Original Article With Video Illustration

Follow-up of a New Arthroscopic Technique for Implantation of Matrix-Encapsulated Autologous Chondrocytes in the Knee

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Purpose: The purpose of this study was to evaluate the clinical and sequential imaging follow-up results at a mean of 36 months after an arthroscopic technique for implantation of matrix-encapsulated autologous chondrocytes for the treatment of articular cartilage lesions on the femoral condyles. **Methods:** Ten patients underwent arthroscopic implantation of autologous chondrocytes seeded onto a bioabsorbable scaffold. The patients were evaluated clinically using a visual analog scale (VAS) for pain and International Knee Documentation Committee (IKDC), Lysholm, and Tegner scores. Magnetic resonance imaging (MRI) T2-mapping and magnetic resonance observation of cartilage repair tissue (MOCART) evaluations were also performed. Second-look arthroscopic evaluation using the International Cartilage Repair Society (ICRS) grading classification was performed at 12 months. **Results:** Compared with their preoperative values, at 36 months mean values ± standard deviation for the VAS scale for pain were 6.0 ± 1.5 to 0.3 ± 0.4. Improvement in clinical scores between preoperative values and 36-month follow-up values in subjective IKDC scores was 46.9 ± 18.5 to 77.2 ± 12.8; in Lysholm scores, it was 51.8 ± 25.1 to 87.9 ± 6.5, and in the Tegner activity scale it was 2.9 ± 1.7 to 5.9 ± 1.9. Mean T2 mapping and MOCART scores improved over time to 38.1 ± 4.4 ms and 72.5 ± 10, respectively. Mean ICRS score by second-look arthroscopy at 1 year was 10.4 ± 0.1. **Conclusions:** All clinical scores improved over time compared with the preoperative values. Clinical results are comparable with MRI T2 mapping and ICRS evaluations, suggesting that this arthroscopic technique for cell-based cartilage repair is efficacious and reproducible at a mean of 36 months of follow-up. **Level of Evidence:** Level IV, therapeutic case series.

Articular cartilage lesions are present in more than 60% of knee arthroscopic procedures, and they have been shown to affect the quality of life.[1,2] Regenerative techniques for cartilage repair based on cultured autologous chondrocytes offer hyaline-like cartilage repair, in comparison with reparative procedures that lead to fibrous tissue of inferior quality and less durability.[3-5] These cell-based approaches may also produce less morbidity at the donor site compared with osteochondral autografts, which are frequently used for bigger lesions.[6]

In the original technique described for autologous chondrocyte implantation (ACI), a flap of periosteum was sutured over the cartilage lesion, and chondrocytes in suspension were injected under the periosteal flap through an open approach. To minimize complications associated with open ACI, research has been focused on better options to deliver and ensure the permanence of chondrocytes at the repair site.[7-9] Matrix-seeded autologous chondrocyte implantation (MACI) and similar techniques address some of the potential limiting factors of ACI. By using an absorbable scaffold to allow cells to adhere and produce extracellular matrix, permanence of cells at the repair site could be obtained and complications related to the periosteal patch could be reduced.[10,11]

Several methods of cell-scaffold fixation have been reported. Erggelet et al.[12] used transosseous sutures. Herbort et al.[13] tested a biodegradable polylactide pin

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that requires precise perpendicular insertion on the subchondral bone. Others have used fixation using fibrin glue or self-adherence of the cell scaffold to the subchondral bone.[12-17]

The advent of new procedures for articular cartilage repair has increased the need for accurate noninvasive methods for objective evaluation of the repair. Magnetic resonance imaging (MRI) is currently being used for structural evaluation of cartilage repair.[18] Normal articular hyaline cartilage shows a predictable spatial variation in T2 relaxation time with depth at MRI, with an increase in T2 values from the subchondral bone to the articular surface. This normally correlates with the microscopic collagen organization and orientation seen in normal articular cartilage. Increased T2 values are most commonly associated with cartilage damage.[18] MRI T2 mapping values of the repair tissue compared with the surrounding normal cartilage can be used to determine the integrity and quality of the treatment. The MOCART scoring system is a qualitative measuring tool widely used for cartilage repair. This method evaluates the degree of defect filling, integration, quality, structure, signal, subchondral lamina, and subchondral bone as well as the presence of complications after cartilage repair.[19]

The purpose of this study is to evaluate the clinical and sequential imaging follow-up results at a mean of 36 months after an arthroscopic technique for implantation of matrix-encapsulated autologous chondrocytes to treat articular cartilage lesions in the knee.

