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Osteochondrosis dissecans of the knee: Evaluation of the evolution of MR morphology during treatment

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Summary

Background: To assess the evolution of MR morphology of OCD lesions in response to treatment and feasibility of MRI as a control study in patients with treated OCD.

Material/Methods: 11 patients (6 women and 5 men, aged 11–24 years, average age 17 years) with lesions affecting 12 knee joints were followed for approximately 24.2 months with repeated clinical examination and MR imaging. All MR studies were performed on a 1.5 Tesla unit. MR arthrography was performed in 3 patients. The evolution of MR morphology of the lesions was assessed with a 5-point scale and correlated with the results of clinical assessment with a modified Lysholm scale.

Results: In 10 patients, a good clinical result was achieved. In 7 knee joints of patients from this group, the features of the healing of the OCD lesion were observed in MRI and in 4 knees the morphology of the OCD lesion was stable. In 5 MR examinations, a transient deterioration was observed, which in 4 cases preceded healing and in 1 case stabilization in MR morphology.

Conclusions: Transient deterioration may be observed in MR studies prior to the healing of OCD lesions irrespective of the improvement in clinical examination. The follow up of patients with OCD should be based mainly on clinical examination, with MR studies reserved for late control or patients with clinical signs of deterioration.

Key words: osteochondrosis dissecans • MRI

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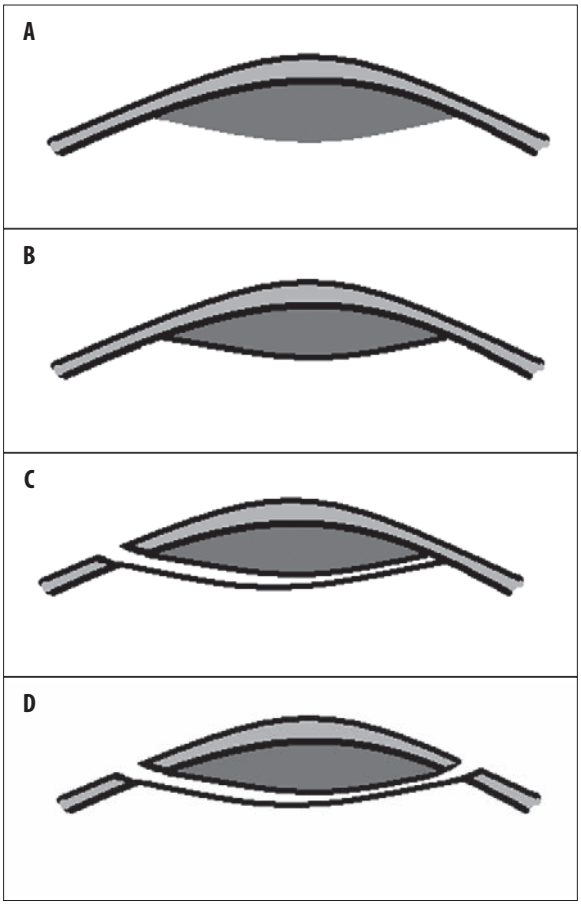
Background

The term osteochondrosis dissecans (OCD) describes a condition leading to detachment of a subchondral bone fragment with secondary damage to the articular cartilage. The disease most often affects the knee joint, usually in the lateral part of the medial femoral condyle; other localizations are less frequent [1]. It occurs in young, physically active people, with a peak incidence among children from 11 to 13 years of age [2]. In adults, it can occur at any age, but is most common in the 17–36 age group [3]. In case of onset before the completion of skeletal development, i.e. so-called juvenile OCD the prognosis is much better than in the adult form, but some authors attribute this difference to misdiagnosing of variations of the ossification falling within normal limits as early stages of OCD [1,2]. Despite the fact that the first reports concerning OCD date back to the 16th century, the etiology of the lesions is still controversial [4]. Traumatic and overstrain lesions, as well as genetic and endocrine factors or nutrient deficits have been mentioned [1]. The inflammatory etiology initially suggested by König has currently few supporters, whereas many authors propose that multiple repeated microtraumas may play a role [5–7]. The cartilage covering the lesion is now considered to be intact at an early stage and to become susceptible to damage only at a later time when it loses mechanical support because of fragmentation of the underlying bone. However, with preserved cartilage integrity the necrotic fragments may be absorbed while the viable bone fragments grow and fill the defect [8]. The diagnostics of OCD includes: anamnesis, clinical examination, conventional radiography, arthroscopy and magnetic resonance (MR). X-ray arthrography, computed tomography and scintigraphy are used less frequently [1]. Delayed diagnosis and inap-

Table 1. MR examination protocol.

Sequence	TR/TE	FA	Slice thickness/interval [mm]	NA	~TA [min]
T1 SE 2D Sag	500/15	90/180	5/0.5	2	3:50
T2 FSE 2D Sag	6000/160	90/160	5/0.5	2	1:30
T1 SE 2D Ax	600/15	90/180	5/0.5	2	3:30
PD FSE 2D Sag	2250/12	90/160	5/0.5	2	2:30
T1 SE 2D Cor	500/15	90/180	5/0.5	1,5	5:30
T2 STIR FSE 2D Cor	4750/120	90/180	5/0.5	2	3:40
T2* FE 2D Sag	440/15	25	4/0.4	3	4:20

TR – repetition time; TE – echo time; FA – flip angle; NA – number of acquisitions; TA – acquisition time; Sag – sagittal plane; Ax – axial plane; Cor – coronal plane.



