



AutoCart™ Procedure Scientific Update

A review of design rationale, techniques, and outcomes

Cartilage defects primarily occur in areas of articular joints that experience biomechanical joint loading. After a traumatic event or if degeneration progresses, these defects can become painful and may limit daily activities. Since chondrocytes of articular cartilage have limited native healing capacity, autologous chondrocyte transplantation has been described as a potential treatment to repair these defects. The GraftNet™ device for autologous cartilage collection augmented with BioCartilage® extracellular matrix allograft and microfracture—also known as the AutoCart procedure—allows for a single-stage implantation procedure. The limitations of microfracture alone are well known, and chondrocyte differentiation is a risk with other two-stage autologous chondrocyte implantation procedures that require cellular expansion in a laboratory setting. The articles below showcase data relating to the principles of the AutoCart procedure, current clinical outcomes, results of competitor two-stage autologous chondrocyte implantation, and the cost analysis of each treatment.

Cole BJ,
Farr J,
Winalski CS,
et al

Technique Principles of Single-Stage Autologous Cartilage Implantation

[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.* 2011;39(6):1170-1179. doi:10.1177/0363546511399382

- Analyzed safety and clinical outcomes of a single-stage cartilage autograft implantation system.
- At 24 months, the single-stage autograft technique provided significantly improved patient outcomes on the IKDC and KOOS scales compared to microfracture alone.
- Single-stage autografting showed a decreased incidence of intralesional osteophyte formation at 6- and 12-month follow-ups.

Takeaway

Compared to microfracture alone, single-stage autograft cartilage implantation provides superior patient outcomes and less negative outcomes associated with osteophyte formation.

Cole BJ,
Haunschild ED,
Carter T,
et al

[Clinically significant outcomes following the treatment of focal cartilage defects of the knee with microfracture augmentation using cartilage allograft extracellular matrix: a multicenter prospective study.](#) *Arthroscopy.* 2021;37(5):1512-1521. doi:10.1016/j.arthro.2021.01.043

- Determined short-term outcomes of allograft extracellular matrix augmentation for focal cartilage defects of knees with microfracture.
- Safe and an effective treatment with a 2.1% failure rate, clinically significant minimally clinically important difference (MCID) of 90%, and a patient acceptable symptomatic state (PASS) of 85% at a 2-year follow-up.
- Patients reported a decrease in incidences of pain that led to a reduction in daily activities and work compared to preoperative values, with an 80% rate of return to functions of daily living at a 2-year follow-up.

Takeaway

Cartilage allograft extracellular matrix for focal cartilage defects appears to be safe, with a minimal failure rate and satisfactory patient-reported outcomes at a 2-year follow-up.



Beletsky A,
Naveen NB,
Tauro T,
et al

[Microdrilling demonstrates superior patient-reported outcomes and lower revision rates than traditional microfracture: a matched cohort analysis.](#) *Arthrosc Sports Med Rehabil.* 2021;3(3):e629-e638. doi:10.1016/j.asmr.2020.10.006

- Comparison of patient-reported outcomes and revision rates of standard microfracture using an awl versus microdrilling.
- Microdrilling achieved a significant difference in MCID at 1 year compared to microfracture and >80% for KOOS, QOL, and SF12 PCS scores. Microfracture achieved ≤60% for both categories.
- At 3-year follow-up, microdrill reoperation rate was half that of microfracture (41.2% and 20.6% respectively).

Takeaway

The microdrilling technique showed improved patient clinical outcomes up to a 1-year follow-up, and decreases in revision rates and subsequent procedures at a 3-year follow-up.

Levinson C,
Cavalli E,
Sindi DM,
et al

[Chondrocytes from device-minced articular cartilage show potent outgrowth into fibrin and collagen hydrogels.](#) *Orthop J Sports Med.* 2019;7(9):2325967119867618. doi:10.1177/2325967119867618

- Investigated the effect of arthroscopic minced cartilage collection on chondrocyte viability and migration potential of chondrocytes into a surrounding matrix.
- After 7 days of growth, chondrocyte viability was similar to hand mincing and a biopsy punch of intact cartilage.
- Chondrocytes had similar migration into the surrounding matrix regardless of collection by device or hand mincing.

Takeaway

The chondrocytes from resected cartilage maintained their viability at a comparable level to an intact punch of cartilage. Chondrocytes show the ability to migrate to surrounding area regardless of mincing type.

Acevedo L,
Iselin L,
Berkelaar MHM,
et al

[Comparison of human articular cartilage tissue and chondrocytes isolated from peripheral versus central regions of traumatic lesions.](#) *Cartilage.* 2021;13(2_suppl):68S-81S. doi:10.1177/1947603520958154

- Analyzed minced cartilage from the central and peripheral regions of traumatic joint injuries for tissue quality, viability, and proliferation capability.
- Peripheral cartilage had similar cellularity and proliferation rate as central cartilage samples.
- Peripheral cartilage had increased cartilage quality, while central cartilage had an increase in cartilage viability. However, peripheral cell viability was still at 96.8%—well above the acceptable percentage for implantation.

