Comparison of five radiographic views for assessment of the medial aspect of the humeral condyle in dogs with osteochondritis dissecans

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Objective—To compare 5 radiographic views for the detection of osteochondritis dissecans (OCD) in dogs with signs of elbow joint pain.

Animals—53 dogs (100 elbow joints) with forelimb lameness and signs of elbow joint pain.

Procedures—Mediolateral (ML), flexed ML, craniocaudal (CC), craniolateral-caudomedial oblique (Cr15L-CdMO), and distomedial-proximolateral oblique (Di35M-PrLO) radiographic views of the 100 elbow joints were obtained. Four examiners graded radiographs with regard to elbow joint OCD. Joints were assessed by use of arthroscopy. Receiver operating characteristic (ROC) curves, kappa measure of agreement, and Fisher exact tests for association between median diagnostic value and actual status were computed.

Results—47 joints had an abnormal medial aspect of the humeral condyle (MAHC), and among them, 11 had OCD. The presence of fractures of the medial coronoid process was significantly and positively correlated with the presence of abnormalities of the MAHC (r = 0.40), but was negatively correlated with the presence of OCD (r = −0.32). At 95% specificity, median sensitivities to detect OCD were 57% for Cr15L-CdMO, 56% for CC, 10% for flexed ML, 7% for ML, and 4% for Di35M-PrLO views. The areas under the ROC curves were significantly larger for the Cr15L-CdMO and CC views than for the ML, flexed ML, and Di35M-PrLO views for the detection of OCD. Only the Cr15L-CdMO and CC views allowed accurate detection of OCD.

Conclusions and Clinical Relevance—In dogs with signs of elbow joint pain, the Cr15L-CdMO view is excellent and the CC view was good for detection of OCD. (Am J Vet Res 2010;71:780–783)
methods that would allow evaluation of their diagnostic values regardless of examiner specificity. The purpose of the study reported here was to determine and compare sensitivities and specificities of 5 radiographic views used to assess the presence of abnormalities and OCD lesions of the humeral condyle by use of ROC curve analysis in dogs with pain response to palpation of the elbow joint.9

Materials and Methods

Animals—Radiographs of 53 dogs enrolled in a previous study19 assessing a novel radiographic view aimed at enhancing the detection of fragmentation of the MCP were used. Dogs that were referred to the Clinique Vétérinaire de l’Ouest between June 1997 and July 1999 for forelimb lameness and signs of pain on palpation of the elbow joint were included in this study. Dogs were excluded from the study if they had an orthopedic disease other than elbow joint dysplasia.

Data collection—The CC, Cr15L-CdMO, ML, flexed ML, and Di35M-PrLO views were made for both elbow joints under sedation. All radiographs were made by use of a nonrigid table-top technique with a detailed film-screen system. Intensity ranged from 9.6 to 15 mA, and penetrability ranged from 50 to 60 kVp. Arthroscopy of both elbow joints was performed during general anesthesia by a highly experienced arthroscopist using the medial portals of a 2.7-mm-diameter 30° oblique arthroscope placed in a 3.5-mm-diameter sleeve. The joints were distended and irrigated with lactated Ringer’s solution. The ulnar notch, lateral coronoid process, radial head, humeral capitulum, humeral trochlea, MCP, and medial collateral ligaments were evaluated. The cartilage of the MAHC and MCP was probed. The procedures were recorded on videotape, and the lesions were documented with still pictures. Lesions (fragmentation of MCP and OCD lesions) observed during this examination were curetted or excised. Meloxicam (0.2 mg/kg) was injected IM at the end of surgery for analgesia. The dogs were discharged on the day of surgery.

Four examiners evaluated the radiographs independently and in random order. Examiners included 2 board-certified surgeons and 2 radiology residents. The examiners assessed the medial aspect of the humeral condyle for the presence of OCD and graded each radiograph as definitely normal, probably normal, possibly abnormal, probably abnormal, and definitely abnormal. Arthroscopically, elbow joint OCD was diagnosed when fibrillation or small, partial-thickness lesions were seen. The ROC curve analysis was used to estimate sensitivities of the CC, Cr15L-CdMO, ML, and flexed ML views at estimated specificities of 90% and 95% for the detection of an OCD fragment.9,11

Statistical analysis—The arthroscopic findings were used as the gold standard for statistical analysis. The radiographic findings were compared with the findings of arthroscopy by use of ROC curve analysis.19

