



# Cigna Medical Coverage Policy

**Subject Chondrocyte Implantation of the Knee**

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## Table of Contents

Coverage Policy .....	1
General Background .....	2
Coding/Billing Information .....	8
References .....	9

## Hyperlink to Related Coverage Policies

[Allograft Transplantation of the Knee](#)  
[Osteochondral Grafts for Articular Cartilage Repair \(Autografts, Allografts, and Synthetic Grafts\)](#)

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## Coverage Policy

**Cigna covers autologous chondrocyte implantation as medically necessary for the treatment of a single symptomatic articular cartilage defect of the femoral condyle of the knee (medial, lateral or trochlear) caused by acute or repetitive trauma when ALL of the following criteria are met:**

- age 15–55 years
- body mass index (BMI) of < 35
- disabling knee pain unresponsive to conservative treatment
- inadequate response to prior arthroscopic or other surgical repair
- femoral condyle defect size of 1–10 cm<sup>2</sup> in an area that affects a weight-bearing surface of the femoral condyle, as demonstrated by magnetic resonance imaging (MRI) or arthroscopy
- articular cartilage defect grade III to IV (full thickness) that involves only cartilage, without associated subchondral bone defect
- knee is stable with intact, fully functional menisci and ligaments, has normal joint space, and is in good alignment (corrective procedures may be performed in combination with or prior to ACT)
- patient willing and able to comply with rigorous rehabilitation program
- no corresponding tibial or patellar lesion (“kissing” lesion) with grade III or greater chondromalacia or exposed bone chondromalacia
- no osteoarthritis of the knee
- normal articular cartilage at lesion border

**Cigna does not cover autologous chondrocyte transplantation for any other indication, including but not limited to the following, because it is considered experimental, investigational, or unproven:**

- lesions of the tibia or patella
- lesions in any other joints, including but not limited to the ankle, hip and shoulder
- treatment of cartilage damage associated with generalized osteoarthritis

**Cigna does not cover juvenile cartilage allograft tissue implantation (e.g., DeNovo<sup>®</sup> NT Natural Tissue Graft, DeNovo<sup>®</sup> ET<sup>™</sup> Engineered Tissue Graft [ISTO Technologies, Inc., St. Louis, MO / Zimmer, Inc., Warsaw IN]) for the treatment of articular cartilage lesions because it is considered experimental, investigational, or unproven.**

**Cigna does not cover matrix-induced autologous chondrocyte implantation (e.g., MACI<sup>™</sup> Implant [Genzyme Biosurgery, Cambridge, MA]) because it is considered experimental, investigational, or unproven.**

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## General Background

Autologous chondrocyte implantation (ACI), also referred to as autologous chondrocyte transplantation (ACT), utilizes a patient's own cells in an effort to repair damage to articular cartilage with the goal of improving joint function and reducing pain. The procedure involves the collection and culture of articular cartilage cells (i.e., chondrocytes) that are then implanted into the cartilage defect with the intent that the cultured cells will contribute to the regeneration and repair of the articular surface.

Normal articular cartilage is a complex tissue composed of matrix, chondrocytes and water. The chondrocytes are responsible for synthesizing the matrix, which is composed primarily of collagen fibers, hyaluronate, and sulfated proteoglycans. Cartilage has a poor intrinsic ability to heal itself. When a full-thickness cartilage injury occurs, the articular surface does not usually regenerate on its own. Pain, effusion, and mechanical symptoms are associated with cartilaginous defects. With femoral lesions, pain is usually localized to the medial or lateral tibiofemoral compartment, and is worse with weight bearing or high-impact activity. Lesions of the patella lesions may cause pain with kneeling, stair climbing, and prolonged sitting. The injury often becomes more severe over time since even small defects involving the full thickness of articular cartilage may progress to osteoarthritis, a debilitating joint disease marked by degeneration of the articular cartilage. Nonsurgical treatments for cartilage injury include physical therapy, braces and orthotics, nonsteroidal anti-inflammatory drugs, and intra-articular injection of hyaluronic acid derivatives. Surgical treatment options include arthroscopic lavage and debridement and articular resurfacing techniques. In some patients, total knee replacement may be necessary.

