



Cartilage defects primarily occur in areas of joints that experience biomechanical joint loading which can become painful and limiting to daily activities once a traumatic event or degeneration has progressed. They are painful and can limit daily activities. As chondrocytes of articular cartilage have limited native healing capacity, autologous transplantation has been described as a potential repair for these defects. The utilization of the GraftNet device for autologous cartilage collection allows for a single-stage implantation procedure and reduces the risk of chondrocyte differentiation to fibroblasts. Combining our cellular and extracellular matrix products, autologous activated serum from Thrombinator, and autologous fluids prepared with our ACP system has been shown to provide an autologous, cohesive scaffold to improve sample handling and sufficient fill of the defect area. 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 contain information relating to the principles of the AutoCart procedure.

## Analysis of the One-Stage Autologous Particulate Cartilage Implantation

### One-Step Autologous Minced Cartilage Procedure for the Treatment of Knee Joint Chondral and Osteochondral Lesions: A Series of 27 Patients With 2-Year Follow-up

- Prospective clinical trial of single-stage reimplantation of autologous cartilage particles for chondral and osteochondral lesions of the knee joint in 27 patients with a follow-up period of 2 years
- The surgical procedure proved to be safe and showed no failure rate; patient-reported NAS pain scores showed significant improvement from  $7.2 \pm 1.9$  to  $2.3 \pm 2.0$  at 1 year and  $1.8 \pm 1.6$  at 2 years; patient-reported functional scores showed similar results
- After treatment, 92.6 % of patients reported that they would choose the surgical procedure again

#### Conclusion:

Single-stage autologous chondrocyte transplantation has been shown to be a safe and well-accepted procedure for the treatment of focal cartilage damage. The patient-relevant assessments regarding postoperative pain and function show promising results.

Massen FK et al.  
Orthop J Sports Med.  
2019;7(6): 232596711  
9853773.  
Published 2019 Jun 13.  
doi:10.1177/232596  
7119853773

Levinson et al. Orthop  
J Sports Med. 2019;  
7(9):23259671198676  
18. Published 2019  
Sep 10. doi:10.1177/  
2325967119867618

## Chondrocyte Collection and Viability With GraftNet™

### Chondrocytes From Device-Minced Articular Cartilage Show Potent Outgrowth Into Fibrin and Collagen Hydrogels

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

#### Conclusion:

Cartilage can be removed by hand mincing or with an arthroscopic shaver, and the chondrocytes maintain their viability at a level comparable to that achieved with a biopsy punch of intact cartilage. Chondrocytes show the ability of migration to the surrounding area regardless of the mincing type.

Acevedo et al.  
Cartilage. 2021;13  
(2\_suppl):68S-81S.  
doi:10.1177/194760  
3520958154

### Comparison of Human Articular Cartilage Tissue and Chondrocytes Isolated From Peripheral Versus Central Regions of Traumatic Lesions

- Analysis of cartilage from the central and peripheral regions of traumatic joint injuries for tissue quality, viability, and proliferation capability of the minced cartilage
- Peripheral cartilage had similar cellularity and proliferation rate to the central cartilage samples
- Peripheral cartilage had increased cartilage quality compared to central cartilage, while central cartilage had an increase in cartilage viability; however, the peripheral cell viability was still at 96.8 % viability, which is well above the acceptable percentage for implantation

#### Conclusion:

Peripheral cartilage surrounding a traumatic lesion may provide cartilage which is of high cartilage quality, acceptable chondrocyte viability, acceptable cellularity, and maintains proliferative potential.



Tsuyuguchi Y, et al.  
Cartilage. 2021;12(1):  
93-101. doi:10.1177/19  
47603518805205

## Chondrogenic Potential of Minced Articular Cartilage

### The Benefit of Minced Cartilage Over Isolated Chondrocytes in Atelocollagen Gel on Chondrocyte Proliferation and Migration

- Analysis of the capabilities of minced cartilage and embedded in atelocollagen gel and isolated chondrocytes with regard to the proliferation, migration, and matrix production of chondrocytes
- Histologically the minced cartilage showed an increased capacity to migrate into the gel than the isolated chondrocytes
- Immunohistochemistry analysis revealed that minced cartilage showed increased matrix content, cellular proliferation and anabolic potential compared to the isolated chondrocytes

#### Conclusion:

Minced cartilage placed into a gel scaffold appears to have a greater potential for regenerating tissue from its chondrocytes than chondrocytes which are isolated and placed in the same gel.

