



Autologous Minced Cartilage Implantation for Arthroscopic One-Stage Treatment of Osteochondritis Dissecans of the Elbow

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Abstract: This Technical Note describes the full arthroscopic one-stage treatment of high-grade osteochondritis dissecans of the humeral capitellum of the elbow joint by means of minced cartilage implantation.

Introduction

Advanced osteochondritis dissecans (OCD) of the humeral capitellum represents a painful and functionally debilitating condition of the elbow joint in young and active patients. Arthroscopic and open therapeutic options include debridement with or without microfracturing/drilling,¹ autologous matrix-induced chondrogenesis,^{2,3} autologous osteochondral transfer/mosaicplasty,^{4,5} allogeneic cartilage transplantation,^{6,7} and autologous chondrocyte implantation (ACI).^{8,9}

ACI aims for recreation of hyaline cartilage, but it is cost- and resource-intensive and subject to high regulations. Moreover, ACI must be performed as a two-step procedure affecting the knee joint for cartilage biopsy.

Alternatively, minced cartilage implantation (MCI) represents a relatively simple and cost-effective one-stage procedure with high biologic potential. Modern techniques of MCI yielded promising mid-term results for treatment of traumatic and degenerative (osteo)chondral defects of the knee joint.^{10,11} So far, transplantation of particulate autologous chondral chips is mostly performed via an open approach with fixation being accomplished by the use of fibrin glue, coverage with a membrane, or a combination of both methods.^{12,13} Previously, an arthroscopic technique for treatment of retropatellar chondral defect was reported.¹⁴

Surgical Technique

Patient Evaluation, Imaging, and Indications

Typically, patients suffering from symptomatic OCD of the humeral capitellum are adolescents or young adults participating in sports, and it is associated with a high biomechanical impact on the elbow joint. The clinical work-up consists of a history of complaints and a detailed clinical examination. Special attention is paid to symptoms of joint blockage and clinical signs of ligamentous instability. Routinely, conventional radiographs and MRI are performed to assess the cartilage and exclude concomitant pathologies, e.g., loose bodies and ligamentous injuries. The ideal indication for arthroscopic MCI (AMCI) is a focal high-grade (3°-4° according to Nelson) OCD of the humeral capitellum covered or surrounded by viable cartilage (Fig 1).

Positioning and Arthroscopy

The patient is placed in a supine position, and the right elbow is put on a sterile bump to facilitate exertion of

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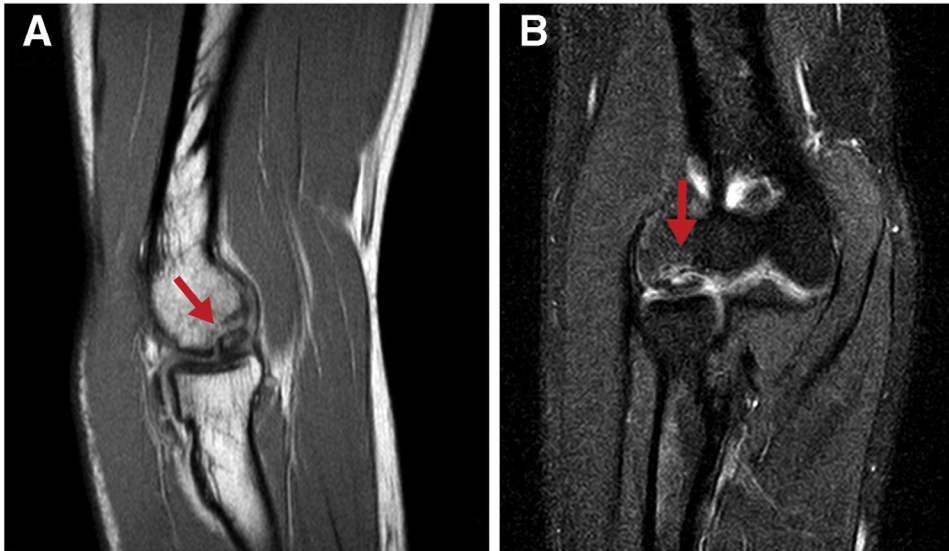


