



Kansas City

An Independent Licensee of the Blue Cross and Blue Shield Association

Autografts and Allografts in the Treatment of Focal Articular Cartilage Lesions

Policy Number: 7.01.78

Last Review: 8/2017

Origination: 8/2002

Next Review: 2/2018

Policy

Blue Cross and Blue Shield of Kansas City (Blue KC) will provide coverage for osteochondral autografts and allografts when it is determined to be medically necessary because the criteria shown below are met.

When Policy Topic is covered

Osteochondral fresh allografting may be considered **medically necessary** as a technique to repair

- 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 the size, location, or depth of the lesion.
- Large (area >1.5 cm²) or cystic (volume >3.0 cm³) osteochondral lesions of the talus when autografting would be inadequate due to the size, depth, or location of the lesion.
- Revision surgery after failed osteochondral autografting for large (area >1.5 cm²) or cystic (volume >3.0 cm³) osteochondral lesions of the talus when autografting would be inadequate due to size, depth or location of the lesion.

Osteochondral autografting, using one 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 patients who have had an inadequate response to a prior surgical procedure, when **all** of the following have been met:
 - Adolescent patients should be skeletally mature with documented closure of growth plates (e.g., 15 years or older). Adult patients should be too young to be considered an appropriate candidate for total knee arthroplasty or other reconstructive knee surgery (e.g., younger than 55 years)

- Focal, full thickness (grade III or IV) unipolar lesions on the weight bearing surface of the femoral condyles or trochlea, or patella that are between 1 and 2.5 cm² 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 cm²) or cystic (volume >3.0 cm³) osteochondral lesions of the talus.
- Revision surgery after failed marrow stimulation for osteochondral lesion of the talus.

When Policy Topic is not covered

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

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 cartilage is considered **investigational**.

Treatment of focal articular cartilage lesions with allogeneic minced 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**.

Considerations

In some situations, the chondral defect may be an incidental finding at the time of arthroscopy and therefore, the decision to undergo osteochondral autografting may be made at that time.

If debridement is the only prior surgical treatment, consideration should be given to marrow stimulating techniques before osteochondral grafting is performed, particularly for lesions less than 1.5 cm² in area or 3.0 cm³ in volume.

Severe obesity, e.g., body mass index (BMI) greater than 35 kg/m², may affect outcomes due to the increased stress on weight bearing surfaces of the joint.

Misalignment and instability of the joint are contraindications. Therefore additional procedures, such as repair of ligaments or tendons or creation of an osteotomy for realignment of the joint, may be performed at the same time. In addition, meniscal allograft transplantation may be performed in combination, either

concurrently or sequentially, with osteochondral allografting or osteochondral autografting.

Description of Procedure or Service

Populations	Interventions	Comparators	Outcomes
Individuals: <ul style="list-style-type: none"> With full-thickness articular cartilage lesions of the knee 	Interventions of interest are: <ul style="list-style-type: none"> Osteochondral autograft 	Comparators of interest are: <ul style="list-style-type: none"> Marrow stimulation Autologous chondrocyte implantation 	Relevant outcomes include: <ul style="list-style-type: none"> Symptoms Functional outcomes Quality of life Treatment-related morbidity
Individuals: <ul style="list-style-type: none"> With full-thickness articular cartilage lesions of the knee when autografting would be inadequate due to size or depth of the lesion. 	Interventions of interest are: <ul style="list-style-type: none"> Fresh osteochondral allograft 	Comparators of interest are: <ul style="list-style-type: none"> Osteochondral autograft 	Relevant outcomes include: <ul style="list-style-type: none"> Symptoms Functional outcomes Quality of life Treatment-related morbidity
Individuals: <ul style="list-style-type: none"> With primary full-thickness articular cartilage lesions of the ankle < 1.5 cm² 	Interventions of interest are: <ul style="list-style-type: none"> Osteochondral autograft 	Comparators of interest are: <ul style="list-style-type: none"> Marrow stimulation 	Relevant outcomes include: <ul style="list-style-type: none"> Symptoms Functional outcomes Quality of life Treatment-related morbidity
Individuals: <ul style="list-style-type: none"> With large (> 1.5 cm²) or cystic (> 3.0 cm³) full-thickness articular cartilage lesions of the ankle 	Interventions of interest are: <ul style="list-style-type: none"> Osteochondral autograft 	Comparators of interest are: <ul style="list-style-type: none"> Marrow stimulation 	Relevant outcomes include: <ul style="list-style-type: none"> Symptoms Functional outcomes Quality of life Treatment-related morbidity
Individuals: <ul style="list-style-type: none"> With full-thickness articular cartilage lesions of the ankle that have failed primary treatment 	Interventions of interest are: <ul style="list-style-type: none"> Osteochondral autograft 	Comparators of interest are: <ul style="list-style-type: none"> Marrow stimulation 	Relevant outcomes include: <ul style="list-style-type: none"> Symptoms Functional outcomes Quality of life Treatment-related morbidity
Individuals: <ul style="list-style-type: none"> With primary full-thickness articular cartilage lesions of the ankle < 1.5 cm² 	Interventions of interest are: <ul style="list-style-type: none"> Osteochondral allograft 	Comparators of interest are: <ul style="list-style-type: none"> Marrow stimulation 	Relevant outcomes include: <ul style="list-style-type: none"> Symptoms Functional outcomes Quality of life Treatment-related morbidity
Individuals: <ul style="list-style-type: none"> With large (>1.5 cm²) or cystic (> 3.0 cm³) 	Interventions of interest are: <ul style="list-style-type: none"> Fresh osteochondral allograft 	Comparators of interest are: <ul style="list-style-type: none"> Osteochondral autograft 	Relevant outcomes include: <ul style="list-style-type: none"> Symptoms Functional outcomes Quality of life Treatment-related

cartilage lesions of the ankle when autografting would be inadequate			morbidity
<p>Individuals:</p> <ul style="list-style-type: none"> With revision of large (>1.5 cm²) or cystic (> 3.0 cm³) cartilage lesions of the ankle when autografting would be inadequate 	<p>Interventions of interest are:</p> <ul style="list-style-type: none"> Fresh osteochondral allograft 	<p>Comparators of interest are:</p> <ul style="list-style-type: none"> Osteochondral autograft 	<p>Relevant outcomes include:</p> <ul style="list-style-type: none"> Symptoms Functional outcomes Quality of life Treatment-related morbidity
<p>Individuals:</p> <ul style="list-style-type: none"> With full-thickness articular cartilage lesions of the elbow 	<p>Interventions of interest are:</p> <ul style="list-style-type: none"> Fresh osteochondral autograft 	<p>Comparators of interest are:</p> <ul style="list-style-type: none"> Marrow stimulation 	<p>Relevant outcomes include:</p> <ul style="list-style-type: none"> Symptoms Functional outcomes Quality of life Treatment-related morbidity
<p>Individuals:</p> <ul style="list-style-type: none"> With full-thickness articular cartilage lesions of the shoulder 	<p>Interventions of interest are:</p> <ul style="list-style-type: none"> Osteochondral autograft 	<p>Comparators of interest are:</p> <ul style="list-style-type: none"> Marrow stimulation 	<p>Relevant outcomes include:</p> <ul style="list-style-type: none"> Symptoms Functional outcomes Quality of life Treatment-related morbidity
<p>Individuals:</p> <ul style="list-style-type: none"> With full-thickness articular cartilage lesions of the knee, ankle, elbow, or shoulder 	<p>Interventions of interest are:</p> <ul style="list-style-type: none"> Autologous or allogeneic minced articular cartilage 	<p>Comparators of interest are:</p> <ul style="list-style-type: none"> Marrow stimulation Autologous chondrocyte implantation 	<p>Relevant outcomes include:</p> <ul style="list-style-type: none"> Symptoms Functional outcomes Quality of life Treatment-related morbidity
<p>Individuals:</p> <ul style="list-style-type: none"> With full-thickness articular cartilage lesions of the knee, ankle, elbow, or shoulder 	<p>Interventions of interest are:</p> <ul style="list-style-type: none"> Decellularized osteochondral allograft plugs 	<p>Comparators of interest are:</p> <ul style="list-style-type: none"> Marrow stimulation procedures 	<p>Relevant outcomes include:</p> <ul style="list-style-type: none"> Symptoms Functional outcomes Quality of life Treatment-related morbidity
<p>Individuals:</p> <ul style="list-style-type: none"> With full-thickness articular cartilage lesions of the knee, ankle, elbow, or shoulder 	<p>Interventions of interest are:</p> <ul style="list-style-type: none"> Reduced osteochondral allograft discs 	<p>Comparators of interest are:</p> <ul style="list-style-type: none"> Marrow stimulation 	<p>Relevant outcomes include:</p> <ul style="list-style-type: none"> Symptoms Functional outcomes Quality of life Treatment-related morbidity

Osteochondral grafts are used in repair of 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.

For individuals who have full-thickness articular cartilage lesions of the knee who receive osteochondral autografts, 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 at short and mid-term. Compared to 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 cm²) when measured at longer follow-up. This is believed to be due to the higher durability of hyaline cartilage compared to the fibrocartilage that is formed 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 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 a meaningful improvement in the net health outcome.

For individuals who have full-thickness articular cartilage lesions of the knee who receive fresh osteochondral allografts, the evidence includes 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 the size, location, or depth of the lesion. The evidence is sufficient to determine that the technology results in a meaningful improvement in the net health outcome.

For individuals who have primary full-thickness articular cartilage lesions of the ankle less than 1.5 cm² who receive an osteochondral autograft, the evidence includes observational studies and a 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 or autologous osteochondral transplantation (AOT). Given the success of marrow stimulation procedures for smaller lesions (<1.5 cm²) and the increase in donor-site morbidity with graft harvest from the knee, current evidence does not support the use of AOT as a primary treatment for smaller articular cartilage lesions of the ankle. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who have large ($>1.5 \text{ cm}^2$) or cystic ($>3.0 \text{ cm}^3$) articular cartilage lesions of the ankle who receive an osteochondral autograft, the evidence includes an RCT and 2 observational studies. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. An RCT in patients with large lesions found similar efficacy for AOT, marrow stimulation and arthroplasty at 2-year follow-up. Longer term results were not reported. Because observational studies of marrow stimulation in the talus generally report worse outcomes and high failure rates for large lesions, there is a strong rationale for using autografts. However, there is limited evidence that osteochondral autografts lead to better outcomes than microfracture at longer follow-up. The strongest evidence is derived from one observational study that showed good improvement in FOAS scores through at least 5-year follow-up using AOT in both larger (2 plugs) and smaller (1 plug) lesions. Additional study is needed to evaluate the durability of AOT in larger lesions. The evidence is insufficient to determine the effects of the technology on health outcomes.

