Subject: Autologous Chondrocyte Implantation for Knee Cartilage Lesions		Original Effective Date: 9/18/19
Policy Number: MCP-347	**Revision Date(s):**	
MCPC Approval Date: 9/18/19, 9/16/20	**Review Date:** 9/16/20	

DISCLAIMER

This Molina clinical policy is intended to facilitate the Utilization Management process. It expresses Molina's determination as to whether certain services or supplies are medically necessary, experimental, investigational, or cosmetic for purposes of determining appropriateness of payment. The conclusion that a particular service or supply is medically necessary does not constitute a representation or warranty that this service or supply is covered (i.e., will be paid for by Molina) for a particular member. The member's benefit plan determines coverage. Each benefit plan defines which services are covered, which are excluded, and which are subject to dollar caps or other limits. Members and their providers will need to consult the member's benefit plan to determine if there are any exclusion(s) or other benefit limitations applicable to this service or supply. If there is a discrepancy between this policy and a member's plan of benefits, the benefits plan will govern. In addition, coverage may be mandated by applicable legal requirements of a State, the Federal government or CMS for Medicare and Medicaid members. CMS's Coverage Database can be found on the CMS website. The coverage directive(s) and criteria from an existing National Coverage Determination (NCD) or Local Coverage Determination (LCD) will supersede the contents of this Molina clinical policy document and provide the directive for all Medicare members. [1]

Contents

DESCRIPTION OF PROCEDURE/SERVICE/PHARMACEUTICAL [32]

Autologous chondrocyte implantation (ACI) or matrix-induced autologous chondrocyte transplantation (ACT) is a form of tissue engineering that creates a graft from a patient's own cartilage cells to repair defects in articular cartilage. The procedure involves the collection of cartilage cells, which are grown in a laboratory to create new cartilage tissue. This new tissue is then implanted into the defect, with the goal of improving the quality of cartilage repair. MACI® is a next-generation matrix-induced autologous chondrocyte implantation

that is the only ACT therapy on the market currently approved by the FDA. The matrix-induced autologous chondrocyte implantation (MACI) procedure is a 2-stage procedure consisting of 4 steps:

- Initial arthroscopy for diagnosing and sizing the defect, securing a chondral biopsy, and harvesting of hyaline cartilage.
- Seeding of the cultivated autologous chondrocytes on an absorbable collagen membrane at a density of 500,000 to 1 million cells per square centimeter. This process may take several weeks.
- A second procedure, an open arthrotomy, to prepare the defect site, appropriately size and shape the implant, and attach the implant to the site of the lesion.
- Postoperative rehabilitation

A variety of procedures are being developed to resurface articular cartilage defects. Damaged articular cartilage typically fails to heal on its own and eventually leads to pain in surrounding tissue, swelling, locking, and/or giving way and can be associated with pain, loss of function, and disability and may lead to debilitating osteoarthritis over time. There is no standard approach to the treatment of hyaline cartilage defects in the knee. Non-surgical treatment in the form of weight reduction, physical therapy, braces and orthotics, nonsteroidal anti-inflammatory drugs, and/or intraarticular injection of hyaluronic acid derivatives may provide effective pain relief for some patients. When these therapies are not sufficient, arthroscopic lavage with saline and/or debridement of loose tissue and unstable cartilage fragments may be performed. Cartilage defects can be classified as chondral (cartilage loss) or osteochondral (OC) (cartilage plus bone loss) fractures. Chondral defects are categorized further into partial thickness or full thickness, the latter of which extends to, but not into, the subchondral bone. Although partial-thickness defects do not always produce significant symptoms, over time they can become full-thickness defects and predispose an individual to osteoarthritis.

RECOMMENDATION [4-31]

Autologous chondrocyte implantation (ACI) or autologous chondrocyte transplantation (ACT) (using the MACI® implant) for the treatment of knee articular cartilage lesions may be considered medically necessary when all of the following clinical criteria are met: [ALL]

- ❑ Diagnosis of symptomatic single or multiple full-thickness cartilage defects of the distal femoral articular surface (i.e., medial condyle, lateral condyle or trochlea) and/or patella caused by acute or repetitive trauma; and
- ❑ Body Mass Index (BMI) 35 or less; and
- ❑ Age 15 - 55 years (e.g., adolescents who are skeletally mature with documented closure of growth plates and adults who are not considered an appropriate candidate for total knee arthroplasty or other reconstructive knee surgery); and
- ❑ Function-limiting pain (e.g., loss of knee function which interferes with activities of daily living); and
- ❑ The following physical examination findings: [ALL]
    - A stable knee with intact or reconstructed ligaments (ACL or PCL) and
    - Normal tibial-femoral and/or patella-femoral alignment or