Fig 1. (A and B) Preoperative magnetic resonance imaging demonstrating an unstable osteochondritis dissecans of the central portion of the capitellum in sagittal (A) and coronal (B) planes (each labeled with →).

varus stress. The operative set-up is shown in Fig 2. The elbow joint is distended with 40 mL of saline solution via the soft spot portal. Diagnostic arthroscopy is performed through an anterolateral standard portal. Next, a posterolateral, paratricipital portal is created 1 cm proximal of the tip of the olecranon. This posterolateral portal is used as a viewing portal throughout the procedure. Within the soft-spot region, a working portal is established using an outside-in technique. Next, the OCD lesion is assessed for stability, cartilage continuity, and viability (Fig 3A). Next, the AMCI procedure (Video 1) is performed using the AutoCart system (Arthrex Inc., Naples, USA). The platelet rich plasma (PRP) is intra-operatively created using the ACP Double Syringe

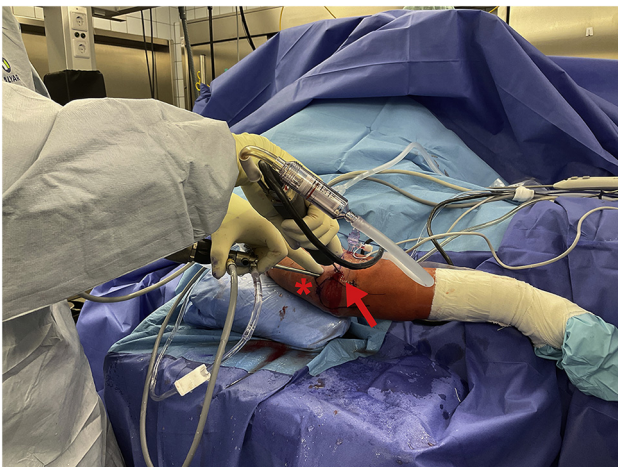
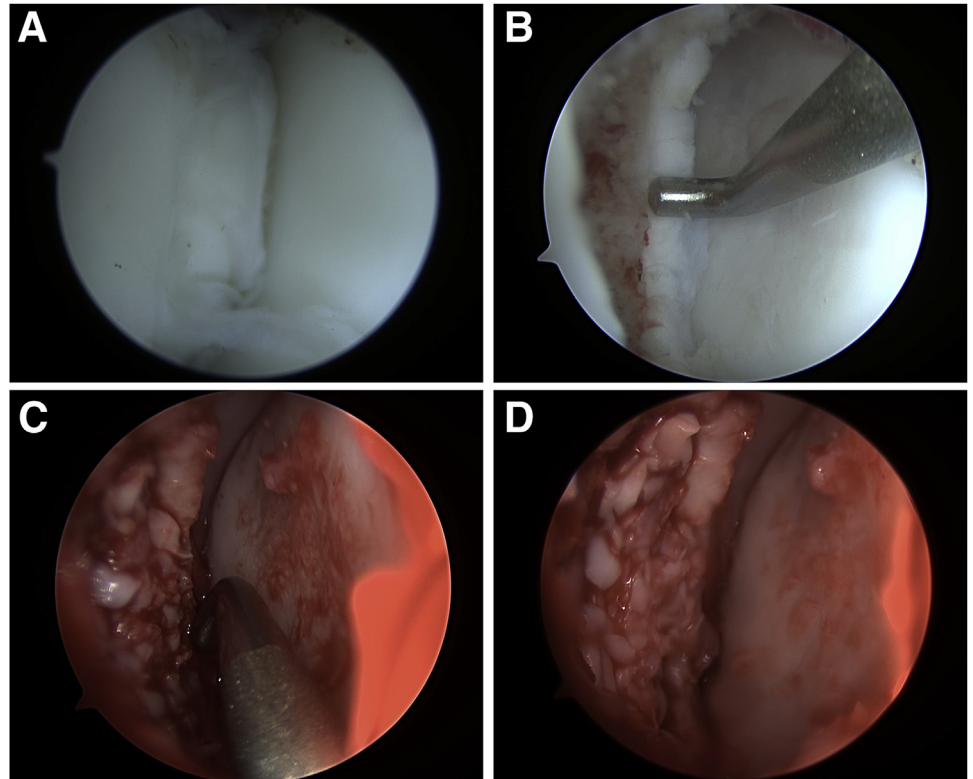