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

For individuals who have primary full-thickness articular cartilage lesions of the ankle less than 1.5 cm^2 who receive fresh osteochondral allografts, there is little evidence. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. Since microfracture is effective as a primary treatment in lesions less than 1.5 cm^2 and AOT is effective as a revision procedure, use of allograft for small primary cartilage lesions has not been reported. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who have large (area $>1.5 \text{ cm}^2$) or cystic (volume $>3.0 \text{ cm}^3$) osteochondral lesions of the ankle when autografting would be inadequate who receive fresh osteochondral allografts, the evidence includes a small number of patients in an RCT, case series, and a systematic review of case series. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. The systematic review found a significant failure rate with osteochondral allografts for talar lesions. Although there is a potential to delay or avoid arthrodesis or total ankle arthroplasty in younger patients, use of an allograft may be detrimental to future treatments. Additional study is needed. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who have revision of large (area >1.5 cm²) or cystic (volume >3.0 cm³) osteochondral lesions of the ankle when autografting would be inadequate who receive fresh osteochondral allografts, the evidence includes an RCT. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. The RCT found that outcomes were slightly, but not significantly, worse with osteochondral allografts compared to autografts. However, failure due to non-union was higher in the allograft group, consistent with other reports. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who have full-thickness articular cartilage lesions of the elbow who receive osteochondral autografts, the evidence includes a meta-analysis of case series. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. Osteochondritis dissecans (OCD) of the elbow typically occurs in patients who play baseball or do gymnastics. The literature on osteochondral autografts for advanced OCD of the elbow consists of small case series, primarily from Europe and Asia, and a systematic review of case series. Although the meta-analysis suggested a benefit of osteochondral autografts compared to débridement or fixation, RCTs are needed to determine the effects of the procedure with greater certainty. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who have full-thickness articular cartilage lesions of the shoulder who receive osteochondral autografts, 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 the effects of the technology on health outcomes.

For individuals who have full-thickness articular cartilage lesions of the knee, ankle, elbow, or shoulder who receive autologous or allogeneic minced 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 1 small RCT from 2011. 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, nonhomogenous 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 the effects of the technology on health outcomes.

For individuals who have full-thickness articular cartilage lesions of the knee, ankle, elbow, or shoulder who receive decellularized osteochondral allograft plugs

or reduced osteochondral allograft discs, the evidence includes 1 small case series. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. The single case series on decellularized osteochondral allograft plugs reported delamination of the implants, and high failure rates. Only small series with 2 to 3 patients have been identified on reduced osteochondral allograft discs. The evidence is insufficient to determine the effects of the technology on health outcomes.

Clinical input obtained in 2017 was focused on the treatment of talar lesions. Input supported use of osteochondral autografts and allografts for the treatment of larger talar lesions or lesions that had failed prior marrow stimulation. The rationale for the medical necessity in these situation was based on the increased failure rate of microfracture for the treatment of large (area >150 mm²) or cystic (volume >3000 mm³) lesions and for revision marrow stimulation procedures. Use of a fresh osteochondral allograft is typically reserved for lesions that are too large to be treated with AOT. RCTs in these populations are unlikely.

Background

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 capitellum being the next most frequent sites. The most common location of lesions is the medial femoral condyle (69%), followed by the weight-bearing portion of the lateral femoral condyle (15%), the patella (5%) and trochlear fossa.¹ Talar lesions are reported to be about 4% of osteochondral lesions.⁽²⁾ 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 is 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.

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 to primarily achieve symptomatic relief: débridement (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 include: abrasion arthroplasty, microfracture, and drilling, all of which are considered standard therapies.

Efficacy of the microfracture technique for articular cartilage lesions of the knee was examined in a 2009 systematic review.⁽³⁾ Twenty-eight studies (total N=3122 patients) were selected; 6 studies were randomized controlled trials (RCTs). 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. A prospective longitudinal study of 110 patients by Solheim et al (2016) found that, at a mean of 12 years (range, 10-14 years) after microfracture, 45.5% of patients had poor outcomes, including 43 patients who required additional surgery.⁽⁴⁾ The size of the lesion has also been shown to have an effect on outcomes following marrow stimulation procedures.

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.

Both fresh and cryopreserved allogeneic osteochondral grafts have been used with some success, although 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 and Nephew), the Osteochondral Autograft Transfer System (AOT; Arthrex), and the COR and COR2 systems (DePuy Mitek). Although mosaicplasty and AOT 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 débridement 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 AOT 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, 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.(5) At an average 47-month follow-up (range, 7-77 months), 5 patients were rated as having an excellent LKS score (95-100 points), 2 as good (84-94 points), and 4 as poor (≤ 64 points). Reported knee problems were instability in daily activities, pain after walking 1 mile or more, having a 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 AOT.(6)

Filling defects with minced articular cartilage (autologous or allogeneic) is another single-stage procedure being investigated for cartilage repair. The Cartilage Autograft Implantation System (CAIS; Johnson and Johnson) harvests cartilage and disperses chondrocytes on a scaffold in a single-stage treatment. 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 with exclusive distribution rights 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 for use. Chondrofix is composed of decellularized hyaline cartilage and cancellous bone; it can be used "off the shelf" with precut cylinders (7-15 mm). Multiple cylinders may be used to fill a larger defect in a manner similar to AOT 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.

DeNovo ET graft (ISTO Technologies) uses juvenile allogeneic cartilage cells.

Autologous chondrocyte implantation (ACI) 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. ACI techniques are discussed in a separate policy.

REGULATORY STATUS

The FDA U.S. Food and Drug Administration (FDA) considers orthopedic manual surgical instrument as class I devices. If a manufacturer's device falls into a generic category of exempted class I devices as defined in 21 CFR Parts 862-892, a premarket notification application and FDA clearance is not required before marketing the device in the U.S. The harvesting and implantation are surgical procedures and is not subject to regulation by the FDA.

As there is no use of chemicals and minimal manipulation, allograft tissue does not require approval for marketing. The U.S. Food and Drug Administration regulates human cells and tissues intended for implantation, transplantation, or infusion through the Center for Biologics Evaluation and Research, under Code of Federal Regulation (CFR) title 21, parts 1270 and 1271.

DeNovo® ET Live Chondral Engineered Tissue Graft (Neocartilage) is marketed by ISTO Technologies outside of the United States. FDA approved ISTO's investigational new drug application for Neocartilage in 2006, which allowed them to pursue phase 3 clinical trials of the product in humans.

Rationale

This evidence review was originally created in August 2001 and has been updated regularly with searches of the MEDLINE database. The most recent literature update was performed through March 23, 2017.

Assessment of the efficacy for a therapeutic intervention involves a determination whether an intervention improves health outcomes compared to available alternatives. The optimal study design for this purpose is a randomized controlled trial (RCT) that compares the therapeutic intervention with existing alternative treatments and includes clinically relevant measures of health outcomes. It is recognized that RCTs are extremely important to assess treatments of cartilage repair procedures, due to the expected placebo effect and the subjective nature of pain. The present review focuses on cartilage repair procedures of the knee, ankle, elbow, and shoulder using allografts and autografts compared to débridement, marrow-stimulating procedures, and autologous chondrocyte implantation (ACI). Following is a summary of key references to date.

OSTEOCHONDRAL AUTOGRAFT FOR ARTICULAR CARTILAGE LESIONS OF THE KNEE

The evidence on osteochondral AOT for articular cartilage lesions of the knee includes systematic reviews and a number of RCTs that compare outcomes from AOT with marrow stimulation or ACI.

Systematic Reviews

A 2016 Cochrane review by Gracitelli et al evaluated surgical interventions (microfracture, drilling, osteochondral autografts, allograft transplantation) for the treatment of isolated cartilage defects of the knee in adults.(7) Three RCTs selected compared AOT to microfracture for isolated cartilage defects. The evidence was considered to be of very low quality with high or unclear risk of bias.

In a 2008 systematic review, at short-term follow-up, neither of the “advanced” cartilage repair techniques (osteochondral transplantation or autologous chondrocyte transplantation) showed superior outcomes compared with traditional abrasive techniques.(8) Finding 5 RCTs and 1 prospective comparative trial, Magnussen et al concluded that no single technique produced superior clinical results for treatment of articular cartilage defects, however, “any differences in outcome based on the formation of articular rather than fibrocartilage in the defect may be quite subtle and only reveal themselves after many years of follow-up. Similarly, complications such as donor-site morbidity in AOT may be late in their presentation and thus not be detected at short follow-up.” However, in a mid-term meta-analysis that included 5 RCTs (described below), Pareek et al (2016) found that Tegner Activity Scale (TAS) scores were higher and failure rates lower with AOT compared to microfracture.(9) In subgroup analysis, activity scores were higher in the subset of patients treated with AOT who had lesions greater than 3 cm² at midterm follow-up.

In a 2011 systematic review, Harris et al evaluated whether outcomes from cartilage repair/restoration techniques remained successful if combined with meniscal allograft.(10) Six level IV studies (case series) with 110 patients were included in the review. Patients underwent meniscal allograft transplantation with either ACI (n=73), osteochondral allograft (n=20), osteochondral autograft (n=17), or microfracture (n=3). All studies showed improved clinical outcomes at final follow-up compared with the preoperative condition. Outcomes were also compared with historical outcomes of each procedure performed in isolation. Four of the 6 studies found outcomes equivalent to procedures performed in isolation, suggesting that the combined procedures did not result in poorer outcomes.

Subsection Summary: Systematic Reviews

Several systematic reviews have evaluated osteochondral autografting for cartilage repair. Evidence is of low quality, and not all reviews found a benefit compared to abrasion techniques. However, there is evidence that, in patients with larger lesions and longer follow-up, treatment with osteochondral autografts decreases failure rates compared with abrasion techniques (eg, microfracture, drilling).

Randomized Controlled Trials

Osteochondral Autografts vs Microfracture

Studies included in the systematic reviews described above included 3 RCTs from the same group of investigators, 1 RCT with mid-term follow-up, and 1 RCT with long-term follow-up; they compared AOT to microfracture. These RCTs are detailed below.

