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Radiological evaluation of cartilage after microfracture treatment: A long-term follow-up study

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ABSTRACT

Introduction: Recent literature revealed good short-term results after microfracturing (MFX) of isolated focal cartilage defects in the knee joint. Study purpose was a long-term evaluation of patients who received MFX through a multimodal approach, correlating clinical scores and morphological pre- and postoperative MRI-scans.

Materials and methods: Between 2000 and 2007 158 patients were treated with MFX for focal femoral or tibial defects at our department. Patients with instabilities, secondary surgical intervention, patellofemoral lesions, a plica mediopatellaris or more than one cartilage defect site and age >55 were excluded. 15 patients were included. Minimum postoperative follow-up (FU) was 18 months (18–78 m). Mean age at surgery was 45 years (27–54), mean FU-interval 48 months (18–78 m). Male to female ratio was 9:6. For clinical assessment the Knee Osteoarthritis Outcome Score (KOOS) and Lysholm Score were used, radiological evaluation was performed with radiographs and 3Tesla-MRI.

Results: Clinical knee function was rated good to excellent in 1 patient, fair in 2 and poor in 10 patients. 2/15 patients received full knee replacement due to insufficient cartilage repair through MFX during FU period. Evaluation of pre- and postoperative MRI showed good cartilage repair tissue in 1 (7.7%), moderate repair in 2 (15.4%) and poor fill in 10 patients (76.9%). In these 10 patients the defect size increased. Average defect size preoperatively was 187 mm^2 (range 12–800 mm^2) and postoperatively 294 mm^2 (40–800 mm^2). The KOOS-Pain averaged 60 (39–94), KOOS-Symptoms 60.6 (21–100), KOOS-ADL 69 (21–91), KOOS-Sports 35.7 (5–60) and KOOS-QUL 37.2 (6–81). The average Lysholm Score was 73.9 (58–94). 10 patients showed a varus leg axis deviation (Ø 5.9°), 3 had a neutral alignment. The alignment correlated positively with KOOS and especially with the Lysholm Score.

Conclusion: Our study demonstrated that MFX as a treatment option for cartilage defect in the knee did not show the anticipated clinical and radiological long-term results. In 12 of 15 patients the cartilage defect size had increased after MFX, in 2 patients indicating full-knee replacement. Especially those with a leg malalignment >5° in varus were more prone to suffer from an increase in defect size. In our cohort the clinical scores correlated with the radiological findings.

What is known about the subject:

Microfracture in the knee is widely used as a first line treatment for cartilage defects. Long-term clinical results have been evaluated in a couple of studies with variable outcome. The basic understanding is that microfracture creates fibrocartilage, which deteriorates in its function over time. Long-term MRI assessment of cartilage repair after microfracture is very limited in the literature.

Adds to existing knowledge:

With the current study we show that in our patient series the cartilage repair after microfracture therapy deteriorates significantly. In this study, MRI evaluation of cartilage repair demonstrates the worsening of cartilage integrity after a mean of 48 months.

MRI assessment in combination with clinical scores helps to objectively compare cartilage repair treatments.

1. Introduction

Osteoarthritis is a problem that in the most cases results from cartilage defects or injuries [1].

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Almost 1 million people in the United States suffer from cartilage injuries every year [2]. Up to date there is still no consensus on how to treat a patient in the best way [3]. There is no valid concept on why cartilage is not able to heal out its own lesion [4]. Yet there are several ways to treat cartilage defects with variable outcomes: microfracture and other bone marrow stimulating techniques, mosaicplasty, transplantation of an osteochondral allograft and the use of synthetic scaffolds.

Microfracture is often used as a first-line treatment option because of its economic advantages and technical simplicity, especially in the young. As invasive cartilage biopsies are not practical for routine follow-up after cartilage repair magnetic resonance imaging is gaining importance in assessing chondral lesions in the initial diagnosis as well as for the follow-up's [5–7]. Conventional MRI has been shown to be sensitive for the morphological characterization after different cartilage repair procedures [7–9]. However, MRI is limited in describing the composition of the cartilage repair tissue [10]. This study tries to evaluate the long-term physical and imaging outcomes with a specific cartilage high resolution MRI technique according to the MOCART criteria (magnetic resonance observation of cartilage repair tissue) [6,7]. These criteria were validated in several studies recently [6,7]. We evaluated the clinical scores of patients with microfracture with MRI variables in a retrospective case series.

2. Methods

In our retrospective study we searched our database in the time from March 2000 until December 2007 for patients whose full cartilage defects ranging from third to fourth degree in the medial and lateral compartment were treated with microfracture. We excluded patients who suffered from additional pathology such as anterior cruciate ligament (ACL) or posterior cruciate ligament (PCL) ruptures. Further exclusion criteria were instabilities, secondary surgical intervention, patellofemoral lesions, plica mediopatellaris or more than one cartilage defect site and age >55. Therefore of our 158 initial patients who were not older than 55 years we excluded 143 patients due to the above-mentioned criteria.