Fig 2. The patient is placed in a supine position. The arthroscope is inserted through the posterolateral, paratricipital portal (labeled with *), and instrumentation is maneuvered through the soft-spot portal (labeled with →).

system (Arthrex, Inc., Naples, FL). Three 15-mL double syringes are used to draw venous blood under sterile conditions before initiation of anesthesia to avoid potentially detrimental effects of narcotic substances on the PRP. Processing of the PRP strictly followed the operating guidelines of the manufacturer. 10 to 15 mL of pure PRP are obtained. The sterile PRP is transferred to the sterile field of the operating table. Then, the production of the autologous thrombin solution is started by using a specific device (Thrombinator; Arthrex, Inc.), in which 3 and 6 mL of PRP are injected consecutively following the instructions for use. Before debridement of the OCD, an autologous tissue collector (GraftNet; Arthrex Inc.) is connected to the shaver for harvesting of the cartilage. We employ a 3.0-mm shaver device (Sabre Shaver blade, Arthrex, Inc.) for debridement of the vital chondral surface of the OCD. Hereby, the cartilage is harvested, minced into small (paste-like) fragments, and collected at once.^{15,16} The OCD is further debrided in standardized fashion by using the shaver and a ringed curette, creating a stable wall and viable rim, as described previously.¹⁷ We do not perform microfracturing or microdrilling of the subchondral bone, since blood inflow into the transplant can negatively affect the biomechanical stability of the transplanted chondral fragments and does not provide a significant amount of mesenchymal stem cells.¹⁸ Figure 3B shows the debrided, oval-shaped osteochondral defect with a size of 15 × 12 mm and a maximum depth of 3-4 mm. This limited bony defect does not require filling by autologous bone grafting.¹⁹ Now, the sterile tourniquet is inflated to 250 mmHg, and the joint is ventilated to implant the cartilage under dry and bloodless conditions. Residual fluid is aspirated out of the joint, and the prepared defect is dried with sterile swabs for optimal

Fig 3. (A) Detachment of the osteochondritis dissecans with cartilage discontinuity at the edges. The central cartilage aspect of the lesion appears vital. (B) Central aspect of the capitellum. The fully debrided osteochondral defect has a size of approximately 15 × 12 mm and a depth of 3-4 mm. A stable wall is created. (C) After complete dehydration of the joint, the defect is filled up to 80-90% with a paste of autologous minced cartilage and PRP. (D) Final arthroscopic view of the transplanted cartilage. At the end, the tissue is sealed with a thin layer of fibrin.



adherence of the transplanted cartilage. Subsequently, the minced cartilage is mixed with PRP (mixing ratio: 3:1), resulting in a malleable substance for arthroscopic transplantation. A curved application device (Tuohy curved needle, Arthrex Inc.) is loaded with the minced cartilage/PRP transplant. Then, 6 mL of PRP is injected into a specific device for creation of the thrombin solution (Thrombinator; Arthrex Inc.). The applicator is introduced via the soft spot portal, and the paste of minced cartilage and PRP is slowly injected and distributed over the defect until a filling height of 80% is achieved (Fig 3C). Total filling or overfilling of the defect is not recommended because of the risk of shear stress on the transplant. Sufficient primary stability is provided

by the pasty consistency of the transplant. In the next step, the prepared thrombin solution is applied drop by drop and from top to bottom over the transplant (Video 1). The thrombin combined with the fibrinogen of the PRP within the cartilage chips generating fibrin. This quick coagulation process causes stable fixation of the minced cartilage transplant within the defect. Finally, the transplanted tissue is sealed with a thin layer of liquid fibrin. Figure 3D shows the final arthroscopic view of the transplanted construct.