The Outer Bridge classification is the most widely used system for judging articular injury to the knee. This system allows delineation of varying areas of chondral pathology, based on the qualitative appearance of the cartilage surface and can assist in identifying those injuries that are suitable for repair techniques. The characterization of cartilage in this system is as follows:

- grade I, softening with swelling
- grade II, fragmentation and fissuring
- grade III, fragmentation and fissuring greater than one-half inch in diameter
- grade IV, subchondral bone exposed
- Grade III and IV lesions are thought to be the most suitable for repair techniques.

ACI is performed by the harvest of healthy cartilage cells from the patient, preparation and growth of the cells in a culture medium, and implantation of the cultured cells into the articular defect. Healthy cartilage is harvested via biopsy from a minor load-bearing area on a rounded projection of the femur. Cartilage is then minced and washed in a buffered solution and placed in a medium containing digestive enzymes for 15 hours. The cells are then filtered, washed, re-suspended in culture medium containing autologous serum, and seeded in culture flasks. The cells are cultivated for 14 days to six weeks. Ochi et al. (2001) developed a modification of this procedure in which autologous chondrocytes are cultivated in a collagen gel for three weeks. An arthrotomy is performed to inject the cultured cells into the defect. The rate of ACI failure varies, depending on several factors, including defect characteristics, willingness to comply with an intensive rehabilitation regimen, preoperative BMI, and patient age. Obese patients have been shown to have worse knee function prior to ACI and fail to experience sustained benefit following surgery. One comparison of ACI based on patient age demonstrated

good to excellent results in 83.7% of patients younger than age 20, compared to 55.9% in those older than age 40. Older chondrocytes are thought to have decreased synthetic capabilities and lower response to growth factors.

**DeNovo<sup>®</sup> NT Natural Tissue Graft (ISTO Technologies, Inc., St. Louis, MO, Zimmer, Inc., Warsaw IN)**

DeNovo<sup>®</sup> NT Natural Tissue Graft is a juvenile cartilage allograft tissue intended for the repair of articular cartilage defects (e.g., knee, ankle, hip, shoulder, elbow, great toe). The DeNovo NT Graft consists of particulated natural articular cartilage with living cells. Tissues are recovered from juvenile donor joints. The cartilage is manually minced to help with cell migration from the extracellular matrix and facilitate fixation. During implantation, the minced cartilage is mixed in a fibrin glue adhesive. DeNovo NT is classified as minimally manipulated allograft tissue and is therefore not subject to the FDA premarket approval process. A case series evaluating this product for the treatment of articular cartilage defects of the knee began in 2006 and is expected to be completed in 2013. There are no studies evaluating the DeNovo NT Natural Tissue Graft in the published medical literature.

**Matrix-Induced Autologous Chondrocyte Implantation (MACI<sup>™</sup> Implant [Genzyme Biosurgery, Cambridge, MA]):**

MACI is a procedure in which cartilage cells are removed during arthroscopy, and shipped to a laboratory, where the cells are cultured over a period of several weeks. The cells are seeded on a membrane, and once the culturing process is complete, the cells seeded on the membrane are returned to the surgeon for implantation during a second procedure. The membrane is placed into the defect, and over several months the cells create a matrix that is intended to cover the articular surface of the knee. MACI has been used in Europe but is not available in the United States (Genzyme website, 2012).