Gudas et al (2005) reported on a blinded comparison of arthroscopic AOT versus microfracture for lesions of the femoral condyle (1-4 cm²) in 60 athletes between 15 and 40 years of age (mean, 24.3 years).(11) Follow-up with 95% of the athletes for up to 3 years after surgery showed that more athletes returned to sports activities (mean, 6.5 months) following AOT (93% vs 52%) and fewer required revision (1 of 28 vs 9 of 29), both respectively. Overall, 96% of patients treated by AOT had an excellent or good result compared with 52% treated by microfracture. At 1-year follow-up, scores on the International Cartilage Repair Society (ICRS) cartilage grading system were higher in the AOT group and at 3-year follow-up, results from the Harris Hip Score (HSS) improved more in the AOT group. Blinded arthroscopic and histologic assessment in a subset of patients showed hyaline cartilage of normal appearance following transplantation, whereas microfracture frequently resulted in surface fibrillation and soft fibroelastic tissue. At 10-year follow-up, there were 4 (14%) failures in the AOT group and 11 (38%) failures in the microfracture group.(12) TAS scores decreased in both groups over time, but remained significantly better following AOT than microfracture. In the subgroup of patients younger than 25 years of age at the time of surgery, 15 (75%) of 20 in the AOT group and 8 (37%) of 22 in the microfracture group maintained the same level of activity (competitive athletes or frequently sporting) as before the injury. The level of sporting activity was reported to decrease in older patients because of age or reasons unrelated to their knee injuries.

Another report by Gudas et al (2013) compared mosaicplasty to microfracture or débridement. One hundred two patients with lesions associated with anterior cruciate ligament (ACL) injury were randomized to 1 of the 3 procedures to repair their ACLs.(13) A matched control group of 34 patients with ACL injury but no articular cartilage lesion was included as a comparator. The postoperative rehabilitation protocol was the same for the 3 treatment groups. At a mean 36.1-month follow-up, patients were evaluated with the International Knee Documentation Committee (IKDC) score, TAS score, and clinical assessment. All groups showed a significant improvement in the IKDC score compared with before surgery. Patients without cartilage lesions had significantly better IKDC subjective scores than patients with cartilage lesions. For the 3 groups with cartilage lesions, the mosaicplasty group's IKDC subjective knee evaluation was significantly better than those for the microfracture or débridement groups, although the differences between the groups were modest. TAS scores were similar for the mosaicplasty (7.1) and microfracture (6.9) groups, and slightly lower for the débridement group (6.2).

Gudas et al (2009) also published a randomized trial of AOT (n=25) versus microfracture (n=25) in children 12 to 18 years of age (mean, 14.3 years).⁽¹⁴⁾ Only children with grade 3 or 4 osteochondritis dissecans (OCD) defects of the femoral condyles were selected. The OCD defects were between 2 and 4 cm² in area, and the mean duration of symptoms was 24 months. Follow-up was obtained in 94% of patients. After 1 year, the proportion of excellent-to-good outcomes was similar for the 2 groups (92% for AOT vs 86% for microfracture). However, after a mean 4.2 years of follow-up (range, 3-6 years), the microfracture group showed 9 (41%) of 22 failures. By comparison, there were no failures in the AOT group, and good-to-excellent outcomes were obtained in 83% of the children. Magnetic resonance imaging (MRI) at a mean of 18 months after surgery showed no evidence of graft loosening or migration, with excellent or good repair in 19 (91%) of 21 children. By comparison, blinded evaluation showed excellent or good repair in 10 (56%) of 18 children after microfracture.

In 2012, Lim et al reported on an RCT comparing AOT (n=22), ACI (n=18), and microfracture (n=30).⁽¹⁵⁾ Outcomes were measured using the Lysholm Knee Scale (LKS), TAS, and HSS. All 3 procedures showed improvement in functional scores, with no significant differences between the groups. Arthroscopy at 1 year showed excellent or good results in about 80% of patients.

In 2014, Ulstein et al reported on a long-term randomized trial (median, 9.8 years; range, 4.9-11.4 years) comparing AOT to microfracture.¹⁶ This smaller study enrolled 25 patients with a lesion of the femoral condyle or trochlea, with an area between 2 and 6 cm². There were no significant differences between the AOT and microfracture groups in patient-reported outcomes (LKS, Knee Injury and Osteoarthritis Outcome Score [KOOS]), muscle strength, or radiologic outcome. However, 4 of 11 patients in the microfracture group underwent a second cartilage procedure compared with none in the AOT group.

Subsection Summary: Osteochondral Autografts vs Microfracture

We identified 5 RCTs that compared osteochondral autografting with microfracture. They are summarized in the systematic reviews. Although the quality of the studies is not high, there is evidence of lower rates of reoperation and higher activity levels, particularly in patients with larger lesions and at longer follow-up, when treated with osteochondral autografting. A limitation of this body of evidence is that most data came from a single research group.

Osteochondral Autografts vs ACI

Several RCTs have compared AOT to ACI for the treatment of articular cartilage lesions. Bentley et al (2003) randomized 100 consecutive patients with larger symptomatic lesions of the knee (average, 4.7 cm²; range, 1-12 cm²) to ACI or mosaicplasty.⁽¹⁷⁾ Seventy-four percent of lesions were on the femoral condyle and 25% were on the patella. Ninety-four patients had had previous surgical interventions, and the average duration of symptoms before surgery was 7 years. Clinical assessment at 1 year showed excellent or good results in 98% of the ACI patients and 69% of the mosaicplasty patients. The mosaicplasty plugs showed incomplete healing of the spaces between the grafts, fibrillation of the repair

tissue, and disintegration of the grafts in some patients. The lack of healing may be related to both the relatively large lesion size and the unusual prominent placement of the plugs in this study, which was intended to allow contact with the opposite articular surface. With 6 patients lost to follow-up at a minimum 10 years after the index surgery, repair was found to have failed in 17% of patients treated with ACI and 55% of patients treated with mosaicplasty.(18)

Dozin et al (2005) reported results from a multicenter RCT that compared ACI with AOT.(19) Forty-four subjects, who had a focal, symptomatic chondral injury of Outerbridge grade III or IV with no previous surgical treatment, were randomized to ACI or AOT 6 months after undergoing arthroscopic débridement. Average lesion size was 1.9 cm. There was a high dropout rate, with only about 50% of patients undergoing the procedure; 10 patients were cured by debridement. With intention-to-treat analysis, the percentages of patients who achieved complete success were 89% (16/18 evaluable cases) in the AOT arm versus 68% (13/19 evaluable cases) in the ACI arm ($p=NS$). The high rate of spontaneous improvement after simple débridement raises questions about the appropriateness of additional surgical intervention in patients with small lesions similar to those included in this trial.

Horas et al (2003) reported 2-year follow-up on a study of 40 patients (age range, 18-42 years) with an articular lesion of the femoral condyle (size range, 3.2-5.6 cm²) who were randomized to undergo ACI or AOT.(20) Eleven (28%) had had prior surgical treatment. Authors reported that both treatments improved symptoms (85% of each group), although those in the AOT group responded more quickly. Histomorphologic evaluation of 5 biopsy specimens at 2 years or less after transplantation indicated that the osteochondral cylinders had retained their hyaline character, although investigators noted a persistent interface between the transplant and the surrounding original cartilage.

Subsection Summary: Osteochondral Autografts vs ACI

Of 3 RCTs identified that compared AOT with ACI, interpretation of 2 is limited. The study by Bentley et al may have been affected by the use of prominent plugs, while the study by Dozin et al included patients with smaller lesions, many of whom did not proceed to surgery. The third RCT included 40 patients with larger lesions (3.2-5.6 cm²) and reported similar improvements in symptoms for the 2 treatments.

Observational Studies

While observational studies do not provide evidence of efficacy or comparative efficacy, they may provide information about the durability of any observed improvements and potential impacts of patient selection factors. Observational studies have reported longer term outcomes and an impact of sex, age, and size and location of the lesion.

Hangody, who first reported use of the mosaicplasty technique in humans in 1992, has coauthored a number of summaries and case series.(21-23) A 2008 summary paper included descriptions of a prospective multicenter comparison of 413

resurfacing procedures and follow-up from 1097 mosaicplasties at the authors' institution.(23) Although authors reported that the comparative study found hyaline-like resurfacing to result in a better clinical outcome than other techniques, the cited study is not publicly available in a peer-reviewed publication. For the retrospective analysis, Hangody et al reported 789 implantations on the femoral condyles, 147 in the patellofemoral joint, 31 on the tibia condyles, 98 on talar domes, 8 on the capitulum humeric, 3 on humeral heads, and 11 on femoral heads. Clinical scores at long-term follow-up suggested good-to-excellent results in 92% of patients with femoral condylar implantations, 87% of tibial resurfacings, and 74% of patellar and/or trochlear mosaicplasty. (AOT for talar procedures is described in a separate section below). Based on their experience with this procedure, Hangody et al considered the optimal indications to be lesions 1 to 4 cm² in diameter, patients 50 years of age or younger (due to decreased repair capacity with aging), and correction of instability, malalignment, and meniscal or ligament tears.(23)

Ollat et al (2011) reported a retrospective multicenter study from the French Society of Arthroscopy that included 142 patients at a mean follow-up of 8 years.(24) (This technique has been used extensively in France due to restrictive legislation on restoration techniques, including chondrocyte transfer.) Mean lesion size was 2.29 cm², and mean number of plugs was 4 (range, 1-14). Most patients (81.8%) were satisfied or very satisfied with their functional outcomes and there was significant improvement in the ICRS, IKDC function, and Hughston scores at follow-up. Factors for a good prognosis were: male sex, location of the defect in the medial femoral condyle, OCD, deep, small defects, and a short interval before surgery.

Solheim et al (2010, 2013) reported 5- to 9-year (N=69) and 10- to 14-year (N=73) follow-up from patients treated for 1 to 5 cm² articular cartilage defects.(25,26) The LKS score improved from 49 at baseline to 72 at mid-term and long-term follow-up. Visual analog scale (VAS) score for pain improved from 58 at baseline to 27 at mid-term follow-up and 33 at long-term follow-up. However, a poor outcome, defined as a Lysholm score of 64 or less or subsequent knee replacement, was observed in 40% of the patients by 10 to 14 years. Factors associated with a poor outcome were patient age (≥ 40 years at the time of surgery), female sex, and articular cartilage defects of 3 cm² or more. The failure rate was 83% for females 40 years or older with a defect area of 3 cm² or more compared to 12.5% for males younger than 40 years old with an articular cartilage defect less than 3 cm².