## Autologous Graft Stability and Fixation with Thrombinator™

### An Ethanol-Free Autologous Thrombin System

- Determination of the reliability and flexibility of a commercially available ethanol-free autologous serum system to activate thrombin activity from a platelet-poor plasma
- The device tolerated the use of varying volumes of blood and was able to generate 4 successive and comparable autologous serum productions
- When the product was combined with platelet-rich plasma and tissue graft material, a cohesive scaffold always formed

#### Conclusion:

This commercially available system was able to activate thrombin activity from platelet-poor plasma without the use of ethanol, and the product was able to form a cohesive scaffold when combined with other autologous fluids and tissue.

Matuska et al. J Extra  
Corpor Technol.  
2018;50(4):237-243.



Karsmarsi et al. J Clin Med. 2022;11(12):3442. Published 2022 Jun 15. doi:10.3390/jcm11123442

### Activated Serum Increases In Vitro Cellular Proliferation and Growth Factor Expression of Musculoskeletal Cells

- Evaluation of the proteomic changes of activating serum and its in vitro effects on musculoskeletal cell lines
- The addition of activated serum to in vitro cell culture increased the cellular proliferation of all cell lines that were tested
- The addition of activated serum was associated with a significant increase in growth factors (PDGF, IGF-1, and VEGF) released by every cell line that was tested

#### Conclusion:

Activated serum from an autologous thrombin system appears to increase the release of growth factors and cellular proliferation of musculoskeletal cell lines, which may be applicable to the reconstruction and regeneration of damaged orthopedic tissue.

Irwin et al. PLoS One. 2019;14(11):e0224756. Published 2019 Nov 8. doi:10.1371/journal.pone.0224756

### The Clot Thickens: Autologous and Allogeneic Fibrin Sealants Are Mechanically Equivalent in an Ex Vivo Model of Cartilage Repair

- Study comparing allogeneic fibrin glue and autologously produced fibrin/thrombin scaffold from PPP/PRP
- The autologous scaffold fixation with PPP/PRP showed the same mechanical quality as an allogeneic product in all aspects considered

#### Conclusion:

The use of an autologous fixation solution of cartilage particles in the regenerate allows equal mechanical stability and autograft integration, with lower thrombin/fibrin concentration than allogeneic fixations, which may lead to better integration of the autograft and defect healing.



Cole et al. Am J Sports Med. 2011;39(6):1170-1179. doi:10.1177/0363546511399382

## AutoCart™ Clinical Results

### Outcomes After a Single-Stage Procedure for Cell-Based Cartilage Repair: A Prospective Clinical Safety Trial With 2-Year Follow-up

- Analysis of the safety and clinical outcomes with a single-stage cartilage autograft implantation system
- After 24 months, the single-stage autograft implantation technique provided significantly improved patient outcomes in the IKDC and KOOS systems when compared to microfracture
- Single-stage autograft implantation showed a decreased incidence of intralesional osteophyte formation at 6 and 12-month follow-up

#### Conclusion:

A single-stage autograft implantation of cartilage provides superior patient outcomes and decreased negative outcomes associated with osteophyte formation when compared to microfracture.

Cugat et al. J Orthop Surg 2020;28(1):230-9499019887547. doi:10.1177/2309499019887547

### A Novel Autologous-made Matrix Using Hyaline Cartilage Chips and Platelet-rich Growth Factors for the Treatment of Full-thickness Cartilage or Osteochondral Defects: Preliminary Results

- Clinical trial in 15 patients with osteochondral as well as chondral lesions for implantation of autologous cartilage particles mixed with PRP
- After 15 months statistically significant improvement compared to preoperative status in VAS pain, Lysholm, IKDSC, WOMAC pain, stiffness and function scores, as well as the Lequesne Index and the SF12PCS
- In addition, significant improvement of the image-based MOCART score, which indicates a good regeneration behavior of the autograft

#### Conclusion:

One-time autologous cartilage cell transplantation shows excellent clinical, functional and MRI-based results in chondral and osteochondral lesions.



