Evaluation of methods for assessment of pain associated with chronic osteoarthritis in dogs

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Objective—To identify variables and evaluate methods for assessing chronic pain in dogs.

Design—Prospective study.

Animals—41 dogs with canine hip dysplasia (CHD), and 24 apparently healthy dogs with no history of pain.

Procedure—2 veterinarians evaluated the dogs' locomotion and signs of pain. Owners of dogs with CHD and control dogs answered a questionnaire regarding their dogs' demeanor, behavior, and locomotion (descriptive scales) and assessed pain and locomotion (visual analog scales). Plasma concentrations of several stress-related hormones were determined, and 13 radiologic variables were assessed in affected hip joints.

Results—For many of the questions, answers provided by owners of dogs with CHD differed significantly from those of owners of control dogs. Stress hormone concentrations differed significantly between dogs with CHD and controls, but individual variation was too great for them to be of value in pain assessment. None of the radiologic variables examined correlated well with owner or veterinarian pain scores.

Conclusions and Clinical Relevance—Chronic pain could be assessed in dogs with CHD through completion of the study questionnaire by a person familiar with the pet (eg, owner) after receiving appropriate education in its use. Eleven variables were identified as being potentially useful in assessment of chronic pain in dogs. (*J Am Vet Med Assoc* 2003;222: 1552–1558)

Having detected signs of chronic pain in dogs, almost all veterinarians and owners nowadays feel that it is of utmost importance that those dogs are given adequate pain-relieving treatment. Accurate detection of pain, however, is difficult. Pain is a subjective sensation and, therefore, should be assessed by the affected individual; dogs cannot directly provide this information and, therefore, other methods must be used. At this time, there is no gold standard for measuring chronic pain in dogs. Results of blood sample analyses and appropriate radiologic examinations can indicate joint disease in dogs, but in regard to chronic joint pain, it is speculated that more useful data may be obtained via veterinarians' and owners' evaluations of abnormal locomotion, behavior, and demeanor of affected dogs.

Various types of scales have been used to assess pain in dogs. These include simple descriptive scales, numerical rating scales, **visual analog scales** (**VASs**), and multifactorial or variable pain scales. Attempts have been made to compare various methods of scoring or assessing pain in dogs, especially acute pain that develops after surgery[1-4] In one of the few publications regarding chronic pain evaluation, Welsh et al[5] compared the use of a VAS and a simple descriptive scale for assessment of lameness in sheep with chronic pain resulting from foot rot. With use of either scale, agreement between 2 observers was good; however, the scales were not interchangeable.[5] There are few data reported on specific changes in behavior and demeanor associated with chronic pain in dogs. Because there are notable breed-specific,[6] socially acquired,[7] and situation-related[8] differences in responses to pain among dogs, we believed that questioning owners about changes in locomotion, behavior, and demeanor that they had observed in their dogs with hip joint disease would provide important information regarding identification of chronic pain. Wiseman et al[9] conducted a study involving unstructured interviews with 13 owners of dogs with chronic pain; all owners reported some changes in their dogs' behavior, and most reported some change in demeanor. In that same study, 6 veterinarians were questioned about their methods of assessment of chronic pain, and they reported similar changes of behavior in those dogs.

As part of our study, other variables that have been traditionally used in clinical settings to evaluate pain were also investigated, although the roles of stress hormones in the physiologic response to chronic pain are still unclear. Radiologic abnormalities and changes in locomotion that result from chronic pain associated with disease of the hip joint in dogs are, however, well documented.[10,11]

The purpose of our study was to examine methods of assessing or measuring chronic pain in dogs; we selected a study population of dogs with **canine hip dysplasia** (**CHD**), because CHD can be considered as an orthopedic disease typified by chronic pain. Our intention was to identify indicators of pain in dogs, such as answers to key questions, changes in plasma

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hormone concentrations, or radiographic findings, that could be easily assessed in a clinical setting; these pain indicators could then be incorporated into a pain assessment scorecard or index for use by both veterinarians and owners.

