantation in the Knee. *Am J Sports Med*. Jun 2017; 45(7): 1608-1614. PMID 28375642
25. Gracitelli GC, Meric G, Briggs DT, et al. Fresh osteochondral allografts in the knee: comparison of primary transplantation versus transplantation after failure of previous subchondral marrow stimulation. *Am J Sports Med*. Apr 2015; 43(4): 885-91. PMID 25817190
26. Feeney KM. The Effectiveness of Osteochondral Autograft Transfer in the Management of Osteochondral Lesions of the Talus: A Systematic Review and Meta-Analysis. *Cureus*. Nov 2022; 14(11): e31337. PMID 36514582
27. Haleem AM, Ross KA, Smyth NA, et al. Double-Plug Autologous Osteochondral Transplantation Shows Equal Functional Outcomes Compared With Single-Plug Procedures in Lesions of the Talar Dome: A Minimum 5-Year Clinical Follow-up. *Am J Sports Med*. Aug 2014; 42(8): 1888-95. PMID 24948585
28. Yoon HS, Park YJ, Lee M, et al. Osteochondral Autologous Transplantation Is Superior to Repeat Arthroscopy for the Treatment of Osteochondral Lesions of the Talus After Failed Primary Arthroscopic Treatment. *Am J Sports Med*. Aug 2014; 42(8): 1896-903. PMID 24907287
29. Ahmad J, Jones K. Comparison of Osteochondral Autografts and Allografts for Treatment of Recurrent or Large Talar Osteochondral Lesions. *Foot Ankle Int*. Jan 2016; 37(1): 40-50. PMID 26333683
30. Georgiannos D, Bisbinas I, Badekas A. Osteochondral transplantation of autologous graft for the treatment of osteochondral lesions of talus: 5- to 7-year follow-up. *Knee Surg Sports Traumatol Arthrosc*. Dec 2016; 24(12): 3722-3729. PMID 25326766
31. Shimoazono Y, Hurley ET, Nguyen JT, et al. Allograft Compared with Autograft in Osteochondral Transplantation for the Treatment of Osteochondral Lesions of the Talus. *J Bone Joint Surg Am*. Nov 07 2018; 100(21): 1838-1844. PMID 30399078
32. Zengerink M, Struijs PA, Tol JL, et al. Treatment of osteochondral lesions of the talus: a systematic review. *Knee Surg Sports Traumatol Arthrosc*. Feb 2010; 18(2): 238-46. PMID 19859695
33. Gobbi A, Francisco RA, Lubowitz JH, et al. Osteochondral lesions of the talus: randomized controlled trial comparing chondroplasty, microfracture, and osteochondral autograft transplantation. *Arthroscopy*. Oct 2006; 22(10): 1085-92. PMID 17027406
34. Emre TY, Ege T, Cift HT, et al. Open mosaicplasty in osteochondral lesions of the talus: a prospective study. *J Foot Ankle Surg*. 2012; 51(5): 556-60. PMID 22789483

35. Petersen W, Taheri P, Schliemann B, et al. Osteochondral transplantation for the treatment of osteochondral defects at the talus with the Diamond twin system® and graft harvesting from the posterior femoral condyles. *Arch Orthop Trauma Surg.* Jun 2014; 134(6): 843-52. PMID 24744009
36. de l'Escalopier N, Barbier O, Mainard D, et al. Outcomes of talar dome osteochondral defect repair using osteocartilaginous autografts: 37 cases of Mosaicplasty®. *Orthop Traumatol Surg Res.* Feb 2015; 101(1): 97-102. PMID 25599924
37. Flynn S, Ross KA, Hannon CP, et al. Autologous Osteochondral Transplantation for Osteochondral Lesions of the Talus. *Foot Ankle Int.* Apr 2016; 37(4): 363-72. PMID 26666678
38. Fraser EJ, Harris MC, Prado MP, et al. Autologous osteochondral transplantation for osteochondral lesions of the talus in an athletic population. *Knee Surg Sports Traumatol Arthrosc.* Apr 2016; 24(4): 1272-9. PMID 25962962
39. Guney A, Yurdakul E, Karaman I, et al. Medium-term outcomes of mosaicplasty versus arthroscopic microfracture with or without platelet-rich plasma in the treatment of osteochondral lesions of the talus. *Knee Surg Sports Traumatol Arthrosc.* Apr 2016; 24(4): 1293-8. PMID 26493549
