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The Knee

Reliability of predictive models for non-operative healing potential of stable juvenile osteochondritis dissecans knee lesions

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ABSTRACT

Background: While juvenile osteochondritis dissecans (JOCD) lesions have greater healing potential than equivalent lesions in adults, only 50% of JOCD lesions demonstrate radiographic healing after six months of non-operative treatment. Two previous studies have produced nomograms to predict a patient's probability of healing with non-operative treatment based on patient and lesion characteristics. The purpose of this study was to determine inter- and intra-observer reliability of the predictive nomograms.
Methods: A consecutive series of 34 skeletally immature patients (40 knees), who underwent non-operative treatment for stable JOCD lesions was retrospectively reviewed. At two time points at least one week apart, two medical students, two orthopaedic surgeons, and a radiologist made measurements of the JOCD lesions. These measurements, along with patient ages and pain type, were used to generate a point value for each lesion based on both nomograms. Intra-class correlations (ICCs) were calculated to determine inter- and intra-rater reliability.
Results: We found near perfect intra-rater correlation (ICC) for all raters' individual OCD measurements, as well as total point score for the two nomograms (ICC range, 0.780–0.929). Additionally, there was near perfect inter-rater reliability among raters for total scores and individual components of each nomogram (ICC range, 0.721–0.974).
Conclusions: There is high inter- and intra-rater reliability for both point systems for predicting healing of JOCD lesions. Clinicians should be aware of these as tools to help guide decision making in patients with JOCD lesions.

1. Introduction

Osteochondritis dissecans (OCD) of the knee is an idiopathic joint disorder in which a small fragment of subchondral bone detaches from the surrounding region, often causing secondary damage to the articular cartilage. OCD lesions are a common cause of knee pain and have been associated with the development of osteoarthritis [1]. Juvenile osteochondritis dissecans (JOCD) lesions are those occurring in skeletally immature patients. Several authors have found that JOCD lesions have a higher healing potential than such lesions occurring in the skeletally mature [2,3]. In fact, an open distal femoral physis is the best predictor for successful nonoperative management [4].

Despite the improved prognosis of JOCD lesions, only 50% demonstrate radiographic healing after six months of non-operative treatment [1,5]. Plain radiographs are routinely used to diagnose and monitor patients with JOCD lesions. However, in order to determine the stability of

the JOCD lesion, magnetic resonance imaging (MRI) has become the gold standard [2]. Stability of the lesion is assessed based on its size, the status of subchondral bone and cartilage, the signal intensity surrounding the lesion and the presence of loose bodies [5–7].

Krause et al. and Wall et al. have described models to predict the potential of a JOCD lesion to heal without surgical intervention based on patient and lesion characteristics [8,9]. Wall et al. [9] reviewed a series of 42 patients with stable JOCD lesions, which they defined as a lesion that showed no breach of the surrounding articular cartilage or the subchondral bone-lesion interface as determined on MRI. All patients were initially treated with six months of non-operative management and then reassessed with clinical exams and plain radiographs of the knee at six months. The maximum width (measured on coronal proton density or T1-weighted images) and depth (measured on sagittal proton density or T1-weighted images) of each lesion was normalized to the width and depth of the respective condyle. After six months of non-operative treatment, which included weight-bearing immobilization in a cylinder cast, the JOCD lesion was evaluated for radiographic evidence of healing. The researchers demonstrated that for every 5% decrease in normalized lesion size, the healing potential increased by 5.36-

fold. Furthermore, lesions found in patients who were asymptomatic were more likely to heal than those who presented with pain and other associated symptoms (i.e. swelling, locking or clicking).

Similarly, Krause et al. [8] reviewed a series of 62 patients (76 knees) with stable JOCD lesions. Patients were evaluated clinically and lesions were assessed via MRI at initial presentation, after six months of non-operative treatment and after one year of non-operative treatment. In this series, JOCD lesions with signs of instability, including high fluid signal intensity, multiple breaks in the subchondral plate, or a second outer rim of low T2-weighted signal intensity were excluded [10]. The researchers measured maximum cyst-like lesion (CLL) width, if present, in addition to the data collected by Wall et al. The non-operative treatment consisted of an initial four week period of partial weight bearing followed by gradual progression to full weight bearing. The authors defined healing or progression toward healing as a reduction in lesion size of at least 15% and a reduction of high signal around the lesion. In this series, the patient's age, maximum cyst-like lesion width and normalized lesion width were all significant predictors of healing in this sample. Krause et al. also demonstrated the Wall et al. nomogram to be moderately accurate for predicting healing status after six months of non-operative management.

The reliability of such models in clinical practice is not known. The purpose of this study was to determine inter- and intra-observer reliability of the predictive nomograms.

