

Magnetic Resonance Imaging of Osteochondritis Dissecans: Validation Study for the ICRS Classification System

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Rationale and Objectives: In this retrospective case series, we utilize arthroscopy as the gold standard to determine if magnetic resonance imaging (MRI) of the knee can predict osteochondritis dissecans (OCD) lesion stability, the most important information to guide patient treatment decisions. It is hypothesized that the classification system of the International Cartilage Repair Society (ICRS) will allow for improved assessment of lesion grade and stability in OCD.

Materials and Methods: Routine MRI studies of 46 consecutive patients with arthroscopically proven OCD lesions (mean age: 23.7 years; 26 male, 16 female) were assessed by three radiologists who were blinded to arthroscopic results. Arthroscopic images were evaluated by two orthopedic surgeons in consensus. The OCD criteria of the ICRS were applied to arthroscopy and imaging interpretations. Inter-rater correlation statistics and accuracy of magnetic resonance (MR) grading with respect to arthroscopy were determined.

Results: Only 56% of the available MR reports assigned a label of stable or unstable to the lesion description. Of these, 58% of the lesions were deemed unstable and 42% were stable. Accuracy was 53% when reports addressed stability. Utilizing the ICRS classification system, for all three readers combined, the respective sensitivity, specificity, and accuracy of MR imaging to determine lesion stability were 70%, 81%, and 76%. When compared to the original MRI report, the overall accuracy increased from 53% to 76% when readers were given the specific criteria of the OCD ICRS classification. However, inter-reader variability remained high, with Krippendorff's alpha ranging from 0.48 to 0.57.

Conclusions: In this paper, we utilize arthroscopy as the gold standard to determine if MRI can predict OCD lesion stability, the most important information to guide patient treatment decisions. To our surprise, the analysis of the existing radiology reports that addressed stability revealed an overall accuracy in defining OCD lesion stability of about 53%. The classification system of the ICRS, created by an international multidisciplinary, multi-expert consortium, did markedly improve the accuracy, but consistency among different readers was lacking. This retrospective study on OCD reporting and classification highlights the inadequacy of existing classification schemes, and emphasizes the critical need for improved diagnostic MRI protocols in musculoskeletal radiology in order to propel it toward evidence-based medicine.

Key Words: Osteochondritis dissecans; knee; magnetic resonance imaging; grading scales.

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INTRODUCTION

Osteochondritis dissecans (OCD) is the term first utilized in 1887 (1) to describe the occurrence of a progeny osteochondral fragment separated from the

parent bone. The etiology remains controversial (2) considering genetic (3), traumatic (4,5), and vascular causes (6). In the knee, OCD most commonly occurs in the central aspect of the medial femoral condyle, followed by the lateral femoral condyle, the trochlea, and the patella (7). Treatment of OCD largely depends on the presence or absence of stability of the progeny and the parent bone (8,9). Surgical fixation is recommended for stable OCD lesions that have failed nonoperative management, as well as for all unstable lesions (9,10).

There is a general consensus that OCD lesion stability is determined based on both clinical and radiological examinations (11–14). Magnetic resonance imaging (MRI) has been shown to be reliable in predicting the stability of OCD once a patient's physis has closed (15). However, the same research

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has shown poor correlation between magnetic resonance (MR) findings and stability on arthroscopy prior to skeletal maturity (15). Another study concluded that MRI should not be used in isolation to assess lesion stability in juvenile OCD (16). Frequently, stability is not specifically assessed on preoperative imaging reports. This has left the preoperative diagnosis of stability to be heavily based on clinical rather than imaging findings (9).

There are several arthroscopic classification systems that have been used (17). The International Cartilage Repair Society (ICRS) has attempted to create a more standardized and universally accepted system (17,18). As higher grades are more likely to be unstable and need intervention, there is a utility to using a corresponding grading system in preoperative MR imaging (19).

