Meniscal Mineralization in Domestic Cats

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Submitted May 2009; Accepted August 2009

DOI:10.1111/j.1532-950X.2010.00648.x

Objective: To (1) determine prevalence of radiographically detectable meniscal mineralization in domestic cats and (2) to evaluate the association between meniscal mineralization and degenerative joint disease (DJD).
Study Design: Prospective study.
Animals: Client-owned cats (n = 100) and 30 feline cadavers.
Methods: Randomly selected client-owned cats were used to determine the prevalence of meniscal mineralization. Stifles from feline cadavers were used to evaluate the relationship between meniscal mineralization (using high-resolution X-ray), radiographic DJD, and cartilage damage. Menisci were evaluated histologically.
Results: Forty-six percent of the client-owned cats had meniscal mineralization detected in 1 or both stifles. Pain scores were not significantly different between stifles with meniscal mineralization and those with no radiographic pathology ($P = .38$). Thirty-four of 57 cadaver stifles had meniscal mineralization, which was always located in the cranial horn of the medial meniscus. Percentage mineralization of the menisci was significantly correlated with the cartilage damage score of the medial femoral ($r^2 = 0.6$; $P < .0001$) and tibial ($r^2 = 0.5$; $P < .0001$) condyles as well as with the total joint cartilage damage ($r^2 = 0.36$; $P < .0001$) score and DJD score ($r^2 = 0.8$; $P < .0001$).
Conclusion: Meniscal mineralization is a common condition in domestic cats and seems to indicate medial compartment DJD.
Clinical Relevance: Clinical significance of meniscal mineralization is uncertain. Further work is needed to determine if the meniscal mineralization is a cause, or a consequence of joint degeneration.

Meniscal mineralization is a poorly understood condition that has been reported in reptiles, rodents, birds, nondomestic cats, and nonhuman primates.[1–4] Although described in people, it is considered a rare condition[5–12] and there have been a few case reports in dogs and domestic cats.[1,13,14]

The cause of meniscal mineralization (meniscal ossification[1,2,11–15]; meniscal ossicles[6–11,16]; meniscal calcification[1,5,13]) is unknown. Developmental (phylogenetic) and posttraumatic causes have been suggested in people.[6,7,10,12] The phylogenetic theory suggests that meniscal mineralization represents a congenital vestigial structure that should be interpreted as a variant of normal anatomy.[6,7] The posttraumatic theory asserts that meniscal mineralization is acquired by degeneration or metaplasia after isolated or recurrent trauma.[7] It has been suggested that meniscal mineralization is a normal anatomic feature in nondomestic cats,[2] a primary vestigial anomaly in dogs and cats,[1,14] and to occur secondary to trauma or in association with cranial cruciate ligament rupture in dogs and cats.[1,13]

The frequency of occurrence of meniscal mineralization in domestic cats is unknown. It is also unknown if meniscal mineralization is associated with joint pain or lameness or if meniscal mineralization is associated with degeneration of joint tissues such as cartilage.

Our purpose was to determine prevalence of radiographically detectable meniscal mineralization in domestic cats. We hypothesized that the prevalence was high (> 30%) and further, that meniscal mineralization is

Study was funded by a grant from Novartis Animal Health through their global Fellowship Research Program

associated with degenerative joint disease (DJD), as indicated by cartilage degeneration.

MATERIALS AND METHODS

We conducted a prospective, observational study. Part I established the prevalence of radiographically detectable meniscal mineralization in domestic cats and part II evaluated the relationship between meniscal mineralization and DJD measured by cartilage damage.

Cats

Prevalence Study. A population of 100 client-owned cats randomly selected from the client database of Morrisville Cat Hospital (Morrisville, NC) was used to determine the prevalence of radiographically detectable meniscal mineralization.

Cadaver Study. Thirty adult cats euthanatized (population control) at a county animal shelter were studied. We aimed to recruit 30 cats of any age, equally distributed between cases with and without radiographically detectable meniscal mineralization, with no other detectable stifle pathology.

