All-Arthroscopic Autologous Matrix-Induced Chondrogenesis-Aided Repair of a Patellar Cartilage Defect Using Dry Arthroscopy and a Retraction System

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Abstract

The technique of all-arthroscopic autologous matrix-induced chondrogenesis (AMIC)-aided repair of patellar cartilage lesions using a retraction system and dry arthroscopy has been recently described. We report the first clinical and radiological data at a short-term follow-up. Twelve patients underwent AMIC-aided cartilage repair for a patellar lesion. All steps of the procedure were performed arthroscopically, which include the use of an intra-articularly placed retraction plate for distraction of the patellofemoral joint and evacuation of saline solution for collagen matrix insertion and fixation. Clinical assessment performed before surgery and at a mean follow-up time of 38 months (range: 24–70) included the following scores: Knee Injury and Osteoarthritis Outcome Score (KOOS), International Knee Documentation Committee (IKDC), and visual analog scale (VAS). Magnetic resonance imaging was performed at the follow-up examination, including the magnetic resonance observation of cartilage repair tissue (MOCART) score. The mean KOOS and IKDC scores increased significantly ($p < 0.01$) from 50.3 and 37.4 points preoperatively to 90.1 and 79.4 postoperatively. The VAS score decreased from 7.8 to 2.3 points. Mean MOCART score at follow-up was 58.3 points. Cartilage repair of patellar lesions aided by a retraction system in a dry arthroscopy setup is a promising approach. Further studies are needed to evaluate this procedure and compare it to existing matrix implantation techniques. The level of evidence for the study is 4 (case series).

Keywords
- cartilage repair
- knee
- patella
- AMIC
- dry arthroscopy

Autologous matrix-induced chondrogenesis (AMIC) is an established surgical treatment of chondral and osteochondral lesions of the knee joint.[1,2] The original technique involves debridement of the cartilage defect, microfracturing of the subchondral bone, and sealing of the defect with a collagen matrix.[3] The procedure is commonly performed through a mini open incision. A trans-arthroscopic insertion of the matrix to the knee joint surface has been described, but can be a challenging undertaking.[4] Some limiting factors of the conventional arthroscopic technique are the presence of arthroscopic fluid and poor accessibility due to confined space, especially at the patellofemoral joint. To simplify arthroscopic collagen-matrix insertion, a novel technique has been recently described.[5] This technique utilizes an intra-articularly placed retraction plate to increase the work space in the patellofemoral joint, and allows good access to the lesion for

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Table 1 Clinical and radiological variables of subjects

Case	Sex, age (*y*)	Side	Patellar facet	modified Outerbridge	Size (mm^2)	Previous surgery	Follow-up (*mo*)	Additional procedures	KOOS pre (*avg*)	KOOS post (*avg*)	IKDC pre (*avg*)	IKDC post (*avg*)	VAS pre (*avg*)	VAS post (*avg*)	MOCART	TTTG (mm)	Caton–Deschamps index	Trochlear dysplasia	Patella tilt
1	M, 22	R	Central-lateral	4	110	N	32	None	83.9	98.2	57.5	95.4	7	2	45	11	0,98	–	–
2	F, 50	L	Lateral	3	200	N	65	None	38.1	77.4	16.1	42.5	8	4	50	17	1,13	+	+
3	F, 46	L	Central-medial	4	400	N	42	None	52	77.4	59.8	63.2	8	4	65	3	1,03	–	–
4	M, 28	R	Lateral	3	84	Y	39	None	80.4	100	58.6	100	8	0	60	15	1,04	+	–
5	F, 39	L	Distal-medial	3	300	N	25	None	29.2	87.5	23	71.3	10	3	30	9	0,93	–	–
6	F, 22	R	Lateral	4	144	N	17	TT	18.5	83.3	10.3	69	6	3	75	25	1,45	+	–
7	M, 34	R	Central-medial	3	195	Y	51	None	57.1	96.4	34.5	92	7	1	75	11	0,89	–	–
8	M, 26	L	Central-medial	3	294	Y	31	TT	56.25	100	90.8	100	3	0	80	23	1,36	+	–
9	M, 38	R	Central-medial	3	247	Y	49	None	70.2	92.1	35.6	64.4	7	6	85	11	1,11	–	–
10	F, 38	R	Central-medial	4	396	N	16	MPFL	17.3	94.6	4.6	96.6	10	0	50	13	1,19	–	+
11	M, 52	L	Central-medial	3	216	N	70	None	58.9	90.9	32.2	81.6	10	4	45	5	1,12	–	+
12	M, 39	R	Central-medial	4	360	Y	19	HTO	41.7	83.9	25.3	77	9	1	40	7	1,03	–	–