40. Li X, Zhu Y, Xu Y, et al. Osteochondral autograft transplantation with biplanar distal tibial osteotomy for patients with concomitant large osteochondral lesion of the talus and varus ankle malalignment. *BMC Musculoskelet Disord.* Jan 19 2017; 18(1): 23. PMID 28103870
41. Park KH, Hwang Y, Han SH, et al. Primary Versus Secondary Osteochondral Autograft Transplantation for the Treatment of Large Osteochondral Lesions of the Talus. *Am J Sports Med.* May 2018; 46(6): 1389-1396. PMID 29537877
42. Adana C, zkan S. Treatment of osteochondral lesions of the talus with transmalleolar open mosaicplasty. *Eastern Journal of Medicine.* 2019, 24:524-9
43. Bai L, Guan S, Liu S, et al. Clinical Outcomes of Osteochondral Lesions of the Talus With Large Subchondral Cysts Treated With Osteotomy and Autologous Chondral Grafts: Minimum 2-Year Follow-up and Second-Look Evaluation. *Orthop J Sports Med.* Jul 2020; 8(7): 2325967120937798. PMID 32782905
44. Basal O, Aslan TT. A triplanar osteotomy technique in arthroscopy-assisted ankle mosaicplasty. *J Orthop Surg (Hong Kong).* 2020; 28(1): 2309499020905054. PMID 32189573
45. Kim T, Haskell A. Patient-Reported Outcomes After Structural Autograft for Large or Cystic Talar Dome Osteochondral Lesions. *Foot Ankle Int.* May 2020; 41(5): 549-555. PMID 32088985
46. Nguyen A, Ramasamy A, Walsh M, et al. Autologous Osteochondral Transplantation for Large Osteochondral Lesions of the Talus Is a Viable Option in an Athletic Population. *Am J Sports Med.* Dec 2019; 47(14): 3429-3435. PMID 31671274
47. Sabaghzadeh A, Mirzaee F, Shahriari Rad H, et al. Osteochondral autograft transfer (mosaicplasty) for treatment of patients with osteochondral lesions of talus. *Chin J Traumatol.* Feb 2020; 23(1): 60-62. PMID 31983529
48. Toker B, Erden T, Çetinkaya S, et al. Long-term results of osteochondral autograft transplantation of the talus with a novel groove malleolar osteotomy technique. *Jt Dis Relat Surg.* 2020; 31(3): 509-515. PMID 32962583
49. de l'Escalopier N, Amouyel T, Mainard D, et al. Long-term outcome for repair of osteochondral lesions of the talus by osteochondral autograft: A series of 56 Mosaicplasties®. *Orthop Traumatol Surg Res.* Dec 2021; 107(8S): 103075. PMID 34563735
50. Wan DD, Huang H, Hu MZ, et al. Results of the osteochondral autologous transplantation for treatment of osteochondral lesions of the talus with harvesting from the ipsilateral talar articular facets. *Int Orthop.* Jul 2022; 46(7): 1547-1555. PMID 35332372
51. Zhang Y, Liang JQ, Wen XD, et al. Triplane osteotomy combined with talar non-weight-bearing area autologous osteochondral transplantation for osteochondral lesions of the talus. *BMC Musculoskelet Disord.* Jan 22 2022; 23(1): 79. PMID 35065640
52. Choi WJ, Park KK, Kim BS, et al. Osteochondral lesion of the talus: is there a critical defect size for poor outcome?. *Am J Sports Med.* Oct 2009; 37(10): 1974-80. PMID 19654429
53. Chuckpaiwong B, Berkson EM, Theodore GH. Microfracture for osteochondral lesions of the ankle: outcome analysis and outcome predictors of 105 cases. *Arthroscopy.* Jan 2008; 24(1): 106-12. PMID 18182210
54. Cuttica DJ, Smith WB, Hyer CF, et al. Osteochondral lesions of the talus: predictors of clinical outcome. *Foot Ankle Int.* Nov 2011; 32(11): 1045-51. PMID 22338953

55. Ramponi L, Yasui Y, Murawski CD, et al. Lesion Size Is a Predictor of Clinical Outcomes After Bone Marrow Stimulation for Osteochondral Lesions of the Talus: A Systematic Review. *Am J Sports Med.* Jun 2017; 45(7): 1698-1705. PMID 27852595
56. Imhoff AB, Paul J, Ottinger B, et al. Osteochondral transplantation of the talus: long-term clinical and magnetic resonance imaging evaluation. *Am J Sports Med.* Jul 2011; 39(7): 1487-93. PMID 21372316