Prevalence Study

Using a database of 1640 cats from a single veterinary practice, a population of 100 cats was randomly selected for study. To achieve this, the cats in the database were divided into 4 age groups (0–5; 5–10; 10–15; and 15–20 years old). Cats that were exactly 5, 10, or 15 years old were assigned to the 6 months–5 years, 5–10 years, and 10–15 years groups, respectively. Within each age group, each cat was assigned a unique number, and then the cats in each group were randomly ranked using computer software. The first 25 cats in each group whose owners were willing to participate in the study were included. Once selected, each cat was evaluated, sedated, and orthogonal radiographic projections of the stifle joints taken using an indirect digital flat panel imaging system (Canon Medical CXDI-50G Sensor, Eklin Medical Systems, Santa Clara, CA).

Digital radiographs made were evaluated by 2 board certified radiologists (A.P., J.B.) and a board certified surgeon (B.D.X.L.) for radiographically detectable pathology including meniscal mineralization. Digital radiographs were viewed (Dell Ultra-sharp 2407WFP color monitors, 24" LCD resolution of 1920 × 1200) and standard medical image viewing software (eFilm 2.1.2, Merge Healthcare, Milwaukee, WI). Radiologic features considered indicative of presence of DJD were: joint effusion, osteophytes, enthesiophytes, joint associated mineralization, sclerosis, subchondral bone erosions-cysts, and presence of intra-articular mineralizations. Meniscal mineralization was considered under intra-articular mineralization as a mineralization detected in the intra-articular space, and which appeared to be located within the area of the lateral or medial menisci in both craniocaudal and mediolateral projections of the stifle (Fig 1). A scale (0–4) was used for grading of severity of each of the radiographic changes identified (0 = normal; 1 = trivial; 2 = mild; 3 = moderate; 4 = severe). A subjective radiographic DJD score (0–10) where 0 = no radiographic abnormalities identified and 10 = ankylosis, was assigned to each stifle based on the presence of radiographic change and its severity. Age, weight, body condition score (BCS; http://www.ivis.org/journals/vetfocus/16_1/en/7.pdf), breed, and sex of the cats were recorded. During orthopedic evaluation, the response to

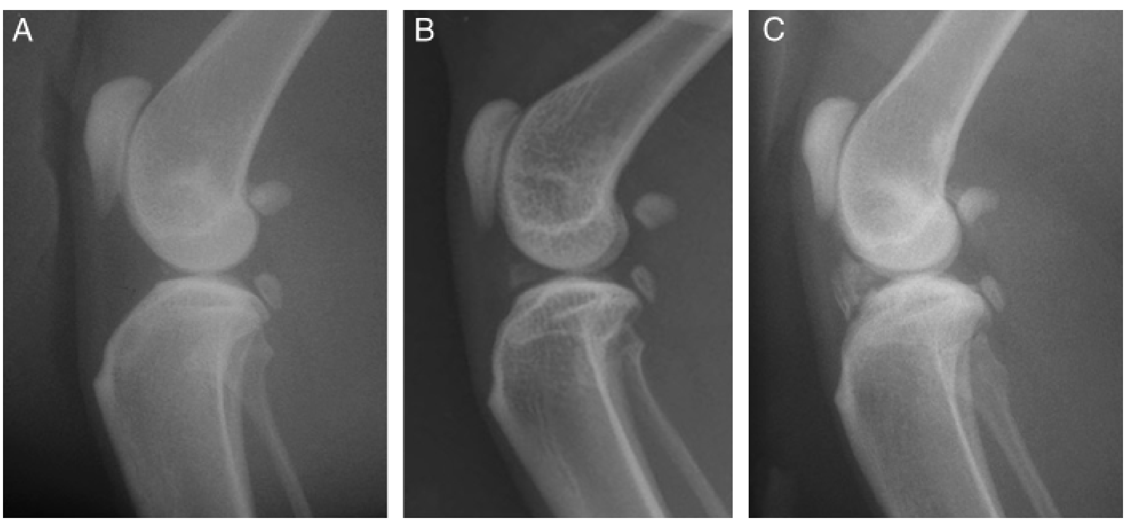

Figure 1 The severity of radiographically detectable meniscal mineralization was graded using a scale from 0–4 (0 = normal; 1 = trivial; 2 = mild; 3 = moderate; 4 = severe). The stifle digital radiographs from cadaver specimens show meniscal mineralizations graded as trivial (A), moderate (B), and severe (C).

palpation of every joint and part of the axial skeleton was graded: 0 = no resentment; 1 = mild withdrawal, mildly resists; 2 = moderate withdrawal, body tenses, may orient to site, may vocalize, increase in vocalization; 3 = orients to site, forcible withdrawal from manipulation, may vocalize or hiss or bite; and 4 = tries to escape, prevent manipulation, bite/hiss, marked guarding of area.