We hypothesized that arthroscopic implantation of matrix-encapsulated autologous chondrocytes can result in significant improvement in clinical and MRI evaluation by T2 mapping and MOCART and close-to-normal cartilage formation seen at second-look arthroscopy after treatment of articular cartilage lesions on the femoral condyles, maintaining a stable improvement over time.

Methods

After institutional review board evaluation and approval of this pilot study, patients with a symptomatic full-thickness cartilage lesion on either femoral condyle, patients scheduled for arthroscopic anterior cruciate ligament (ACL) reconstruction or treatment of a meniscal lesion who were between 18 and 50 years of age were considered to be candidates for the study. Exclusion criteria included any type of arthritis, previous total meniscectomy, previous treatment of the chondral lesions, treatment for competitive athletes, and failure to adhere to a strict rehabilitation protocol. The patients signed an informed consent before surgery and were included when a full-thickness cartilage lesion was identified during arthroscopy. Patients underwent an index surgical procedure during which ACL or meniscal lesions were treated and osteochondral biopsy samples were obtained for chondrocyte isolation. A conventional rehabilitation program for the index procedure was conducted. During this time, cells were isolated and expanded in culture in a laboratory at the National Institute of Rehabilitation. A second surgical procedure was performed between 6 and 8 weeks after the first operation.

By this time, patients had no pain, had mild swelling, and had recovered full extension and more than 110° of knee flexion. Arthroscopic cell-polymer scaffold implantation was performed followed by a strict rehabilitation protocol. Clinical evaluation was performed preoperatively at 3, 6, 12, 18, 24, and 36 months, as was MRI evaluation using T2 mapping and MOCART scores. Second-look arthroscopy was performed at 12 months for ICRS classification. No biopsy specimens were obtained at this time.

Surgical Technique

Index Procedure and Cartilage Biopsy

Patients included in the study were those with preoperative full-thickness articular cartilage lesions diagnosed by MRI or patients with ACL or meniscal injuries in whom full-thickness articular cartilage lesions were identified during the index procedure and who had previously signed an informed consent. In either case, during the first surgical procedure, the full-thickness articular cartilage lesion was assessed and measured with an arthroscopic probe. Three 4 × 10 mm osteochondral cylinder biopsy specimens were obtained from a non–weight-bearing area adjacent to the intercondylar notch using an osteochondral graft harvester (COR; DePuy Mitek, Raynham, MA). The osteochondral cylinders were placed in a sterile container with transport media containing antibiotics/antimycotic agents and sent out for chondrocyte isolation, in vitro expansion, and cell-polymer scaffold formation as described previously.[9]

Chondrocyte Isolation, in Vitro Expansion, and Cell-Scaffold Construct Preparation. The 3 4-mm–diameter osteochondral cylinders obtained during the index or first surgical procedure were transported to a good manufacturing practice laboratory facility located in the surgical area of the National Institute of Rehabilitation. There, under sterile conditions in a laminar flow hood, cartilage was separated from bone by sharp dissection. Cartilage fragments were then digested in class I collagenase, cells were counted, and viability was assessed. Chondrocytes were then seeded onto a T-75 culture flask at a minimum density of 300,000 cells per 100 mg with culture medium (Dulbecco's Modified Eagle Medium-F12 GIBCO, Grand Island, NY) and 1% antibiotic-antimycotic agents and supplemented with 10% autologous patient serum. A sample of the cell suspension was sent to a laboratory in a different institution for microbiological evaluation (bacteria,

fungi, and *Mycoplasma*) for quality control. Cells were expanded in culture until 90% to 100% confluence was present. Cells were then trypsinized, evaluated, and reseeded for cell expansion until passage 2. At the beginning of the second passage, culture flasks were supplemented with ascorbic acid. Samples of culture media were intermittently obtained for microbiological analysis. Once the culture flask was 90% to 100% confluent, chondrocyte pellets were seeded onto 8-mm–diameter collagen-based bioabsorbable scaffold disks and then encapsulated in extracellular matrix, as described by Masri et al.,[9] and cultured in vitro for 1 additional week to allow cell adherence to the collagen scaffold (Restore Orthobiologic Soft Tissue Implant; DePuy Orthopaedics, Warsaw, IN) and extracellular matrix production.