Materials and Methods

Dogs—Forty-one client-owned dogs with CHD were included in the study. The dogs were large or giant breeds and 1 to 11 years old (mean, 5.1 years); there were 20 females and 21 males in the group. A diagnosis of uni- or bilateral CHD with signs of pain or locomotion deficits had been made in all dogs on the basis of history, clinical signs, results of physical examination and palpation of the hip region, and radiographic findings. Pain was considered chronic, because all dogs had appeared to have pain for > 3 months (range, 3 months to 9 years).

As controls, apparently healthy dogs with no history of pain and no signs of pain were assessed for inclusion in the study. Thirty-three owners of control dogs completed the study questionnaire; on the basis of their responses, 9 dogs were excluded from the study, because VAS scores were not < 0.7 (which is the accepted 7% error margin for an individual mark[12]). The 24 dogs included in the study as controls for the questionnaire data were large or giant breeds and 1 to 9 years old (mean, 4.6 years); there were 15 females and 9 males in the group. Many of these dogs were owned by personnel or students at the university. Twenty-three apparently healthy dogs with no history of pain were used as a control group for plasma hormone analyses. These control dogs were large or giant breeds and 1 to 11 years old (mean, 4.8 years); there were 12 females and 11 males in the group. In these dogs, degree of pain and locomotion difficulties were rated by all owners as 0 on numerical (0 to 10) scales. Many of these dogs were owned by personnel or students at the university.

Pain assessment questionnaire—The questionnaire contained 25 questions about behavior and locomotion of the owner's dog; owners answered these questions by means of a descriptive scale of 0, 1, 2, 3, or 4. Regarding their dog, owners were asked about appetite (very good [0], good [1], neither good nor poor [2], poor [3], or very poor [4]); mood (very alert [0], alert [1], neither alert nor indifferent [2], indifferent [3], or very indifferent [4]); frequency of contact with human family members (very often [0], often [1], sometimes [2], hardly ever [3], never [4]); frequency of tail wagging (very often [0], often [1], sometimes [2], hardly ever [3], never [4]); frequency of pacing (very often [0], often [1], sometimes [2], hardly ever [3], never [4]); activity (overactive [0], active [1], neither active nor calm [2], calm [3], too calm [apathy; 4]); willingness to participate in play (very willingly [0], willingly [1], reluctantly [2], very reluctantly [3], does not participate at all [4]); willingness to walk, trot, gallop, jump, and to walk up and down stairs (responses to each question: very willingly [0], willingly [1], reluctantly [2], very reluctantly [3], does not participate in action at all [4]); observation of excessive panting, licking of lips, vocalization (audible complaining), vocalization when stretching hind legs caudally, aggressiveness toward humans, aggressiveness toward dogs in its own pack, aggressiveness toward other dogs, submissiveness in the pack, problems in moving after a long rest, and problems in moving after heavy exercise (responses to each question: never [0], hardly ever [1], sometimes [2], often [3], very often [4]); and ease with which the dog lies down and ease with which it rises from a prone position (with great ease [0], easily [1], neither easily nor with difficulty [2], with difficulty [3], with great difficulty [4]). The questionnaire was in the Finnish language, and translation has been made as accurately as possible.

Positive behavior was behavior in which an increase was considered positive, and negative behavior was behavior in which an increase was considered negative. For 23 of the 25 questions, a score of 0 to 1 was considered typical for a dog with no pain, and a score of 2 to 4 was considered typical of a dog with chronic pain. For the questions regarding activity and pacing, a score of 1 to 3 and 3 to 4, respectively, were considered typical of a dog with no pain. In addition, owners were asked to use two 10-cm plain line VASs to rate their perception of pain and locomotion of their dogs. The end of the line to the left signified no pain or no difficulties in locomotion, whereas the right end of the line signified the worst possible pain or the most severe difficulties in locomotion. The owners of the control dogs answered similar questionnaires.