- History of malalignment for deformity of the tibial femoral joint and/or patella maltracking that has been corrected and fixed; and
- ❑ Failure of non-surgical medical management for at least three (3) months in duration as appropriate (e.g., weight reduction, physical therapy, braces and orthotics, intraarticular injection of hyaluronic acid derivatives, and nonsteroidal anti-inflammatory agents); and
- ❑ Focal, full-thickness (grade III or IV) unipolar lesions of the patella or on the weight-bearing surface of the femoral condyles or trochlea at least 1.5 centimeters squared in size identified by MRI or CT arthrogram, or during an arthroscopy; and
- ❑ 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; and
- ❑ Absence of osteoarthritis, generalized tibial chondromalacia, and inflammatory arthritis or other systemic disease affecting the joints

Autologous chondrocyte implantation for all other joints, including talar, and any indications other than those listed above is considered experimental, investigational and unproven based on insufficient evidence in the peer reviewed published literature.

SUMMARY OF MEDICAL EVIDENCE [4-31]

There is a large body of evidence suggesting that ACI may be an efficacious and a reasonably safe treatment for symptomatic articular cartilage defects of the knee and can improve symptoms in some patients over short- and intermediate-term follow-up. A summary of the more recent relevant studies are outlined below.

RCT's

In 2017, Ebert et al., reported two-year outcomes of a randomized trial investigating a 6-week return to full weight bearing after matrix-induced autologous chondrocyte implantation. A total of 35 patients were randomly allocated to either an 8-week return to full weight bearing or an accelerated 6-week weight bearing approach. Patients were evaluated preoperatively and at 1, 2, 3, 6, 12, and 24 months after surgery. Magnetic resonance imaging (MRI) was undertaken to evaluate the quality and quantity of repair tissue as well as to calculate an MRI composite score. Results showed significant improvements were observed in all subjective scores, active knee flexion and extension, 6-minute capacity, peak knee extensor torque in the operated limb, and knee extensor, although no group differences existed. The authors concluded that patients who reduced the length of time spent ambulating on crutches produced comparable outcomes up to 24 months, without compromising graft integrity. [12]

In 2016, Knutsen G et al., reported results of a randomized multicenter trial comparing autologous chondrocyte implantation with microfracture and long-term follow up at 14 to 15 years of eighty patients with a single symptomatic chronic cartilage defect on the femoral condyle without general osteoarthritis. At the long-term follow-up evaluation, no significant differences between the treatment groups were detected with respect to the results on the clinical scoring systems. At the 15-year evaluation, there were 17 failures in the ACI group compared with 13 in the microfracture group. We observed that more total knee replacements were needed in the ACI group than in the microfracture group (6 compared with 3). The surviving patients in both groups, i.e., those who had not had a failure, had significant improvement in the clinical scores compared with baseline.

Fifty-seven percent of the surviving patients in the ACI group and 48% of such patients in the microfracture group had radiographic evidence of early osteoarthritis (a Kellgren and Lawrence grade of≥2); the difference was not significant. The survivors in both groups improved their clinical scores in the short, medium, and long-term evaluations, and no significant difference between the groups was found at the long-term follow-up. [16]

In 2016, Clavé et al., reported results of a multicenter randomized controlled trial that compared 2-year functional outcomes (IKDC score) after Cartipatch® versus mosaicplasty in patients with isolated symptomatic femoral chondral defects (ICRS III and IV) measuring 2.5-7.5 cm(2). 55 patients were included, 30 of them were allocated at random to Cartipatch® and 25 to mosaicplasty. After 2 years, eight patients had been lost to follow-up, six in the Cartipatch® group, and two in the mosaicplasty group. The baseline characteristics of the two groups were not significantly different. The mean IKDC score and score improvement after 2 years were respectively 73.7±20.1 and 31.8±20.8 with Cartipatch® and 81.5±16.4 and 44.4±15.2 with mosaicplasty. The 12.6-point absolute difference in favor of mosaicplasty is statistically significant. Twelve adverse events were recorded in the Cartipatch® group against six in the mosaicplasty group. After 2 years, functional outcomes were significantly worse after Cartipatch® treatment compared to mosaicplasty for isolated focal osteochondral defects of the femur. [7]