Other reports have focused on AOT for treating patellar lesions. In 2014, Astur et al prospectively analyzed 33 patients with symptomatic patellar lesions (diameter, 1-2.5 cm) treated with AOT.(27) At a minimum 2-year follow-up (range, 24-54 months), all patients were reported to have significant improvement in functional scores, as measured by the LKS, Kujala, and Fulkerson scores and the 36-Item Short-Form Health Survey quality of life score. Nho et al (2008) reported average 29-month follow-up following patellar resurfacing with osteochondral autografts in 22 patients. Mean lesion size was 1.6 cm², filled with an average of 1.8 plugs per

defect.(28) The IKDC score improved from 47 preoperatively to 74 at follow-up. The activity of daily living score increased from 60 preoperatively to 85 at follow-up.

The importance of concomitant realignment procedures is addressed by other studies. Laprell and Petersen (2001) reported 6- to 12-year follow-up from 29 (83%) of 35 patients with severe osteochondral defects (77% with OCD) who were treated by autologous AOT.(29) Average age of the patients at the time of surgery was 26 years. Clinical evaluation at an average of 8 years after the procedure found 12 (41%) patients to be normal, 14 (48%) as nearly normal, and 3 (10%, all of whom refused correction of malalignment) as abnormal. Another report (2007) described 7-year follow-up of 30 patients treated with autologous AOT for symptomatic grade III to IV chondral lesions (average, 1.9 cm; range, 1.0-2.5 cm).(30) Nineteen patients received other procedures (ACL reconstruction, meniscectomy, medial collateral ligament repair) at the same time. MRI at 7 years showed complete bone integration in 96% of patients, complete integration of the grafted cartilage in 75% of cases, complete filling of the cartilage defect in 63%, and congruency of the articular surface in "some" patients.

Subsection Summary: Observational Studies

A number of observational studies have provided additional information with longer follow-up and factors (ie, patient age at the time of surgery, lesion size, location of lesion) associated with outcomes after treatment with osteochondral autografts. Overall, these studies have indicated that outcomes of osteochondral autografting are superior in younger male patients who have lesions smaller than 3 cm². Outcomes are reported to be superior in lesions of the femoral condyles, although treatment of patellar lesions has also been reported to improve pain and function.

Section Summary: Osteochondral Autograft for Articular Cartilage Lesions of the Knee

Several systematic reviews of RCTs have evaluated AOT for cartilage repair of the knee at short and mid-term. The RCTs are not high quality, and not all reviews found a benefit compared to abrasion techniques. However, compared to abrasion techniques (eg microfracture, drilling), there is evidence that AOT decreases failure rates and improves outcomes in patients with medium size lesions (eg, 2-6 cm²) when measured at longer follow-up. This is believed to be due to better durability of the natural hyaline cartilage compared to the fibrocartilage that is obtained with abrasion techniques. The least problematic RCT, which compared AOT to ACI in patients with lesions measuring 3.2 to 5.6 cm², found similar improvements in symptoms for both treatments. Factors shown to affect success in observational studies are younger male patients with lesions smaller than 3 cm². Thus, there is a relatively narrow range of lesion size for which AOT is most effective. In addition, the best results have been observed with lesions on the femoral condyles, although treatment of trochlea and patella lesions also improves outcomes. Correction of malalignment is important for success of the procedure.

FRESH OSTEOCHONDRAL ALLOGRAFT FOR ARTICULAR CARTILAGE LESIONS OF THE KNEE

Systematic Reviews

The 2016 Cochrane review by Gracitelli et al did not identify any RCTs on fresh allograft transplantation.(7)

A 2015 systematic review by De Caro et al included 11 articles that had at least 10 patients and were published in the previous 5 years.(31) Articles included a combined total of 374 knees in 358 patients treated with fresh osteochondral allografting. The size of the lesions ranged from 1 to 27 cm². Different outcome measures were used, but overall results showed improvement in objective and subjective clinical scores, a high rate of return to some level of sport or active duty, and graft survival rates of 82% at 10 years and 66% at 20 years. Although bony integration was usually achieved, cartilage integration was limited. In a 2015 review of indications, techniques, and outcomes, Chui et al stated that fresh osteochondral allografting is indicated for lesions greater than 2 cm² for which other techniques such as microfracture, AOT, and ACI are inadequate due to the size, location, or depth of the lesion.(32) Reviewers also considered fresh osteochondral allografting to be a salvage procedure for previously failed restoration treatments of the knee.

Observational Studies

Long-term outcomes with fresh osteochondral allografting have been reported in other case series. Emmerson et al (2007) reported mean 7.7 year follow-up (range, 2-22 years) for 66 knees of 64 patients who underwent fresh osteochondral allografting for OCD of the femoral condyle.(33) All patients had undergone previous surgery, with an average of 1.7 prior surgeries on each knee. Mean allograft size was 7.5 cm². One knee was lost to follow-up. Of the remaining 65 knees, 10 (15%) knees had additional surgery, 47 (72%) were rated good to excellent, and 8 (13%) were rated fair to poor. Kaplan-Meier analysis demonstrated a 91% graft survival rate at 5 years and 76% graft survival rates at 10 and 15 years. The mean D'Aubigne and Postel score improved from 13.0 (fair) preoperatively to 16.4 (good) at the most recent follow-up. Subjective knee function improved from a mean of 3.4 to 8.4 on a 10-point scale.

Gross et al (2005) reported minimum 5-year follow-up on a series of 60 patients who received femoral condylar grafts and 65 patients who received tibial plateau grafts for knee defects.(34) Eligible recipients of allografts were younger than 60 years and had traumatic unipolar osteochondral defects of at least 3 cm in diameter and 1 cm deep. If the meniscus was also significantly damaged, it was resected and replaced with allograft meniscus. Realignment of the involved leg was also performed to unload the graft. Patients were assessed preoperatively and postoperatively using the modified HSS. If there were no outcome data in the database within the last 12 months, the patients were contacted and a follow-up visit was arranged or a questionnaire was administered by telephone. Referring physicians were also contacted to obtain recent radiographs of the knee. Follow-up was obtained for 86% of patients who received a femoral graft (average, 10

years) and 97% of patients with a tibial graft (average, 11.8 years). For the femoral grafts, 12 failed and required graft removal or conversion to total knee replacement. At the end of the study period, 48 (80%) of the 60 femoral grafts were in situ with an average HSS of 83 out of 100. Kaplan-Meier analysis showed a 95% graft survival rate at 5 years, 85% at 10 years, and 74% at 15 years. For the tibial grafts, 21 failed at a mean interval of 9.7 years. At the end of the study, 44 (68%) of 65 tibial grafts were in situ and functioning with an HSS greater than 70 points. Survival analysis revealed a 95% graft survival rate at 5 years, 80% at 10 years, and 65% at 15 years.

Fresh osteochondral allografting for patellar cartilage injury was reported by Gracitelli et al (2015).(35) Of 28 knees (27 patients) that had osteochondral transplantation, 8 (28.6%) were considered failures and 9 (45%) required further surgery. Allograft survival was estimated to be 78.1% at 10 years and 55.8% at 15 years. The mean follow-up duration was 9.7 years (range, 1.8-30.1 years) for the 20 knees (71.4%) with intact grafts.

Section Summary: Fresh Osteochondral Allograft for Articular Cartilage Lesions of the Knee

The evidence on fresh osteochondral allografts for articular cartilage lesions of the knee includes case series and systematic reviews of case series. Due to the lack of alternatives, this fresh allograft 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, ACI) would be inadequate due to the size, location, or depth of the lesion.

OSTEOCHONDRAL AUTOGRAFT FOR ARTICULAR CARTILAGE LESIONS OF THE ANKLE

Osteochondral lesions of the talus are typically associated with ankle sprain or fracture, but comprise a relatively small proportion of lesions (=4%) when compared to cartilage lesions of the knee joint.(2) Therefore, RCTs on AOT for talar lesions may be limited. One RCT with 32 patients, case series, and a systematic review of these studies have been identified on AOT for lesions of the talus.

Zengerink et al published a systematic review on treatment of osteochondral lesions of the talus in 2010.(36) Fifty-one nonrandomized and 1 randomized trial (Gobbi et al, 2006(37); described below) were included. Studies described a variety of lesion sizes, some cystic, some as primary treatment, and some after a failed arthroscopic procedure, with follow-up of at least 6 months. Success rates averaged 85% for bone marrow stimulation, 87% for osteochondral autografting, and 76% for ACI. Because of the high cost of ACI and the knee morbidity seen with osteochondral autografting, the review concluded that bone marrow stimulation is the treatment of choice for primary osteochondral talar lesions. However, analysis was not conducted to assess the relation between lesion characteristics and success rates, limiting interpretation of these results.

The following sections review the evidence for lesions that have failed a prior arthroscopic procedure, and for larger lesions, defined as at least 1.5 cm² in size. This size threshold is derived from studies that have determined that bone marrow stimulation procedures for articular cartilage lesions of the talus that are at least 1.5 cm² in area have lower success rates than for smaller lesions.(38-40) For lesions that are less than 1.5 cm² in size, multiple studies show high success rates with marrow stimulation alone. (41) Because of the increase in morbidity with AOT, marrow stimulation would be the most appropriate treatment for small primary lesions. Of the relatively small number of talar osteochondral lesions, about 20% will be considered too large for marrow stimulation.(38) This series reported by Choi et al (2009) also estimated that failure rate following marrow stimulation was 10.5% for lesions less than 1.5 cm²; whereas 80% of lesions at least 1.5 cm² failed after a marrow stimulation procedure.