Abbreviations: Avg, average; F, female; HTO, high tibial osteotomy; IKDC, International Knee Documentation Committee; KOOS, Knee Injury and Osteoarthritis Outcome Score; M, male; MOCART, magnetic resonance observation of cartilage repair tissue—protocol; MPFL, medial patellofemoral ligament reconstruction; post, after surgery; pre, before surgery; TT, tuberosity osteotomy and transfer; VAS, visual analog scale.

debridement and bone marrow stimulation.[6] The retraction plate also prevents the joint cavity from collapsing after evacuation of the saline solution, which allows insertion of the matrix in a fluid-free setup (dry arthroscopy). We present the first clinical and radiological results of a cohort of patients in which this novel technique has been utilized to treat cartilage defects of the patella.

Methods

Patient Demographics

The study cohort consisted of 12 patients with patellar cartilage lesions (five females, seven males; mean age, 36 years; range: 22–52 years) admitted to our tertiary orthopedic department with unilateral chronic knee pain (►**Table 1**). Patients with a first-time diagnosis or failure of a previous operative cartilage treatment were included. Various sizes of lesions were included. Patients were not scheduled for surgery if they were younger than 18 years and older than 55 years or there was involvement of femoral side of the patellofemoral joint (kissing lesion).

Previous knee trauma was reported by 11 of the 12 patients. The medial patellar facet bridging across the median ridge was involved in seven patients, the lateral facet was involved in four patients, and distal part of patella was involved in one patient (►**Table 1**). Four patients had prior arthroscopy with debridement, and one patient had prior arthroscopic microfracture.

Clinical and Radiological Assessment

Clinical and radiological assessment was performed before surgery and at a minimum of 24 months after surgery (mean: 38 months; range: 24–70 months). Prospectively collected data included clinical assessment with the Knee Injury and Osteoarthritis Outcome Score (KOOS)[7] and the International Knee Documentation Committee (IKDC) Subjective Knee Evaluation Form.[8] Pain status was measured by a visual analog scale (VAS; use of a 10-cm graded line, with 0 indicating no pain and 10 indicating the worst pain imaginable).[9]

All patients in this case series underwent preoperative radiological imaging of the knee. Lateral standing (30-degree flexion) radiographs of the knee were analyzed to determine patellar height using the Caton–Deschamps index.[10] Magnetic resonance imaging (MRI; T1/T2/PD-weighted sequences) was performed and morphological appearance of the cartilage repair tissue was assessed according to the magnetic resonance observation of cartilage repair tissue (MOCART) protocol.[11] The MOCART score was evaluated by a senior radiologist who specialized in musculoskeletal imaging and was blinded to the clinical results and patient data. The tibial tuberosity–trochlear groove distance (TTTG) was noted.[12]

An operative treatment was chosen in agreement with the patient. Informed consent was obtained from the patient.