Postoperative Rehabilitation

Postoperatively, the elbow is immobilized with an orthosis in 90° flexion and neutral rotation until the

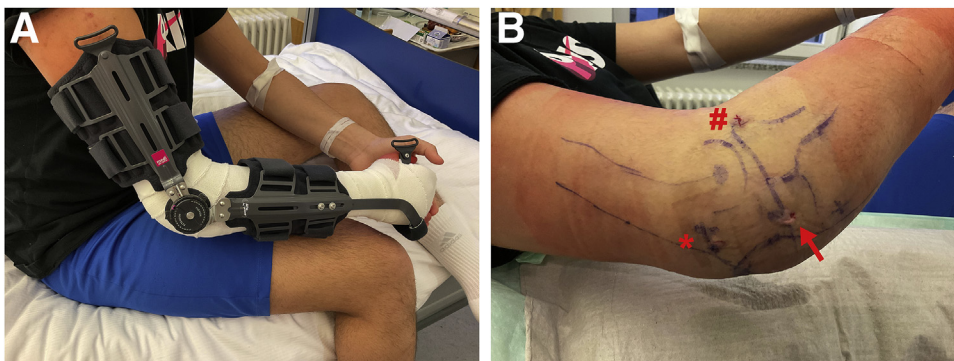


Fig 4. (A) Postoperatively, the elbow is immobilized with an orthosis in 90° flexion and neutral rotation to protect the transplant during the early phase of consolidation. (B) Right elbow. View from a lateral perspective on the three incisions (antero-lateral labeled with #, postero-lateral labeled with *, and soft spot portal labeled with →) 2 days after surgery.

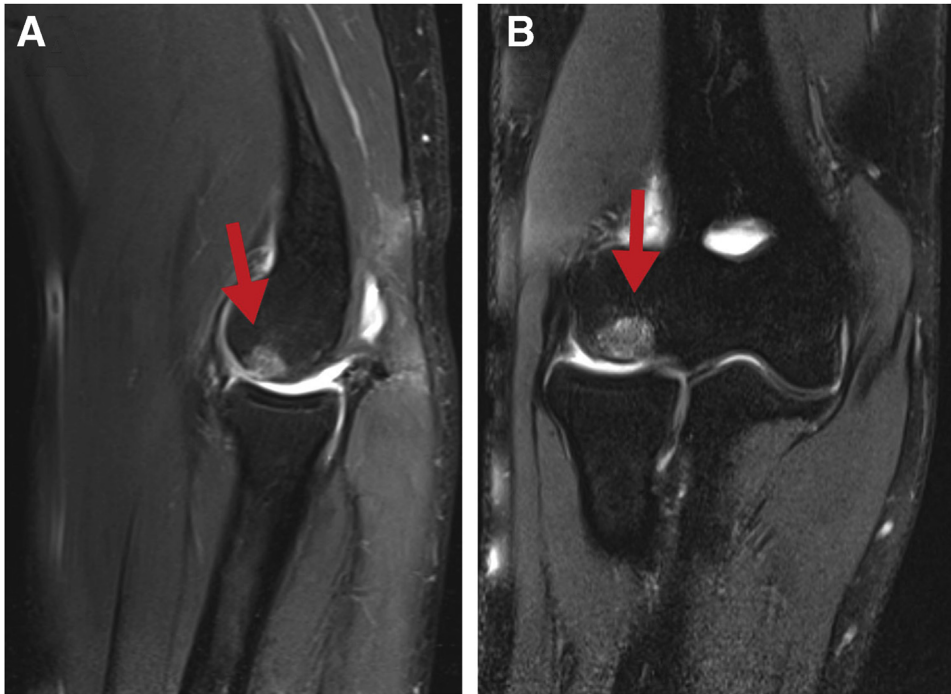


Fig 5. (A and B) The post-operative magnetic resonance imaging after 3 month shows a flush integration of the transplant in sagittal (A) and coronal (B) planes (each labeled with →) The filling level of the graft perfectly matches the level of the surrounding joint cartilage.

second postoperative day for further consolidation of the transplant (Fig 4A). Fig 4B shows the three arthroscopic incisions at discharge on the second day after surgery. From the second day after surgery, active flexion and extension are allowed within a range of 90°–30°– 0° (Video 1). Pronation and supination are restricted for 1 postoperative week by the orthosis. From the second postoperative week, free active ranges of motion are resumed without further use of an orthosis. Weight bearing and axial loading are strictly avoided for 6 postoperative weeks. A control MRI is performed 3 months postoperatively (Fig 5, A and B). The graft is found to be fully integrated showing a

perfect junction and alignment with the surrounding joint cartilage.