**U.S. Food and Drug Administration (FDA)**

The FDA determined that Carticel<sup>®</sup> (Genzyme Corporation, Cambridge, MA), a commercial process of producing autologous chondrocytes for transplantation, fell outside existing regulations regarding medical technology. The FDA permitted marketing of the service while guidelines were developed for manipulated autologous structural cells. In May 1996, the FDA announced its guidelines for manipulated autologous structures, which include completion of a Biologics Licensing Application (BLA) and evidence of product safety and efficacy. On August 22, 1997, the FDA granted a Biologics License for Carticel, for provision of autologous chondrocytes for the repair of clinically significant, symptomatic cartilaginous defects of the femoral condyle caused by acute or repetitive trauma. The FDA based its approval of Carticel primarily on a number of case reports consisting of 153 patients treated in Sweden, and early data from a US registry of patients treated with Carticel. As a condition of approval, the FDA requested that Genzyme conduct two randomized controlled studies—one to determine the contribution of the cartilage cells to the treatment of the defect, and the other to compare long-term outcomes in patients treated with Carticel to outcomes achieved with other procedures currently in use, including abrasion arthroplasty and microfracture. In addition, all patients enrolled in the Carticel Patient Registry must be followed for a minimum of two years with submission of periodic reports of safety and clinical outcomes to the FDA. Genzyme subsequently concluded that running randomized trials sufficiently large enough to satisfy these requirements would not be feasible and requested that the FDA narrow the indication for autologous cultured chondrocytes to second-line therapy for patients who have failed other therapies. The FDA granted a supplement to the Biologics License for Carticel on March 2, 2000. In response to the request made by Genzyme, FDA narrowed the indication for use of autologous cultured chondrocytes to second-line therapy for patients who have failed other therapies.

In June 2007, the FDA granted a request from Genzyme to supplement the biologics license application for Cultured Chondrocytes to revise the package insert to include safety and efficacy data from the Study of the Treatment of Articular Repair (STAR), discussed below. The STAR study fulfilled the post-approval commitment to conduct a prospective, longitudinal, multicenter study of 100 subjects with articular cartilage defects of the medial or lateral condyles or trochlea having inadequate response to prior non-Carticel surgical treatment (including marrow stimulation techniques, transplantation of cells or tissues, or debridement followed by an adequate rehab program, but not including lavage, biopsy, or diagnostic arthroscopy). The June 2007 package insert contains the following indications and usage information:

- Carticel is an autologous cellular product indicated for the repair of symptomatic cartilage defects of the femoral condyle (medial, lateral or trochlea), caused by acute or repetitive trauma, in patients who have

had an inadequate response to a prior arthroscopic or other surgical repair procedure (e.g., debridement, microfracture, drilling/abrasion arthroplasty, or osteochondral allograft/autograft).

- Carticel should only be used in conjunction with debridement, placement of a periosteal flap and rehabilitation.
- Carticel is not indicated for:
  - Treatment of cartilage damage associated with generalized osteoarthritis
  - Patients with total meniscectomy, unless surgically reconstructed prior to or concurrent with Carticel implantation

The 2007 package insert listed the following as the most common serious adverse events (> 5% of patients) from the STAR study: arthrofibrosis/joint adhesions, graft overgrowth, chondromalacia or chondrosis, cartilage injury, graft complication, meniscal lesion and graft delamination.

### Literature Review

Niemeyer et al. (2013) published a case series evaluating long-term clinical and MRI outcomes of ACI of the knee (n=86). Defects were located on the medial femoral condyle in 34 patients, lateral femoral condyle in 13, trochlear groove in 6, and patellar lesions in 17 patients. The mean age of treated patients was 33, and the mean BMI, 26.3. At a mean follow-up of  $10.9 \pm 1.1$  years, 70 patients were available for evaluation of knee function using standard instruments, and 59 of these patients were evaluated by MRI to quantify the MR observation of cartilage repair tissue (MOCART) score. Clinical function was assessed using the Lysholm score, International Knee Documentation Committee (IKDC) score, and the Knee Injury and Osteoarthritis Outcome Score (KOOS). Patient activity was assessed using the Tegner score, and pain was assessed using a visual analog scale (VAS). The mean IKDC score at follow-up was  $74.0 \pm 17.3$ . The mean Lysholm score improved from  $42.0 \pm 22.5$  before surgery to  $71.0 \pm 17.4$  at follow-up ( $p < .01$ ). The mean pain score decreased from  $7.2 \pm 1.9$  to  $2.1 \pm 2.1$ . The mean MOCART score was  $44.9 \pm 23.6$ . Defect-associated bone marrow edema was found in 78% of cases. There was no correlation between MOCART score and clinical outcome (KDC score). The authors concluded that although ACI leads to satisfying clinical results in terms of patient satisfaction, pain reduction, and improvement in knee function, full restoration of knee function cannot be achieved.