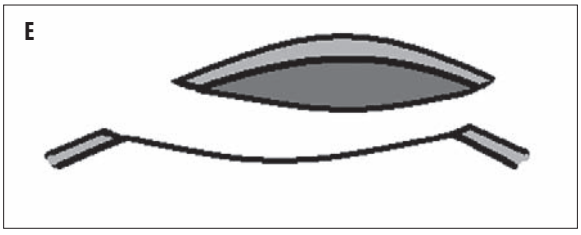


Figure 1. Staging of OCD lesions in MRI. (**A**) Type I – subchondral area of a decreased signal intensity with a fuzzy border, (**B**) Type II – demarcation, (**C**) Type III – focal articular cartilage defect with partial separation of the lesion, (**D**) Type IV – complete separation of the osteochondral fragment which becomes surrounded by articular fluid, Type V – displacement of the osteochondral fragment with the formation of loose intraarticular body.

propriate treatment of OCD leads in case of an unfavorable outcome to early degenerative changes. The value of MR in the preliminary assessment of OCD is well-documented. High consistency of the lesion morphology and stability assessed by MR with arthroscopic images and good assessment of the articular cartilage with MR has been emphasized [7–9]. However, there are relatively few publications concerning the use of the method in assessment of treatment results. Therefore, the aim of our study was to assess the evolution of OCD type lesions in response to treatment by control MR and to attempt determination of usefulness of the method in monitoring of OCD treatment results.

Material and Methods

All MR scans were performed using the unit with 1.5 T field induction (Visart, Toshiba) with a dedicated superficial coil. The examination protocol included T1-weighted images in the coronal, sagittal and axial plane, proton density images in the sagittal plane, and T2-weighted ones in the sagittal and coronal planes. In 3 patients, the protocol was supplemented with T1-weighted images obtained after administration of a contrast medium (40 ml gadolinium in 2 mmol/l solution). The detailed examination protocol is presented in Table 1.

Grading of OCD lesions in MR was based on a 5-grade scale, which was a modification of the scale proposed by Kramer at al. [9,10]. The used scale was primarily designed so as to assess the evolution of signal on the demarcation line between normal bone and an OCD focus and disruption of the integrity of cartilage covering the lesion (Figure 1). Clinical assessment of treatment results was based on a knee function assessment scoring system proposed by Lysholm, and used in Poland with modifications introduced by Górecki (Table 2) [11].

The frequency of control examinations, both clinical and radiological, was dependent on the severity of clinical symptoms, assuming the necessity of at least 2 control examinations within 1 year following the diagnosis or

Table 2. Lysholm score modified by Górecki [11].

	Score
1. Limping	
absent	5
slight or periodic	3
significant or permanent	0
2. Walking assistance	
non necessary	5
walking stick or crutch	1
load-bearing by the extremity impossible	0
3. Thigh muscle atrophy	
absent	5
1–2 cm	4
over 2 cm	0
4. Gait, run, jumps	
A. Instability	
no „escaping knee" episodes	25
rare „escaping knee" episodes during sports activities or on considerable exertion	20
frequent „escaping knee" episodes during sports activities or on physical exertion (making it impossible to practice sports)	15
sometimes during everyday activities	10
frequently during the day	5
on each step	0
B. Pain	
absent	30
periodic and slight on considerable exertion	25
present in case of subluxations	20
on considerable exertion	15
during or after over 2 km walk	10
during or after walk shorter than 2 km	5
persistent pain	0
C. Edema	
absent	8
in case of subluxations	5
after considerable exertion	3
after moderate exertion	1
persistent	0
D. Turn on one leg	
without painful symptoms and signs of instability	7
insignificant subluxation, performance of the movement possible	6
performance of the movement difficult	3
performance of the movement impossible	0
5. Ascending and descending stairs	
without abnormalities	10
slightly impaired	6
using one leg	2
impossible	0
6. Squatting	
without abnormalities	5
slightly impaired	4
impossible over 90°	2
impossible	0

institution of treatment (at ca. 3 and 6 months), and then distant follow-up at 12-month intervals.

In patients with arthroscopic findings of instability of the osteochondrous fragments, control examinations were performed earlier (after 30 days) and more frequently to check whether rehabilitation did not cause the loss of stability.

Evolution of lesions in 12 knees of 11 patients was assessed. The study group included 6 women and 5 men aged 11–24 years (mean age 17). The duration of the observation period ranged from 10 to 39 months (24.2 months on the average).

In 1 patient both femoral condyles were involved, in 2 the lateral femoral condyle only, in the remaining cases the lesions were located in the lateral portion of the medial condyle.

Differentiation from additional ossification centers was based on the finding of T1-weighted signal decrease in the focus in case of OCD.

Juvenile OCD was diagnosed in 5 patients, the remaining subjects had reached skeletal maturity by the moment of onset of the disease. In 2 patients, only conservative treatment was instituted. One patient underwent open surgery stabilization of the osteochondrous fragment. The remaining 8 patients underwent arthroscopic drilling of OCD foci, with additional fixation of osteochondrous fragments with polyactide arrows for better stabilization.