Discussion

Symptomatic OCD of the humeral capitellum often affects adolescents practicing sports with high force transmission on the elbow such as overhead disciplines.²⁰ According to the current state of knowledge, procedures aiming at restoration of hyaline cartilage and physiological joint homeostasis appear to be most promising to maintain joint function and prevent joint degeneration in the long term. Existing techniques

Table 1. Pearls and Pitfalls of the Arthroscopic Minced Cartilage Technique for Treatment of (Osteo)chondral Lesions at the Elbow Joint

Pearls	Pitfalls
- Precise preparation of operative set-up and equipment	- Demanding operative technique because of narrow joint conditions
- Knowledge of all arthroscopic portals	- Possibility of conversion to open surgery should be considered.
- Exact planning of working portal using an outside-in technique	- Qualified personnel required for PRP preparation and handling
- Arthroscopic diagnosis and treatment of concomitant pathologies	

Table 2. Advantages and Disadvantages of the Arthroscopic Minced Cartilage Technique for Treatment of (Osteo)chondral Lesions at the Elbow Joint

Advantages	Disadvantages
- Cost- and resource-efficient one-step procedure limited to the elbow joint	- Complex procedure with high personnel and material requirements
- Minimally invasive, arthroscopic technique	- No mid- or long-term results available for the elbow joint
- Fast postoperative recovery and rehabilitation compared to open surgery	
- Autologous procedure with high biologic potential for regeneration of hyaline cartilage	
- High cost and resource efficacy	

Table 3. Specific Limitations and Risks of the Arthroscopic Mincd Cartilage Technique for Treatment of (Osteo)chondral Lesions at the Elbow Joint

Limitations	Risks
- PRP contraindications (e.g., malignancy, hematological/ coagulation disorders, infectious disease, therapeutic anticoagulation)	- Early or secondary graft detachment, potentially requiring revision surgery
- Limited to unifocal defect without corresponding lesion of the radial head	- Insufficient graft incorporation
- Limitations given by defect location (stable borders and intact lateral wall required)	- Hypotrophy or hypertrophy of the chondral graft
- Limitations given by defect depth (depth >3-5 mm may require cancellous bone grafting)	- Biological or biomechanical graft failure with increased risk of secondary arthritis
- Limitations given by appropriate arthroscopic accessibility of the defect	

aiming at regeneration of hyaline cartilage, such as OATS or ACI, are afflicted with relevant deficiencies. Most studies of the OATS procedure reported only satisfactory long-term results.^{4,20,21} Most likely, the reasons for this are incomplete restoration of joint congruity and tribology, the invasiveness of an open approach, and donor site morbidity. ACI represents a two-step procedure usually performed in an open manner.^{8,9} The procedure is highly regulated and cost- and resource-intensive. In addition, there exists only very limited clinical experience for the elbow joint. Moreover, experimental studies showed a negative impact of in vitro expansion (culture) on chondrocyte differentiation.^{12,13}

As a cost-effective one-step procedure, MCI has evolved as an attractive alternative to other more elaborate, expensive, and regulated cartilage repair techniques. Previous experimental studies clearly proved the strong biologic potential of activated, differentiated, autologous chondrocytes.^{12,13} MCI is indicated for treatment of symptomatic chondral and osteochondral lesions with a contained, focal, and unipolar morphology and localization. We report treatment of an OCD located at the humeral capitellum, although the described procedure could also be applied for other (osteo)chondral lesions of the elbow joint. Especially with regard to the elbow joint, an arthroscopic approach offers significant benefits compared to open surgery. For adequate exposure, an open lateral approach would require detachment of the lateral collateral ligament and extensor muscles being associated with prolonged postoperative rehabilitation and potentially inferior functional outcome.^{22,23} Table 1

summarizes the main pearls and pitfalls, Table 2 lists the advantages and disadvantages of this novel and innovative technique, and Table 3 describes the specific limitations and risks of this technique. Prospective clinical trials for comparison with alternate cartilage repair techniques and nonoperative treatment are warranted.

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