Takeaway

Peripheral cartilage surrounding a traumatic lesion may provide cartilage with high quality, acceptable chondrocyte viability, acceptable cellularity, and proliferative potential.



Tsuyuguchi Y,
Nakasa T,
Ishikawa M,
et al

[The benefit of minced cartilage over isolated chondrocytes in atelocollagen gel on chondrocyte proliferation and migration.](#) *Cartilage*. 2021;12(1):93-101. doi:10.1177/1947603518805205

- Analyzed the capability of minced cartilage and isolated chondrocytes embedded in atelocollagen gel for chondrocyte proliferation, migration, and matrix production potential.
- Histologically, minced cartilage showed a higher capacity for migration into gel than the isolated chondrocytes.
- In immunohistochemistry analysis, minced cartilage showed higher matrix content, cellular proliferation, and anabolic potential than isolated chondrocytes.

Takeaway

Minced cartilage placed into a gel scaffold appears to have greater potential for regenerating tissue from its chondrocytes than isolated cartilage.

de Windt TS,
Sorel JC,
Vonk LA,
Kip MMA,
Ijzerman MJ,
Saris DBF

[Early health economic modelling of single-stage cartilage repair. Guiding implementation of technologies in regenerative medicine.](#) *J Tissue Eng Regen Med*. 2017;11(10):2950-2959. doi:10.1002/term.2197

- Analyzed cost-effectiveness of a single-stage cartilage regeneration technique.
- In early modeling, single-stage autologous chondrocyte implantation is more than 2.5x more cost-effective than two-stage procedures when accounting for quality-adjusted life years (QALY).
- If long-term clinical outcome data continues to show the single-stage procedure is superior, it may prove to be even more cost effective than two-stage procedures.

Takeaway

Early health economic modeling shows single-stage cartilage repair is significantly more cost effective than two-stage repair when accounting for QALY. Long-term data may increase this discrepancy.

Darling EM,
Athanasίου KA

Limitations of Two-Stage Autologous Chondrocyte Implantation

[Rapid phenotypic changes in passaged articular chondrocyte subpopulations.](#) *J Orthop Res*. 2005;23(2):425-432. doi:10.1016/j.jorthres.2004.08.008

- Investigated the cellular phenotypic differentiation that occurs during cellular expansion of chondrocytes and whether the differentiations revert to native phenotypes when implanted back into a 3D cellular matrix.
- In an in vitro setting, monolayer expansion of chondrocytes takes more than 4 weeks, resulting in multiple surgical operations.
- Monolayer expansion is associated with loss of native chondrocyte phenotype and a shift toward a more fibroblastic cell type.
- 3D encapsulation of expanded cells does not return cell phenotype to a chondrocyte-like state, resulting in the reimplanted chondrocytes having a fibrous phenotype.

Takeaway

In vitro expansion of chondrocytes and encapsulation into a 3D structure may result in the implantation of a fibrous cellular phenotype and not a chondrocyte cellular phenotype.



AS Shekkeris,
JR Perera,
G Bentley,
et al

[Histological results of 406 biopsies following ACI/MACI procedures for osteochondral defects in the knee.](#) *Orthop Proceedings.* 2012(94)12-12.

- Investigated the histological quality of autologous chondrocyte implantation (ACI) and its correlation to functional outcomes.
- One to two years after implantation, only 42.4% of defects were filled with hyaline-like or mixed cartilage; 53.6% of defects were filled with fibrocartilage or fibrous tissue.
- Of the hyaline-like and mixed filled defects, 70% of patients achieved fair or excellent functional outcomes.
- In comparison, 89% of patients with fibrous tissue-filled defects had poor functional outcomes.

Takeaway

The majority of filled defects with ACI did not demonstrate chondrocyte cellular properties. Defects filled with fibrous tissue were associated with less-favorable functional outcomes for patients.

Sochacki KR,
Varshneya K,
Calcei JG,
et al

[Comparison of autologous chondrocyte implantation and osteochondral allograft transplantation of the knee in a large insurance database: reoperation rate, complications, and cost analysis.](#) *Cartilage.* 2021;13(1_suppl):1187S-1194S. doi:10.1177/1947603520967065

- Large-scale study with 909 subjects compared reoperation rates, complications, and cost differences in ACI and osteochondral allograft (OCA) procedures.
- ACI and OCA procedures had associated reoperation rates of 67.6% and 40.4%, respectively, with a mean follow-up of 39.2 months.
- At 2 years postoperative, OCA had an associated cost of \$33,426, compared to \$56,578 for ACI.

Takeaway

At early and midterm follow up, OCA procedures have a lower cost and reoperation rate than ACI, providing another cost-effective cartilage restoration option alongside the AutoCart procedure.