Results

In 10/11 observed patients, clinical improvement of knee function was achieved. At the beginning of the observation,

Table 3. Comparison of the results of control MRI studies with the clinical assessment of knee function (Lysholm score). I, II, III, IV – subsequent control studies, (arthro) – evaluation based on MR arthrography.

#	Patient	Date of surgery/initiation of treatment	Assessment by MR				Clinical assessment			
			I	II	III	IV	I	II	III	IV
1.	F aged 12	Conservative (IX 2004)	I (XI 2004)	III (IV 2005)	synostosis (IV 2007)	–	60	95	95	–
2.	F aged 21	Condyle drilling (VI 2004)	I (XII 2005)	II (IX 2006)	healing (I/II) (I 2007)	–	45	86	90	–
3.	F aged 20	Condyle drilling (V 2006)	III (VIII 2006)	healing (I) (III 2007)	–	–	52	90	–	–
4.	F aged 13	Condyle drilling (II 2003)	III (II 2003)	synostosis (VI 2004)	–	–	49	94		–
5.	F aged 24	Condyle drilling (V 2005)	II (V 2002)	III (XII 2004)	no change (VIII 2005)		60	94	95	–
6.	M aged 17	Condyle drilling (VI 2005)	II (VII 2004)	no change (II 2006)	–	–	56	94		–
7.	F aged 11 RK	Condyle drilling (II 2005)	III (XII 2004)	III + partial fragment synostosis (VIII 2005)	no change (VIII 2006)	–	45	86	86	–
	LK	Condyle drilling (X 2005)	II (XII 2004)	III/II (arthro) (II 2006)	synostosis (IV 2007)	–	60	94	100	–
8.	M lat 15	Open surgery sequester stabilization with PLA arrows (IV 2004)	IV/V (IV 2004)	III (V 2004)	III (VIII 2004)	synostosis (VIII 2006)	35	40	66	100
9.	M aged 21	Lateral condyle drilling with PLA arrows stabilization (III 2005) Fragment sequestration treated with mosaic reconstruction (VI 2006)	II (III 2005)	II (VIII 2005)	III (arthro) (I 2006)	–	60	86	63	–
10.	M aged 21	Drilling with sequester stabilization with a 6.4mm mosaic cylinder 6.4mm (IX 2004)	II (II.2004)	II (XII 2004)	II (arthro) (XII 2005)	–	60	90	94	–
11.	M aged 12	Conservative (XII 2005)	I (V 2006)	synostosis (III 2007)	–	–	60	100	–	–

the average knee function score assessed with the clinical scale was 53.5 (range 35–60 points), to increase at the end of treatment to 91.75 (range 63–100).

Control MR scans performed in these patients revealed the signs of healing in 7 knee joints, and in 3 stable presentation of the lesion.

In 5 MR scans, the signs of progression were observed. This group consisted of 4 patients with good treatment results and 1 patient showing no clinical improvement. In 3 cases demonstrating no functional deterioration, such changes were of transient character and subsequent scans revealed the signs of healing, whereas in 1 patient the condition stabilized after transient deterioration. In 1 patient who failed to comply with the doctor's recommendation and did not limit his physical activity, the clinical symptoms aggravated with detachment of the osteochondrous fragment confirmed by MR arthrography. Table 3 presents a detailed comparison of symptoms observed in MR with the results of clinical examinations at consecutive check-ups.

Discussion

Arthroscopy remains the method of choice in assessment of the knee articular surfaces. However, it is an invasive method, associated with complications in a few cases. Therefore, magnetic resonance (MR) imaging has also been