In 2012, Bentley et al., reported ten-year results of a prospective randomised study of autologous chondrocyte implantation versus mosaicplasty for symptomatic articular cartilage lesions of the knee. This study represents the first long-term randomised comparison of the two techniques in 100 patients at a minimum follow-up of ten years. The mean age of the patients at the time of surgery was 31.3 years (16 to 49); the mean duration of symptoms pre-operatively was 7.2 years (9 months to 20 years). The lesions were large with the mean size for the ACI group being 440.9 mm(2) (100 to 1050) and the mosaicplasty group being 399.6 mm(2) (100 to 2000). Patients had a mean of 1.5 previous operations (0 to 4) to the articular cartilage defect. Patients were assessed using the modified Cincinnati knee score and the Stanmore-Bentley Functional Rating system. The number of patients whose repair had failed at ten years was ten of 58 (17%) in the ACI group and 23 of 42 (55%) in the mosaicplasty group ($p < 0.001$). The functional outcome of those patients with a surviving graft was significantly better in patients who underwent ACI compared with mosaicplasty ($p = 0.02$). [6]

In 2010, Zeifang et al., reported results of a randomized controlled trial of 21 patients followed for 2 years and found that first-generation ACI gave a statistically significant improvement in Lysholm and Gilquist score relative to third-generation ACI, but there were no significant differences in 2 other measures of knee outcomes. [31]

Systematic Reviews

A 2018 systematic review by Kraeutler et al., was conducted to compare the midterm to long-term clinical outcomes of Microfracture (MFx) versus autologous chondrocyte implantation (ACI) for focal chondral defects of the knee. A total of 210 patients (211 lesions) undergoing MFx and 189 patients (189 lesions) undergoing ACI were reviewed. The average follow-up among all studies was 7.0 years. Four studies utilized first-generation, periosteum-based ACI (P-ACI), and 1 study utilized third-generation, matrix-associated ACI (M-ACI). Treatment failure occurred in 18.5% of patients undergoing ACI and 17.1% of patients undergoing MFx. Lysholm and KOOS scores were found to improve for both groups across studies, without a significant

difference in improvement between the groups. The only significant difference in patient-reported outcome scores was found in the 1 study using M-ACI in which Tegner scores improved to a significantly greater extent in the ACI group compared with the MFx group. The authors found that patients undergoing MFx or first/third-generation ACI for articular cartilage lesions in the knee can be expected to experience improvement in clinical outcomes at midterm to long-term follow-up without any significant difference between the groups. [18]

In 2017, the National Institute for Health Research (NIHR) reported on a systematic review assessing the clinical effectiveness ACI in the knee. The NIHR review focused on reports from previous systematic reviews including adults with symptomatic articular cartilage defects in the knee published between 2004 and 2014. Twelve systematic reviews including 19 studies (11 RCTs) were selected. The main comparator of interest was microfracture and 4 trials (n=712) were identified that compared second- and third-generation ACI with microfracture. One of the trials (ACTIVE, N=390) shared selected results with the NIHR reviewers but no results have been published. In summary, both MACI and ChondroCelect were more clinically effective than microfracture for the outcomes of reductions in pain and improvements in function on the Knee injury and Osteoarthritis Outcome Score (KOOS) over 2 to 5 years. Limited long-term data were available on the failure rates of both ACI and microfracture after 5 years; data were available from 6 observational studies. The conclusions regarding follow-up after 5 years were primarily based on one of the observational studies judged to be the highest quality (Nawaz et al [2014], N=827), For ACI, failure rates were lower in patients who had no previous knee repair and in people with minimal evidence of osteoarthritis. Larger defect size was not associated with poorer outcomes in these patients. [20]

A 2017 systematic review by Schuette et al., was conducted to review mid to long-term clinical outcomes of Matrix-assisted autologous chondrocyte transplantation (MACT) in the patellofemoral (PF) and tibiofemoral (TF) joints. A total of 442 TF patients and 136 PF patients were reviewed. Treatment failure occurred in 9.7% of all patients, including 4.7% of PF patients and 12.4% of TF patients. The authors concluded that patients undergoing MACT in the knee show favorable mid- to long-term clinical outcomes. A significantly higher treatment failure rate was found in patients undergoing MACT in the TF joint compared with the PF joint. [26]