Osteochondral Autograft for the Primary Treatment of Large (≥ 1.5 cm²) or Cystic Articular Cartilage Lesions of the Ankle

Randomized Controlled Trials

The sole RCT identified on AOT for articular cartilage lesions of the talus was by Gobbi et al in 2006.(37) The study included 32 patients with large (mean, ≈ 4 cm²; range, 1-8 cm²) lesions to chondroplasty, microfracture, or AOT. Assessment at 24-month follow-up showed similar improvements (≈ 40 points) for the 3 treatment groups, as measured by the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score (baseline score, 31-37; an AOFAS score of 90 to 100 is considered excellent, 80-89 is good, 70-79 is fair, and <70 is poor) and the Subjective Assessment Numeric Evaluation (baseline score, 35-36). Complication rates were also similar. Postoperative pain, measured by numeric pain intensity scores, was greater following AOT (5.25) than after chondroplasty (3.3) or microfracture (3.4). Although authors reported following subjects through a mean of 53 months (range, 24-199 months), durability results after 24 months was not reported. Thus any potential differences between hyaline and fibrocartilage at longer term follow-up cannot be determined from this study.

Observational Studies

In 2014, Haleem et al reported minimum 5-year follow-up on AOT for larger lesions of the talus.(42) Fourteen patients who had a double plug graft for a larger lesion (mean, 208 ± 54 mm²) were matched by age and sex to a cohort of 28 patients who had a single plug graft for a smaller osteochondral lesion (mean, 74 ± 26 mm²). Both groups had significant improvements in the Foot and Ankle Outcome Score (FAOS) and SF-12, with no significant difference between the single plug and double plug groups. In the single-plug group the FAOS scores improved from 51.6 ± 10.2 at baseline to 87.1 ± 5.1 at final follow-up, while in the double-plug group the FAOS group improved from 49.5 ± 12.1 to 86.2 ± 6.5 .

In the 2008 report by Hangody et al described above, they reported a series AOT for knee and ankle and included 98 talar lesions (23) Good to excellent results were reported for 93% of the talar procedures, including durable results over a

mean 4.2 year period (range 2 to 7 years). The average size of the grafts was 1 cm² and an average of 3 osteochondral cores (range 1 to 6) were used.

Subsection Summary: Osteochondral Autograft for the Primary Treatment of Large (≥ 1.5 cm²) or Cystic Articular Cartilage Lesions of the Ankle

The evidence on AOT for the treatment of large or cystic articular cartilage lesions includes an RCT that found similar efficacy results for AOT, marrow stimulation and arthroplasty at 2-year follow-up. Longer term results were not reported. For the alternative of marrow stimulation, observational studies generally report worse outcomes and high failure rates for large lesions. Thus, there is a rationale for use of osteochondral autograft that is supported by an observational study that showed good improvement in FOAS scores through at least 5-year follow-up using AOT in both small and medium sized lesions.

Osteochondral Autograft for Treatment of Articular Cartilage Lesions of the Ankle That Have Failed a Prior Marrow Stimulation Procedure

Nonrandomized Comparative Trials

In 2014, Yoon et al compared outcomes from 22 patients who underwent AOT to outcomes from 22 patients who underwent repeat arthroscopy with marrow stimulation after failed treatment of osteochondral lesions of the talus.⁽⁴³⁾ The treatment was selected by the patient after discussion with the surgeon about the risks and benefits of the 2 procedures, including possible nonunion of the osteotomy site, donor site morbidity, and the recovery period. The study included consecutive patients who met study criteria and had failed primary marrow stimulation. Exclusion criteria were diffuse arthritic changes or diffuse fibrillated articular cartilage or axial malalignment or chronic ankle instability. The 44 were among 399 patients who received arthroscopic marrow stimulation during the study period, indicating that for about 90% of patients, primary marrow stimulation was effective. The 2 groups were comparable at baseline. Independent and blinded evaluation showed an excellent or good outcome on AOFAS scores (≥ 80) in 19 (86.4%) of patients treated with AOT compared to 12 (54.5%) of patients who received repeat marrow stimulation ($p=0.021$). All patients showed initial improvement in the VAS and AOFAS score after 6 months, but over a mean follow-up of 50 months only 7 (31.8%) in the repeat marrow stimulation group achieved excellent or good results and 14 (63.6%) of this group underwent further revisions. For patients with large lesions who were treated with repeat microfracture, 100% underwent a subsequent procedure. Conversely, a significantly higher proportion of the group treated with AOT 18 (81.8%) achieved excellent or good results over mean follow-up of 48 months and none required further revisions.

In 2011, Imhoff et al conducted a retrospective study of 26 AOT procedures (25 patients) in the talus at a mean follow-up of 7 years (range, 53-124 months); 9 of the patients had failed a prior marrow stimulation procedure.⁽⁴⁴⁾ Two additional patients had undergone a revision procedure and were not included in the follow-up data. The lesion size was less than 3 cm² and an average of 1.5 cylinders was grafted. From baseline to follow-up, AOFAS improved from 50 to 78 points

($p < 0.01$), Tegner from 3.1 to 3.7 ($p < 0.05$), and VAS for pain from 7.8 to 1.5 ($p < 0.01$). However, outcomes were significantly worse in patients who had undergone a prior marrow stimulation procedure (see Table 1).

Table 1. Results at 7-Year Follow-up

Outcomes	AOFAS (SD)	Tegner (SD)	VAS (SD)
Repeat procedure	62.0 (16.4)	2.0 (1.9)	3 (3.2)
Initial procedure	87.0 (15.0)	4.6 (2.2)	0.6 (1.1)
P value	<0.01	<0.01	<0.01

AOFAS: American Orthopedic Foot & Ankle Society; VAS: visual analog scale.

Observational Studies

Osteochondral autografting for OCD was also reported by Hangody et al (2001) for 36 consecutive patients.⁽⁶⁾ Most patients had previous surgical interventions and presented with stage III or IV lesions (completely detached or displaced fragment). The average size of the defect was 1 cm, and the average number of grafts per patients was 3 (range, 1-6). At mean follow-up of 4.2 years, ankle function measured by the Hannover scoring system showed good-to-excellent results in 34 (94%) cases. Examination by radiograph, computed tomography (CT), and MRI showed incorporation into the recipient bed and congruency of the articular surface.

In 2006, Kreuz et al reported outcomes from a prospective series of 35 patients who underwent osteochondral grafting from the ipsilateral talar articular facet following failed bone marrow stimulation.⁽⁴⁵⁾ Mean lesion diameter was 6.3 mm. At a mean follow-up of 49 months (range, 33-77 months), the AOFAS Ankle-Hindfoot Score had improved from 54.5 points (range, 47-60 points) to 89.9 points (range, 80-100 points).

In 2016, Georgiannos et al reported 5- to 7-year follow-up on a prospective cohort of 46 patients who had failed a prior marrow stimulation procedure.⁽⁴⁶⁾ Osteochondral plugs, which ranged from 4.75 to 8 mm in diameter, were taken from the talar facet. A temporary block of bone was removed to provide access to the talar dome. At a median follow-up of 5.5 years (range, 52-75 months) AOFAS score had improved from 55 ± 4.2 to 90 ± 5.8 , and the median VAS score improved from $52/100 \pm 6.6$ to 91 ± 8.2 . All grafts had incorporated and osteotomy sites healed, although 5 patients underwent subsequent surgery for osteophytes.

Subsection Summary: Osteochondral Autograft for Articular Cartilage Lesions of the Ankle That Have Failed a Prior Marrow Stimulation Procedure

The evidence for AOT in patients with articular cartilage lesions of the talus that have failed a prior marrow stimulation procedure includes 2 nonrandomized comparative trials and case series. A nonrandomized comparative study suggests improved outcomes with AOT compared to repeat marrow stimulation. However, another study suggests that outcomes may be diminished when AOT is used for a

revision procedure compared to use as a primary treatment. Case series indicate good to excellent results of AOT at mid-term follow-up.

FRESH OSTEOCHONDRAL ALLOGRAFT FOR ARTICULAR CARTILAGE LESIONS OF THE ANKLE

Use of AOT is limited by the number of cores that can be taken from the non-weight bearing part of the talus or ipsilateral knee. AOT may also be inadequate due to the depth of the lesion or the location, such as on the talar shoulder. For osteochondral lesions for which AOT would be inadequate due to the size, depth, or location of the lesion, the use of fresh osteochondral allografts has been reported. Use of fresh allografts for defects of the talus has been reported mainly in case series and a systematic review of these series. Due to the relatively rare occurrence of this condition, most series have fewer than 20 patients. One RCT was identified that compared AOT to allograft plugs for recurrent cartilage lesions.

Systematic Review of Studies That Included Large and/or Revision Cartilage Lesions

In a 2017 systematic review, Van Tienderen et al included 5 studies with a total of 90 patients (91 ankles) who received a fresh osteochondral allograft for osteochondral lesions of the talus.(47) Studies were included that reported at least 1 outcome of interest, including AOFAS score, Foot Functional Index, VAS, reoperation rate, or rate of allograft collapse. The mean lesion volume was 3.7 cm³ (range 1.0 to 10.9) and the number of prior procedures range from 1 to 4. At a mean follow-up of 45 months (range, 6-91 months), AOFAS scores improved from 48 to 80 and VAS scores improved from 7.1 to 2.7. However, some failures occurred, 23 (25.3%) patients required at least one reoperation and 12 (13.2%) patients were considered failures, defined as postoperative graft nonunion or resorption or persistence of symptoms leading to arthrodesis or arthroplasty.

In addition to the failure rate of osteochondral allograft transplantation, van Dijk noted that an osteochondral allograft can compromise a future arthrodesis or arthroplasty by failure of bony ingrowth since the bulk of the graft will consist of dead bone.(48)

Primary Full-thickness Articular Cartilage Lesions of the Ankle Less Than 1.5 cm²

Literature on fresh allograft for the treatment of small lesions of the ankle is very limited, since it is considered when there is no other treatment available to delay arthrodesis or arthroplasty. Since microfracture is effective as a primary treatment in lesions less than 1.5 cm² and AOT is effective as a revision procedure, use of allograft for small lesions has not been reported. Note that other allograft products, such as minced juvenile cartilage and reduced allograft discs, are described in other sections.

Large (Area >1.5 cm²) or Cystic (Volume > 3.0 cm³) Osteochondral Lesions of the Ankle

In 2016, Ahmad and Jones reported a comparison between osteochondral autograft or fresh allograft plugs for the treatment of large (>1.5 cm², n=9) or

recurrent (n=27) osteochondral lesions of the talus.(49) There were only 5 patients with large lesions treated with autograft and 4 patients with large lesions treated with allograft, so the ability to compare the treatments in this trial is limited.