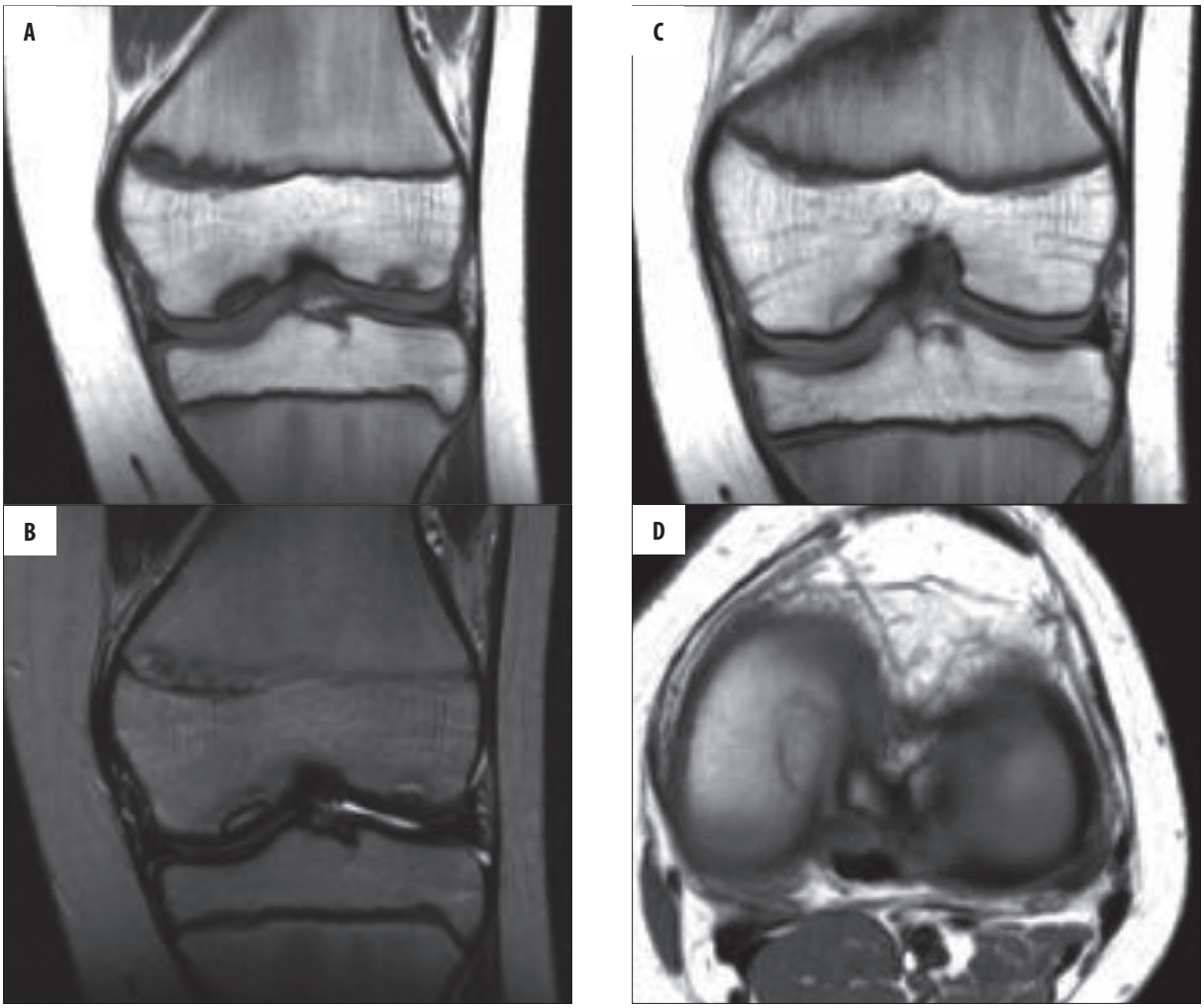
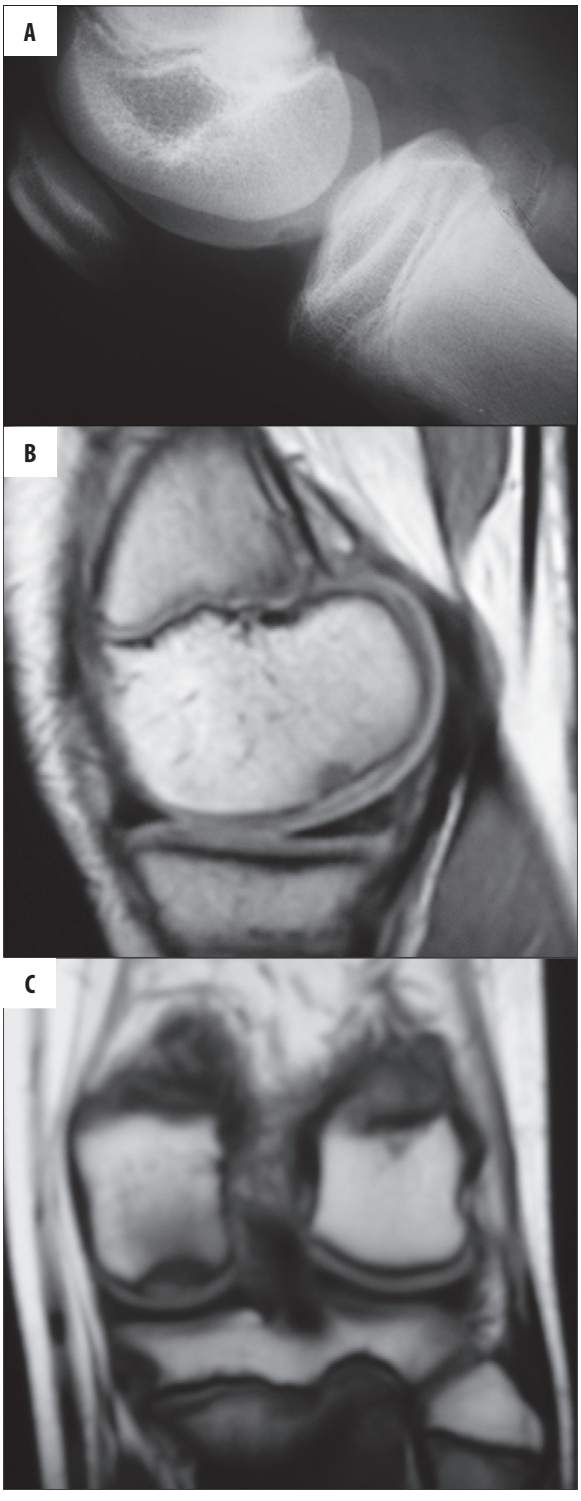