Cadaver Study

After euthanasia, body weight and BCS were recorded and an orthopedic examination of each stifle joint was performed. Only cats without grossly detectable stifle pathology (cranial cruciate ligament rupture, patella luxation) were included in the study. The presence of grade I patella luxation was considered acceptable. Orthogonal radiographs of the cadaver stifle joints were acquired using a digital imaging system (described above) and also with a high detail film/screen system (Kodak Lanex Fine screens, Carestream Health, Rochester, NY; Super HR-U × 30 ray film, Fuji Medical Systems, Stamford, CT). Both digital and analog radiographs were evaluated blindly by the same board certified veterinary radiologists and surgeon to determine radiographic scores based on the features described earlier.

Morphologic Examination. Stifle joints were carefully opened to avoid damage to any cartilage surfaces for gross observation. Menisci were dissected from their attachments and retained for evaluation. The surface appearance of the joints was studied for fibrillation and/or erosion of the articular cartilage using India ink application.[17] The cartilage surface was painted with India ink twice, rinsing the cartilage with water each time, 3 minutes after the ink was applied. The severity of surface damage of the articular cartilage was scored based on ink retention, and graded[18]: grade 1 = intact surface: surface appears normal and does not retain any ink; grade 2 = minimal fibrillation: site appears normal before staining, but retains India ink as elongated specks or light gray patches; grade 3 = overt fibrillation: the cartilage is velvety in appearance and retains ink as intense black patches; and grade 4 = erosion: loss of cartilage exposing the underlying bone.

The severity of articular cartilage damage present in each stifle joint was expressed as the total cartilage damage score (TCDS) calculated from the addition of the cartilage damage score (CDS) of 6 articular areas: medial and lateral femoral condyles, medial, and lateral tibial condyles, patella and femoral trochlea. CDS of each of those areas was calculated as the percent of the total articular cartilage area damaged, multiplied by the degree of cartilage damage based on the ink retention grading system. CDS value ranged from 0 to 400 (0 = no cartilage damage; 400 = complete exposure of subchondral bone over the whole of the articular surface of that bone). TCDS and CDS were calculated using the following equations:

$$\text{CDS} = [\%\text{area}_1 \times \text{ink grade}_{\text{area1}}] + [\%\text{area}_2 \times \text{ink grade}_{\text{area2}}]$$

$$\begin{aligned}\text{TCDS} = {} & \text{CDS}_{\text{lat fem condyle}} + \text{CDS}_{\text{med fem condyle}} \\ & + \text{CDS}_{\text{lat tibial condyle}} + \text{CDS}_{\text{med tibial condyle}} \\ & + \text{CDS}_{\text{patella}} + \text{CDS}_{\text{femoral trochlea}}\end{aligned}$$

TCDS value ranged from 0 to 2400 (0 = no cartilage damage present; 2400 = complete exposure of subchondral bone over all articular surfaces).

To calculate CDS and TCDS, digital photographs of the femoral condyles, femoral trochlea, tibial plateau, and patella, after the application of the India ink, were made by photographing these surfaces in exactly the same way each time. Computer software (Adobe Photoshop 7.0, Adobe, San Jose, CA) was used to calculate the percent of the cartilage area retaining India ink as a result of cartilage fibrillation. Despite the fact that some of the surfaces being measured were curved, pilot work established that the use of X-ray film or thin plastic compared with digital photographs to measure damaged areas resulted in significantly greater variance, and small areas of cartilage damage were difficult to define through the plastic.

Imaging. High detail radiographs (Faxitron X-Ray system, Fuji Medical X-Ray Film; Super HR-U 30; Fujifilm; Stamford, CT; 30 kV, 40 seconds) of menisci from the stifle joints were evaluated looking for presence of meniscal mineralization. Location and number of discrete areas of mineralization were described. High detail radiographic images were digitized (1.5″ by 3″ radiographs photographed using Nikon D2 × 10MP 35 mm digital camera, producing images of 4288 × 2848 pixels) and using computer software (Adobe Photoshop 7.0) the calcified area of the meniscus was calculated and expressed as a percent of the total area of the meniscus (%Min_{FAX}).