Bentley et al. (2012) conducted a randomized comparative study of autologous chondrocyte implantation (ACI) vs. mosaicplasty for symptomatic articular cartilage lesions of the knee (n=100). Patients with an isolated articular cartilage lesion with persistent knee pain and functional deficit in a stable knee were randomized to undergo ACI (n= 58) or mosaicplasty (n=42). Lesions were located on the medial femoral condyle (53), lateral femoral condyle (18) or patella (25). The rehabilitation protocol was identical in both groups. Assessment was performed using the modified Cincinnati knee score and the Stanmore-Bentley Functional Rating system. At ten years, 10 of 58 (17%) patients in the ACI group experienced repair failure compared to 23 of 42 (55%) in the mosaicplasty group ( $p < 0.001$ ). Of those with a surviving graft, the functional outcome was significantly better in patients who underwent ACI compared to mosaicplasty ( $p = 0.02$ ).

Harris et al. (2010) conducted a systematic review to determine a) whether the current literature supports the choice of using autologous chondrocyte implantation (ACI) over other cartilage procedures, b) whether the literature supports the use of a specific generation of ACI, and c) whether there are patient-specific and defect-specific factors that influence outcomes. Thirteen randomized controlled and prospective cohort studies (917 patients) met the inclusion criteria. Patients underwent ACI (n=604), microfracture (n=271), or osteochondral autograft (n=42). Improvement was seen with all surgical techniques compared to preoperative status. Three of seven studies showed better clinical outcomes after ACI compared to microfracture after one to three years of follow-up; one study showed better outcomes two years after microfracture, and three studies showed no difference in these treatments after one to five years. Clinical outcomes after microfracture deteriorated at 18–24 months in three of seven studies. ACI and osteochondral autograft demonstrated equivalent short-term clinical outcomes, but improvement was more rapid following osteochondral autograft. Outcomes were similar between first and second generation ACI, and between open and arthroscopic ACI, but complication rates were higher with open, periosteal-cover, first-generation ACI (four studies). For both ACI and microfracture, the best outcomes were seen in younger patients with a shorter preoperative duration of symptoms. A defect size of  $> 4 \text{ cm}^2$  was the only predictor of better outcomes when ACI was compared with a non-autologous chondrocyte implantation technique.

A Cochrane systematic review of autologous chondrocyte implantation (ACI) for full thickness articular cartilage defects of the knee (Vasiliadis and Wasiak, updated 2010, included six trials with 431 patients. Methodological flaws of the trials included incomplete follow-up and inadequate outcomes reporting. Three of the trials compared ACI vs. mosaicplasty; one reported statistically significant results in favor of ACI at one year, based on the number of patients with “good” or “excellent” functional results. A second trial found significant improvement in the mosaicplasty group when assessed using one functional scoring system at two years, but no differences based on two other scoring systems. A third trial found no difference between ACI and mosaicplasty at an average of ten months after surgery. In trials comparing ACI with microfracture, there was no statistically significant difference in functional outcomes at two years. Results of the sixth trial comparing matrix-guided ACI vs. microfracture were undetermined due to significant loss to follow-up. The authors concluded that there is insufficient evidence to draw conclusions on the use of ACI for treating full thickness articular cartilage defects in the knee. Further good quality randomized controlled trials with long-term functional outcomes are required.