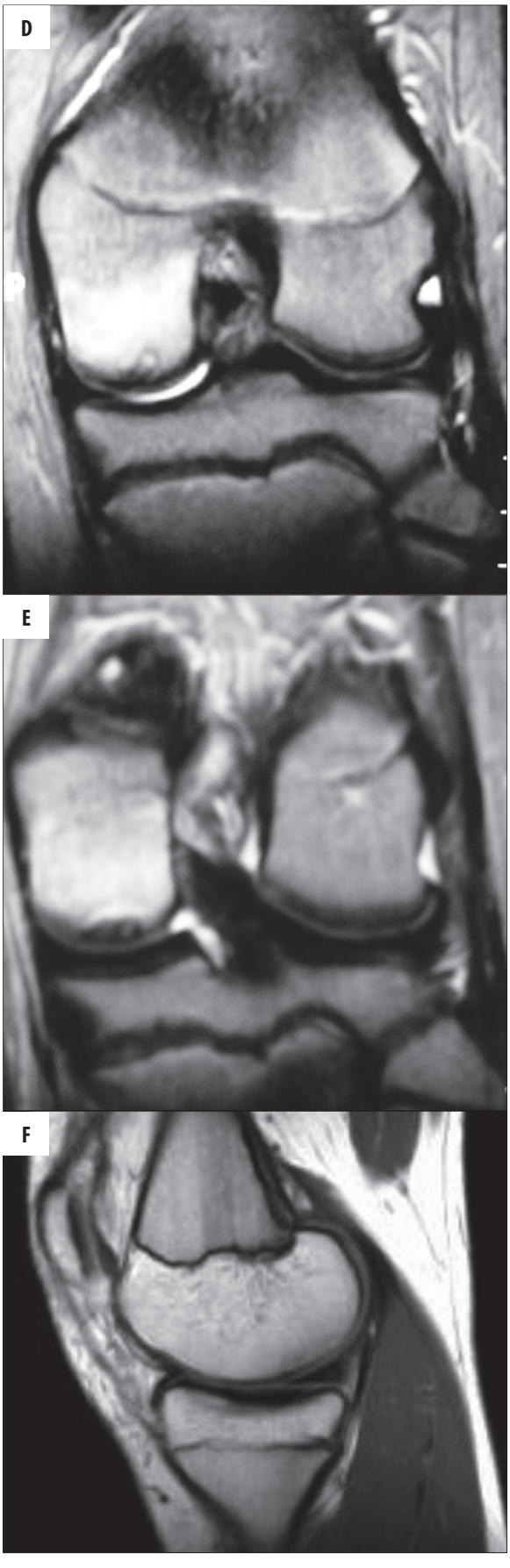
Figure 2. Healing of OCD lesions on conservative treatment. (**A,B**) small type II OCD lesions in both femoral condyles; (**C,D**) complete resolution of lesions after 10 months of conservative treatment.

applied in the diagnostics of OCD patients. The first reports concerning the use of this method in preliminary assessment of OCD date back to the late 1980's. These reports, like many later ones, concerned the primary clinical problem, i.e. the assessment of osteochondrous fragment stability [5–7,12,13]. The prognosis is much better in case of lesions covered by normal or mildly affected cartilage than in more advanced ones, with disruption of cartilage integrity and the risk of detachment of the bone fragment and loose articular body formation. In the first group of patients, conservative or low-invasive treatment such as arthroscopic drilling of the OCD focus to improve blood supply and induce regeneration processes is possible.

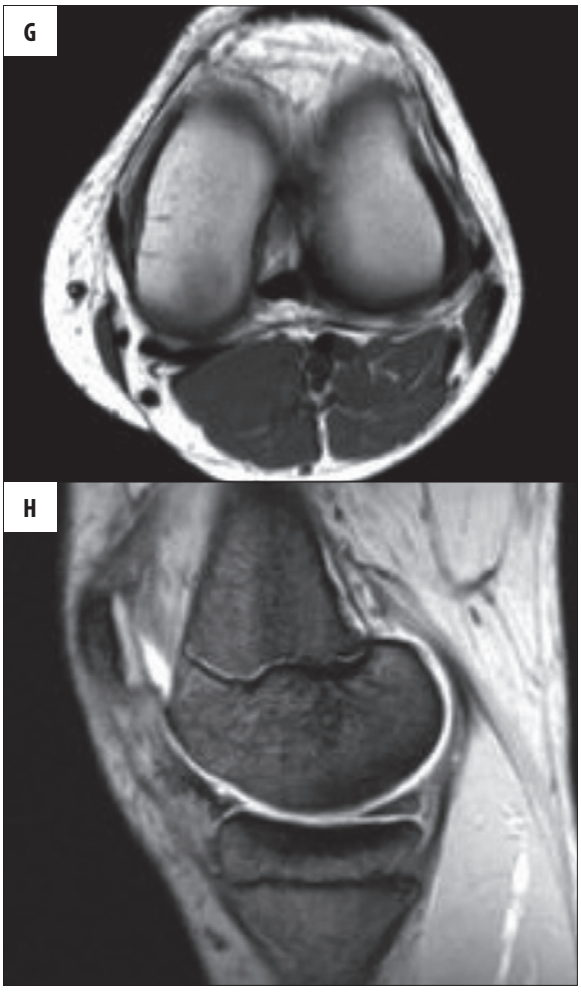
After the institution of treatment, the most important problem is to check whether the lesion is healing and there is no progression with loss of the osteochondrous fragment stability.