The mean age of the remaining fifteen patients at surgery was 45 years (27–54). There were nine (60%) males and six (40%) females. None of the patients were obese according to the BMI classification. The preoperative lesion size averaged 187 mm^2 (12–800 mm^2) and postoperatively 294 mm^2 (40–800 mm^2). The lesions were located on the medial femoral condyle (69%), lateral femoral condyle (31%). The etiology of the defect was nontraumatic in all patients. They had been treated for single outerbridge grade 3 or 4 lesions of the medial or lateral femoral condyle.

In all patients we obtained pre- and postoperative MRI and assessed them by using the magnetic resonance observation of cartilage repair tissue (MOCART) score in order to evaluate the long-term results on imaging of microfracture therapy. The mean follow-up of the patients with MR imaging was forty-eight months ranging from eighteen to seventy-eight months.

In all of our patients anteroposterior radiographs of the affected knee were taken in a weight-bearing position, lateral knee and skyline radiographs of the knee were also obtained.

2.1. Clinical outcome evaluation

For evaluation of the clinical results, the Knee Osteoarthritis Outcome Score (KOOS) and Lysholm–Gillquist-Score (LGS) were used, both validated for cartilage-defects and osteoarthritis in the knee, used in this context by several authors previously [6,11–19]. KOOS Score is a 42-item questionnaire that covers the clinical aspects of pain, disease-specific symptoms, activities in daily life, sport and recreation-function and knee-related quality of life. Score-points are transferred to a scale from 0 to 100, 100 points representing 100% pain-free unlimited function of the knee. The Lysholm–Gillquist-Score (LGS) summarizes the clinical status of the knee, assessing pain, swelling-tendency and range of motion. Hereby 100 score-points representing pain-free unlimited motion and full load capacity.

The clinical outcome was correlated to the postoperative MRI images.

2.2. MRI classification

The follow-up MR imaging examinations were performed with a Philips Medical Systems Achieva 3 Tesla-unit, using a SENSE-knee coil (Phased-Array coil with 8 elements). Imaging sequences included the following:

- Sagittal T1 TSE (Turbospinecho): TE: 20, TR: 581, SL: 2, FA: 90
- Sagittal 3D_WATS: TE: 5, TR: 20, FA: 15 SL: 3
- Coronal STIR TSE SENSE: 30, TR: 3321, TP: 40, SL: 3, FA: 90
- Coronal and sagittal SPAIR: TP: 36, TE: 30, TR: 2902, FA: 90, SL: 3
- Sagittal PDW_TSE: TE: 30, TR: 4000; FA: 90, SL: 2
- Axial PDW_SPAIR: TE: 30, TR: 2900, FA: 90, SL: 3
- Field of view: 160×160

All images were assessed by two radiologists first independently and then reviewed in consensus.

Marlovits et al. [7] proposed a new MRI evaluation for cartilage repair, the magnetic resonance observation of cartilage repair tissue (MOCART) score. Morphology and signal intensity of the repair tissue compared to the adjacent native cartilage were described using nine variables. Definition of pertinent parameters for the evaluation of articular cartilage repair tissue with high-resolution magnetic resonance imaging. These variables include the degree of defect repair and filling of the defect, integration to border zone, surface of the repair tissue, structure of the repair tissue, signal intensity of the repair tissue, subchondral lamina, subchondral bone, adhesions, and effusion. Similar variables were also described by Roberts et al. [20] to be relevant in the MRI-assessment of cartilage-repair techniques (size, surface integrity and contour, cartilage signal in graft region, cartilage thickness and changes in underlying bone).

The repair was considered complete when the repair tissue appeared as thick as the adjacent native cartilage with complete integration of the margins, and a smooth articular surface that reproduced the original articular contour with no adhesions and an intact subchondral bone plate and marrow. Synovitis was considered as an effusion, however the effusion was defined when the accumulation of fluid in the synovial joint increases more than one centimeter in any section of the knee.

2.3. Surgical procedure

Detailed information on surgical interventions was provided to all patients. All patients signed an informed consent form concerning the operative technique to be performed.

After thorough diagnostic arthroscopy performed by well-experienced surgeons with the microfracture technique, cartilaginous remnants on the subchondral bone were fully debrided with an arthroscopic curette and shaver. A partial tear in the white–white zone of the meniscus was found in three patients (18.75%) and was the only concomitant lesion included in the study.

According to the method described by Steadman et al. [21] microfracture of the cartilage lesion was then performed. Debridement was continued until steep and intact surrounding cartilaginous tissue was obtained. Removal of the calcified carti-