The Study of the Treatment of Articular Repair (STAR) (Zaslav et al., 2009), a prospective, longitudinal, multicenter study, examined the efficacy, durability and safety of ACI in patients with failed prior treatment for articular cartilage defects of the knee (n=154). Eligibility criteria included a history of at least one grade III or IV defect located on the medial or lateral femoral condyle or trochlea, and an inadequate response to a prior non-ACI surgical procedure performed within three years to treat the cartilage lesion. Patients with any of the following were excluded: previous ACI treatment on the ipsilateral knee; history of total meniscectomy or required concurrent total meniscectomy; grade III or IV defects on areas other than the medial or lateral femoral condyle or the trochlea; or widespread osteoarthritis or inflammatory arthritis of the involved knee. Of 154 patients who received ACI, 126 (82%) completed the protocol. Mean follow-up was 45.3 months; median follow-up was 48.7 months. The treatment was considered successful in 76% of patients, and 24% were considered treatment failures. Mean improvements were seen from baseline to all time points ( $p < .001$ ) for all outcome measures. Preoperative and 48 month results, respectively, were 48.7 and 72.2 on the Knee Injury and Osteoarthritis Outcome Score subscales of pain; 51.8 and 70.8 for other symptoms, 29.0 and 52.2 for knee quality of life, and 58.6 and 81.0 for ADL. Preoperatively and at 48 months, respectively, Modified Cincinnati Overall Knee scores were 3.3 and 6.3; Visual Analog Scores were 28.8 and 69.9, and SF-36 Overall Physical Health scores were 33.0 and 44.4. The most frequent serious adverse events were graft overgrowth, arthrofibrosis, cartilage injury, chondromalacia, graft complication, and meniscus lesion. A total of 84 patients (54%) experienced at least one serious adverse event. A total of 76 patients (49%) underwent a total of 113 subsequent surgical procedures, primarily arthroscopy or manipulation under anesthesia, during the four year follow-up. The authors noted that the subsequent surgical procedure rate in this study appears higher than generally reported after ACI.

Knutsen et al. (2007) published five-year results of a randomized controlled trial that compared ACI to microfracture in 80 patients with a single symptomatic cartilage defect on the femoral condyle in a stable knee. The procedure was considered to have failed if the patient required reoperation because of symptoms due to a lack of healing of the treated defect. At five years, there were nine failures (23%) in each group, compared to the two year results of two failures in the ACI group and one failure in the microfracture group. Seven patients were unavailable for examination. Failure occurred at a mean of 26.2 months after ACI and 37.8 months after microfracture treatment ( $p = 0.101$ ). In the patients who did not have a failure, the mean Lysholm scores and mean pain scores on the visual analog scale (VAS) remained significantly improved ( $p < 0.05$ ). When adjustments were made for pretreatment measurements using linear regression analysis, there was no significant difference between the two treatment groups at five years in the Lysholm score ( $p = 0.227$ ) or VAS ( $p = 0.278$ ). There was no significant improvement from baseline in the SF-36 physical component score in the ACI group ( $p = 0.309$ ). There was a significant improvement in the microfracture group, however ( $p < 0.001$ ). Patients less than age 30 had a better outcome, regardless of the treatment group. The authors proposed that, based on these results, microfracture, a less costly, less invasive procedure, should be preferred as the first-line cartilage repair procedure for defects located on the medial or lateral femoral condyle of the knee. The authors stated that ACI may be preferred as a second-line treatment, particularly for large defects that are not contained.

Mandelbaum et al. (2007) conducted a case series to test the hypothesis that patients treated with ACI for moderate to large isolated lesions located on the trochlea will report improvement in the modified overall condition scale score of the Cincinnati Knee Rating System. This rating system assigns a score from one (poor) to ten (excellent). Patients from the Cartilage Repair Registry (n=40) rated their overall condition and symptoms at baseline, and at a mean follow-up of  $59 \pm 18$  months. Patients were age 16–48, and had a mean total defect

size of 4.5 cm<sup>2</sup>. Many patients (48%) had failed a prior marrow stimulation procedure. Tibiofemoral osteotomy had been performed in 23% of patients at baseline, and lateral release or Fulkerson for patella maltracking had been performed on 13% of patients. The mean BMI of included patients was 27.2 and mean age, 37 years (range 16-48). Patients reported a mean improvement in their overall condition score from 3.1 ± 1.0 points at baseline, to 6.4 ± 1.7 points at follow-up (p<.0001). Pain and swelling scores also improved from 2.6 ± 1.7 to 6.2 ± 2.4 points, and 3.9 ± 2.7 to 6.3 ± 2.7 points, respectively (p<.0001). The degree of improvement was not significantly different between patients who had a concurrent procedure with ACI and those who did not. There were no failed implantations. Eleven patients received subsequent procedures for adhesions, periosteal flap detachment, chondromalacia, loose bodies, torn meniscus, fibrotic tissue, and decreased range of motion.