In our material, all OCD foci were initially characterized by a signal lower than that of normal bone in T1-weighted images or an inhomogeneous signal in T2-weighted ones. We assumed approximation by the lesion signal of normal bone signal with gradual disappearance of the demarcation line as a sign of healing (Figure 2). Such evolution was observed in 7 patients. Interestingly, in 3 patients such changes in MR were preceded by the signs of deterioration, with more clear demarcation of the focus (transition from type I to II, n=1) or by appearance of a hyperintense T2-weighted signal band between the OCD focus and healthy bone, which suggests progression from type II to III (n=2). This concerned both the patients on conservative treatment (n=1), and after arthroscopic drilling of the lesion (n=2). Moreover, in one of these patients, a 12-year-old girl on conservative treatment, the focus size markedly increased during the treatment with bone marrow edema increase in the vicinity. However, the subsequent MR scan revealed complete healing of the lesion (Figure 3). In another patient, the appearance of hyperintense signal between the lesion and healthy bone was accompanied by edema of the articular cartilage covering the OCD focus manifested as its thickening and signal increase in T2-weighted images with adipose tissue signal suppression. On the same day, MR arthrography revealed no contrast penetration between the OCD focus and healthy bone. In the next MR performed in the same patients, the disappearance of hyperintense signal of the cartilage and signs of healing of the osteochondrous fragment were observed. In the third patient, more significant demarcation





of the focus with hyperintense signal in T2-weighted images followed by the signs of healing was observed (Figure 4). Such changes appeared as late as 2 years after arthroscopic drilling of the focus, while they were not visible in the control scan performed after 1 year, so it seems they could be associated with slowly progressing revascularization. Moreover, in 1 patient whose disease stabilized, previous progression from type II to III was observed. In all these patients, clinical examinations not only did not reveal any



signs of deterioration, but on the contrary, various grades of regression of symptoms. (Table 3).

Interpretation of elevated T2-weighted signal between the OCD focus and the bone may be somewhat difficult. Even the first reports concerning MR assessment of OCD emphasized the importance of such finding in the evaluation of lesion instability as a sign of articular fluid penetration between the lesion and the remaining part of the bone [5]. Later reports confirmed high diagnostic value of this finding in the prognosis of lesion instability [6,7]. Thus, such a sign should be interpreted as arousing anxiety. However, some authors relate this type of signal changes also to the regeneration process [8]. Hughes at al. analyzed control MR scans in 8 patients treated for juvenile OCD [8]. AS it follows from their experience, the presence of hyperintense signal on the borderline between the bone and the osteochondrous fragment in T2-weighted images (type II and III according to the classification they used) had no negative effect on the prognosis, providing there was no damage of the cartilage covering the lesion. These authors emphasize the importance of linear signal increase across the articular cartilage, corresponding to its disruption, in T2-weighted images (type IV according to their classification). On the basis of analysis of our material it seems that in case of small lesions accurate assessment of their extent is difficult, and detection of some of them requires using MR arthrography.

Figure 3. Healing of an OCD lesion with transient worsening in MRI on conservative treatment. (**A,B**) small type I lesion in the medial femoral condyle; (**C–E**) at 8 months: the increase in the size of the lesion (**C**) with prominent edema (**D**), high signal intensity line demarcating the lesion (**E**), and small cysts in the proximity of the lesion (**D**); (**F–I**) at two years: complete resolution of the lesion with the regression of bone marrow edema (**I**) and normal articular cartilage (**H**).

Similarly to our study, Hughes et al. also observed in 1 patient a signal increase between the OCD focus and healthy bone after the institution of treatment. In 4 of their patients MR results deteriorated during the treatment period, including 2 cases with the following evolution of changes in control MR examinations: an increase in focus size – stabilization – healing.

Schneider et al. assessed MR used in postoperative diagnostics of 56 patients with knee joint and 30 with ankle joint pathologies [14]. The authors emphasize worse results of treatment in case of findings of damage to articular cartilage and increased signal band in T2-weighted STIR images accompanied by finding of chondrous lesions in echo gradient sequence images in control MR. Similarly in our material no progress in healing was associated with the evidence of damage (n=1) or thinning of the articular cartilage (n=2). The authors also suggest that intravenous contrast uptake by the osteochondrous fragment may be helpful in assessment of the fragment viability. Unfortunately, their paper does not contain a detailed description of lesion evolution in control MR imaging.

Our study was limited by small study group size due to rarity of the disease and the criteria of inclusion. We assessed only patients with relatively early stages of the disease, because the remaining patients with unstable OCD foci require in most cases total or partial focus resection and reconstruction of the articular surface with chondrocyte grafts or cartilage autografts. Such treatment makes it impossible to assess the natural history of OCD healing. On the basis of the obtained results it could, however be postulated that deterioration of MR findings in a conservatively or arthroscopically treated OCD focus may be one of the normal stages of healing associated with the induction of the repair process and increased local blood supply.