Clinical evaluation—Two veterinarians (EK, MR) independently evaluated locomotion of the dogs with CHD by viewing videotapes. The locomotion index was the combined scores of lameness (scored from the front, back, and side view of the dog during walk, trot, and gallop), ability to jump on and off a table, and ability to climb and descend stairs. The evaluators used an evaluation form with 3 simple descriptive scales with 5 grades (1 scale for each of the 3 variables). This combined locomotor index was used in statistical analyses. The veterinarians did not evaluate the control dogs.

Plasma hormone assays—Concentrations of the catecholamines[a] epinephrine and norepinephrine, β-endorphin,[13] cortisol,[b] and vasopressin[c] were measured. Blood samples were collected from dogs via the saphenous vein of the left forelimb and placed into prechilled EDTA tubes kept in melting ice. Plasma was directly separated by refrigerated centrifugation at 1,100 × *g* for 10 minutes; plasma was frozen to –20°C (–4°F) for vasopressin and cortisol assays and to –80°C (–112°F) for measurement of catecholamines and β-endorphin concentrations.

Radiographic examination of hip joints—Dogs were sedated and positioned in ventrodorsal recumbency with limbs fully extended and the stifle joints internally rotated. Radiographs were obtained of the hip joints. One veterinarian (AL) performed masked evaluation of all the radiographs. Hip joints were evaluated for osteoarthritic changes separately, and the findings associated with the more severely affected of the 2 joints in each dog were used in analyses. The degree of abnormality in a hip joint was assessed from 13 radiographic features using 2- to 5-point Likert scales and were combined to form 9 variables. The radiographic features included assessment of the Norberg angle (1 = > 105°, 2 = 90 to 105°, 3 = 75 to 90°, 4 = 60 to 75°, or 5 = 45 to 60°); changes of the femoral neck as a combination of length of the femoral neck (1 = normal or 2 = shortened) and exostosis of the femoral neck (1 = none, 2 = present, or 3 = severe); change within the area of physeal scar (1 = none, 2 = present, or 3 = severe); shape of the femoral head (1 = normal, 2 = slightly flattened, 3 = severely flattened, or 4 = grossly deformed); exostosis of the acetabular rims as a combination of exostosis of the dorsal, cranial, and caudal acetabular rims (1 = none, 2 = present, or 3 = severe); integrity of the acetabulum as a combination of the depth of the acetabular cavity (1 = deep, 2 = shallow, or 3 = nonexistent) and incongruence of the joint space (1 = none, 2 = partial, or 3 = total); appearance of the acetabular fossa (1 = normal, 2 = slightly filled, or 3 = completely filled), exostosis in any region of the joint (1 = none, 2 = present, or 3 = severe); and number of bone chips in any region of the joint (1 = none, 2 = one, or 3 = several [≥ 2]). The control dogs were not radiographed.

Statistical analyses—Possible bias among the 2 control groups and the group of dogs with CHD was assessed with a *t* test and cross tabulation. Data obtained from the questionnaires were compared with VAS scores and with the veteri-

narians' lameness scores by means of the Spearman rank correlation test. Because of the uneven distribution of the data, a Mann-Whitney test was used to compare the questionnaire answers given by the owners of control dogs with those given by owners of dogs with CHD, and to compare plasma hormone concentrations in control and affected dogs. Radiographic changes were correlated to each other and to the pain VAS and locomotion VAS by means of the Spearman rank correlation test. Values of $P < 0.05$ were considered significant.

Results

There was no bias among the 2 control groups and the group of dogs with CHD with regard to age, sex, or breed.

Questionnaires and clinical evaluation—Comparison of the answers to the questionnaire provided by owners of dogs with CHD with those provided by owners of control dogs revealed significant differences in answers to 17 of the 25 questions (**Table 1**). Eleven of those 17 questions, which could easily be answered by all types of owners for all types of dogs, were selected for inclusion in the chronic pain index. The index number was derived from the 5 possible answers (scores of 0, 1, 2, 3, or 4) obtained by use of the descriptive scales; for the 11 questions selected, there was a possible minimum index number of 0 (11 × 0) and a possible maximum index number of 44 (11 × 4). In our study, control dogs had a chronic pain index of 0 to 5, and dogs with CHD had a chronic pain index of 7 to 35.