The purpose of this study was to determine the accuracy and inter-rater variability of MR diagnosis of grade and stability of OCD in the knee as compared to the gold standard of arthroscopy using the ICRS classification system for both MRI and arthroscopic assessment. In this study, it is hypothesized that lesion grade and stability determination in OCD will be more accurate and consistent with specific assessment criteria than without.

MATERIALS AND METHODS

Study Design and Patient Selection

This study was a retrospective review of consecutive patients with OCD of the knee from November 2006 through May 2014. The study was approved by the local institutional review board and performed in accordance with the Health Insurance Portability and Accountability Act (HIPAA) guidelines. Inclusion criteria were OCD in the knee, preoperative MR imaging, and arthroscopic images and report. Exclusion criteria were prior surgery on the same knee, nondiagnostic MR images, and nondiagnostic arthroscopic images.

MR Examination

Patients underwent MR imaging at multiple clinical imaging sites, and studies were deemed to be of diagnostic quality by two board-certified radiologists (8 years and 7 years of experience, respectively) with fellowship training in musculoskeletal (MSK) radiology. All studies contained at a minimum axial, coronal, and sagittal fluid-sensitive (proton density [PD] or T2-weighted) sequences with or without fat saturation.

Several other imaging characteristics that have been associated with OCD were determined. These characteristics consist of bone marrow edema deep to the lesion, fluid signal at the interface between normal bone and the lesion, hypointense linear signal deep to the fluid signal, cartilage disruption, cartilage edema, cartilage thickening, hypointense signal in the cartilage, and overall size of the lesion (15,19–21).

TABLE 1. (A) MRI Grading of Osteochondral defects (ICRS Classification System for OCD Lesions) and (B) International Cartilage Repair Society (ICRS Classification System for OCD Lesions)

(A)

Grade 1: Thickening of cartilage without disruption

1a: Bone marrow edema

1b: Fluid at lesion–bone interface

Grade 2: Cartilage breached, fluid at interface, but not entire interface

Grade 3: Cartilage completely disrupted with fluid interface surrounding lesion

Grade 4: Displaced fragment

Dipaola et al. (1991) (19)

(B)

ICRS OCD I: Stable lesions with a continuous but softened area covered by intact cartilage

ICRS OCD II (A with intact cartilage, B cartilage lesion): lesions with partial discontinuity at the lesion and bone interface that are stable when probed

ICRS OCD III (A intact articular cartilage, B cartilage lesion): lesions with a complete discontinuity that are not yet dislocated (“dead in situ”)

ICRS OCD IV: Empty defects and defects with a dislocated fragment or a loose fragment within the bed

Brittberg and Winalski (2003) (18)

MRI, magnetic resonance imaging; OCD, osteochondritis dissecans.

Following this, an overall grade and stability on MR imaging was determined by the same two board-certified radiologists with MSK fellowship training (MR readers 1 and 2), as well as an MSK radiology fellow (MR reader 3). Grading was based on previously published standards (19), as well as subcategories based on additional cartilage imaging features (Table 1A). During the collection of imaging features, and grading and determination of stability, image reviewers were blinded to the operative findings as well as to the initial MR interpretation. Additionally, a retrospective review of the MR reports was performed when report was available (34 of 42 total cases [81%]) for the presence of a grade or determination of stability.

Arthroscopic Evaluation

Two orthopedic surgeons with fellowship training and subspecialty board certification in sports medicine reviewed arthroscopy images. Through this review, an overall grade based on the ICRS arthroscopic criteria (Table 1B) and determination of the presence or absence of stability was made (18). The two surgeons reviewed each case independently. On cases where there was a discrepancy between the two interpretations (16 cases, 38%), a consensus agreement was reached between the two.

Statistical Analysis

Inter-rater correlation statistics, accuracy of MR grading with respect to the standard of arthroscopic review, and accuracy of the initial MRI reports were determined using Krippendorff's alpha.

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