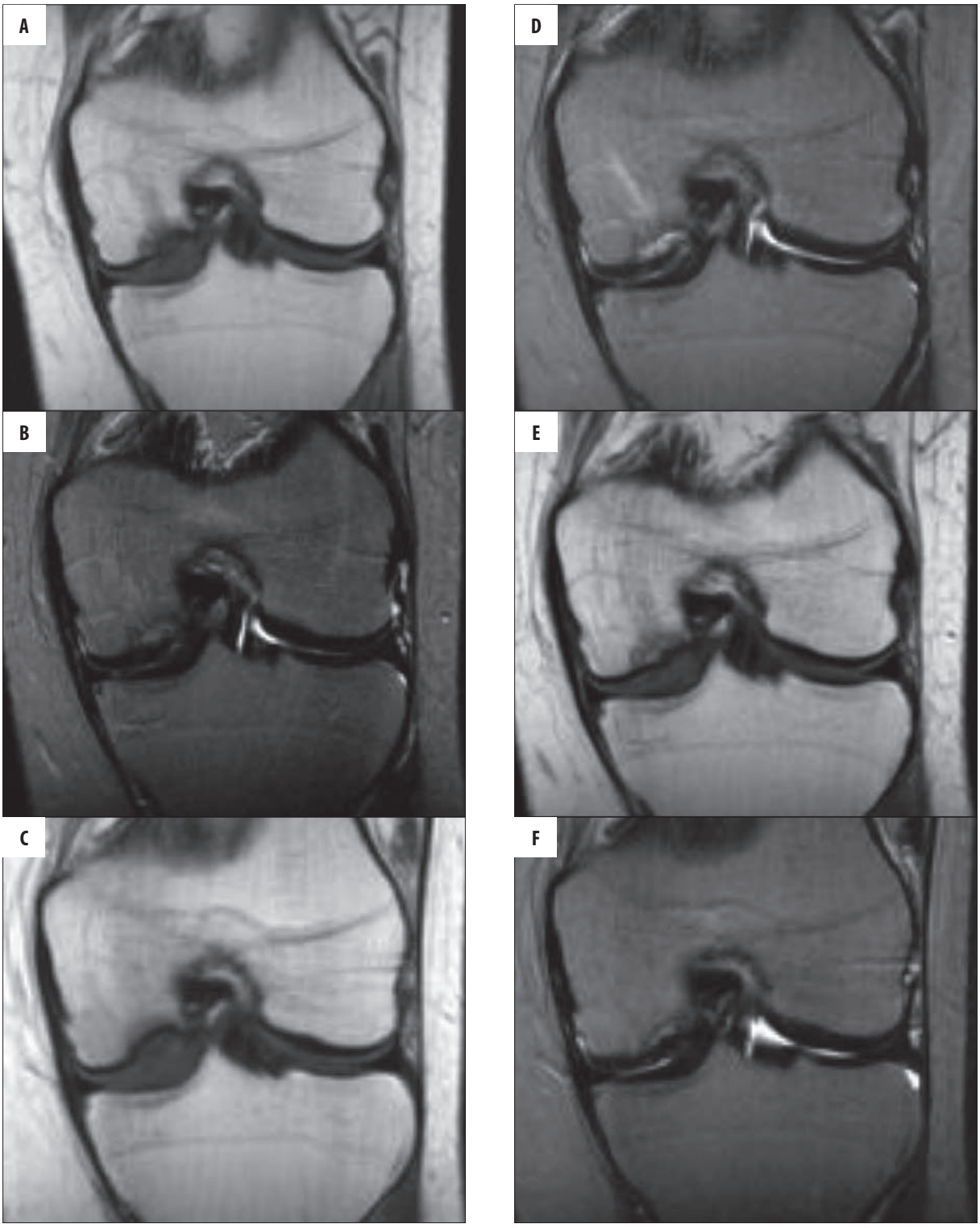
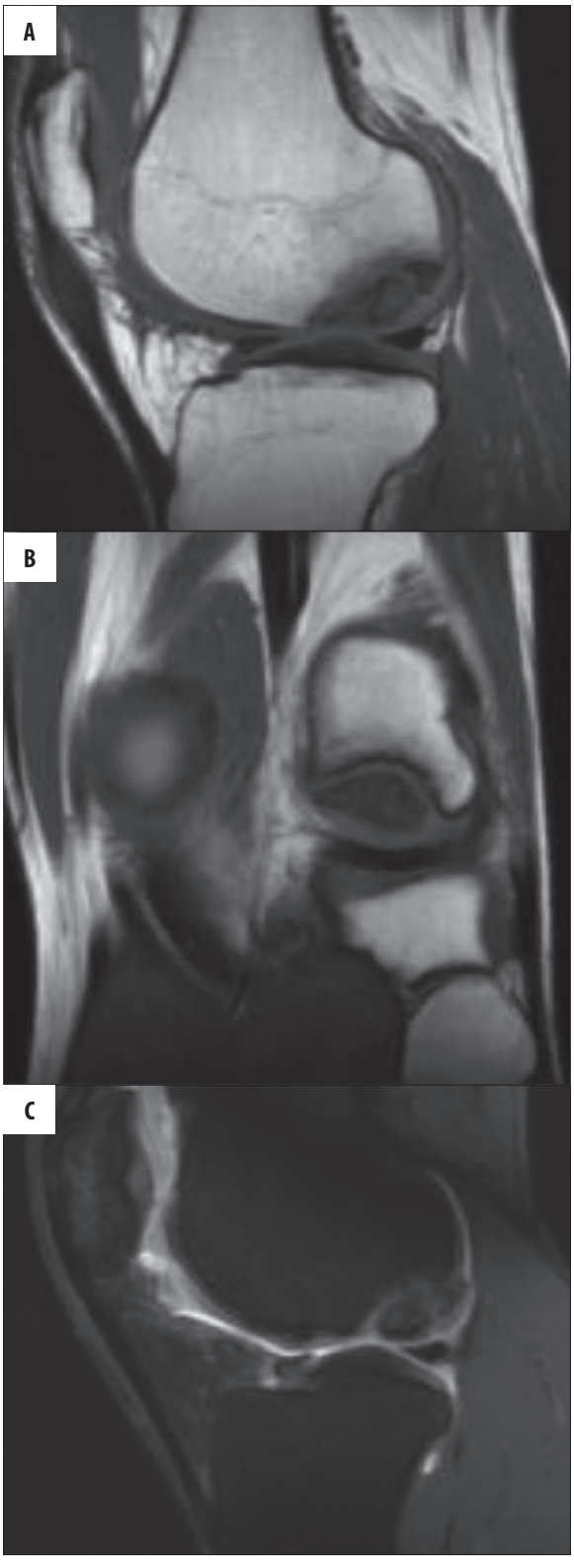