Arthroscopic Implantation of Matrix-Encapsulated Autologous Chondrocytes. Eight-millimeter–diameter and 2- to 4-mm–thick cell-scaffold disk constructs were received in a sterile container with culture medium. The number of disks available depended on the lesion size. One additional disk was always received and available for implantation. For an 8- to 10-mm lesion, 1 disk was used; if the lesion is 2 cm^2, 2 discs can be used. For this pilot study, just patients with 1 cm^2 single chondral lesions were included. With the patient supine on the operating table and under regional anesthesia, the knee was prepared and draped in a conventional manner. A tourniquet was placed around the proximal thigh, although normally it was not insufflated. A conventional longitudinal anterolateral portal was established for arthroscopic examination of the joint using a superolateral portal for irrigation. Under direct vision, an oblique anteromedial portal was established over the lesion (if medial) to have perpendicular access. This allowed for medial-lateral or proximal-distal extension of the portal if needed. If the lesion was on the lateral femoral condyle, the anterolateral portal could be extended proximally or distally to allow perpendicular access, or a new portal could be established. In neither case did the portals exceed 10 mm. The articular cartilage injury was then identified, measured, and prepared for treatment, using straight and angled curettes to remove damaged unstable cartilage edges and the calcified layer of cartilage on the bottom, trying to cause the least possible damage to the subchondral bone.

Construct Implantation and Fixation for Femoral Condyle Lesions. The lesion was measured with an arthroscopic probe. An 8-mm–diameter tamper and a sharp osteochondral harvester were used to shape the lesion in a circular fashion. To determine the center of the lesion, a superficial mark was made with the drill bit at the site visually considered the center. A 5-mm arthroscopic probe was then used to measure the distance from the edge of the lesion to the created mark in 4 quadrants, and the best site was determined. A 2-mm hole was drilled at the determined center, and a 2.3-mm bioabsorbable suture anchor (MINILOK, Depuy Mitek, Raynham, MA) with No. 2-0 PDS suture (Ethicon, Somerville, NJ) was inserted through the anteromedial or anterolateral portal (Fig 1A). Stability was tested by pulling on the sutures (Fig 1B). At the same time, the cell-scaffold disk was prepared on the side table. An 8-mm transparent cannula was then inserted through the portal directly over the lesion, and the sutures from the anchor were pulled outside the joint through an arthroscopic cannula. The anchor sutures were passed through the construct before entering the cannula. A self-locking arthroscopic sliding knot was tied, the water flow pump was eliminated, and the construct was inserted through the cannula into the joint by simply pulling on the post under direct vision (Fig 1C). Once the construct was sitting in place at the bottom of the lesion, the knot was tightened by pulling on the wrapping limb of the suture, and 2 additional half-hitch knots were tied with the assistance of a knot pusher (Fig 1D). The sutures were then cut flush to the knot and the cannula was retrieved. Stability of the implant was then tested with the probe, and the knee was taken through a range of motion to verify the stability and permanence of the implant at the repair site (Video 1, available at www.arthroscopyjournal.org).

Rehabilitation Protocol

After implantation, patients were included in a very strict rehabilitation protocol that started the same day of the procedure with cryotherapy, continuous passive motion from the first day after surgery up to 8 weeks (6 to 8 hours/d), no weight bearing for 8 weeks, and progressive open-chain strengthening after a first isokinetic evaluation at 3 months after surgery. Continuous passive motion was started from 0° to 60° of flexion the same day of surgery in patients with femoral condyle lesions, adding 10° per day until 90° of flexion was obtained in the first week. Ten degrees of flexion were added at each subsequent week. Patients were allowed to return to sports activities after 12 months and when isokinetic evaluation reported 90% of strength of the contralateral extensor and flexor muscles of the knee.

Clinical Evaluation

For efficacy, clinical evaluation was performed by the 2 treating surgeons and recorded by a clinical sports medicine fellow at 3, 6, 9, 12, 18, 24, and 36 months using a visual analog scale (VAS) for pain, subjective and objective International Knee Documentation Committee (IKDC) forms, Lysholm knee score, and Tegner activity scale. For safety, adverse events were recorded, and they were graded as mild when they did