Microscopy. Harvested menisci were fixed in 10% formalin for 48 hours. Menisci that could not be cut were decalcified in formic acid solution for 24–48 hours. After fixation and decalcification, menisci were divided into 3 with 2 cuts oriented radially to the peripheral margin of the meniscus, creating cranial, middle, and caudal sections. Meniscal segments were sectioned, stained with hematoxylin and eosin and evaluated histologically. In every case with radiographically detectable mineralization, sectioning was continued until the area of mineralization was identified histologically.

Statistical Analysis

Descriptive statistics were used to describe the prevalence of meniscal mineralization in the clinical population. Cats with no radiographic stifle pathology and those with only meniscal mineralization were compared for age, weight, BCS, and sex of cat, using t-tests, χ^2-tests, and Kruskal–Wallis tests. Individual stifles with no radiographic stifle pathology and those with only meniscal mineralization were compared for pain on manipulation using a Kruskal–Wallis test.

For the cadaver study, using $\%Min_{FAX}$ as the gold standard for the detection of meniscal mineralization, the sensitivity and specificity of digital and (traditional) analog high-detail film/screen radiographs were calculated. Subjective total DJD scores between stifles with and without meniscal mineralization were compared using the Kruskal–Wallis test. Nonpaired t-tests were used to compare TCDS and CDS between stifles with and without meniscal mineralization. A correlation coefficient was calculated to describe the relationship between the $\%Min_{FAX}$ and CDS and TCDS of the joint surfaces, as well as with the subjective total DJD score. Values of $P < .05$ were considered significant.

RESULTS

Prevalence Study

Twenty-five cats in each age group were successfully recruited and studied; 18 were pure-bred and 82 were domestic short or long hair. There were 40 male castrated (MC) and 60 female spayed (FS). Mean ($\pm$SD) age was 9.42 ± 5.05 years and mean weight was 5.12 ± 1.63 kg (range, 2.08–10.16 kg).

Forty-six cats had meniscal mineralization detected in one or both stifles (27 cats bilateral, 19 cats unilateral). In those cats with unilateral meniscal mineralization, the right stifle was affected in 10 and the left stifle in 9 cats. Cats with meniscal mineralization were 17 castrated males and 29 spayed females with a mean age of 10.70 ± 4.73 years and mean weight of 4.92 ± 1.57 kg. Fifty-four cats (54%; 17 castrated males, 31 spayed females; mean age, 8.33 ± 5.13 years; mean weight, 5.80 ± 1.7 kg) had no meniscal mineralization detected on digital radiographs. Of 100 cats evaluated, 21 (21%) had meniscal mineralization as the only radiographic change detected on digital radiographs of the stifles, and 36 cats (36%) had no radiographic signs indicative of any stifle pathology. Cats with meniscal mineralization were significantly older (10.50 ± 5.2 years; $P = .027$), weighed significantly less (4.57 ± 1.46 kg; $P = .043$) and were of significantly lower BCS (median, 2; range, 1–5; $P = .039$) than those with no radiographic stifle pathology (age, 7.46 ± 4.64 years; weight, 5.50 ± 1.71 kg; median BCS, 3 [range, 2–5]).

Of 200 stifles evaluated, 73 (37%) had meniscal mineralization identified on digital radiographs. Of the affected stifles, 54 (27% of all stifles) had no other radiographic signs of DJD besides meniscal mineralization. There was no significant difference between the pain scores for stifles with no radiographic pathology and those with only meniscal mineralization ($P = .38$).

Cadaver Study

Of 30 cats, 3 stifles were excluded: 1 because intra-articular mineralization other than meniscal mineralization was identified in both stifles (the origin of those mineralizations could not be determined on macroscopic examination) and 1 cat had a cranial cruciate ligament rupture in the right stifle. Thus, 57 stifles from 29 cats were included in the analysis. Breeds were domestic short hair (23), domestic medium hair (2), domestic long hair (2), Main Coon (1), and Himalayan (1). There were 6 spayed females, 13 females, 8 castrated males, and 2 males. Mean ($\pm$SD) age of the cats was 9.91 ± 4.61 years, mean weight was 4.8 ± 1.33 kg, and median BCS was 3 (range, 2–5). No significant differences were found in age ($P = .15$), weight ($P = .44$), and BCS ($P = .61$) between cats with and without meniscal mineralization.