Wood et al. (2006) reported on an investigation performed at the FDA Center for Biologics Evaluations and Research that describes the adverse events following Carticel implantation as reported to the FDA from 1996 to 2003. FDA regulations require manufacturers to report adverse events. Since reporting by clinicians and others is voluntary, adverse event reporting is likely to underestimate the number of event occurrences. A total of 497 adverse events among 294 patients receiving Carticel were reported. Of the 270 events for which the anatomic site was noted, 258 (96%) involved the femoral condyles. More than one adverse event was reported for 135 patients (46%). The most commonly reported events were graft failure (n=73; 25%), delamination (n= 65; 22%), and tissue hypertrophy (n= 52; 18%). Eighteen surgical site infections were reported, including 11 joint and seven soft-tissue infections. Surgical revision subsequent to Carticel implantation was mentioned in the records for 273 patients (93%). The reasons for the 389 revision procedures included graft-related problems (187 procedures; 48.1%), periarticular soft-tissue problems (97 procedures; 24.9%), and intra-articular problems (63 procedures; 16.2%). Eight patients had a total knee replacement. Based on the manufacturer's reported distribution of 7500 Carticel lots between 1995 and 2002, 285 patients (3.8%) had an adverse event that was reported to the FDA.

Brown et al. (2005) conducted a multicenter cohort study to assess the clinical outcome of patients treated with ACI for lesions of the distal femur. Modified 10-point scales of the Cincinnati knee rating system were used to measure outcome assessments at baseline and at five years. Eighty-seven percent of patients completed five-year follow-up assessments. Patients were an average of age 37 and had a mean total defect size of 4.9 cm<sup>2</sup>. At least one prior cartilage repair procedure had failed in 70% of the patients. At follow-up, 87 patients reported a mean improvement of 2.6 points in the overall condition score, including 62 with improved conditions, six with no change in condition, and 19 with worsened conditions. The authors stated that the factors that contributed to some treatment failures highlight the importance of careful clinical evaluation and patient selection. Ligament instability and joint malalignment should be corrected either before or concurrent with ACI. The authors also stated that ACI is not indicated for cartilage damage associated with osteoarthritis or inflammatory arthritis. Of the 62 patients who improved, the mean overall condition score improved 4.1 points at follow-up.

Horas et al. (2003) conducted a randomized controlled trial to investigate two-year outcomes in 40 patients with an articular cartilage lesion of the femoral condyle who had been randomly treated with either transplantation of an autologous osteochondral cylinder or ACI. Biopsy specimens from representative patients of both groups were evaluated with histological staining, immunohistochemistry, and scanning electron microscopy. Both surgical treatments resulted in a decrease in symptoms, although the improvement provided by ACI lagged behind that provided by the osteochondral cylinder transplantation. The authors report that the defects treated with ACI were primarily filled with fibrocartilage, whereas the osteochondral cylinder transplants retained their hyaline character (e.g., a more favorable outcome), although there was a persistent interface between the transplant and the surrounding original cartilage. Limitations to this study included the small number of patients and limited follow-up of two years.

Jobanputra et al. (2001) conducted a systematic review commissioned by the UK National Health Service on behalf of the National Institute for Clinical Excellence (NICE). Seventeen studies (n=2600 patients) who were treated with ACT were reviewed. All reports included in the analysis were case series with variable follow-up times. The outcome of the surgery two years after treatment was rated as good or excellent by 70% of the patients. Approximately 16% of the patients required further arthroscopic surgical procedures during follow-up, and treatment was judged to have failed in 3–7% of the patients. The two-year outcome for comparator treatments was rated as good or excellent in 10–95% of patients. The authors concluded that the literature on ACT and comparators is subject to bias because of the inherent weaknesses of case series, and stated that the long-term impact of conventional surgical treatments or no surgical treatment is poorly documented. Recommendations for further research included the need to provide more accurate data on the occurrence of

hyaline cartilage defects, evaluate the natural history of cartilage defects, clarify the relationship of cartilage defects to clinical symptoms, and compare ACT with other treatments based on randomized trials.