Revision of Large (area >1.5 cm²) or Cystic (volume >3.0 cm³) Osteochondral Lesions of the Ankle

Randomized Trials

In the 2016 study by Ahmad and Jones there were 9 large and 27 recurrent osteochondral lesions of the talus.(49) Most patients had failed a prior microfracture. The study randomized 20 patients to AOT and 20 patients to plugs taken from a size-matched donor talus. However, 4 patients from the allograft group had significant damage of the shoulder of the talar dome. These 4 received a hemi-talus allograft and were excluded from the study. Foot and Ankle Ability Measures (FAAM) and VAS scores were similar in the 2 groups. In the allograft group, the mean FAAM score increased from 55.2 to 80.7 and the mean VAS decreased from 7.8 to 2.7 at final follow-up. These were reported as being better outcomes in the autograft group, but the difference was not statistically significant (numerical results were reported separately for anterior and medial approach). More patients in the allograft group had graft nonunion (3/16 [18.8%] patients compared to the autograft group (2/20 [10%] patients), consistent with the systematic review by Van Tienderen et al (described above).

Section Summary: Osteochondral Allograft for Articular Cartilage Lesions of the Ankle

The evidence on osteochondral allografts for articular cartilage lesions of the ankle includes an RCT, case series and a systematic review of case series.

There is little evidence on fresh osteochondral allografts for the primary treatment of full-thickness articular cartilage lesions of the ankle < 1.5 cm². Since microfracture is effective as a primary treatment in lesions less than 1.5 cm², AOT is effective as a revision procedure, and allografts have a high failure rate, use of allograft for small primary cartilage lesions is not appropriate.

The evidence on fresh osteochondral allografts for the treatment of large (area >1.5 cm²) or cystic (volume >3.0 cm³) osteochondral lesions of the ankle includes a small number of patients in an RCT, case series and a systematic review of case series. The systematic review found a high failure rate with osteochondral allografts for talar lesions. In addition, use of allografts may have a negative impact on any future arthroplasty or arthrodesis.

The evidence on fresh osteochondral allografts for revision of large (area >1.5 cm²) or cystic (volume >3.0 cm³) osteochondral lesions of the ankle includes an RCT. The RCT found that outcomes were slightly, but not significantly, worse with osteochondral allografts compared to autografts. However, failure due to non-union was higher in the allograft group, consistent with other findings.

OSTEOCHONDRAL AUTOGRAFT FOR ARTICULAR CARTILAGE LESIONS OF THE ELBOW

Systematic Reviews

A 2016 systematic review by Westermann et al included 24 case series (total N=492 patients) that assessed return to sports after operative treatment for OCD of the capitulum.(50) The most common primary sport was baseball (371/464) followed by gymnastics (35/464). The overall return to sports was 86% at a mean 5.6 months. Average lesion size was similar for the different treatments among 8 studies with information available. Among all 24 studies, patients were more likely to return to their preoperative sport after AOT (0.95; 95% CI, 0.89 to 0.99) compared with débridement or microfracture (0.62; 95% CI, 0.46 to 0.77; $p<0.001$) or fixation with pins, wires, or screws (0.72; 95% CI, 0.51 to 0.89; $p=0.01$). Grafts were taken from the lateral femoral condyle or ribs.

Donor-Site Morbidity

Nishimura et al (2011) evaluated recovery of the donor knee after osteochondral autograft harvesting for capitellar OCD in 12 young athletes (age range, 12-17 years).(51) Pain and function were assessed at 1, 2, 3, 6, 12, and 24 months after the surgery. Knee joint effusion persisted in 7 of the 12 patients at 1 month, but none had effusion at 3 months. At 3 months, muscle power of the knee extensor was reduced in 8 patients compared with the preoperative level. At 12 months, 11 patients had reached preoperative knee extensor muscle strength. All patients were pain-free at the donor site by 6 months (mean Lysholm score, 100) and returned to the previous competitive level of their sport.

Section Summary: Osteochondral Autograft for Articular Cartilage Lesions of the Elbow

OCD of the elbow typically occurs in patients who play baseball or do gymnastics. The literature on AOT for advanced OCD of the elbow consists of small case series, primarily from Europe and Asia, and a systematic review of case series. Although the meta-analysis suggested a benefit of AOT compared to débridement or fixation, further study is needed to determine the effects of the procedure with greater certainty.

OSTEOCHONDRAL AUTOGRAFT FOR ARTICULAR CARTILAGE LESIONS OF SHOULDER

A 2009 European study reported 9-year follow-up after AOT for cartilage defects of the shoulder in 7 patients.(52) One additional patient was reported to have had donor-site morbidity at the knee and chose not to return for follow-up. All plugs showed full integration with the surrounding bone, and 6 of 7 patients showed a congruent joint surface. The Constant score improved from 76 points preoperatively to 90 points at 33 months and remained at 91 points at the 9-year follow-up. Subscores for pain and activities of daily living showed significant improvement at 33-month follow-up, with a very slight nonsignificant decline at 9-year follow-up. None of the patients required additional shoulder surgery.

MINCED CARTILAGE FOR ARTICULAR CARTILAGE LESIONS

Autologous Minced Cartilage

In 2011, Cole et al reported a multicenter trial with 29 patients (of 582 screened) randomized in a 1:2 ratio to microfracture or Cartilage Autograft Implantation System (CAIS).(53) In the single-stage CAIS procedure, autologous hyaline cartilage was harvested, minced, affixed on a synthetic absorbable scaffold, and fixed on the lesion site with absorbable staples. At baseline, there were no significant differences between groups in the duration of symptoms, ICRS grade, and area and depth of the chondral defect. There was a difference in the sex and work status of the 2 groups. At 3-week and 6-month follow-ups, there were no significant differences in outcomes between the 2 groups, but, at later time points, there were differences reported. The IKDC score was significantly higher in the CAIS group compared with the microfracture group at both 12 (73.9 vs 57.8) and 24 (83.0 vs 59.5) months. All subdomains of the KOOS symptoms and stiffness, pain, activities of daily living, sports and recreation, knee-related quality of life were significantly increased at 24 months in the CAIS group compared with microfracture patients. Qualitative analysis of MRI at 3 weeks and 6, 12, and 24 months showed no differences in fill of the graft bed, tissue integration, or presence of subchondral cysts. Adverse events were similar for the 2 groups.

Allogeneic Juvenile Minced Cartilage

Knee

Evidence on the efficacy of DeNovo NT is limited to case reports and small case series. The largest series identified was an industry-sponsored prospective study by Farr et al (2014), which included 25 patients with cartilage lesions of the femoral condyle or trochlea.(54) Patients had symptomatic, focal, contained chondral lesions of the femoral condyles or trochlea with defect areas ranging between 1 cm² and 5 cm² (mean, 2.7 cm²; range 1.2-4.6 cm²). Mean number of prior surgeries was 1.1, with 18 patients reporting prior débridement and/or microfracture. Patients returned for follow-up at 3, 6, 12, 18, and 24 months for radiographs, IKDC examination, and completion of questionnaires. Outcomes included the KOOS, IKDC, Marx Activity Scale, and 100-mm VAS score for pain. IKDC score improved over the 24 months of follow-up. At 24 months, IKDC score had improved from 45.7 preoperatively to 73.6 of 100. There were also significant improvements in KOOS subscores ($p < 0.001$) and VAS pain score (from 43.7/100 at baseline to 11.1 at 24 months, $p < 0.001$). MRI showed a mean lesion fill of 109.7% with mild graft hypertrophy identified in 20.7% of patients. Of 11 elective second look arthroscopies at 24 months, 2 grafts (18%) showed either partial or complete delamination. Histology from 8 patients with biopsy showed a mixture of hyaline and fibrocartilage; areas with hyaline cartilage varied across sections. There was good integration with the surrounding native cartilage.

A 2013 study included 13 patients (15 knees) who received particulated juvenile allograft to the patella.(55) Ten of the 15 knees underwent concomitant procedures, limiting interpretation of functional outcomes. Cartilage repair assessed at a mean of 28.8 months was reported to be nearly normal in 73% of

knees while 27% of knees had evidence of graft hypertrophy. Currently available evidence is insufficient to evaluate the effect of this technology on health outcomes.

Ankle

One proposed advantage of particulated articular cartilage for osteochondral lesions of the talus is that it is not always necessary to perform an osteotomy to access the lesion. At this time, use of DeNovo NT for the talus has been reported in case reports, small case series and a systematic review of these studies.

In 2017, Saltzman et al reported a descriptive systematic review of the published case reports and case series.(56) Included were data on 33 ankles from 2 case reports, a series of 7 patients by Breazy and Brigido (2012),(57) and a series of 24 ankles by Coetzee et al (2013)(58) described next.

The largest series is from a preliminary report of a larger study by Coetzee et al in 2013.(58) In this preliminary report, 24 ankles (23 patients) with osteochondral lesions of the talus (mean lesion size, 125 ± 75 mm²) were treated with DeNovo NT. Fourteen (58%) of the ankles had failed at least 1 prior bone marrow stimulation procedure. At an average follow-up of 16.2 months, 78% of ankles had good-to-excellent scores on the AOFAS Ankle-Hindfoot Score, with a final mean VAS score of 24 out of 100. However, 18 (76%) ankles had at least 1 concomitant procedure (hardware removal and treatment for impingement, synovitis, instability, osteophytes, malalignment), limiting interpretation of the functional results. One treatment failure was caused by partial graft delamination.

In addition to their systematic review of the literature, Saltzman et al reported on 6 patients who had been treated at their institution with particulated juvenile articular cartilage for articular cartilage lesions of the talus.(56) Lesion size ranged from 96 to 308 mm². Two of the 6 patients underwent a medial malleolar osteotomy to access the lesion. Implantation procedures included debridement, marrow stimulation, and fixation of the particulated cartilage with fibrin glue. At a mean of 13 months follow-up, all 6 patients reported subjective improvements in pain and function. However, for all 3 patients who had MRI between 3 months and 2 years postoperatively, there was persistent subchondral edema and nonuniform chondral surface.

Section Summary: Minced Cartilage for Articular Cartilage Lesions

The evidence on autologous minced cartilage includes 1 small RCT from 2011. The evidence on allogeneic minced cartilage includes case reports and case series. The case series have suggested an improvement in outcomes compared with baseline, but there is also evidence of subchondral edema, nonuniform chondral 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 available procedures. For articular cartilage lesions of the ankle, there are few treatment options and, in the largest case series, over half of the patients had failed prior marrow stimulation. However, the concomitant procedures performed in that study limited interpretation of its results. A

randomized comparison with microfracture in patients who have not received prior treatment would permit greater certainty about the effectiveness of this procedure.