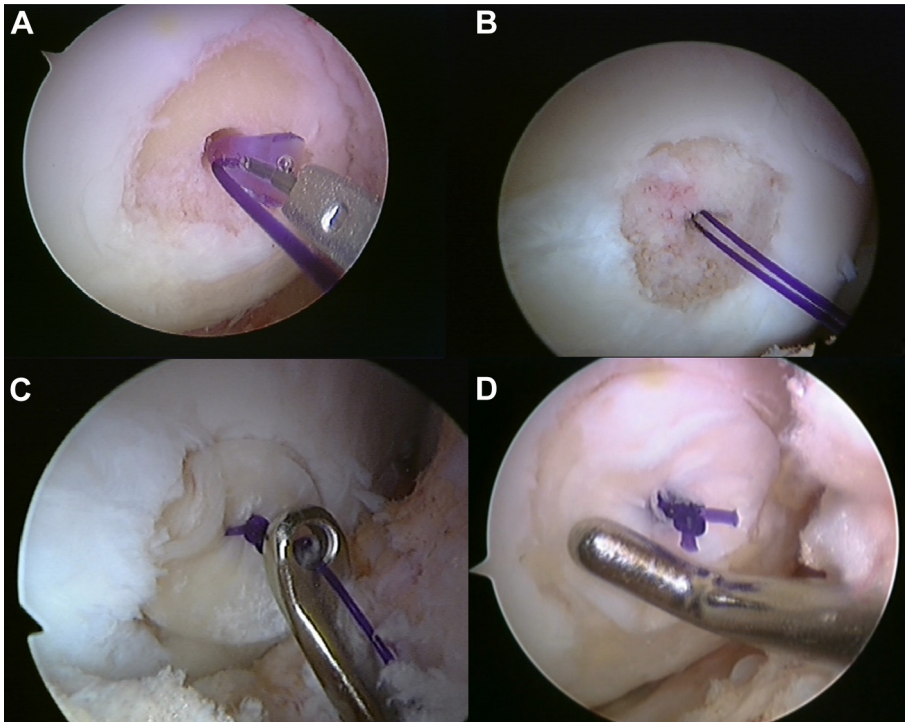

Fig 1. Procedure of arthroscopic chondrocyte implantation for femoral condyle lesions. (A) After debridement, a 2-mm hole is drilled in the center of the lesion and a 2.3-mm bioabsorbable suture anchor with No. 0 PDS suture (Ethicon, Somerville, NJ) is inserted. (B) Stability of the anchor is tested by pulling on the sutures. (C) The sutures are pulled outside the joint and passed through the construct. A self-locking arthroscopic sliding knot is tied, the water flow pump is eliminated, and the construct is inserted through the cannula into the joint by simply pulling on the post under direct vision. Once the construct is sitting at the bottom of the lesion, 2 additional half-hitch knots are tied with the assistance of a knot pusher. (D) The remainder of the suture is cut and the construct is tested for stability.

not require a surgical procedure (inflammation, effusion, mild pain) or severe if they required hospitalization or a surgical procedure to improve. Any severe adverse event was considered failure of treatment.

Imaging Evaluation

MRI evaluation was performed preoperatively and before cell-construct implantation using T2-mapping and MOCART scores and at 3, 6, 12, 18, 24, and 36 months postoperatively. MRI was performed on a 1.5 Tesla clinical imaging system (GE Healthcare, Milwaukee WI), using an 8-channel HD knee array (GE Healthcare). Standard morphologic MRI evaluation was performed using a fast spin echo sequence in the axial, sagittal, and coronal planes. Images were acquired with repetition time of 1800 to 1450 ms, echo time of 30 to 40 ms, echo train length of 6, and spatial resolution of 256 μm (frequency) × 256 μm (phase) × 3 mm at 2 excitations.

The qualitative evaluation of cartilage repair was performed by 2 independent radiologists using the magnetic resonance observation of cartilage repair tissue (MOCART) scoring system.[1] The score consists of 9 variables: (1) degree of defect repair, (2) integration of border zone, (3) surface of the repair tissue, (4) structure of the repair tissue, (5) signal intensity of the repair tissue, (6) subchondral bone, (7) subchondral lamina, (8) adhesions, and (9) effusion.

T2 mapping (FuncTool 4.5.1, GE Healthcare, Little Chalfont, Buckinghamshire, UK) was performed to assess the biochemical integrity of native and repaired cartilage. The color map is coded to capture T2 values ranging from 25 to 95 ms. Quantitative T2 mapping was performed using a multislice multiecho pulse sequence. Eight echoes were sampled: sequential multiples of the first echo time (10 to 11 ms) at a repetition time of 800 ms and in-plane resolution of 384 μm (frequency) × 256 μm (phase) × 3mm at 2 excitations. Data sets were analyzed (FuncTool 4.5.1; GE Healthcare). T2 values were calculated taking a region of interest (ROI) (2 to 6 mm) within a fixed area in the center of the repair (named ROI6) and normal cartilage (named ROI3).[20]

Arthroscopic Evaluation

Second-look arthroscopy was performed in all patients at 12 months, and 3 experienced arthroscopic surgeons performed evaluation using the ICRS classification system by independently watching the surgical video. No biopsy samples were obtained from the repair site for ethical reasons.

Statistical Analysis

Dimensional data were expressed as means and standard deviation or range, or both. Qualitative data were presented in absolute numbers or percentages, or both. The Wilcoxon signed-rank test for paired samples was used to compare before and after preoperative clinical and MRI values to 36 month follow-up and comparisons against MRI controls of healthy cartilage. $P < .05$ was considered significant. For agreement evaluation of independent observers in ICRS cartilage repair assessment, we used the intraclass correlation coefficient.