The use of ACI became widely available in the U.S. following FDA approval of Carticel and early reports of success in Sweden, although controversy remains regarding the efficacy of the procedure and indications for use. The Washington State Department of Labor and Industries guideline, Review Criteria for Knee Surgery, (2004, updated 2012) includes the following findings for consideration of ACI.

- physical therapy for a minimum of two months
- capable and willing to follow the rehabilitation protocol
- failure of traditional surgical interventions (i.e., microfracture, drilling, abrasion, osteochondral graft) Debridement alone does not constitute a traditional surgical intervention for ACI.
- single, clinically significant lesion that measures between 1–10 cm<sup>2</sup> in area that affects a weight-bearing surface of the medial femoral condyle or the lateral femoral condyle
- full-thickness lesion (Modified Outerbridge Grade III–IV) that involves only cartilage
- knee is stable with intact, fully functional menisci and ligaments
- normal knee alignment
- normal joint space
- less than 60 years old
- body mass index (BMI) of less than 35
- Chondral defect on the weight bearing surface of the medial or lateral femoral condyle on: MRI or arthroscopy

The guideline lists the following exclusion criteria for ACI:

- lesion that involves any portion of the patellofemoral articular cartilage, bone, or is due to osteochondritis dissecans
- a "kissing lesion" or \*Modified Outerbridge Grade II, III, or IV exists on the opposite tibial surface
- mild to severe localized or diffuse arthritic condition that appears on standing x-ray as joint space narrowing, osteophytes, or changes in the underlying bone
- unhealthy cartilage border; the synovial membrane in the joint may be used as a substitute border for up to 1/4 of the total circumference
- prior total meniscectomy of either compartment in the affected knee. Must have at least 1/3 of the posterior meniscal rim
- history of anaphylaxis to gentamycin or sensitivity to materials of bovine origin
- chondrocalcinosis diagnosed during the cell culture process

**Matrix-Induced Autologous Chondrocyte Implantation (MACI™ Implant :** A prospective case series was conducted by Ebert et al. (2011) to assess clinical and MRI-based outcomes to five years in 41 patients (53 grafts) after MACI. Following surgery and a 12-week structured rehabilitation program, patients underwent clinical assessments (Knee injury and Osteoarthritis Outcomes Score, SF-36, 6-minute walk test, knee range of motion) and MRI assessments at 3, 12, 24 months, and 5 years after surgery. A significant improvement was demonstrated for all Knee Injury and Osteoarthritis Outcome Scores and SF-36 subscales, as well as the 6-minute walk test and active knee extension ( $p < 0.05$ ). At five years, 67% of MACI grafts demonstrated complete infill, while 89% demonstrated good to excellent filling of the chondral defect. The authors concluded that these results suggest that MACI provides a suitable midterm treatment option for articular cartilage defects in the knee. Long term follow-up is essential to confirm whether the repair tissue has the durability required to maintain long-term patient quality of life.

Zeifang et al. (2010) conducted a randomized controlled trial to compare MACI vs. the original periosteal flap technique ( $n=21$ ). At one and two-year follow-up, no difference in efficacy was reported in knee function as assessed by the International Knee Documentation Committee (IKDC), and no difference was reported in the health-related quality of life (Short Form-36) and knee functionality (Tegner Activity Score). Significant differences in knee functionality (Lysholm and Gilquist score) were found in favor of the periosteal flap technique.