Operative Course

The detailed surgical technique has been described recently.[6] All surgeries were performed by the first author (blinded). The procedure was performed either with spinal or general

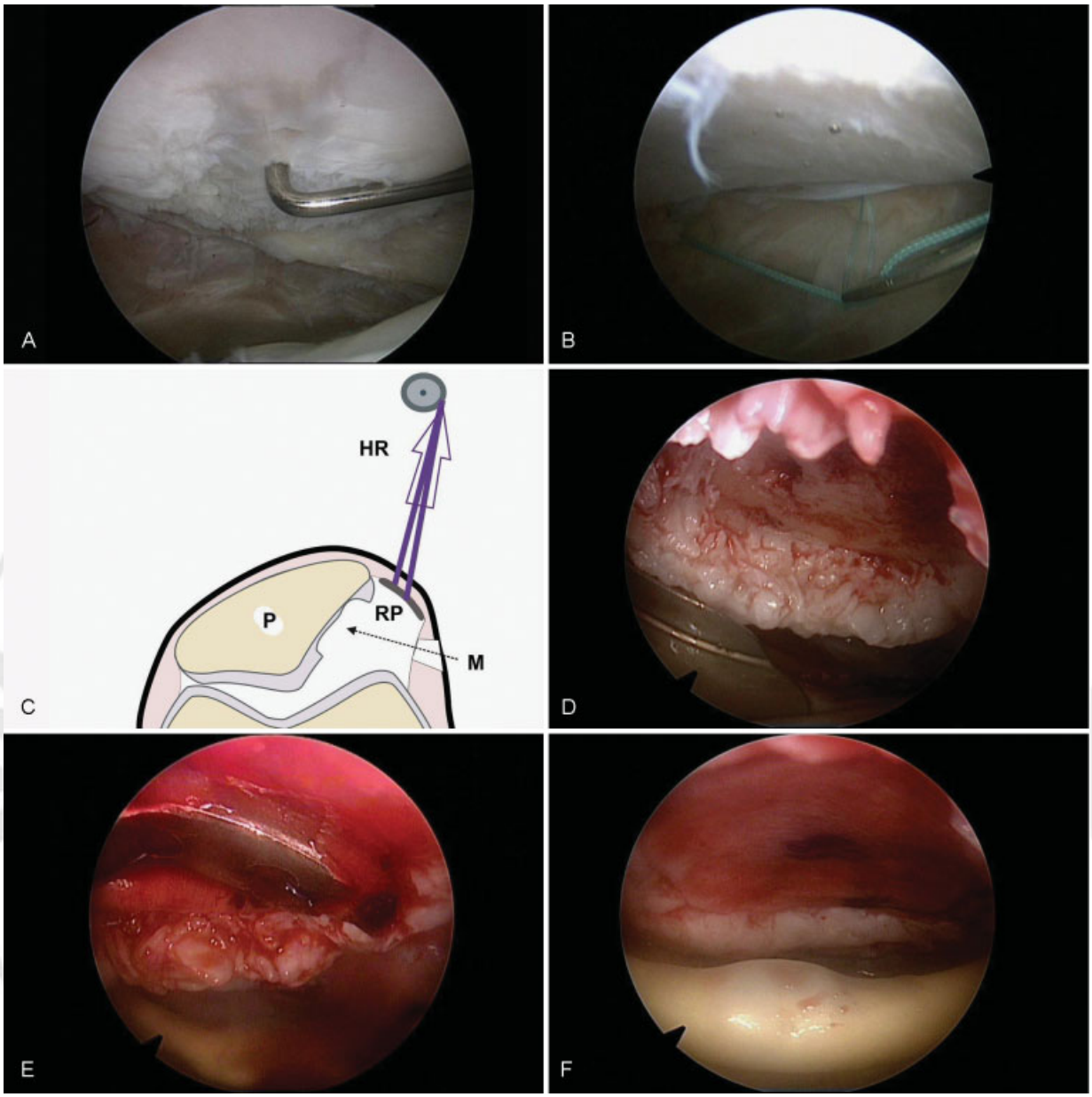

Fig. 1 Course of the arthroscopic surgery. Case no. 7 from ►**Table 1**. The surgery starts with a conventional arthroscopy where the cartilage defect was located at the inferomedial patellar pole (**A**). The retracting plate was introduced into the joint and placed in the medial patellar retinaculum (**B**). The threads attached to the plate run to the outside of the joint. When the threads were pulled, the retraction plate (RP) tilted the patella (P) to create better access to the lesion through the medial portal (M). The threads were attached to a holder rod (HR) to keep this position (**C**). The cartilage was debrided and the subchondral bone was microfractured (**D**). The fluid from the joint was evacuated to create a dry environment. The collagen matrix was finally introduced into the joint (**E**) and implanted into the defect with fibrin glue (**F**).