Results

Demographics

Ten patients with full-thickness articular cartilage lesions on the femoral condyles who had completed at least 2 years of follow-up were included in this study. Mean age was 35.05 years (23 to 48 years). Eight patients were men (80%) and 2 were women (20%); the mean defect size was 1.0 cm^2 (± 0.0). Eight patients had lesions on the medial femoral condyle (80%) and 2 had lesions on the lateral femoral condyle (20%). Body mass index was calculated, with a mean of 25 (± 3.9).

Clinical Assessment

All patients improved significantly over time on all clinical scales compared with their preoperative scores. A statistically significant improvement was observed in the VAS for pain from preoperative evaluation to the latest follow-up. The Lysholm knee score improved consistently as did the IKDC subjective score and the Tegner activity scale (Table 1).

Imaging Evaluation

MRI T2-mapping values improved over time from the first evaluation to the last follow-up (Table 2; Figs 2 and 3). Moreover, when comparing control values to tissue repair at the 36-month follow-up, the T2 values were not significant ($P = .23$). MOCART score images of the repaired area showed improvement over time, with mean values of 40.0 ± 16.2 at 3 months, 68.89 ± 14 at 12 months, and 68.5 ± 11 and 72.5 ± 10 after 36 months (Table 2; Fig 4). The intraclass correlation coefficient for T2 mapping was 0.67 and for MOCART it was 0.63.

Second-Look Arthroscopic Assessment

Second-look arthroscopy was performed at 12 months. The repaired lesion assessed with the ICRS classification was "nearly normal," with a mean of 10.38 ± 0.79. The intraclass correlation coefficient for these measurements was 0.702 (Fig 5). No complications or severe adverse events were related to the second-look arthroscopic procedure.

Safety

No implant-specific severe adverse events were recorded for any of the 10 patients. Typical postoperative swelling and effusion resolved uneventfully after a period of 4 to 6 weeks. No postoperative fever, signs of infection or repeated interventions occurred. We found no hypertrophy of the grafts. There were no deaths.

Discussion

All patients in this study improved significantly on all clinical grading scales progressively over time, reaching a stable improvement after 12 months, and maintaining that improvement for a mean of 36 months and in 1 patient up to 48 months. The repair tissue that filled the cartilage lesions with this new arthroscopic technique for ACI also improved over time as assessed by MRI T2 mapping and the MOCART score. This improvement reached a significant level at 12 months, consistent with the findings of the second-look arthroscopy performed at the same time, which found "close to normal" tissue. However, subsequent MRI evaluations showed further improvement in the imaging quality of the repair tissue, approaching the characteristics of the surrounding normal cartilage. These findings support our initial hypothesis.

In this prospective study, we found steady improvement in the subjective perception of pain and function in the knee as observed with Lysholm and IKDC scales at a mean of 36 months. Participation in sports improved in our patients but did not reach preinjury state. Several conditions may cause this finding. First, our rehabilitation protocol in these patients did not allow for contact sports in the first year after implantation, and we did not include competitive athletes in this cohort.

ACI has shown short, midterm, and long-term clinical efficacy as an open procedure.[21,22] Although there is a relative paucity of published literature in arthroscopic delivery of chondrocytes, there is increasing interest in this process. Filardo et al.[4,5,16] used an arthroscopic technique to deliver autologous chondrocytes in patients with chondral lesions of the knee using a self-adherent scaffold to subchondral bone as the fixation method. Good clinical results were found in 89% of the patients. Ebert et al.[8] showed efficacy and safety with an arthroscopic matrix-induced ACI technique using fibrin glue implant fixation to the subchondral bone. They showed improvement in clinical and MRI findings at the 24-month follow-up in 20 patients, with 1 failure seen by MRI.

Table 1. Clinical Results

Scale	Preoperative Values	12-Month Follow-Up	24-Month Follow-Up	36-Month Follow-Up	*P* Value
VAS	6 ± 1.5*	0.7 ± 0.9	0.3 ± 0.5	0.3 ± 0.4*	.005*
Lysholm	51.8 ± 25.1*	80.7 ± 11.9	92 ± 9.3	87.9 ± 6.5*	.005*
Subjective IKDC score	46.9 ± 18.5*	66.3 ± 14	76.5 ± 13.3	77.2 ± 12.8*	.01*
Tegner activity scale	2.9 ± 1.7*	3.8 ± 1.8	5.8 ± 2.1	5.9 ± 1.9*	.007*

IKDC, International Knee Documentation Committee; VAS, visual analog scale (pain).

*All comparisons were conducted with the Wilcoxon signed-rank test contrasting preoperative values to 36-month follow-up.