Mean values obtained from the pain VAS and locomotion VAS (0.0 to 10.0 cm) for dogs with chronic pain were 5.09 (range, 1.0 to 9.3) and 5.93 (2.2 to 9.9), respectively. Mean values obtained from the pain VAS and locomotion VAS for control dogs were 0.00 (0 to 0.6) and 0.00 (0 to 0.6), respectively.

The locomotion evaluations provided by the 2 veterinarians were in agreement (lameness, $r = 0.60$, $P = < 0.001$; ability to jump on and off a table, $r = 0.78$, $P < 0.001$; and ability to climb and descend stairs, $r = 0.63$, $P = < 0.001$). However, for dogs with CHD, the veterinarians' combined locomotion score did not correlate with the owners' pain VAS scores or locomotion VAS scores ($r = 0.06$, $P = 0.72$ and $r = 0.17$, $P = 0.29$, respectively). Some correlation between the calculated chronic pain index and the veterinarians' combined score was detected, but there was poor correlation between most of the answers to individual questions in the owner questionnaire and the veterinarians' combined score (**Table 2**). The pain and locomotion VAS scores for dogs with CHD correlated significantly with each other ($r = 0.71$, $P < 0.001$).

Plasma hormone assays—Significant differences in epinephrine, β-endorphin, cortisol, and vasopressin concentrations were found between the controls and dogs with CHD; there was no significant difference between groups with regard to norepinephrine concentrations (**Table 3**). However, there was considerable individual variation in all the measured plasma hormone concentrations. Pain VAS score, locomotion VAS score, and the veterinarians' combined score did not

Table 1—Comparison of 25 questionnaire answers (scores, 0 to 4) provided by owners of 41 dogs with pain associated with canine hip dysplasia (CHD) with those provided by owners of 24 dogs with no pain

	Scores for dogs with CHD		Scores for control dogs		
Question topic	**Median**	**Range**	**Median**	**Range**	***P value***
Positive behavior					
Appetite	0	0–3	0	0–2	0.59
Mood*	1	0–3	0	0–1	< 0.001
Frequency of contact with human family members	1	0–2	0	0–2	0.086
Frequency of tail wagging	1	0–3	0	0–2	0.013
Activity	1.5	0–4	1	0–3	0.052
Play and games*	1	0–4	0	0–1	< 0.001
Negative behavior					
Excessive panting	1	0–4	0	0–2	< 0.001
Licking of lips	0	0–4	0	0–3	0.97
Vocalization (audible complaining)*	1	0–3	0	0–1	< 0.001
Vocalization when stretching hind legs caudally	2	0–4	0	0–1	< 0.001
Aggressiveness towards humans	0	0–3	0	0–2	0.88
Aggressiveness towards other dogs	2	0–3	1	0–3	0.47
Aggressiveness towards dogs in its own pack	1	0–4	1	0–2	0.09
Submissiveness in the pack	1.5	0–4	2	0–4	0.27
Locomotion					
Walking*	1	0–3	0	0–1	< 0.001
Trotting*	1.5	0–4	0	0–1	< 0.001
Pacing	1	0–4	2	0–4	< 0.001
Galloping*	1	0–4	0	0–1	< 0.001
Jumping*	2	0–4	0	0–1	< 0.001
Climbing stairs	2	1–4	0	0–1	< 0.001
Descending stairs	2	0–4	0	0–2	< 0.001
Laying down*	2	0–4	0	0–1	< 0.001
Getting up*	2.5	0–4	0	0–1	< 0.001
Difficulty moving after rest*	2	0–4	0	0	< 0.001
Difficulty moving after major activity*	3	1–4	0	0–1	< 0.001
Chronic pain index (sum of answers to 11 questions)	19	7–35	2	0-5	< 0.001

*Question selected for inclusion in chronic pain index. Values of $P < 0.05$ were considered significant.