Meniscal mineralization was detected on high detail radiographs of medial and lateral menisci in 34 of 57 stifles (60%). Mineralization was located in the cranial horn of the medial meniscus in all instances and partially involved the cranial intermeniscal ligament in 3 stifles. Sixteen cats had bilateral (left and right stifle medial meniscus) mineralization, 1 cat had unilateral meniscal mineralization, 1 cat had bilateral meniscal mineralization but the right stifle was not included because of cranial cruciate ligament rupture, and 11 cats had no meniscal mineralization in either stifle. Mineralization was confined to a single area in 13 (38%) menisci and multiple areas in 21 (62%) menisci. In menisci with mineralization, $\%Min_{FAX}$ had a mean ($\pm$SD) value of $7.83 \pm 11.22\%$ of the total area of the meniscus (range, 1.5–55%; Fig 2). Digital radiographs had a

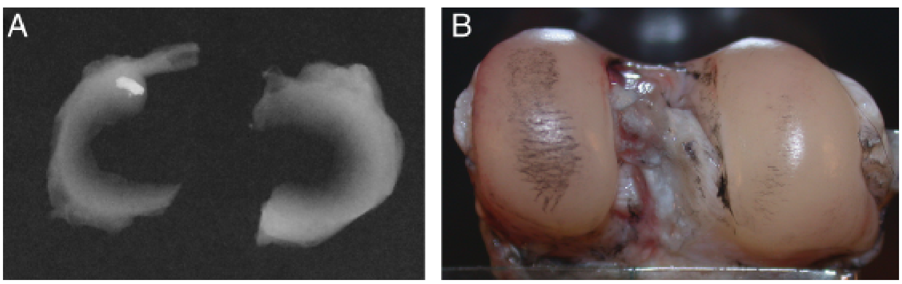

Figure 2 Mineralization of the cranial horn of the medial meniscus (left) on a cadaver specimen detected on high detail (Faxitron) radiographs (A) Severity of meniscal mineralization based on digital radiographs of this cadaver specimen was graded as trivial. Articular surface of the distal femur of the same specimen shows the difference in cartilage fibrillation and erosion of the medial (left) and lateral (right) femoral condyles after the application of India ink (B).

sensitivity and specificity of 91% and 100%, respectively, for detection of meniscal mineralization. Analog high detail film/screen radiographs had a sensitivity and specificity of 88% and 100%, respectively, for detection of meniscal mineralization.

Significant differences were found for subjective total DJD scores assigned from digital (median 1; range 0–5) and analog high detail film/screen radiographs (median 1; range 0–4; $P = .021$). The largest paired difference was 1, occurring in 8 of 57 stifles and in 3 stifles a score of 0 was assigned for the analog films, and 1 for the digital images. The subjective total DJD score from digital images was significantly different between stifles with meniscal mineralization (median, 1; range, 0–5) and without meniscal mineralization (median, 0; range, 0–1; $P < .001$).

Gross Morphologic Findings

The TCDS of the 57 stifles evaluated had a mean ($\pm$SD) value of 51 ± 92. CDS mean value for the 6 articular surfaces in the stifle joint were: medial femoral condyle 27 ± 42; lateral femoral condyle 3.8 ± 7.5; femoral trochlea 8.7 ± 15; medial tibial condyle 12 ± 24; lateral tibial condyle 2.6 ± 5.7; and patella 27 ± 32. The Ink score representing the worse cartilage damage in each stifle joint had a median value of 2 (range, 1–4). The TCDS was significantly different between stifles with meniscal mineralization (104 ± 103) and stifles without meniscal mineralization (50.5 ± 62.2; $P = .028$).