Table 2. Magnetic Resonance Imaging Results

MRI Evaluation	3-Month Follow-Up	12-Month Follow-Up	24-Month Follow-Up	36-Month Follow-Up	*P* Value
T2 values repair ROI	53.7 ± 10.7*	39.5 ± 3.5	40.4 ± 6.2	38.1 ± 4.4*†	0.01*
T2 values control ROI	36.03 ± 5.1	35.9 ± 3.1	35.0 ± 3.3	36.6 ± 5.2†	0.23†
MOCART score	40.0 ± 16.2*	68.8 ± 14	68.5 ± 11	72.5 ± 10*	0.01*

MOCART, Magnetic resonance observation of cartilage repair tissue; ROI, region of interest.

*Wilcoxon signed-rank test was conducted in before and after comparisons in repair tissue ROI and MOCART score from 3-month follow-up to 36-month follow-up.

†Wilcoxon signed-rank test was used to compare repair ROI to control ROI.

Although some authors use the intrinsic adherence of the scaffolds or fibrin glue to paste the scaffolds to subchondral bone, others rely on other types of fixation.[7,8,12,13,15] Herbort et al.[13] described bioabsorbable pins as a fixation method for cell-less scaffolds used for cartilage repair. In an in vitro model, they found that the biomechanical strength of pin fixation was superior to suturing to the adjacent cartilage and that the angle of pin insertion was critical to avoid damage to the tibial surface. We believe that the use of absorbable mini-anchors in the subchondral bone of the femoral condyles provides sufficient pullout strength to the construct and avoids the risk of damage to the tibial surface. The soft consistency of our-10 mm scaffold allows it to adapt to the curvature of the condyle against the subchondral bone at the bottom of the defect with a single point of fixation. Arthroscopic implantation of matrix-encapsulated autologous chondrocytes under direct vision with fluid flow using an arthroscopic pump has been shown in an animal model.[9] Although perforation of the subchondral bone can be of concern, the number of blood cells coming from bone marrow through 1 drill hole may be insignificant in contrast to the number of cells in our construct (5×10^6 cells). Moreover, blood from the subchondral bone can be occluded by 1 of the collagen disks that is used as a cell-less scaffold deep to our cell-seeded construct, thus not affecting the quality of each construct.

Our study showed that the repair tissue after arthroscopic delivery of matrix-encapsulated chondrocytes resembles normal cartilage based on T2 mapping MRI. This finding is consistent with other studies. Various authors have described repair tissue maturation after cartilage lesion treatment. After about 12 to 18 months, the signal intensity of the repaired tissue contains less fluid and looks more like native hyaline cartilage, especially after chondrocyte implantation treatment.[20,21] In a long-term study of patients treated with