57. Kreuz PC, Steinwachs M, Erggelet C, et al. Mosaicplasty with autogenous talar autograft for osteochondral lesions of the talus after failed primary arthroscopic management: a prospective study with a 4-year follow-up. *Am J Sports Med.* Jan 2006; 34(1): 55-63. PMID 16157849
58. Pereira GF, Steele JR, Fletcher AN, et al. Fresh Osteochondral Allograft Transplantation for Osteochondral Lesions of the Talus: A Systematic Review. *J Foot Ankle Surg.* 2021; 60(3): 585-591. PMID 33642164
59. Diniz P, Pacheco J, Flora M, et al. Clinical applications of allografts in foot and ankle surgery. *Knee Surg Sports Traumatol Arthrosc.* Jun 2019; 27(6): 1847-1872. PMID 30721345
60. van Dijk CN. Editorial Commentary: Bulk Osteochondral Talar Grafts Compromise Future Arthrodesis or Prosthesis. *Arthroscopy.* Jan 2017; 33(1): 223-224. PMID 28003071
61. Migliorini F, Maffulli N, Baroncini A, et al. Allograft Versus Autograft Osteochondral Transplant for Chondral Defects of the Talus: Systematic Review and Meta-analysis. *Am J Sports Med.* Oct 2022; 50(12): 3447-3455. PMID 34554880
62. VanTienderen RJ, Dunn JC, Kusnezov N, et al. Osteochondral Allograft Transfer for Treatment of Osteochondral Lesions of the Talus: A Systematic Review. *Arthroscopy.* Jan 2017; 33(1): 217-222. PMID 27546173
63. Gaul F, Tírigo LEP, McCauley JC, et al. Osteochondral Allograft Transplantation for Osteochondral Lesions of the Talus: Midterm Follow-up. *Foot Ankle Int.* Feb 2019; 40(2): 202-209. PMID 30383977
64. Sayani J, Plotkin T, Burchette DT, et al. Treatment Strategies and Outcomes for Osteochondritis Dissecans of the Capitellum. *Am J Sports Med.* Dec 2021; 49(14): 4018-4029. PMID 33886390
65. Westermann RW, Hancock KJ, Buckwalter JA, et al. Return to Sport After Operative Management of Osteochondritis Dissecans of the Capitellum: A Systematic Review and Meta-analysis. *Orthop J Sports Med.* Jun 2016; 4(6): 2325967116654651. PMID 27482526
66. Kirsch JM, Thomas JR, Khan M, et al. Return to Play After Osteochondral Autograft Transplantation of the Capitellum: A Systematic Review. *Arthroscopy.* Jul 2017; 33(7): 1412-1420.e1. PMID 28413129
67. Sato K, Iwamoto T, Matsumura N, et al. Costal Osteochondral Autograft for Advanced Osteochondritis Dissecans of the Humeral Capitellum in Adolescent and Young Adult Athletes: Clinical Outcomes with a Mean Follow-up of 4.8 Years. *J Bone Joint Surg Am.* Jun 06 2018; 100(11): 903-913. PMID 29870440
68. Bexkens R, Ogink PT, Doornberg JN, et al. Donor-site morbidity after osteochondral autologous transplantation for osteochondritis dissecans of the capitellum: a systematic review and meta-analysis. *Knee Surg Sports Traumatol Arthrosc.* Jul 2017; 25(7): 2237-2246. PMID 28391550
69. Kircher J, Patzer T, Magosch P, et al. Osteochondral autologous transplantation for the treatment of full-thickness cartilage defects of the shoulder: results at nine years. *J Bone Joint Surg Br.* Apr 2009; 91(4): 499-503. PMID 19336811
70. Cole BJ, Farr J, Winalski CS, et al. Outcomes after a single-stage procedure for cell-based cartilage repair: a prospective clinical safety trial with 2-year follow-up. *Am J Sports Med.* Jun 2011; 39(6): 1170-9. PMID 21460066
71. Farr J, Tabet SK, Margerrison E, et al. Clinical, Radiographic, and Histological Outcomes After Cartilage Repair With Particulated Juvenile Articular Cartilage: A 2-Year Prospective Study. *Am J Sports Med.* Jun 2014; 42(6): 1417-25. PMID 24718790