In 2016, DiBartola reported a systematic review of clinical outcomes after ACI in the knees of adolescents ranging from 11 to 21 years (mean age 16.2), including five case series (N=115). No RCT's or comparative studies were included in this review. Overall, 99 patients (83%) underwent ACI with periosteal cover, six (5%) with type I/type III collagen cover, and 14 (12%) with matrix-induced ACI. Follow-up ranged from 12 to 74 months (mean, 52.3 months). Mean defect size was 5.3 cm2 (range, 0.96 to 14 cm2). All studies reported significant improvement in clinical outcomes scores. Graft hypertrophy was the most common complication (7.0%). The overall percentage increase in clinical outcome scores was 35.7% (SD, 14.2%). [10]

Professional Society Guidelines [2-3]

National Institute for Health and Care Excellence (NICE) Guidelines [3] state that: Autologous chondrocyte implantation (ACI) is recommended as an option for treating symptomatic articular cartilage defects of the knee, only if:

- the person has not had previous surgery to repair articular cartilage defects
- there is minimal osteoarthritic damage to the knee (as assessed by clinicians experienced in investigating knee cartilage damage using a validated measure for knee osteoarthritis)
- the defect is over 2 cm^2

American Academy of Orthopaedic Surgeons (AAOS) Appropriate Use Criteria for management of osteochondritis dissecans of the femoral condyle, (2015) indicated that patients with OCD that have pain, mechanical symptoms (catching or locking), effusion, with closed growth plates, stable, and unsalvageable; that ACI may be appropriate. This recommendation was given a rating of 7 out of 9 total points. All other clinical conditions including no mechanical symptoms did not recommend ACI. [2]

CODING INFORMATION: THE CODES LISTED IN THIS POLICY ARE FOR REFERENCE PURPOSES ONLY. LISTING OF A SERVICE OR DEVICE CODE IN THIS POLICY DOES NOT IMPLY THAT THE SERVICE DESCRIBED BY THIS CODE IS COVERED OR NON-COVERED. COVERAGE IS DETERMINED BY THE BENEFIT DOCUMENT. THIS LIST OF CODES MAY NOT BE ALL INCLUSIVE.

CPT	Description
27412	Autologous chondrocyte implantation, knee

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

ICD-10	Description: [For dates of service on or after 10/01/2015]
M17.0-M17.9	Osteoarthritis of Knee
M22	Disorder of patella
M25.561- M25.569	Pain in the knee

REFERENCES

Government Agency

1. Centers for Medicare & Medicaid Services (CMS). Medicare Coverage Database. National coverage determination (NCD) Search. Accessed at: http://www.cms.gov/medicare-coverage-database/

Professional Society Guidelines

2. American Academy of Orthopaedic Surgeons (AAOS). [website]: https://www.aaos.org/
    - The Diagnosis and Treatment of Osteochondritis Dissecans. Guideline and Evidence Report. December 4, 2010. [archived]
    - Appropriate use criteria for management of osteochondritis dissecans of the femoral condyle 12/4/15. [archived]
3. National Institute for Health and Care Excellence (NICE). Accessed at: https://www.nice.org.uk/

- Autologous chondrocyte implantation using chondrosphere for treating symptomatic articular cartilage defects of the knee. Technology appraisal guidance [TA508]. March, 2018.
- Autologous chondrocyte implantation for treating symptomatic articular cartilage defects of the knee. Technology appraisal guidance [TA477]. Oct, 2017.