2. Patients

After obtaining Institutional Review Board approval, billing records were queried for all patients aged 18 years or younger who were diagnosed with an OCD lesion by a single surgeon at our institution between 2008 and 2014. This search identified a consecutive series of 201 patients (214 OCD knees). Cases were excluded if the patients were skeletally mature (98), underwent surgical intervention for their OCD lesion (35) or did not have longer than one year MRI follow-up (41). This yielded a total of thirty-four patients (40 knees) for inclusion in the study. A musculoskeletal radiologist evaluated the JOCD lesions for radiographic evidence of stability and all 40 lesions were determined to be stable on imaging.

3. Methods

At two time points at least one week apart, two medical students, two orthopaedic surgeons, and a radiologist made measurements of the JOCD lesions as described by Krause et al. and Wall et al.

3.1. Radiographic measurements

OCD lesion and condyle measurements were performed on sagittal and coronal proton-density (PD) and/or T1-weighted MRI sequences with the use of electronic calipers (Figs. 1 & 2). Maximum OCD lesion length was defined as the greatest linear distance within the boundaries of the OCD lesion in the sagittal view, and maximum OCD lesion width was defined as the greatest linear distance within the boundaries of the OCD lesion in the coronal view. Condyle length was defined as the greatest horizontal distance within the boundaries of the femoral condyle in the sagittal view, and maximum femur width was defined as the greatest horizontal distance within the boundaries of the femoral condyle in the coronal view.

Cyst-like lesion (CLL) measurements were performed on sagittal inversion recovery (IR) MRI sequences with the use of electronic calipers. CLL size was defined as the greatest linear width within the boundaries of the CLL (Fig. 3). These measurements, along with patient age, were used to generate a point value for each lesion based on both the Krause and Wall models [8,9].
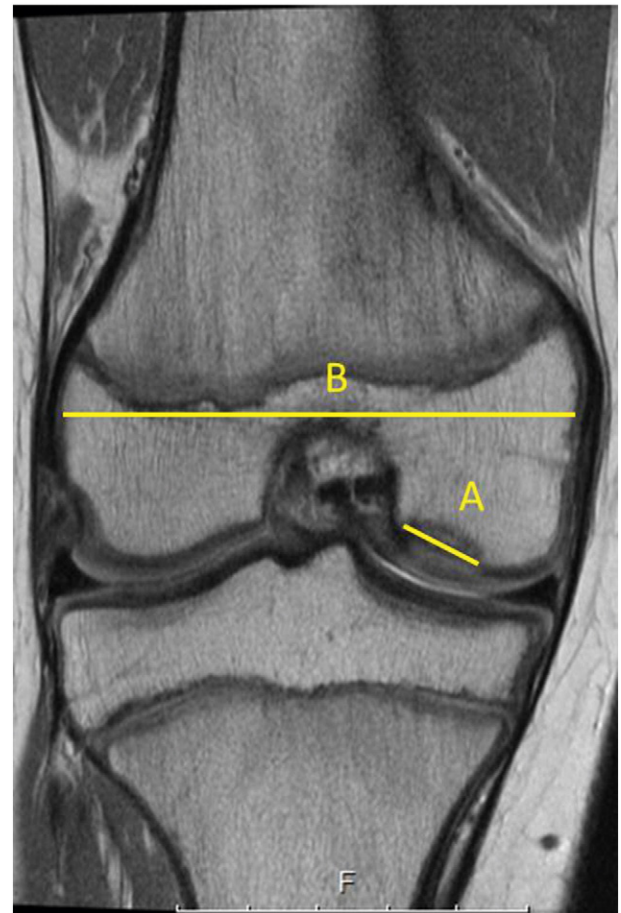
Fig. 1. Coronal measurements. Coronal proton density (PD) MRI sequence demonstrating measurements of maximal OCD lesion width (A) and maximal femoral condyle width (B). Normalized lesion width was calculated as the ratio of these two measurements.

3.2. Statistical methods

Data management and statistical analyses were performed using SAS® 9.3 (SAS Institute, Inc., Cary, NC). Intra-rater reliability and inter-rater reliability were evaluated using interclass correlation coefficients (ICCs). To assess the precision of our estimates, 95% confidence intervals (95% CI) were calculated.

4. Results

4.1. Intra-rater reliability

Based on the Landis & Koch threshold [11], we found near perfect intra-observer correlation for all raters for individual OCD measurements (width of lesion in sagittal and coronal planes, total bicondylar width in the coronal plane, condylar width in area of lesion in sagittal plane, and cyst-like lesion width), as well as total point score as calculated by both Krause (ICC = .772–.901) and Wall methods (ICC = .831–.937) (Table 1).

4.2. Inter-rater reliability

Additionally, amongst the five raters there was near perfect inter-rater reliabilities in total scores (ICC = 0.857 for the Wall et al. total score and ICC = 0.843 for Krause et al. total score), as well as substantial to near perfect reliability in measuring the individual components of the scores (ICC = 0.780-0.929) (Table 2).

5. Discussion

There is high inter- and intra-rater reliability for both the Krause and Wall point systems for categorizing JOCD lesions. These models