Table 2—Correlation coefficient (*r*) and probability (*P*) matrix between answers to the questionnaire, pain visual analog scale (VAS) score, and locomotion VAS score provided by owners, and lameness as scored by 2 veterinarians for 41 dogs with CHD

	Pain VAS score		Locomotion VAS score		Veterinarians' combined score	
Question topic	***r***	***P***	***r***	***P***	***r***	***P***
Positive behavior						
Appetite	–0.06	0.6892	–0.07	0.6523	0.13	0.4439
Mood*	0.58	< 0.001	0.52	0.0011	0.15	0.3580
Frequency of contact with human family members	0.27	0.0977	0.43	0.0075	0.08	0.6104
Frequency of tail wagging	0.44	0.0068	0.35	0.0312	0.28	0.0851
Activity	0.39	0.0149	0.44	0.0065	0.47	0.0045
Play and games*	0.50	0.0022	0.58	< 0.001	0.22	0.1834
Negative behavior						
Excessive panting	0.19	0.2403	0.25	0.1233	0.21	0.2160
Licking of lips	0.31	0.0697	0.25	0.1384	–0.35	0.8392
Vocalization (audible complaining)*	0.11	0.4994	–0.07	0.6551	–0.06	0.7318
Vocalization when stretching hind legs caudally	0.21	0.2053	0.10	0.5365	–0.004	0.9983
Aggressiveness towards humans	–0.11	0.4979	–0.05	0.7470	0.18	0.2678
Aggressiveness towards other dogs	–0.05	0.7583	–0.15	0.3648	–0.30	0.0657
Aggressiveness towards other dogs in its own pack	–0.02	0.9222	–0.03	0.8267	–0.29	0.0783
Submissiveness in the pack	0.38	0.0194	0.30	0.0589	–0.10	0.5270
Locomotion						
Walking*	0.30	0.0666	0.38	0.0180	0.25	0.1304
Trotting*	0.21	0.2012	0.33	0.0413	0.27	0.0965
Pacing	0.11	0.4905	–0.05	0.7325	–0.07	0.6800
Galloping*	0.09	0.5789	0.10	0.5443	0.31	0.0602
Jumping*	0.47	0.0039	0.50	0.0020	0.26	0.1176
Climbing stairs	0.29	0.0864	0.40	0.0153	0.25	0.1488
Descending stairs	0.44	0.0089	0.60	< 0.001	0.23	0.1815
Laying down*	0.46	0.0045	0.51	0.0014	0.22	0.1885
Getting up*	0.46	0.0048	0.59	< 0.001	0.09	0.5728
Difficulty moving after rest*	0.37	0.0238	0.45	0.0058	0.26	0.1155
Difficulty moving after major activity*	0.48	0.0031	0.54	< 0.001	0.02	0.9154
Chronic pain index (sum of answers to 11 questions)	0.65	< 0.001	0.65	< 0.001	0.35	0.0474

*Question selected for inclusion in chronic pain index. Values of $P < 0.05$ were considered significant.

Table 3—Plasma hormone concentrations (mean ± SD and range) in 41 dogs with CHD and 23 control dogs

	Dogs with CHD		Control dogs		
Hormone	**Mean ± SD**	**Range**	**Mean ± SD**	**Range**	***P* value**
Epinephrine (nmol/L)	1.37 ± 0.73	0.52–4.40	1.00 ± 0.55	0.30–2.21	0.0178
Norepinephrine (nmol/L)	3.42 ± 1.22	1.54–6.36	3.64 ± 1.02	1.70–5.06	0.2388
Beta-endorphin (pg/mL)	85.4 ± 25.8	47–150	125.0 ± 60.0	57–293	0.0061
Cortisol (nmol/L)	83.5 ± 55.9	26.6–271.0	46.0 ± 18.4	11.3–93.9	0.0017
Vasopressin (pg/mL)	12.45 ± 9.67	3.92–57.35	8.77 ± 6.18	1.72–27.71	0.0311

correlate with plasma hormone concentrations in dogs with CHD. Epinephrine concentration had a significant positive correlation with norepinephrine and cortisol concentrations.