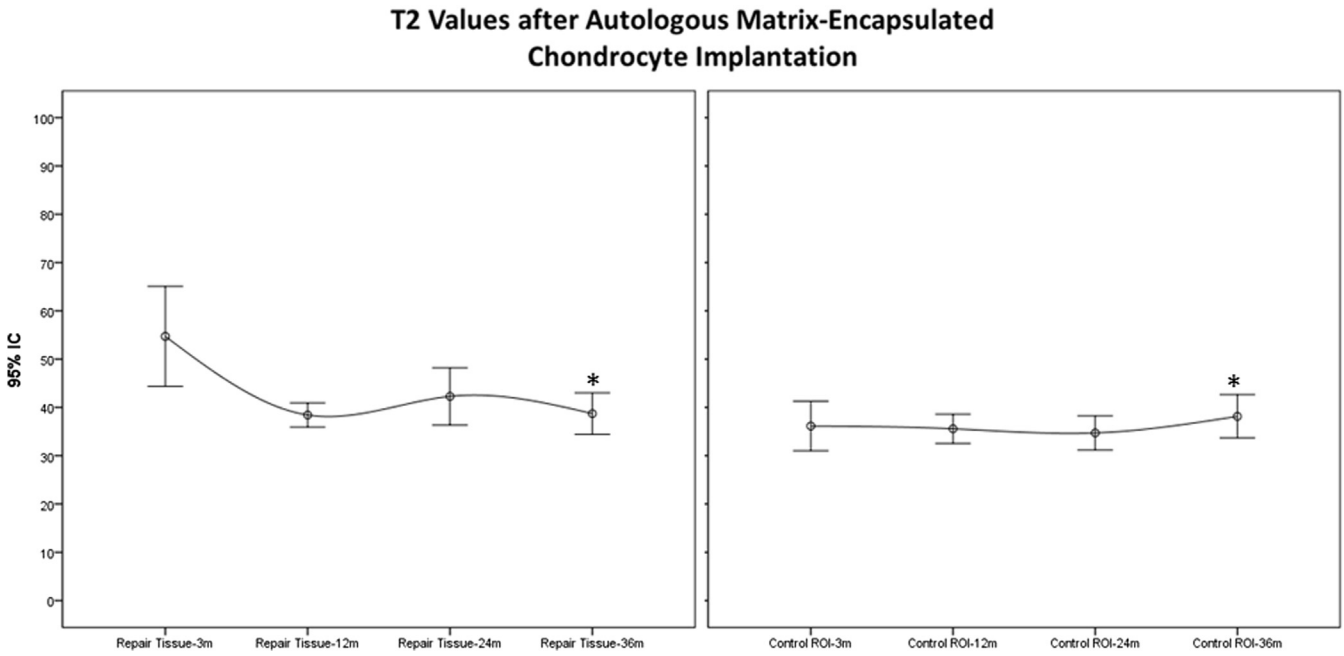

Fig 2. Magnetic resonance imaging (MRI) T2 mapping values of the repaired tissue improved over time. At 3-month follow-up, mean T2 values were 53 ms, reaching 38 ms at 36-month follow-up. Normal control values have a mean of 36.6 ms. *When we compared the repair tissue region of interest (ROI) at 36 months versus control ROI, no statistical difference was detected ($P = .23$).

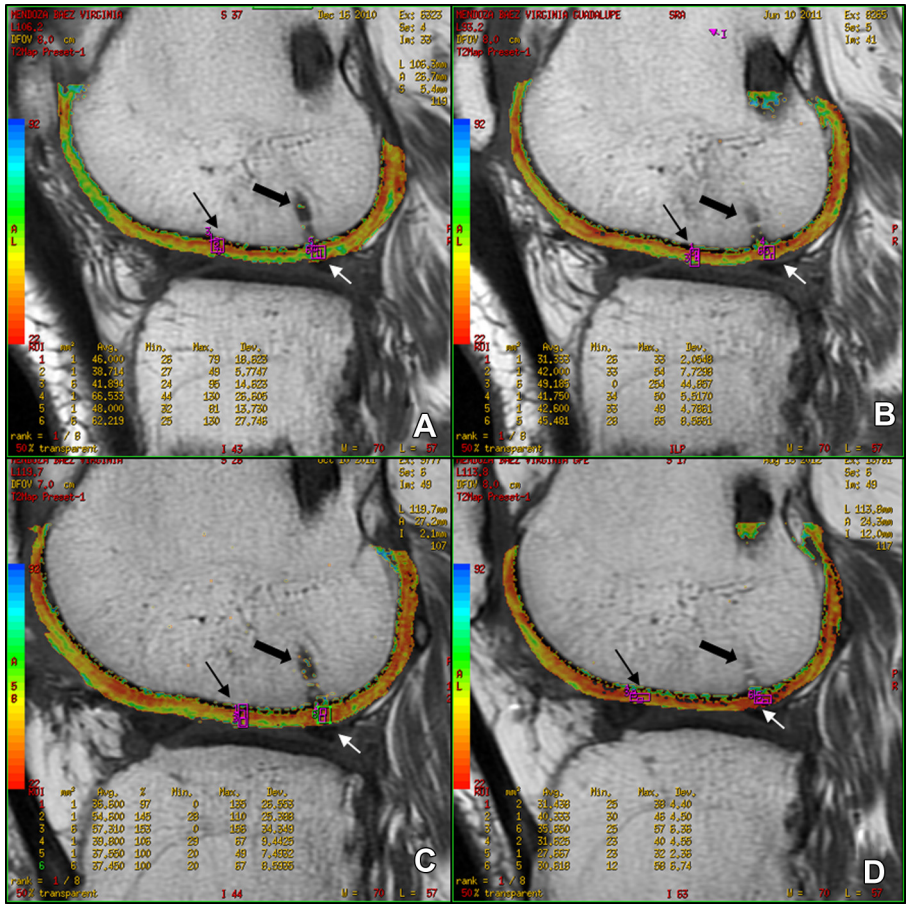

Fig 3. T2 mapping of the lateral femoral condyle in a patient after arthroscopic matrix-encapsulated chondrocyte implantation over time; the region of interest 6 (ROI6) represents the total width of the repair tissue, which shows progressive decline of its T2 values. (A) One-month after implantation; (B) 6 months after implantation; (C) 12 months after implantation; (D) 24 months after implantation. The white arrow is the region of interest (ROI) of the repair tissue; the thick black arrow shows the minianchor firmly fixed to the subchondral bone; and the thin black arrow shows the ROI of the control tissue. The color map on the left of each image indicates the range of T2 values. Green to blue values represent higher T2 values; in contrast, yellow to red values represent lower T2 values. The mean values of normal cartilage range from 30 to 40 ms.