DECELLULARIZED OSTEOCHONDRAL ALLOGRAFT

The first report of use of decellularized osteochondral allograft plugs (Chondrofix) was published by Farr et al in 2016.⁽⁵⁹⁾ Review of records for 32 patients identified high failure rates. With failure defined as structural damage of the graft identified by MRI or arthroscopy, or any reoperation resulting in removal of the allograft, 23 (72%) of 32 knees were considered failures.

SUMMARY OF EVIDENCE

Osteochondral grafts are used in repair of 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.

For individuals who have full-thickness articular cartilage lesions of the knee who receive osteochondral autografts, 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 at short and mid-term. Compared to 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 cm²) when measured at longer follow-up. This is believed to be due to the higher durability of hyaline cartilage compared to the fibrocartilage that is formed 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 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 a meaningful improvement in the net health outcome.

For individuals who have full-thickness articular cartilage lesions of the knee who receive fresh osteochondral allografts, the evidence includes 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 the size, location, or depth of the lesion. The evidence is sufficient to determine that the technology results in a meaningful improvement in the net health outcome.

For individuals who have primary full-thickness articular cartilage lesions of the ankle less than 1.5 cm² who receive an osteochondral autograft, the evidence includes observational studies and a 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 or autologous osteochondral transplantation (AOT). Given the success of marrow stimulation procedures for smaller lesions (<1.5 cm²) and the increase in donor-site morbidity with graft harvest from the knee, current evidence does not support the use of AOT as a primary treatment for smaller articular cartilage lesions of the ankle. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who have large (>1.5 cm²) or cystic (>3.0 cm³) articular cartilage lesions of the ankle who receive an osteochondral autograft, the evidence includes an RCT and 2 observational studies. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. An RCT in patients with large lesions found similar efficacy for AOT, marrow stimulation and arthroplasty at 2-year follow-up. Longer term results were not reported. Because observational studies of marrow stimulation in the talus generally report worse outcomes and high failure rates for large lesions, there is a strong rationale for using autografts. However, there is limited evidence that osteochondral autografts lead to better outcomes than microfracture at longer follow-up. The strongest evidence is derived from one observational study that showed good improvement in FOAS scores through at least 5-year follow-up using AOT in both larger (2 plugs) and smaller (1 plug) lesions. Additional study is needed to evaluate the durability of AOT in larger lesions. The evidence is insufficient to determine the effects of the technology on health outcomes.

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

For individuals who have primary full-thickness articular cartilage lesions of the ankle less than 1.5 cm² who receive fresh osteochondral allografts, there is little evidence. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. Since microfracture is effective as a primary treatment in lesions less than 1.5 cm² and AOT is effective as a revision

procedure, use of allograft for small primary cartilage lesions has not been reported. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who have large (area >1.5 cm²) or cystic (volume >3.0 cm³) osteochondral lesions of the ankle when autografting would be inadequate who receive fresh osteochondral allografts, the evidence includes a small number of patients in an RCT, case series, and a systematic review of case series. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. The systematic review found a significant failure rate with osteochondral allografts for talar lesions. Although there is a potential to delay or avoid arthrodesis or total ankle arthroplasty in younger patients, use of an allograft may be detrimental to future treatments. Additional study is needed. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who have revision of large (area >1.5 cm²) or cystic (volume >3.0 cm³) osteochondral lesions of the ankle when autografting would be inadequate who receive fresh osteochondral allografts, the evidence includes an RCT. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. The RCT found that outcomes were slightly, but not significantly, worse with osteochondral allografts compared to autografts. However, failure due to non-union was higher in the allograft group, consistent with other reports. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who have full-thickness articular cartilage lesions of the elbow who receive osteochondral autografts, the evidence includes a meta-analysis of case series. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. Osteochondritis dissecans (OCD) of the elbow typically occurs in patients who play baseball or do gymnastics. The literature on osteochondral autografts for advanced OCD of the elbow consists of small case series, primarily from Europe and Asia, and a systematic review of case series. Although the meta-analysis suggested a benefit of osteochondral autografts compared to débridement or fixation, RCTs are needed to determine the effects of the procedure with greater certainty. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who have full-thickness articular cartilage lesions of the shoulder who receive osteochondral autografts, 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 the effects of the technology on health outcomes.

For individuals who have full-thickness articular cartilage lesions of the knee, ankle, elbow, or shoulder who receive autologous or allogeneic minced 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 1 small RCT from 2011. 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, non-homogenous 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 the effects of the technology on health outcomes.

For individuals who have full-thickness articular cartilage lesions of the knee, ankle, elbow, or shoulder who receive decellularized osteochondral allograft plugs or reduced osteochondral allograft discs, the evidence includes 1 small case series. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. The single case series on decellularized osteochondral allograft plugs reported delamination of the implants, and high failure rates. Only small series with 2 to 3 patients have been identified on reduced osteochondral allograft discs. The evidence is insufficient to determine the effects of the technology on health outcomes.

SUPPLEMENTAL INFORMATION

CLINICAL INPUT FROM PHYSICIAN SPECIALTY SOCIETIES AND ACADEMIC MEDICAL CENTERS

While the various physician specialty societies and academic medical centers may collaborate with and make recommendations during this process, through the provision of appropriate reviewers, input received does not represent an endorsement or position statement by the physician specialty societies or academic medical centers, unless otherwise noted.

2011 Input

In response to requests, input was received from 3 academic medical centers while this policy was under review in 2011. Clinical input generally agreed with the stated criteria for osteochondral grafting, with the exception of the following: input was mixed on the requirement for an inadequate response to a prior surgical procedure, the size of the lesion, and the requirement for an absence of meniscal pathology. Input was also mixed on the investigational status of osteochondral grafts in other joints, including the patellar and talar joints, and for the use of autologous minced cartilage.

2008 Input

In response to requests, input was received from 1 physician specialty society and 3 academic medical centers while this policy was under review in 2008. All reviewers agreed that osteochondral autografts and allografts are considered

reasonable for patients with full-thickness chondral defects who meet specific criteria.

PRACTICE GUIDELINES AND POSITION STATEMENTS

American Academy of Orthopaedic Surgeons

In 2010 guidelines, which remain available on the American Academy of Orthopaedic Surgeons (AAOS) website in 2017, on the diagnosis and treatment of osteochondritis dissecans (OCD), AAOS was unable to recommend for or against a specific cartilage repair technique in symptomatic skeletally immature or mature patients with an unsalvageable OCD lesion.(60,61)

A 2010 AAOS review of articular cartilage restoration methods stated that “osteochondral autografting is generally used for smaller focal lesions of the femoral condyle no greater than 1.5 to 2 cm.”(62)

National Institute for Health and Care Excellence

The National Institute for Health and Care Excellence (NICE) conducted a 2005 review of mosaicplasty for knee cartilage defects.(63) The corresponding NICE guidance, released in 2006,(63) stated that “There is some evidence of short-term efficacy, but data on long-term efficacy are inadequate.”

U.S. PREVENTIVE SERVICES TASK FORCE RECOMMENDATIONS

Not applicable.

MEDICARE NATIONAL COVERAGE

There is no national coverage determination (NCD). In the absence of an NCD, coverage decisions are left to the discretion of local Medicare carriers.

ONGOING AND UNPUBLISHED CLINICAL TRIALS

Some currently unpublished trials that might influence this review are listed in Table 1.

Table 1. Summary of Key Trials

NCT No.	Trial Name	Planned Enrollment	Completion Date
Ongoing			
NCT01347892a	Post Market, Longitudinal Data Collection Study of Articular Cartilage Lesions in the Ankle Treated With DeNovo(R) NT	205	Sep 2019
NCT01329445a	Post Market, Longitudinal Data Collection Study of DeNovo NT for Articular Cartilage Defects of the Knee	200	Dec 2019
NCT01670617a	A Stratified, Post-Market Study of DeNovo NT for the Treatment of Femoral and Patellar Articular Cartilage Lesions of the Knee	254	Dec 2021
Unpublished			
NCT01410136a	A Post Market Study to Evaluate the Chondrofix® Osteochondral Allograft	29	Terminated (enrollment)

	Utilized for Treatment of Subjects With Cartilage Lesions in the Knee		
--	--	--	--

NCT: national clinical trial.

a Denotes industry-sponsored or cosponsored trial.

REFERENCES

1. Durur-Subasi I, Durur-Karakaya A, Yildirim OS. Osteochondral Lesions of Major Joints. *Eurasian J Med.* Jun 2015;47(2):138-144. PMID 26180500
2. Freeland E, Dowd T. Osteochondral Lesions of the Talus. 2015; <http://www.aofas.org/PRC/conditions/Pages/Conditions/Osteochondral-Lesions-of-the-Talus.aspx>. Accessed June 5, 2017.
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):2053-2063. 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):1587-1593. 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):80-85. PMID 16957009
6. Hangody L, Kish G, Modis 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):552-558. PMID 11503979
7. 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:CD010675. PMID 27590275
8. 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):952-962. PMID 18196358
9. 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
10. 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.* Oct 26 2011;27(3):409-418. PMID 21030203
11. Gudas R, Kalesinskas RJ, Kimtys V, et al. A prospective randomized clinical study of mosaic osteochondral autologous transplantation versus microfracture for the treatment of osteochondral defects in the knee joint in young athletes. *Arthroscopy.* Sep 2005;21(9):1066-1075. PMID 16171631
12. Gudas R, Gudaite A, Pocius A, et al. Ten-year follow-up of a prospective, randomized clinical study of mosaic osteochondral autologous transplantation versus microfracture for the treatment of osteochondral defects in the knee joint of athletes. *Am J Sports Med.* Nov 2012;40(11):2499-2508. PMID 23024150
13. Gudas R, Gudaite A, Mickevicius T, et al. Comparison of osteochondral autologous transplantation, microfracture, or debridement techniques in articular cartilage lesions associated with anterior cruciate ligament injury: a prospective study with a 3-year follow-up. *Arthroscopy.* Jan 2013;29(1):89-97. PMID 23142295
14. Gudas R, Simonaityte R, Cekanauskas E, et al. A prospective, randomized clinical study of osteochondral autologous transplantation versus microfracture for the treatment of osteochondritis dissecans in the knee joint in children. *J Pediatr Orthop.* Oct-Nov 2009;29(7):741-748. PMID 20104156
15. Lim HC, Bae JH, Song SH, et al. Current treatments of isolated articular cartilage lesions of the knee achieve similar outcomes. *Clin Orthop Relat Res.* Aug 2012;470(8):2261-2267. PMID 22422593
16. Ulstein S, Aroen A, Rotterud JH, et al. Microfracture technique versus osteochondral autologous transplantation mosaicplasty in patients with articular chondral lesions of the knee: a prospective randomized trial with long-term follow-up. *Knee Surg Sports Traumatol Arthrosc.* Jun 2014;22(6):1207-1215. PMID 24441734