Radiographic examination of hip joints—Significant correlation was found between the Norberg angle and change in the area of the physeal scar ($r = 0.52$, $P = 0.001$), shape of the femoral head ($r = 0.44$, $P = 0.009$), exostosis of the acetabular rims ($r = 0.35$, $P = 0.034$), integrity of the acetabulum ($r = 0.72$, $P < 0.001$), and appearance of the acetabular fossa ($r = 0.65$, $P = < 0.001$). Of the radiographic variables, none correlated with the veterinarians' combined score or with the owners' pain VAS score; variables that correlated with the locomotion VAS score were limited to exostosis in any region of the joint ($r = 0.34$, $P = 0.04$) and number of bone chips in any region of the joint ($r = 0.34$, $P = 0.034$). There was no correlation between duration of clinical signs of CHD and the severity of the radiographic abnormalities.

Discussion

Our questionnaire for evaluating chronic pain in dogs involved a combination of multifactorial (demeanor, behavior, and locomotion) descriptive scales, a VAS for pain, and a VAS for locomotion. To assess whether different scales were interchangeable, the same question was asked twice; owners were asked about locomotion via a 5-point descriptive scale and also via the VAS. There was good correlation between them for almost all locomotion variables. To test the

validity of the questionnaire as a tool to detect dogs with chronic pain, owners of apparently healthy dogs with no history of pain (control dogs) were also asked to complete it. Many answers to questions were clearly different between controls and dogs with CHD; this suggested that the variables being assessed by those questions may be indicative of chronic pain. However, all of these differences did not correlate with the pain VAS score. This discrepancy may be time-related; changes in ability to jump, descend stairs, lie down, and stand up are often noticed quite suddenly. Owners remember the occasion on which the change became apparent to them; therefore, even untrained owners may relate these sudden changes with pain. Changes in other variables that are frequently considered indicative of pain, such as gait, vocalization, and onset of excessive panting, had no correlation with the pain VAS score in our study. Changes in those variables often develop slowly or the signs have been there since the dogs were puppies. A dog with pain associated with CHD gallops in a unusual manner, which is often referred to as bunny hopping.[11] Pacing is often considered a sign of a problem in locomotion, but is also a normal gait in some breeds. There were pacers and nonpacers in both groups in our study, but a greater number of pacers were present in the group of dogs with CHD than in the control group. Both bunny hopping and pacing, as well as hesitant walking and trotting, may be evident at a young age or develop insidiously.

It is known that humans respond innately to vocalization as an indicator of pain. Many dog owners reported that they had not considered that their dogs might be in pain, because there had been no vocalization. Therefore, the lack of correlation between answers to the question of vocalization (referred to as audible complaining on the questionnaire) and the pain VAS score was unexpected. The reason for this may be that dogs, unless hurt acutely, rarely vocalize sufficiently to elicit a reaction from their owners. The nature of the vocalization is probably different for acute and chronic pain; vocalization in response to continuous pain is usually limited to grunting on expiration,[14] whining, or whimpering.[15] Owners may recognize that their dogs are different from other dogs with regard to gait and pacing, vocalization, socialization, aggressiveness, and panting; however, those characteristics are normal for their dogs and, therefore, are not considered to be signs of pain. Also, an owner may remark that the dog has become more vocal or less interactive with age, but consider it normal for dogs to become less active and tire more easily with age; an owner may not realize that a 6-year-old Labrador Retriever is not old and it should not want to go home after a short walk.

There was good agreement between locomotion scores of the 2 veterinarians. Interestingly, there was no correlation between the veterinarians' combined locomotion score and the owners' descriptive-scale locomotion scores. The veterinarians' combined score was comprised of scores for lameness, ability to jump, and ability to ascend and descend stairs; as such, 66% of the combined score related to jumping and traversing stairs, which are activities that dogs seem to undertake with excessive or minimal vigor in stressful situations. These variables are difficult to assess by a veterinarian in a clinical situation; in our experience, some dogs will not jump or attempt stair walking at the clinic, while other dogs jump as they would never do at home. Thus, a veterinarian can easily interpret these findings incorrectly.