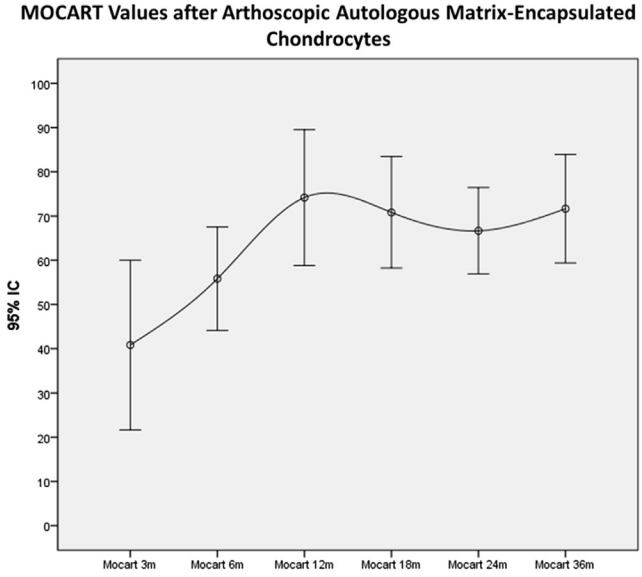

Fig 4. Magnetic resonance observation of cartilage repair tissue (MOCART) values also showed an improvement of the repaired area over time, with mean values of 40.8 at 3 months, reaching values greater than 70 at 12 months of follow-up. (IC, confidence interval.)

ACI using delayed gadolinium-enhanced MRI of cartilage as the primary outcome, Vasiliadis et al.[23] found that repair tissue was not different from normal cartilage.

From a morphologic point of view, our study shows that maturation of the tissue takes 12 months and after that it remains stable at values greater than 70 MOCART points. Others have found similar findings using scaffolds for chondrocyte implantation. Trattnig et al.[24] and Welsch et al.[25] found that after 52 weeks, MOCART values ranged around 70 to 73 points. Ebert et al.[8] reported an excellent graft infill score in 90% of their patients after 24 months. Filardo et al.[16] found that after 7 years of implantation there were perfect morphologic results in filling of the defect in 57% of patients, integration in 62% of patients, surface in 50% of patients, structure in 43% of patients, intensity in 43% of patients, subchondral lamina in 45% of patients, subchondral bone in 38% of patients, absence of adhesions in 95% of patients, and absence of effusion in 86% of patients. These findings should be viewed with caution, as stated in a recent systematic review; although improved MRI scores and sequences are being used more often, the correlation with subjective knee scores needs to be improved.[18]

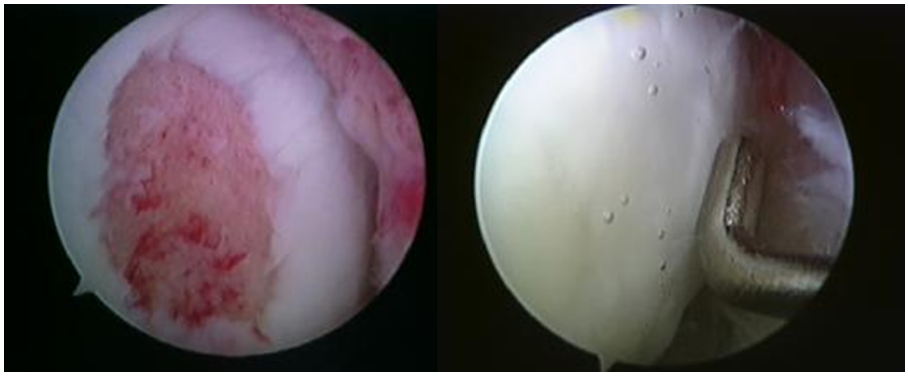

Fig 5. Second-look arthroscopic evaluation was performed in all patients 12 months after the arthroscopic autologous matrix-encapsulated chondrocyte procedure. Repaired tissue was evaluated with the International Cartilage Repair Society (ICRS) grading classification, with values close to normal (mean, 10.38).

Limitations

The small number of patients, lack of randomization, small size of the lesions, length of follow-up reported, and lack of biopsy samples for histologic examination as an outcome measure are limitations in this study.

Conclusions

All patients improved in all clinical scores over time compared with their preoperative values. Clinical results are comparable with MRI T2-mapping and ICRS evaluations, suggesting that this arthroscopic technique for cell-based cartilage repair is efficacious and reproducible at a mean of 36 months' follow-up.

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