In stifles with mineralization of the menisci, CDS was significantly different when comparing medial (40.4 ± 48.9) and lateral (3.91 ± 6.33) femoral condyles ($P = .0001$), and medial (15.5 ± 29.0) and lateral (2.81 ± 6.42) tibial condyles ($P = .01$). In stifles without meniscal mineralization no significant differences were found in CDS when comparing medial (8.97 ± 16.8) and lateral (3.80 ± 9.05) femoral condyles ($P = .22$); however, CDS was significantly different for medial (8.70 ± 12.6) and lateral (2.21 ± 4.39) tibial condyles ($P = .009$).

Meniscal Mineralization and CDS Correlation

The percent area of the menisci taken up by the meniscal mineralization was significantly correlated with the CDS of medial femoral and medial tibial condyles as well as with the TCDS and subjective total DJD score ($P < .05$). This correlation was good with the medial femoral condyle ($r^2 = 0.6$; $P < .0001$), moderate with the medial tibial condyle ($r^2 = 0.5$; $P < .0001$), fair with the TCDS ($r^2 = 0.36$; $P < .0001$) and very good with the subjective total DJD score ($r^2 = 0.8$; $P < .0001$). No significant correlation was found between the percent of the menisci taken up by the meniscal mineralization and the CDS of the lateral femoral or tibial condyles, patella or femoral trochlea ($P > .05$).

Meniscal Histopathology

Meniscal mineralization was identified histologically in all the menisci in which mineralization was detected on high detail radiographs. Histopathologically, 14 menisci (41% of all the mineralized menisci), had intrameniscal ossification consisting of cancellous bone and bone marrow structure, and metaplasia of the fibrocartilage surrounding the ossified area (Fig 3). Twenty menisci (59% of all the mineralized menisci) showed intrameniscal mineralizations consisting of areas of chondro-osseous metaplasia of the fibrocartilage with no organized structure. No abnormalities were detected histopathologically in any of the lateral menisci (Fig 3).

DISCUSSION

Our results indicate that meniscal mineralization is a common feature detected on conventional orthogonal radiographs of the stifle in domestic cats. In a population of 100 cats selected from a database of a single practice, meniscal mineralization was identified in 37% of the stifles radiographed. Although the cats in the clinical study did not have the presence of meniscal mineralization confirmed by imaging of the menisci, or by histopathology, when the same features were observed in the cadaver study, meniscal calcification was found in every instance. Additionally, we found it relatively easy to find cats with meniscal mineralization for the cadaveric study although we do not know the prevalence of meniscal mineralization in this population of cats. Walker et al[16] described meniscal mineralization to be radiographically evident in 8 of 12 African lions and 6 of 7 Bengal and Bengal-cross tigers (all except 1 were > 1 year of age), but their study did not establish the

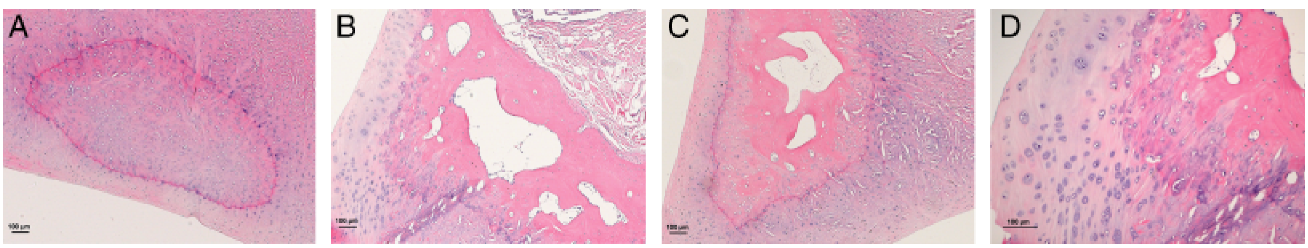

Figure 3 Histology of meniscal mineralization and ossification. Meniscal mineralization appeared as areas of chondro-osseous metaplasia (A) or as organized structures with cancellous bone and bone marrow, surrounded by metaplasia of the fibrocartilage (B, C, and D). Hematoxylin and eosin stain (A, B, C $\times 5$; D $\times 10$).

prevalence of meniscal mineralization in these species. Meniscal mineralization has been reported in dogs[13,14] but the prevalence in the canine population is unknown. In humans, regional mineralization of the knee meniscus is a rare finding with an incidence of 0.15% according to a study where 1287 patients were evaluated with magnetic resonance imaging.[10] Approximately 50 cases of human meniscal mineralization have been reported, mainly in case reports.[6–12,19]