17. Bentley G, Biant LC, Carrington RW, et al. A prospective, randomised comparison of autologous chondrocyte implantation versus mosaicplasty for osteochondral defects in the knee. *J Bone Joint Surg Br.* Mar 2003;85(2):223-230. PMID 12678357
18. Bentley G, Biant LC, Vijayan S, et al. Minimum ten-year results of a prospective randomised study of autologous chondrocyte implantation versus mosaicplasty for symptomatic articular cartilage lesions of the knee. *J Bone Joint Surg Br.* Apr 2012;94(4):504-509. PMID 22434467
19. Dozin B, Malpeli M, Cancedda R, et al. Comparative evaluation of autologous chondrocyte implantation and mosaicplasty: a multicentered randomized clinical trial. *Clin J Sport Med.* Jul 2005;15(4):220-226. PMID 16003035
20. Horas U, Pelinkovic D, Herr G, et al. Autologous chondrocyte implantation and osteochondral cylinder transplantation in cartilage repair of the knee joint. A prospective, comparative trial. *J Bone Joint Surg Am.* Feb 2003;85-A(2):185-192. PMID 12571292
21. Hangody L, Kish G, Karpati 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):262-267. PMID 9430578
22. Hangody L, Kish G, Karpati Z, et al. Mosaicplasty for the treatment of articular cartilage defects: application in clinical practice. *Orthopedics.* Jul 1998;21(7):751-756. PMID 9672912
23. Hangody L, Vasarhelyi G, Hangody LR, et al. Autologous osteochondral grafting--technique and long-term results. *Injury.* Apr 2008;39 Suppl 1:S32-39. PMID 18313470
24. Ollat D, Lebel B, Thaunat M, et al. Mosaic osteochondral transplantations in the knee joint, midterm results of the SFA multicenter study. *Orthop Traumatol Surg Res.* Dec 2011;97(8 Suppl):S160-166. PMID 22036243
25. 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):84-87. PMID 19666226
26. Solheim E, Hegna J, Oyen 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):287-290. PMID 23482060
27. 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):816-823. PMID 24875022
28. 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):1101-1109. PMID 18337357
29. Laprell H, Petersen W. Autologous osteochondral transplantation using the diamond bone-cutting system (DBCS): 6-12 years' follow-up of 35 patients with osteochondral defects at the knee joint. *Arch Orthop Trauma Surg.* May 2001;121(5):248-253. PMID 11409552
30. 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):2014-2021. PMID 17724094
31. 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):757-765. PMID 25660010
32. 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):340-350. PMID 25893177
33. Emmerson BC, Gortz S, Jamali AA, et al. Fresh osteochondral allografting in the treatment of osteochondritis dissecans of the femoral condyle. *Am J Sports Med.* Jun 2007;35(6):907-914. PMID 17369560
34. Gross AE, Shasha N, Aubin P. Long-term followup of the use of fresh osteochondral allografts for posttraumatic knee defects. *Clin Orthop Relat Res.* Jun 2005(435):79-87. PMID 15930924
35. 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):885-891. PMID 25817190
36. 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):238-246. PMID 19859695

37. 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):1085-1092. PMID 17027406
38. 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):1974-1980. PMID 19654429
39. 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):106-112. PMID 18182210
40. Cuttica DJ, Smith WB, Hyer CF, et al. Osteochondral lesions of the talus: predictors of clinical outcome. *Foot Ankle Int*. Nov 2011;32(11):1045-1051. PMID 22338953
41. 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. *Am J Sports Med*. Jun 2017;45(7):1698-1705. PMID 27852595
42. 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):1888-1895. PMID 24948585
43. 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):1896-1903. PMID 24907287
44. 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):1487-1493. PMID 21372316
45. 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
46. 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
47. VanTijenderen 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
48. van Dijk CN. Editorial commentary: Bulk osteochondral talar grafts compromise future arthrodesis or prosthesis. *Arthroscopy*. Jan 2017;33(1):223-224. PMID 28003071
49. 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
50. 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
51. Nishimura A, Morita A, Fukuda A, et al. Functional recovery of the donor knee after autologous osteochondral transplantation for capitellar osteochondritis dissecans. *Am J Sports Med*. Apr 2011;39(4):838-842. PMID 21189356
52. 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
53. 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):1170-1179. PMID 21460066
54. 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*. Apr 9 2014;42(6):1417-1425. PMID 24718790
55. 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):1661-1670. PMID 23876608
56. 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

57. 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):300-305. PMID 22935411
58. 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):1205-1211. PMID 23576118
59. 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):2015-2022. PMID 27179056
60. American Academy of Orthopaedic Surgeons Diagnosis and Treatment of Osteochondritis Dissecans Work Group. The diagnosis and treatment of osteochondritis dissecans: Guideline and evidence report. 2010, December 4; http://www.aaos.org/research/guidelines/OCD_guideline.pdf. Accessed May 22, 2017.
61. Chambers HG, Shea KG, Anderson AF, et al. American Academy of Orthopaedic Surgeons clinical practice guideline on: the diagnosis and treatment of osteochondritis dissecans. *J Bone Joint Surg Am.* 2012;94(14):1322-1324. PMID 22810404
62. Trice ME, Bugbee WD, Greenwald AS, et al. Articular cartilage restoration: A review of currently available methods. 2010; http://www.aaos.org/cc_files/aaosorg/research/committee/biologic/bi_se_2010.pdf. Accessed May 22, 2017.
63. National Institute for Health and Care Excellence (NICE). Mosaicplasty for knee cartilage defects [IPG162]. 2006; <http://www.nice.org.uk/guidance/ipg162>. Accessed November 14, 2016.

Billing Coding/Physician Documentation Information

27415	Osteochondral allograft, knee, open
27416	Osteochondral autograft(s), knee, open (eg, mosaicplasty)(includes harvesting of autografts(s))
28446	Open Osteochondral Autograft, Talus (Includes Obtaining Grafts)
29866	Arthroscopy, knee, surgical; osteochondral autograft(s) (e.g., mosaicplasty) (includes harvesting of the autograft)
29867	Arthroscopy, knee, surgical; osteochondral allograft (e.g., mosaicplasty)
29891	Arthroscopy, ankle, surgical, excision of osteochondral defect of talus and/or tibia, including drilling of the defect
J7330	Autologous cultured chondrocytes, implant
S2112	Arthroscopy, knee, surgical for harvesting of cartilage (chondrocyte cells)

ICD-10 Codes

M12.561-	Traumatic arthropathy knee, code range
M12.569	
M17.0-	Osteoarthritis of knee, code range
M17.9	
M23.8x1-	Other internal derangement of knee, code range
M23.92	
M25.861-	Other specified joint disorder, knee, code range
M25.869	
M85.671-	Other cyst of bone, ankle and foot
M85.679	
M89.8x6	Other specified disorders of bone, lower leg
M89.9	Disorder of bone, unspecified
M93.261-	Osteochondritis dissecans knee, code range

M93.269

M93.271- Osteochondritis dissecans of ankle and joints of foot, code range

M93.279

M94.261- Chondromalacia knee, code range

M94.269

M94.8x6 Other specified disorders of cartilage lower leg

M94.9 Disorder of cartilage, unspecified

S89.81xA- Other specified injuries of lower leg, code range

S98.119S

S89.90xA- Unspecified injury of lower leg, code range

S89.92xS

Additional Policy Key Words

N/A

Policy Implementation/Update Information

8/1/02 New policy, considered investigational.

8/1/03 No policy statement changes. Added new tracking codes to policy.

8/1/04 Policy statement revised to include allografting as investigational. The title of the policy was updated to include allografting.

2/1/05 No policy statement changes. Added new specific CPT code to policy.

8/1/05 No policy statement changes.

2/1/06 No policy statement changes.

8/1/06 No policy statement changes.

2/1/07 No policy statement changes.

8/1/07 No policy statement changes.

2/1/08 No policy statement changes.

8/1/08 No policy statement changes.

11/13/08 Policy statement revised; allografts considered medically necessary for large lesions; autografts considered medically necessary if marrow stimulating procedures have failed; all other indications considered investigational.

2/1/09 No policy statement changes.

2/1/10 No policy statement changes.

2/1/11 No policy statement changes.

2/1/12 Investigational policy statement for autograft and allograft separated; meniscal pathology removed from policy statement per separate policy.

2/1/13 No policy statement changes.

8/1/13 Coding updated.

2/1/14 Investigational statements added on autologous and allogeneic minced cartilage. Removed "Osteochondral" from title.

2/1/15 Medical policy statement revised to indicate osteochondral autografting for patellar lesions may be considered medically necessary.

10/1/15 Medical necessity statement for allografting revised from "to repair large (e.g., 10 cm²) full thickness chondral defects of the knee caused by acute or repetitive trauma" to "repair 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 the size, location, or depth of the lesion.”

2/1/16

No policy statement changes.

2/1/17

Added to Investigational Statements: “Treatment of focal articular cartilage lesions with decellularized osteochondral allograft plugs (eg, Chondrofix)” and “Treatment of focal articular cartilage lesions with reduced osteochondral allograft discs (eg, Prochondrix, Cartiform).”

8/1/17

Osteochondral autografts considered medically necessary for lesions of the talus that have failed prior surgical treatment.

State and Federal mandates and health plan contract language, including specific provisions/exclusions, take precedence over Medical Policy and must be considered first in determining eligibility for coverage. The medical policies contained herein are for informational purposes. The medical policies do not constitute medical advice or medical care. Treating health care providers are independent contractors and are neither employees nor agents Blue KC and are solely responsible for diagnosis, treatment and medical advice. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, photocopying, or otherwise, without permission from Blue KC.