72. Tompkins M, Hamann JC, Diduch DR, et al. Preliminary results of a novel single-stage cartilage restoration technique: particulated juvenile articular cartilage allograft for chondral defects of the patella. *Arthroscopy.* Oct 2013; 29(10): 1661-70. PMID 23876608
73. Dawkins BJ, Shubin Stein BE, Mintz DN, et al. Patellofemoral joint cartilage restoration with particulated juvenile allograft in patients under 21 years old. *Knee.* Jun 2022; 36: 120-129. PMID 34376348
74. Saltzman BM, Lin J, Lee S. Particulated Juvenile Articular Cartilage Allograft Transplantation for Osteochondral Talar Lesions. *Cartilage.* Jan 2017; 8(1): 61-72. PMID 27994721

75. Bleazey S, Brigido SA. Reconstruction of complex osteochondral lesions of the talus with cylindrical sponge allograft and particulate juvenile cartilage graft: provisional results with a short-term follow-up. *Foot Ankle Spec.* Oct 2012; 5(5): 300-5. PMID 22935411
76. Coetzee JC, Giza E, Schon LC, et al. Treatment of osteochondral lesions of the talus with particulated juvenile cartilage. *Foot Ankle Int.* Sep 2013; 34(9): 1205-11. PMID 23576118
77. Dekker TJ, Steele JR, Federer AE, et al. Efficacy of Particulated Juvenile Cartilage Allograft Transplantation for Osteochondral Lesions of the Talus. *Foot Ankle Int.* Mar 2018; 39(3): 278-283. PMID 29262723
78. DeSandis BA, Haleem AM, Sofka CM, et al. Arthroscopic Treatment of Osteochondral Lesions of the Talus Using Juvenile Articular Cartilage Allograft and Autologous Bone Marrow Aspirate Concentration. *J Foot Ankle Surg.* 2018; 57(2): 273-280. PMID 29305041
79. Farr J, Gracitelli GC, Shah N, et al. High Failure Rate of a Decellularized Osteochondral Allograft for the Treatment of Cartilage Lesions. *Am J Sports Med.* Aug 2016; 44(8): 2015-22. PMID 27179056
80. Johnson CC, Johnson DJ, Garcia GH, et al. High Short-Term Failure Rate Associated With Decellularized Osteochondral Allograft for Treatment of Knee Cartilage Lesions. *Arthroscopy.* Dec 2017; 33(12): 2219-2227. PMID 28967543
81. Mehta VM, Mehta S, Santoro S, et al. Short term clinical outcomes of a Prochondrix® thin laser-etched osteochondral allograft for the treatment of articular cartilage defects in the knee. *J Orthop Surg (Hong Kong).* 2022; 30(3): 10225536221141781. PMID 36527357
82. American Orthopaedic Foot and Ankle Society. Position Statement: The Use of Osteochondral Transplantation for the Treatment of Osteochondral Lesions of the Talus. [https://www.aofas.org/docs/default-source/research-and-policy/osteochondral-lesions-position-statement.pdf?sfvrsn=95e8c93b\\_2](https://www.aofas.org/docs/default-source/research-and-policy/osteochondral-lesions-position-statement.pdf?sfvrsn=95e8c93b_2). Accessed February 27, 2024.
83. Smyth NA, Murawski CD, Adams SB, et al. Osteochondral Allograft: Proceedings of the International Consensus Meeting on Cartilage Repair of the Ankle. *Foot Ankle Int.* Jul 2018; 39(1\_suppl): 35S-40S. PMID 30215308
84. American Academy of Orthopaedic Surgeons Diagnosis and Treatment of Osteochondritis Dissecans Work Group. The diagnosis and treatment of osteochondritis dissecans: Guideline and evidence report. 2023, December 1; <https://www.aaos.org/globalassets/quality-and-practice-resources/osteochondritis-dissecans/osteochondritis-dissecans-rapid-update-2023.pdf>. Accessed February 28, 2024.
85. Trice ME, Bugbee WD, Greenwald AS, et al. Articular cartilage restoration: A review of currently available methods. 2010; <http://orl-inc.com/wp-content/uploads/2016/03/Cartilage-Repair-2010.pdf>. Accessed February 28, 2024.
86. National Institute for Health and Care Excellence. Mosaicplasty for symptomatic articular defects of the knee [IPG607]. <https://www.nice.org.uk/guidance/ipg607>. Accessed February 27, 2024.