It appears that some variables are easier for the dog owner to assess while others are easier for a veterinarian to assess. For optimal pain assessment, the 2 parties should work together. This can be facilitated by use of a scorecard or an index that categorizes the dog as having chronic pain presently or not having chronic pain presently. From our data, we integrated 11 questions into a chronic pain index. The answers to those questions were assigned index scores; scores were 0 or 1 if the behavior or locomotion was apparently normal and 2, 3, or 4 if there were indications of pain (0 representing the least pain, and 4 representing the most pain). Study dogs with no pain had index numbers of between 0 and 5, whereas the dogs with chronic pain had index numbers ranging from 7 to 35. From this finding, we proposed that dogs with index scores < 6 could be presumed to not have pain, and dogs with index scores of > 6 could be presumed to have chronic pain. However, for all questions, answers of 0 and 1 were considered indicative of lack of pain (normal); therefore, there could be a maximum index score of 11 for the apparently healthy dogs with no history of pain and a minimum index score of 12 for painful dogs. Unfortunately, index scores of between 6 and 11 constitute a gray area between the categories of having chronic pain presently or not having chronic pain presently; a dog with an index score in that range may or may not have chronic pain. This intermediate category (ie, may or may not have chronic pain presently) is probably an inevitable feature of any pain index, regardless of time and effort spent on its perfection. In our study, answers to other questions were also significantly different between control dogs and dogs with CHD, but it was considered impractical to include those questions in a chronic pain index to be used by owners. For example, most giant dogs pant excessively in the summer whether in pain or not; dog owners, in general, do not want to stretch their dogs' legs just to test if signs of pain can be elicited; hyperactivity may be as abnormal a behavior as hypoactivity, but this fact is not recognized by owners; not all dogs traverse stairs in their everyday life; and often owners do not know what pacing is. Nevertheless, other variables should be examined until a reliable tool for determining chronic pain in dogs has been established. Furthermore, observable changes in behavior and locomotion in dogs resulting from chronic pain caused by a disease other than osteoarthritis of the hip joints might differ from those identified in our study and necessitate that different questions be asked to assess pain.

Also, if pain assessment is most accurate when owner and veterinarian are both involved in the process, the question is raised as to what parameters each should evaluate. We suggest that the veterinarian should evaluate only walking, trotting, and galloping,

and the owner should evaluate the remainder of the index variables. However, after training in recognition of gait abnormalities, an owner could also participate in their evaluation at home.

In many studies, blood samples are obtained via a preplaced jugular catheter to minimize the effects of stress on the dogs. Our intention was to monitor plasma hormone concentrations in a more realistic clinical setting; therefore, we used a group of apparently healthy dogs with no history of pain as controls. However, as many of the control dogs were owned by department personnel, some controls may have been more used to blood sampling than the dogs with CHD. Various hormone concentrations have been used to assess stress in animals. It is known that epinephrine, norepinephrine, β-endorphin, cortisol, and vasopressin concentrations increase in stressful situations such as trauma and surgery,[16] but information regarding change in concentration of any of these hormones in response to chronic pain in dogs is not available. In horses that were expected to have severe postoperative (acute) pain, β-endorphin concentration was found to increase.[19] In a study by McCarthy et al,[20] however, a control horse with painful chronic osteoarthritis had decreased β-endorphin concentration. Almay et al[21] found that organic pain in humans resulted in decreased CSF endorphin concentrations. In a study by Ley et al,[22] sheep with chronic foot rot-associated lameness had increased plasma epinephrine and norepinephrine concentrations, compared with those of control sheep. In another study,[23] those investigators found no consistent changes in vasopressin concentration in chronically lame sheep, but cortisol concentration was decreased, compared with controls. However, in a later study[24] with a greater number of sheep, an increase in plasma cortisol concentration was observed in lame sheep, but there was no correlation between the severity of the disease and the cortisol concentration. In our study, the stress of transporting dogs to the clinic may also have influenced our results, as it has been reported that dogs that are new arrivals at an animal shelter have higher cortisol concentrations than those that had been resident for a longer time.[25] The control dogs' baseline hormone concentrations were compared with baseline concentrations in healthy dogs obtained in recent studies[17,18] and were found to be of the same order, but not identical. Results of our study suggested that chronic pain may decrease plasma β-endorphin concentration but increase epinephrine, cortisol, and vasopressin concentrations. Although there were significant differences in hormone concentrations between the groups of dogs with and without chronic pain, large individual variations in measurements made it impossible to define concentration limits that would specifically indicate pain.