anesthesia in the supine position. A tourniquet was applied. All patients received a single dose of 1 g of intravenous cefazolin 1 hour before skin incision. Standard anterolateral and anteromedial and, depending on lesion location, a high medial and/or lateral portals were installed. The status of the cartilage lesion was assessed arthroscopically, including location, size, and depth according to the modified Outerbridge classification (►**Fig. 1A**),[13] followed by installation of an intra-articular retraction system. In this case, a retraction plate (Retraction plate, ATMED—Rafalski, Katowice, Poland) was inserted through the anteromedial (anterolateral) portal and placed in the medial (lateral) parapatellar recessus (►**Fig. 1B**). Thick sutures attached to the end of each plate that run to the outside of the joint were attached to a holder rod (Artromast, ATMED—Rafalski; ►**Fig. 1C**). When tension is applied, the sutures lift the plate, subsequently distracting the joint cavity and tilting the patella. Additionally, the retraction plate prevents the joint cavity from collapsing after evacuation of the saline solution. The defective cartilage was debrided (►**Fig. 1D**) and lesion size was determined. A collagen matrix (Chondro-Gide, Geistlich Pharma AG, Wolhusen, Switzerland) was cut to match the defect size and immersed in bone marrow aspirate concentrate. Antegrade microdrilling was performed through the medial (lateral)

arthroscopic portal. The intra-articular fluid was evacuated from the joint cavity to create a dry environment. The matrix was attached to an inserter rod with a flat tip and two holes.[5] A guide was used to channel the rod with the matrix through the anteromedial (anterolateral) arthroscopic portal into the fluid-free joint cavity (►**Fig. 1E**). The matrix was fixated with fibrin glue along the edges of the defect and pressed into the subchondral surface for 3 to 4 minutes (►**Fig. 1F**). Additionally, the matrix surface was covered by a thin layer of fibrin glue. With the matrix in place, the knee joint was moved several times through its range of motion to ensure it remained in place.

Postoperative Care

Rehabilitation of all patients was performed at the in-house physiotherapy clinic. Patients were kept non–weight-bearing with a knee brace in extension for the first week following surgery. Gradual increase of weight bearing with the use of crutches began at the second postoperative week. Additionally, a continuous passive motion machine was used twice a day for a period of 1 hour, with progressive increase of ROM by 10 degrees per day. Full weight bearing with the aid of a brace and crutches in extended knee position was allowed at the fourth postoperative week. Full weight bearing with the knee in a flexed position was allowed at the sixth postoperative week. At week 8, full weight bearing without the use of crutches was achieved.

Statistical Analysis

This study was approved by the institutional review board, and written informed patient consent was obtained. The study was performed in accordance with the World Medical Association Declaration of Helsinki. Statistical analysis was performed with use of a standard paired *t*-test by an independent statistician.

Results

The KOOS score improved significantly from a mean of 50.3 points (range: 17.3–83.9 points) preoperatively to 90.1 points (range: 77.4–100 points) postoperatively ($p < 0.01$). The IKDC score improved significantly from a mean of 37.4 points (range: 4.6–90.8 points) preoperatively to 90.1 points (range: 42.5–100 points) postoperatively ($p < 0.01$). The preoperative VAS pain score averaged 7.8 (range: 3–10 points). The score improved to an average of 2.3 (range: 0–6 points; $p < 0.01$). According to intraoperative inspection, seven patients showed a modified Outerbridge classification grade 3 lesion, and another seven patients showed grade 4 lesion. No intraoperative or postoperative complications were encountered. Additional procedures included a medial patellofemoral ligament plasty (one case), an osteotomy of the tibial tuberosity (modified Elmslie-Trillat osteotomy;[14] two cases), a high tibial osteotomy (one case), and medial patellofemoral ligament reconstruction (one case).

