Matrix-Based Autologous Chondrocyte Implantation for Cartilage Repair: Noninvasive Monitoring by High-Resolution Magnetic Resonance Imaging

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Introduction

Articular cartilage injury is a common disorder in the knee joint. Over the past a number of surgical interventions have been developed and now autologous chondrocyte implantation is the most common therapy for cartilage defects (1). For the long-term follow-up of this procedure clinical scores and results from biopsies were taken during control arthroscopies. Noninvasive MRI has shown to be useful in the evaluation of the repair tissue (2).

The aim of our study was introduce high-resolution MRI (HR-MRI) to improve the evaluation of morphology of biological cartilage repair and to evaluate the development of cartilage repair tissue over 52 weeks with HR-MRI performed at varying time intervals and to quantify this assessment by an MRI scoring system with a point scale evaluation.

Patients and methods

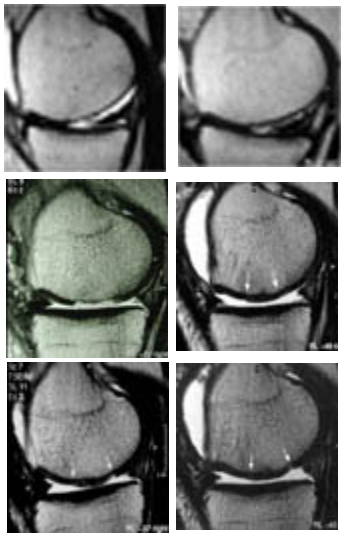
Twenty patients after matrix associated autologous chondrocyte implantation (MACI) for cartilage repair (medial femoral condyle: 13; lateral femoral condyle: 1, patella: 6) had postoperative MRI follow-up examinations on 4th, 12th, 24th and 52nd week.

For the matrix two carriers were used, a collagen typeI/III membrane (MACI, Verigen, Kopenhagen, Denmark) and a hyaluronic acid sponge (FAB, Abano, Italy).

MRI Technique

All MR-examinations were performed on a 1.0 Tesla MR unit (Philips, Gyroscan Intera, Best, the Netherlands). When imaging an patient with cartilage repair procedures, at first a standard knee MRI protocol was applied. Using the circular polarized knee coil the following sequences were performed: *sagittal T1-SE, sagittal dual TSE, coronal STIR-TSE* and fat-suppressed *3D-gradient echo sequence.* After the standard protocol, high-resolution imaging using a surface phased array-coil (TMJ), which was placed over the knee compartment of interest, including the cartilage repair site and a *dual TSE* with a FOV: 120mm, Matrix: 512x512 and slice thickness: 2mm was performed

The repair tissue was described with separate variables: the degree of defect repair in thickness and length, the surface, structure, and signal intensity of the repair tissue and the status of the subchondral lamina and bone. For these variables a grading system with point scale evaluation was proposed with a maximum number of 100. The mean average values were calculated for every follow-up MR exam.



FSE-Images
Filling of the defect at the repair site from 4 to 24 weeks after surgery

Decrease of signal intensity of implant from fluid-like signal after 4 weeks to isointensity to native cartilage after 52 weeks

Improved integration (right arrow), and normalization of surface and structure alterations from 12 to 24 weeks

Table 1. Calculated mean score values

4th week	12th week	24th week	52nd week
46	53	63	73
SD:16.67	SD:14.91	SD:18.25	SD:24.57

Results and Conclusion

The calculated mean average values from the scoring system are shown in table 1.

In 17 of 20 patients an increase of calculated values from 4th to 52th week was found. More than 80 points were found in 13 of these 17 patients. In 3 of 20 patients a decrease of calculated values in the period from 4th to 52th week was seen.

Cartilage repair tissue from matrix-based ACI techniques showed dynamic processes:

Filling defects at the cartilage repair site in the earlier postoperative period (3-6 months) filled up in later examinations (6-12 months). Hypertrophy of cartilage repair tissue disappeared. Signal intensity of repair tissue changed to native hyaline cartilage signal intensity (6-12 months). Surface defects and structure inhomogeneities normalized in the follow-up.

These changes may represent a normal maturation process of the repair tissue over time. One may conclude that an inverse development is associated with a poor prognosis.

In summary, high-resolution MRI provides an accurate non-invasive evaluation of the repair site in matrix associated autologous chondrocyte implantation for cartilage repair. It offers a simple scoring system which allows to evaluate the development of the cartilage repair site over time and makes comparison interindividually possible.

References: 1.Minas et al, Op Tech Sports Med 2000;8:144-157; 2.Alparslan et al, Seminars in Musculoskeletal Radiology, 2001;4