Compared with cats with no radiographically visible pathology, cats with suspected meniscal mineralization and no other radiographic lesions were significantly older, weighed less, and had a lower BCS. If meniscal mineralization is associated with DJD, then these associations likely represent an association between age and DJD. It is known that cats tend to lose weight and BCS as they get older.[20–22]

Quantifying meniscal mineralization and investigating the relationship to DJD has not been reported in cats, dogs, or humans. Kapadia et al[15] reported the volume of meniscal mineralization in the menisci of 2 age groups (6 and 24 month old) of guinea-pigs using micro-computed tomography. In both age groups, the ossified region of the medial meniscus was significantly larger than the lateral meniscus. The volume of the medial meniscal mineralization increased significantly between 6 and 24 months of age, and the medial compartment of the stifle had more new bone formation, which was also associated with increasing age. It was suggested that the bone remodeling and cartilage degeneration evident in the medial compartment of the stifle joint could be a consequence of the presence of ossification of the medial meniscus which might have altered the joint biomechanics and, in part, initiated medial compartment joint degeneration. The authors suggested that meniscal mineralization in guinea-pigs, being a model of osteoarthritis (OA), could offer insights into the role of the meniscus in the development of OA in humans as well. The present study, showed a clear relationship between meniscal mineralization and cartilage damage on the medial femoral condyle and medial tibial plateau. However, it is not known if the meniscal mineralization is a cause, or result of the cartilage damage. The fact that there was more cartilage damage on the medial tibial plateau compared with the lateral tibial plateau in the normal stifles might suggest that meniscal mineralization is a response to degenerative changes.

As with Kapadia et al,[15] our results suggest that meniscal mineralization may be associated with medial compartment joint disease of the stifle joint in cats. In people, medial compartment DJD of the knee has been associated with high adduction moment at the knee during ambulation.[23–27] It may be that gait patterns, alteration of gait patterns, or pelvic limb conformation in some cats may predispose to meniscal mineralization, and this may in turn hasten the progression of DJD. This of course is speculative, but further investigation of the condition in cats may help in preventing the disease in this species, and may reveal a naturally occurring model of medial compartment pathology that could be used to study the disease in people.

The high correlation ($r^2 = 0.8$; $P < .0001$) between the percent of the area of the menisci taken up by the meniscal mineralization and subjective total DJD score should be interpreted cautiously since meniscal mineralization was

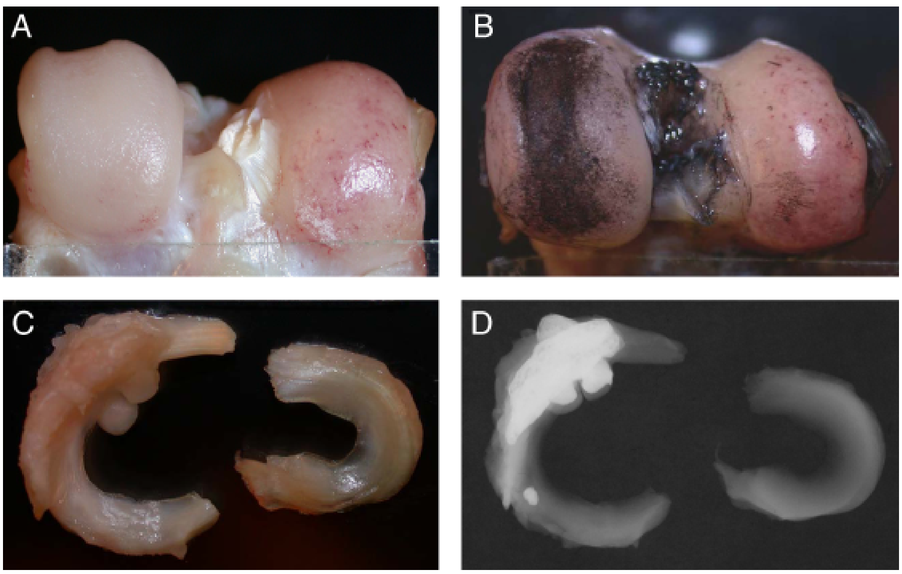

Figure 4 Articular surface of the distal femur of a cadaver specimen showing a distinct groove in the medial femoral condyle (left) (A). Note the retention of India ink by the medial condyle because of fibrillation and erosion of the articular cartilage (B). Appearance of the lateral (right) and medial (left) menisci of the same cadaver specimen (C). Note the normal size of the lateral menisci, compared with the irregularly shaped and enlarged medial menisci. High detail (Faxitron) radiographs showed mineralization of the medial menisci (D) (43% of the total area of the medial meniscus is taken up by the mineralization).