Basad et al. (2010) conducted a randomized controlled trial to compare clinical outcomes of patients with symptomatic cartilage defects treated with MACI (n=40) or microfracture (n=20). Outcome measures included the Tegner, Lysholm and International Cartilage Repair Society (ICRS) scores. The difference between baseline and 24 months was significant for both treatment groups for the Tegner, Lysholm patient ICRS, and surgeon ICRS scores (all p<0.0001), but MACI was more effective than microfracture according to the Lysholm (p=0.0005), Tegner (p=0.04), ICRS patient (p=0.03) and ICRS surgeon (p=0.02) scores.

There is insufficient evidence in the published medical literature to demonstrate the safety and efficacy of matrix-induced autologous chondrocyte transplantation (MACI), or to determine how this technique compares to the standard periosteal flap technique.

## **ECRI**

An ECRI Institute Evidence Report, Autologous Chondrocyte Implantation for Knee Cartilage Defects (ECRI, 2004) concluded that there is insufficient evidence to determine whether ACI is effective for treating cartilage defects of the knee. The three available controlled trials compared ACI to competing technologies (e.g., mosaicplasty, microfracture). These trials did not provide the most appropriate control group to determine ACI's basic efficacy. Because hyaline cartilage regenerates over a long period of time, the controlled trials that followed patients for one year and two years do not provide the long-term evidence needed to reach conclusions about the efficacy of the ACI techniques. The report states that, thus far, ACI has not produced durable hyaline cartilage in most patients, and that was the rationale behind the technology's initial development. Adverse event rates cannot be reliably calculated from the small studies that reported such occurrences.

## **Use Outside the U.S.**

### **National Institute for Clinical Excellence (NICE) (United Kingdom)**

Guidance issued in 2005 states that autologous chondrocyte implantation (ACI) is not recommended for the treatment of articular cartilage defects of the knee joint except in the context of ongoing or new clinical studies that are designed to generate robust and relevant outcome data, including the measurement of health-related quality of life and long-term follow-up. Patients should be fully informed of the uncertainties about the long-term effectiveness and the potential adverse effects of this procedure.

## **Summary**

Prospective, randomized clinical studies are needed to assess the impact of autologous chondrocyte transplantation (ACT) on functional status, disability, and pain. In addition, studies need to compare the effectiveness of ACT to established methods of treatment of cartilage defects of the knee. Based on the available evidence, guidelines, and revised FDA indications for use, ACT should be limited to use as a second-line treatment for carefully selected symptomatic individuals with defects of the femoral condyle caused by acute or repetitive trauma who have had an inadequate response to prior arthroscopic or other surgical repair.

The DeNovo<sup>®</sup> NT Natural Tissue Graft, a minced juvenile cartilage allograft has been proposed for the treatment of articular cartilage lesions. There are no studies evaluating these products in the published medical literature. There is insufficient evidence to determine the safety and efficacy of this procedure in the treatment of articular cartilage defects of the knee.

There is insufficient evidence in the published medical literature to demonstrate the safety and efficacy of matrix-induced autologous chondrocyte transplantation (MACI<sup>™</sup> Implant [Genzyme Biosurgery, Cambridge, MA]), or to determine how this technique compares to the standard periosteal flap technique.

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## **Coding/Billing Information**

**Note:** 1) This list of codes may not be all-inclusive.

2) Deleted codes and codes which are not effective at the time the service is rendered may not be eligible for reimbursement

**Covered when medically necessary for autologous chondrocyte implantation (excludes juvenile cartilage allograft tissue implantation and matrix-induced autologous chondrocyte implantation which are experimental/investigation/unproven and not covered for any indication):**

CPT <sup>®</sup> * Codes	Description
27412	Autologous chondrocyte implantation, knee

HCPCS Codes	Description
J7330	Autologous cultured chondrocytes, implant
S2112	Arthroscopy, knee, surgical harvesting of cartilage (chondrocyte cells)

**Experimental/Investigational/Unproven/Not Covered when used to report juvenile cartilage allograft tissue implantation or matrix-induced autologous chondrocyte implantation:**

CPT* Codes	Description
27599	Unlisted procedure, femur or knee

**\*Current Procedural Terminology (CPT<sup>®</sup>) © 2013 American Medical Association: Chicago, IL.**

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