de Windt et al.  
J Tissue Eng  
Regen Med.  
2017;11(10):2950-  
2959. doi:10.1002/  
term.2197

Darling et al. J Orthop  
Res. 2005;23(2):425-  
432. doi:10.1016/j.  
orthres.2004.08.008

## Cost-benefit Comparison of the AutoCart™ Procedure

### Early Health Economic Modelling of Single-stage Cartilage Repair. Guiding Implementation of Technologies in Regenerative Medicine

- The objective of the study was to analyze the cost-effectiveness of a single-stage cartilage regeneration technique
- In larger defects the two-stage and single-stage autologous cartilage implantation have been indicated as potential viable treatment options to reduce patient pain and increase patient activity or return to sports
- Single-stage autologous chondrocyte implantation is over 2.5 times more cost effective than a two-stage procedure when accounting for quality-adjusted life years in early modeling
- With long-term outcome data, a single-stage procedure may be even more cost effective compared to a two-stage procedure if clinical outcomes continue to prove the single-stage treatment as superior

#### Conclusion:

Early health economic modeling shows single-stage cartilage repair has a significant increase in cost effectiveness compared to two-stage repair when accounting for quality-adjusted life years. Long-term data may demonstrate even higher cost effectiveness for a single-stage procedure.

## Limitations of a Two-stage Autologous Chondrocyte Implantation:

### Cellular Dedifferentiation In Vitro Rapid Phenotypic Changes in Passaged Articular Chondrocyte Subpopulations

- The cellular phenotypic differentiation that occurs during cellular expansion of chondrocytes, and whether the differentiations revert to native phenotypes with the implantation back into a 3D cellular matrix, was investigated
- Monolayer expansion of chondrocytes in an in vitro setting takes 4+ weeks, meaning the overall procedure requires multiple surgical operations
- Monolayer expansion is associated with a loss of native chondrocyte phenotype with a shift toward a more fibroblastic cell type
- Furthermore, 3D encapsulation of expanded cells does not return the cell phenotype to a chondrocyte-like state, which means that reimplanted chondrocytes have a fibrous phenotype

#### Conclusion:

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.



Shekkeris et al.  
Orthopaedic  
Proceedings,  
2018, 94-B, 12.  
doi:10.1302/1358-  
992X.94BSUPP\_  
XXXVI.BORS2011-012

## Clinical Results Associated with With Two-stage Cartilage Procedures

### Histological Results of 406 Biopsies Following ACI/MACI Procedures for Osteochondral Defects in the Knee

- Investigated the histological quality of an autologous chondrocyte implantation and its correlation to functional outcomes
- 1 - 2 years following implantation, only 42.4 % of defects were filled with hyaline-like or mixed cartilage, while 53.6 % of defects were filled with fibrocartilage or fibrous tissue
- In case of hyaline-like and mixed filled defects, 70 % of patients achieved fair or excellent functional outcomes
- Of the fibrous tissue filled defects, 89 % of patients were reported to have poor functional outcomes

#### Conclusion:

A majority of the filled defects with autologous chondrocyte implantation were not filled with any chondrocyte cellular properties and the fibrous filled defects were associated with less favorable functional outcomes for the patient.

## Cost Analysis Comparing Fresh OCA vs 2-Stage Cartilage Procedures

### Comparison of Autologous Chondrocyte Implantation and Osteochondral Allograft Transplantation of the Knee in a Large Insurance Database: Reoperation Rate, Complications, and Cost Analysis

- Comparison of the reoperation rates, complications, and cost differences in ACI and OCA procedures
- In a large scale (909 subjects) with a mean follow-up of 39.2 months, there was an associated reoperation rate of 67.6 % with ACI and 40.4 % with OCA
- The associated cost with each procedure 2 years after the initial procedure was \$ 33,426 for OCA and \$ 56,578 for ACI

#### Conclusions:

ACI and OCA procedures are both associated with high costs and revision rates 2 years after the initial procedure. This can lead to a supposedly cost-efficient process becoming inefficient due to high revision rates.

Sochacki et al.  
Cartilage. 2021;13  
(1\_suppl):1187S-1194S.  
doi:10.1177/194760352  
0967065