one of the radiographic features considered indicative of DJD and its detection on radiographs contributed directly to increase the total DJD score. The case with the largest meniscal mineralization we describe (55% of the total area of the meniscus) had a distinct groove in the medial femoral condyle and it appeared the mineralization of the medial meniscus had been articulating with the femur (Fig 4). A previous study also reported the presence of a groove in the medial femoral condyle that articulated with an ossicle of the medial meniscus in the stifle joint of a tiger (*Pantera tigris*).[2] In that report, the authors suggested that the ossicles within the medial meniscus were a normal adaptive anatomic feature that helped distribution of load through the meniscus thereby reducing wear and fatigue of the articular surfaces of the femur and tibia. In contrast to this, we consider the changes in the medial femoral condyle to be degenerative, likely in response, at least in part, to the presence of the meniscal mineralization.

The cause of meniscal ossification is debated. Our histologic findings seem to suggest that menisci undergo a process of ossification, starting with a chondro-osseous transformation of the fibrocartilage with mineral deposition, ultimately organizing into cancellous bone and bone marrow structure. That the ossified areas continue to grow by conversion of fibrocartilage to bone is suggested by the presence of chondro-osseous metaplasia of the fibrocartilage observed in the periphery of the ossified area. The bilateral symmetrical appearance of the meniscal mineralizations could support a nondegenerative origin, however, repetitive microtrauma because of bilateral gait abnormalities, or pelvic limb conformation in some cats could trigger the degenerative transformation at specific areas of the menisci bilaterally. In people, chondrocalcinosis of the meniscus has been associated with several distinct metabolic disorders including hemochromatosis, hyperparathyroidism, and hypothyroidism.[28] The association between metabolic disorders and mineralization of menisci in cats is unknown.

The clinical significance of the presence of meniscal mineralization in domestic cat menisci is unknown. Indeed, our study showed no difference in pain scores between radiographically normal stifles and those with just meniscal mineralization. However, despite all the assessments being performed by a single individual, musculoskeletal pain is difficult to assess in cats. Further work might look at such groups of cats and make the evaluations before and after the administration of a known analgesic.

Using high detail (Faxitron) radiographs as a gold standard for detection of meniscal mineralization, digital radiographs and analog high detail film/screen radiographs were 100% specific and had a high sensitivity for detection of meniscal mineralization (91% and 88%, respectively). Both radiographic techniques are considered acceptable for detection of meniscal mineralization in cats, although some of the smaller areas of mineralization may be missed with both techniques. Given the superior dynamic range afforded by digital imaging, it is not surprising that the digitally acquired images had higher sensitivity.

One criticism of our study is the use of digital images to make measures of cartilage damage. Pilot work using X-ray film and thin plastic or flexible film (parafilm: Pechiney Plastic Packaging Company, Chicago, IL) indicated that the results from using flexible film had a higher coefficient of variation, the lesions in the cartilage were difficult to see through the parafilm, it was very difficult to delineate the lesions with a marker and the flexible film was impossible to place around some surfaces. Measures taken from digital photographs of the articular surface itself, despite being two-dimensional were considered to be more accurate and feasible to be performed for all the surfaces. Additionally, our study was a comparative study of the stifles with and without meniscal mineralization.

Little is known about the origin of meniscal mineralizations in the feline menisci as well as in other species, and the clinical significance of radiographically detected meniscal mineralization is uncertain. However, the presence of meniscal mineralizations is a common condition in domestic cats and seems to indicate medial compartment joint disease. Further work to characterize this phenomenon and its role in the development of DJD in cats is required. A better understanding of this phenomenon in cats could help to understand this process in people and other animals.

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