Peer Reviewed Publications

4. Akgun I, Unlu MC, Erdal OA et al. Matrix-induced autologous mesenchymal stem cell implantation versus matrix-induced autologous chondrocyte implantation in the treatment of chondral defects of the knee: A 2-year randomized study. Arch Orthop Trauma Surg. 2015;Feb;135(2):251-263.
5. Becher C, Laute V et al. Safety of three different product doses in autologous chondrocyte implantation: results of a prospective, randomised, controlled trial. J Orthop Surg Res. 2017 May 12;12(1):71.
6. Bentley G, Biant LC 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. 2012 Apr;94(4):504-9.
7. Clavé A, Potel JF, Servien E, et al. Third-generation autologous chondrocyte implantation versus mosaicplasty for knee cartilage injury: 2-year randomized trial. J Orthop Res 2016; 34:658.
8. Crawford DC, DeBerardino TM et al. NeoCart, an autologous cartilage tissue implant, compared with microfracture for treatment of distal femoral cartilage lesions: an FDA phase-II prospective, randomized clinical trial after two years. J Bone Joint Surg Am. 2012 Jun 6;94(11):979-89.
9. Devitt BM, Bell SW, Webster KE, Feller JA and Whitehead TS. Surgical treatments of cartilage defects of the knee: Systematic review of randomised controlled trials. Knee. 2017;Jun;24(3):508-517.
10. DiBartola, AC, Wright, BM, Magnussen, RA, Flanigan, DC. Clinical Outcomes After Autologous Chondrocyte Implantation in Adolescents' Knees: A Systematic Review. Arthroscopy. 2016 May 7. PMID: 27161508
11. DiBartola, AC, Everhart, JS, Magnussen, RA, et al. Correlation between histological outcome and surgical cartilage repair technique in the knee: A meta-analysis. Knee. 2016 Jun;23(3):344-9. PMID: 26898766
12. Ebert JR, Edwards PK, Fallon M, Ackland TR, Janes GC and Wood DJ. Two-year outcomes of a randomized trial investigating a 6-week return to full weight bearing after matrix-induced autologous chondrocyte implantation. Am J Sports Med. 2017;Mar;45(4):838-848.
13. Filardo G, et al. Arthroscopic second generation autologous chondrocytes implantation associated with bone grafting for the treatment of knee osteochondritis dissecans: Results at 6 years. Knee 2012;19(5):658-663. DOI: 10.1016/j.knee.2011.08.007.
14. Gille J, Behrens P, Schulz AP, Oheim R, Kienast B. Matrix-associated autologous chondrocyte implantation: a clinical follow-up at 15 years. Cartilage 2016;7(4):309-315. DOI: 10.1177/1947603516638901
15. Kon E, Filardo G, Berruto M, et al. Articular cartilage treatment in high-level male soccer players: a prospective comparative study of arthroscopic second-generation autologous chondrocyte implantation versus microfracture. Am J Sports Med. 2011;39(12):2549-2557.
16. Knutsen G, Drogset JO, Engebretsen L, et al. A randomized multicenter trial comparing autologous chondrocyte implantation with microfracture: Long-term follow-up at 14 to 15 years. J Bone Joint Surg Am 2016; 98:1332.

17. Kon E, Filardo G, Di Matteo B, Perdisa F, Marcacci M. Matrix assisted autologous chondrocyte transplantation for cartilage treatment: a systematic review. Bone Joint Res. 2013;2(2):18-25. Available at: http://www.bjr.boneandjoint.org.uk/content/2/2/18.full.
18. Kraeutler MJ, Belk JW et al. Microfracture Versus Autologous Chondrocyte Implantation for Articular Cartilage Lesions in the Knee: A Systematic Review of 5-Year Outcomes. Am J Sports Med. 2018 Mar;46(4):995-999.
19. Krill M, Early N, Everhart JS, Flanigan DC. Autologous chondrocyte implantation (ACI) for knee cartilage defects: a review of indications, technique, and outcomes. Journal of Bone and Joint Surgery Reviews 2018;6(2):e5.
20. Mistry H, et al. Autologous chondrocyte implantation in the knee: systematic review and economic evaluation. Health Technology Assessment 2017;21(6):1-294. DOI: 10.3310/hta21060
21. Niemeyer P1, Laute V et al. The Effect of Cell Dose on the Early Magnetic Resonance Morphological Outcomes of Autologous Cell Implantation for Articular Cartilage Defects in the Knee: A Randomized Clinical Trial. Am J Sports Med. 2016 Aug;44(8):2005-14.
22. Ogura T, Mosier BA, Bryant T, Minas T. A 20-year follow-up after first-generation autologous chondrocyte implantation. American Journal of Sports Medicine 2017;45(12):2751-2761. DOI: 10.1177/0363546517716631
23. Pareek A, Carey JL, Reardon PJ, Peterson L, Stuart MJ, Krych AJ. Long-term outcomes after autologous chondrocyte implantation: a systematic review at mean follow-up of 11.4 years. Cartilage 2016;7(4):298-308.
24. Samsudin EZ, Kamarul T. The comparison between the different generations of autologous chondrocyte implantation with other treatment modalities: a systematic review of clinical trials. Knee Surgery, Sports Traumatology, Arthroscopy 2016;24(12):3912-3926.
25. Saris D, Price A et al. Matrix-applied characterized autologous cultured chondrocytes versus microfracture: Two-year follow-up of a prospective randomized trial. Am J Sports Med. 2014;Jun;42(6):1384-1394.
26. Schuette HB, Kraeutler MJ, McCarty EC. Matrix-assisted autologous chondrocyte transplantation in the knee: a systematic review of mid- to long-term clinical outcomes. Orthopaedic Journal of Sports Medicine 2017;5(6):2325967117709250.
27. Vasiliadis HS, Wasiak J. Autologous chondrocyte implantation for full thickness articular cartilage defects of the knee. Cochrane Database of Systematic Reviews 2010, Issue 10. Art. No.: CD003323. DOI: 10.1002/14651858.CD003323.pub3.
28. Vavken P, Samartzis D. Effectiveness of autologous chondrocyte implantation in cartilage repair of the knee: a systematic review of controlled trials. Osteoarthritis and Cartilage 2010;18(6):857-863. DOI: 10.1016/j.joca.2010.03.005.
29. Volz M, Schaumburger J, Frick H, Grifka J and Anders S. A randomized controlled trial demonstrating sustained benefit of autologous matrix-induced chondrogenesis over microfracture at five years. International Orthopaedics. 2017;41(4):797-804.
30. Wasiak, J, Clar, C, Villanueva, E. Autologous cartilage implantation for full thickness articular cartilage defects of the knee. The Cochrane database of systematic reviews. 2006(3):CD003323. PMID: 16856003