The radiographic features of CHD are well documented, but we could find no reports in which radiographic changes within the hip joint are correlated with pain or locomotion assessment scales. However, it is generally accepted that the clinical status or the extent of pain of an animal cannot be predicted from the pathologic changes seen on radiographs.[26] Our findings agreed with this presumption. Only exostosis and bone chips in any region of the hip joint correlated significantly with the locomotion VAS score, but neither correlated with the pain VAS score; it is possible that these abnormalities are associated with a physical restriction of movement because of the bony deformations in the joint. Since the appearance of the acetabular fossa correlated with most other variables, it can be postulated that this may be one of the last radiographically detectable changes in the development of CHD. We found it surprising, however, that there was no correlation between the duration of the clinical signs of CHD and the severity of any of the evaluated radiographic changes.

Our study illustrated the value of the owner-completed questionnaire. The working party of the Association of Veterinary Teachers and Research Workers[27] recommended an overall pain assessment based on observation of the assessed animal by a person who is able to distinguish subtle changes in its demeanor, behavior, and locomotion (in a clinical situation, this is often the owner), with interpretation of the findings by a person with knowledge and experience (a veterinarian) of pain assessment. We agree with this recommendation; owners' observations of changes in behavior and demeanor of their dogs may be more useful than behavioral evaluations made by veterinarians, as the latter are unlikely to know how any of the dogs usually reacts in different situations. Moreover, from our data, the inclusion of radiographic data or physiologic measurements, such as plasma hormone concentrations, did not seem to provide much additional information regarding pain in individual dogs.

Dogs in which the diagnosis of osteoarthritis has been made by radiographic examination should be treated for pain as soon as signs of pain are noted. As some breeds seem to be prone to painful chronic diseases, such as CHD, it would be of great value to teach owners of dogs of susceptible breeds how to assess pain and to begin evaluations before the dog is suspected to be in pain. Often owners are unaware that their dogs are in pain. Many signs of pain are recognized by owners only after they have been presented with a leading question by the veterinarian or after a period of successful pain relief in which the dogs' behavior or locomotion noticeably changed. However, we believe that owners who know how their dogs react in different settings should be key contributors to the evaluation of pain. Also, chronic pain has to be monitored daily by owners to ensure continued effective treatment; to be able to do this, owners must first be trained by a veterinarian. Assessing pain by means of a scorecard will also actively involve owners in maintaining their pets' well being, which in our opinion is important.

In the study reported here, our intention was to identify indicators of pain in dogs, such as answers to key questions, changes in plasma hormone concentrations, or radiographic findings, that could be assessed easily in a clinical setting. As there is no gold standard for the measurement of chronic pain in dogs, it was not possible in our study to use multiple logistic regression to determine how well the variables examined, both separately and combined, explain the variation of chronic pain. Nevertheless, our study did reveal some

correlation between the chronic pain index calculated from the owners' scores and the combined locomotion score provided by the 2 veterinarians. As there was poor correlation among any of the questions asked of the owners and the scores by the veterinarians, the entire battery of 11 questions that comprised the pain index was required to achieve correlation. This emphasized the need to consider a variety of behaviors or responses in each dog as part of pain evaluation. Results of our study suggested that in dogs, a multi-factorial questionnaire that focuses on behavior and locomotion, completed by a veterinarian and an owner together, is better for evaluating chronic pain than a veterinary evaluation alone, even if the latter was combined with radiographic examination or measurement of plasma hormone concentrations.

[a]ESA CoulArray, Model 5000, ESA Inc, Chemsford, Mass.
[b]Cortisol coat-a-count 200, Diagnostic Products Corp, Los Angeles, Calif.
[c]RK-VPD Vasopressin Direct, Buhlmann Laboratories AG, Allschwil, Switzerland.

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