Area under the curve of the ROC for the median rating among 4 raters was estimated empirically for detection of an OCD fragment by use of the trapezoid rule.9

Pairwise significance tests of the hypothesis of equal population AUC were conducted.12,15 For each of the 5 views, the κ measure of agreement was computed for all 6 pairs of raters.14 The Fisher exact test was used to test for an association between the diagnosis of OCD provided by use of the median rating of a given view and the actual status of the dog. For these analyses, the median rating was compared with a threshold of possibly abnormal. If the median of the 4 raters was possibly abnormal, probably abnormal, or definitely abnormal, the joints would be diagnosed as having OCD. Pearson correlation coefficients between abnormalities of the MAHC and lesions of the MCP were calculated. Results were considered significant at P < 0.05.

Results

One hundred joints of 53 dogs were included in this study.10 Forty-seven joints had an abnormal MAHC, and among them, 11 joints had OCD of the MAHC. Forty-six of the 47 joints with abnormal MAHC had an abnormal medial coronoid process. The presence of abnormalities (fissures or fractures) of the MCP was positively correlated with the presence of abnormalities of the MAHC (r = 0.41; P < 0.001). The presence of fractures of the MCP was also positively correlated with the presence of abnormalities of the MAHC (r = 0.40; P < 0.001). The presence of abnormalities (fissures or fractures) of the MCP was not correlated with the presence of OCD of the MAHC (r = 0.09; P = 0.380). The presence of fractures of the MCP was negatively correlated with the presence of OCD of the MAHC (r = −0.32; P = 0.001).

At a specificity of 90%, median sensitivities to detect OCD were 84% for the Cr15L-CdMO view, 73% for the CC view, 20% for the flexed ML view, 14% for the ML view, and 7% for the Di35M-PrLO view. At a specificity of 95%, median sensitivities to detect OCD were 57% for the Cr15L-CdMO view, 56% for the CC view, 10% for the flexed ML view, 7% for the ML view, and 4% for the Di35M-PrLO view. The ROC curves representing the detection of OCD of the MAHC by use of the median value of the examiners for each view were

![Figure 1—Receiver operating characteristic curves for detection of OCD of the MAHC in 100 elbow joints of 53 clinically affected dogs calculated on the basis of the median values of 4 independent radiographic readers, compared with findings on arthroscopy. The 5 curves represent the true-positive fraction (sensitivity) of 5 radiographic views to detect OCD at various false-positive fractions (1-specificity). The areas under the curves for the various radiographic views are proportional to the diagnostic values of the views. CC = Cr15L-CdMO view; D = Di35M-PrLO view; FML = flexed ML view.](image-url)
The aim of this study was to compare the diagnostic values of 5 radiographic views to detect OCD lesions of the MAHC in dogs with pain response to palpation of the elbow joint. The radiographic findings were compared with the arthroscopic findings of OCD. We included the Cr15L-CdMO view, an oblique mediolateral projection that has better diagnostic value than other radiographic views to detect the presence of OCD lesions of the MAHC (Table 1). The inter-rater agreement (kappa statistic) was good for the Cr15L-CdMO view, fair for the CC view, and slight for the ML, flexed ML, and Di35M-PrLO views (Table 2). Detection of OCD on Cr15L-CdMO and CC radiographic views was significantly associated with the presence of arthroscopic lesions of the MAHC (P < 0.001 for the Cr15L-CdMO view and CC view), but detection of OCD on ML and flexed ML views was not (P = 0.383 for the ML view and P = 0.110 for the flexed ML view).

**Discussion**

The aim of this study was to compare the diagnostic values of 5 radiographic views to detect OCD lesions of the MAHC in dogs with pain response to palpation of the elbow joint. The radiographic findings were compared with the arthroscopic findings of OCD. We included the Di35M-PrLO view, an oblique mediolateral projection that has better diagnostic value than other radiographic views to detect the presence of an abnormal medial coronoid process.

We anticipated that the Di35M-PrLO view would enhance the detection of OCD lesions, compared with ML and flexed ML views, because the medial and lateral aspects of the condyle are offset on the Di35M-PrLO view but not on the ML and flexed ML views. This was not confirmed by the results of the present study. The ability to detect OCD of the MAHC on the Di35M-PrLO view was probably negatively affected by the fact that the MAHC appeared foreshortened and distorted by superimposition of the ulna and MAHC and by residual superimposition of the medial and lateral aspects of the humeral condyle. Also included was a cranial oblique to humeral incisure (notch) in 101 canine elbow joints. In that report, 8 elbow joints appeared normal via arthroscopy but a lesion of the MCP was detected via computed tomography, suggesting that dogs may have normal cartilage over the MCP as seen arthroscopically, but may also have abnormal subchondral bone in that region.