The MOCART score for cartilage repair tissue on postoperative MRI averaged 58.3 points (range: 30–85 points) (►**Fig. 2**).

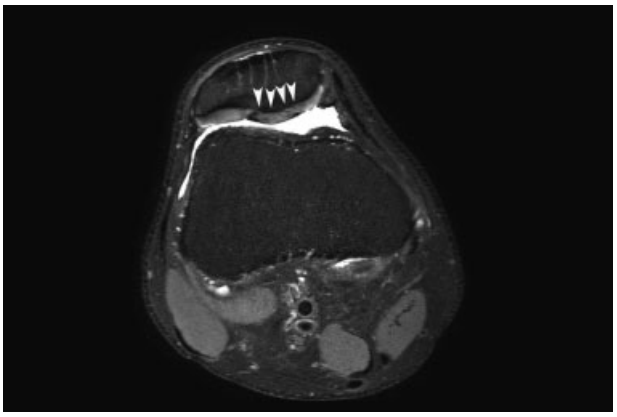

Fig. 2 Postoperative MRI. At 4 years after surgery, the MRI shows an overall good signal of the repaired cartilage (→) with good integration into the surrounding cartilage.

Discussion

Matrix-assisted cartilage repair of patellar cartilage is a demanding procedure due to limited access to the patellofemoral joint. To simplify access to the patellar surface and insertion of the matrix, an arthrotomy with dislocation of the patella is commonly performed.[15] However, an all-arthroscopic approach avoiding disruption of the joint capsule and the patellar stabilizing ligaments would be favorable. This would also reduce the risk for postoperative complications (arthrofibrosis, postoperative hematoma, infection) and facilitate speedy postoperative mobilization.

We present a case series of patients undergoing an AMIC-aided cartilage repair of patellar cartilage. All steps of the surgery including matrix insertion were performed arthroscopically. An excellent clinical and radiological outcome 4 years after surgery was presented.

The first important step of the described procedure is to gain adequate access to the lesion in the confined space of the patellofemoral joint. To address this issue, several techniques describing distraction of the patella from the femoral surface have been reported.[16,17] The authors favor a minimally invasive retraction system consisting of an intra-articular retraction plate, which can be used to lift the patella, preventing the joint from collapsing.[6] Once adequate work space in the knee joint is established, the arthroscopic fluid is evacuated creating a dry joint cavity.[6] Substituting gas for saline solution is an alternative to create a fluid-free environment, but has been criticized for increased risk of gas-induced vascular embolization. Another issue is the constant outflow of gas, which complicates the insertion of the matrix. In our opinion, a fluid- or gas-free joint cavity is recommended for use of soft collagen matrices known to roll up and fold easily. Also a dry environment is needed to fixate the matrix in place when using fibrin glue.[4]

No randomized controlled trials have yet investigated the performance of AMIC compared with other cartilage repair procedures. Our results are comparable with the results of other level 4 studies showing good to excellent results at

short-term and midterm follow-up. Kusano et al reported the outcome in 20 patients after AMIC repair of patellar cartilage.[2] The mean IKDC score improved from 51 to 74 points. VAS score improved from a mean of 6 points to 2 points. Schiavone et al assessed a cohort of 17 patients with patellofemoral and femoral condyle lesions at an average follow-up of 36 months.[18] Mean IKDC score increased from 32 to 82 points. Data from the AMIC registry show significant improvement of pain with VAS decreasing from 7 to 2.7 points at 24 months of follow-up.[19]

Four of 12 (33%) patients received additional stabilizing procedures or realigning osteotomy of the tibia. It needs to mention that cartilage repair using the described technique needs to be performed in combination with surgical management of any accompanying comorbidities.

Limitations of this study are its small cohort and short follow-up time. No conclusion about potential degenerative changes of the patellofemoral joint can be made.

Conclusion

We presented significantly improved clinical and radiological results after all-arthroscopic AMIC repair of patellar lesions aided by a retraction system in a dry arthroscopy setup. Further studies are needed to evaluate this procedure and compare it to conventional open matrix implantation techniques.

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