31. Zeifang F, Oberle D, Nierhoff C, Richter W, Moradi B, Schmitt H. Autologous chondrocyte implantation using the original periosteum-cover technique versus matrix-associated autologous chondrocyte implantation: a randomized clinical trial. *Am J Sports Med*. 2010;38(5):924-933.

Other References

32. Hayes a Tract Manager Company. Winifred Hayes Inc., Lansdale Pa.
    - Comparative Effectiveness Review of First-Generation Autologous Chondrocyte Implantation of the Knee. Updated July 2020.
    - Comparative Effectiveness Review of Second and Third-Generation Autologous Chondrocyte Implantation of the Knee. Updated July 2020.
    - Evidence Analysis. Matrix-Induced Autologous Chondrocyte Implantation (MACI) Procedure for Repair of Articular Cartilage of the Knee. May, 2019
33. UpToDate [website]. Waltham, MA: Walters Kluwer Health; 2020.
    - Mandi L, Martin G. Overview of surgical therapy of knee and hip osteoarthritis.
34. Advanced Medical Review (AMR): Policy reviewed by practicing MD board certified in Orthopaedic Surgery. 6/13/19. References included in this review are:
    - J Knee Surg. 2018 Mar;31(3):212-226. doi: 10.1055/s-0037-1607294. Epub 2017 Oct 16.Patellofemoral Cartilage Restoration: Indications, Techniques, and Outcomes of Autologous Chondrocytes Implantation, Matrix-Induced Chondrocyte Implantation, and Particulated Juvenile Allograft Cartilage. Hinckel BB1, Gomoll AH
    - Clin Sports Med. 2017 Jul;36(3):525-548. doi: 10.1016/j.csm.2017.02.008. Autologous Chondrocytes and Next-Generation Matrix-Based Autologous Chondrocyte Implantation. Hinckel BB1, Gomoll AH2
    - Am J Sports Med. 2016 Jul;44(7):1888-95. doi: 10.1177/0363546515589167. Epub 2015 Jul 2. Cartilage Restoration of the Knee: A Systematic Review and Meta-analysis of Level 1 Studies. Mundi R1, Bedi A2, Chow L1, Crouch S3, Simunovic N3, Sibilsky Enselman E2, Ayeni OR4.
    - Am J Sports Med. 2017 Apr;45(5):1028-1036. doi: 10.1177/0363546516681000. Epub 2017 Jan 5. Cell-Seeded Autologous Chondrocyte Implantation: A Simplified Implantation Technique That Maintains High Clinical Outcomes. Gomoll AH1, Ambra LF1,2, Phan A1, Mastrocola M1, Shah N3.

Review/Revision History:

9/18/19: New Policy

9/16/20: Policy reviewed, no changes. No new guidelines identified. Updated references and added TOC.