Several dogs in the present study had a fragmented medial coronoid process. Abnormalities of the MAHC were more likely to occur in joints with fissures or fractures of the MCP than in joints with normal MCP. By comparison, OCD of the MAHC was less likely to occur in joints with fractures of the MCP than in other joints.

We used ROC curve analysis because that method provides more perspective on the value of diagnostic tests than other methods. When a fixed threshold is used to diagnose an abnormality, the personality of a rater might influence the conventional assessment of a diagnostic test. For example, the sensitivity of a test is decreased and its specificity is increased when a rater is conservative in judgment of the test. With ROC curve analysis, however, the diagnostic value of a test is determined across all thresholds, regardless of reader personality. The area under the ROC curve is a description of the overall quality of a diagnostic test: the higher the AUC, the more efficient a test is to discriminate between diseased and disease-free populations. In recent veterinary publications, the area under ROC curves for tests that were considered accurate by the investigators varied between 0.94 and 0.88. The Cr15L-CdMO and CC views were in that range for detection of OCD of the MAHC.

In the present study, arthroscopy was used as a gold standard for the assessment of kissing and OCD lesions of the MAHC because it allows direct inspection of all compartments of the elbow joint. Computed tomography has recently been advocated as a reliable test and compared favorably with arthroscopy to assess fragmentation of the medial coronoid process, kissing lesions on the humeral condyle, and irregular radial incisure (notch) in 101 canine elbow joints. In that report, 8 elbow joints appeared normal via arthroscopy but a lesion of the MCP was detected via computed tomography, suggesting that dogs may have normal cartilage over the MCP as seen arthroscopically, but may also have abnormal subchondral bone in that region.

A recent report comparing the detection of osteochondral lesions of the talus in humans identified a sensitivity of 70% (specificity, 94%) for radiographs, 81% (specificity, 99%) for computed tomography, 96% (specificity, 60%) for magnetic resonance imaging, and...
100% (specificity, 97%) for arthroscopy. In that study, arthroscopy and computed tomography were clearly superior to radiographs, and magnetic resonance imaging had a surprisingly low specificity for detection of osteochondral lesions.

Results of the present study indicated that the Cr15L-CdMO view was excellent, the CC view was good, and the 3 ML views were poor for detection of OCD by use of the scoring system proposed by Tape. The observed AUC determined by use of the Cr15L-CdMO view was greater than that for the CC view, although the difference was not significant. The sensitivities of the Cr15L-CdMO and CC views to detect OCD lesions (84% and 73% at 90% specificity and 57% and 56% at 95% specificity, respectively) were higher than those reported in a study involving 18 dogs (sensitivity, 46%). This discrepancy may have resulted from differences in the grading system and the relatively small sample size of the previous study. In the present study, inter-rater agreement was moderate for the Cr15L-CdMO view, fair to moderate for the CC and ML views, and poor to fair for the flexed ML view. The inter-rater agreement of the Di35M-PrLO view ranged from no agreement to fair for the flexed ML view. The inter-rater agreement was moderate for the Cr15L-CdMO view, fair to moderate for the CC and ML views, and poor to fair for the flexed ML view. This most likely resulted from differences in the grading system and the relatively small sample size of the previous study.

The Fisher exact test was used to investigate the accuracy of the under the median grade of the 4 raters, using a given view to diagnose OCD. These analyses were conducted to quantify the amount of evidence against the null hypothesis that the diagnosis was unrelated to the actual status of the dog with regard to OCD. The Fisher exact tests computed the probability of observing entries within at 2 × 2 contingency table that were more contradictory of the null hypothesis, while having the same fixed row and column totals. It was not possible to obtain a P value for the Di35M-PrLO view because none of the dogs had a median rating exceeding 3 by use of this view and the contingency table had 0 entries for the positive diagnosis. This most likely resulted from lack of rater confidence with regard to the presence of OCD when reading Di35M-PrLO views.

Results indicated that the Cr15L-CdMO view was excellent and the CC view was good for detection of OCD of the MAHC in dogs with a pain response to palpation of the elbow joint. The ML, flexed ML, and Di35M-PrLO views had low diagnostic value for detection of OCD lesions.

References