Figure 4. The evolution of MR morphology of an OCD lesion after arthroscopic drilling. (**A,B**) small type I lesion; (**C,D**) 9 months later: demarcation of the lesion with edema within the lesion and in the adjacent bone; (**E,F**) 4 months later: the healing of the lesion manifested by signal intensity resembling the normal bone.

It should be emphasized that despite considerable dynamics of symptoms observed in MR the clinical course of the disease in our patients was much less dramatic. Almost in all cases, treatment resulted with regression of symptoms and improvement of the joint function. Only in 1 patient who after transient clinical improvement neglected the recommendations concerning limited physical activity and went to a skiing camp the symptoms aggravated with confirmation of OCD focus stability loss in control MR (Figure 5).



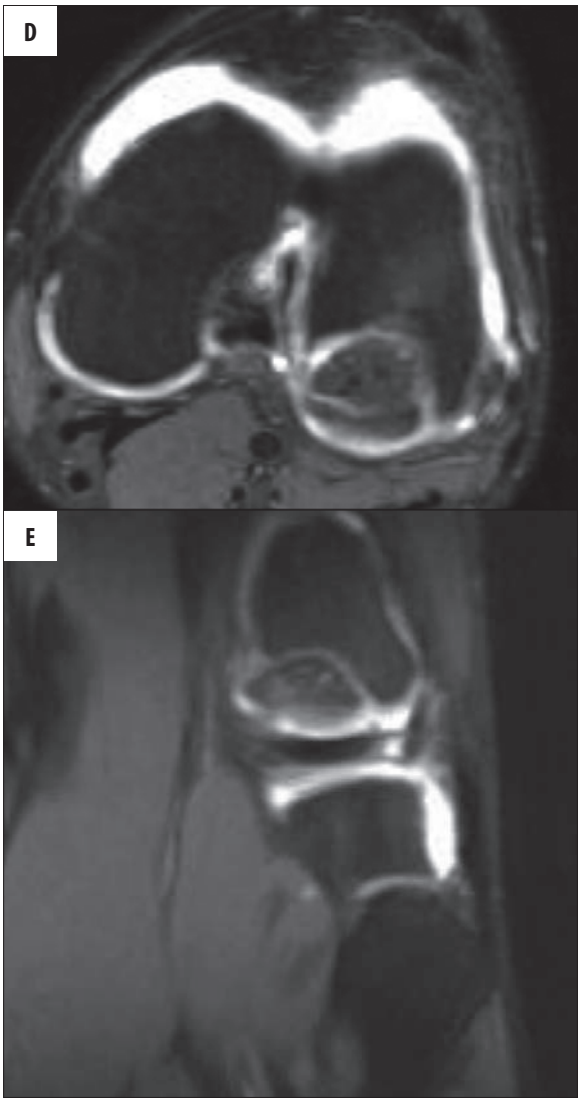


Figure 5. Failure of treatment due to inadequate patient's cooperation. (**A,B**) a large OCD lesion covered with thickened articular cartilage in the posterior part of the lateral femoral condyle; (**C–E**) MR arthrography: the fragment is replaced posteriorly and contrast medium penetrates into the crater through the defect in the articular cartilage

Conclusions

1. MR performed at an early stage of healing of OCD type changes can cause interpretation difficulties associated with the possibility of transient deterioration of the lesion.

2. Arthrography visualizing the penetration of contrast into the lesion site, or contrast-enhanced scans can be helpful in differential diagnostics. Routine use of these methods, however, would eliminate the non-invasiveness, which is an advantage of MR.

3. Postoperative evaluation of OCD should be based primarily on clinical assessment, with optional use of MR as a control examination later in the follow-up period or in patients with clinical signs suggestive of deterioration.

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