Assessment of Pain in Dogs: Veterinary Clinical Studies

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Abstract

Hundreds of thousands of animals are presented to US veterinarians annually for surgery or for evaluation of painful disease. This large population offers the opportunity for clinical research of both acute and chronic pain syndromes. Although there is growing interest by veterinary clinical specialists to explore the nature of animal pain and how best to treat it, this resource is relatively unknown to the pain research community. Computer-assisted collection of behavioral data has created new opportunities for characterizing the pain experience in animal species for the benefit of both animals and humans. This review describes the current state of veterinary clinical pain studies in dogs and an application of computer-assisted behavioral analysis.

Key Words: animal pain; dog; movement; pain; pain behavior; postoperative pain; surgery; videography

Introduction

Recognition and assessment of pain have always been an integral part of animal care and veterinary clinical practice, but clinical research in this aspect of animal welfare has grown dramatically in the past 20 yr (Hansen 1997). This modern emphasis is probably due, at least in part, to public expectations for relief of pain both in ourselves and in our pets. Interest in animal pain and welfare is closely tied to the increased public awareness of issues surrounding the use of animals in biomedical research. The ethical mandate to justify the value of animal research and to guarantee that every effort is made to limit pain and distress, codified in the Animal Welfare Act (AWA 1966) and its subsequent amendments, drives the planning, review, and execution of most biomedical research using live animals. Not long after the Animal Welfare Act became law, the editor of the journal *Pain* called on the pain research community to investigate chronic pain syndromes in pet animals to determine whether animals suffer the same chronic pain syndromes found in humans (Wall 1976). Unfortunately, that call went largely unheeded, and in spite of the growth in veterinary interest in clinical studies of animal pain, the pain research community has paid relatively little attention to this resource.

Whereas most pain research using animal models has been conducted to increase our understanding of the mechanisms underlying human pain, the recent growth of veterinary clinical interest in the subject has opened the doors to studies of pain in animals for the benefit of animals. Much of this work has focused on acute pain, and the most common models used for this work have included experimental (using heat or pressure) and clinical (traumatic) pain. Studies of acute clinical pain have most often evaluated the effects of surgical trauma on pet animals presented to veterinary teaching hospitals for surgery. Of these surgical models, ovariohysterectomy (OHE[1]) of dogs appears to be among the most popular, possibly because OHE is a relatively standardized source of soft tissue pain. The Center for Veterinary Medicine of the US Food and Drug Administration considers OHE to cause moderate pain, making it suitable for clinical studies of analgesia (Connolly 2000). Although the procedure is an integral component of surgical instruction in the professional curriculum at many veterinary colleges, many more OHEs are performed at community veterinary practices. Indeed, it is probably one of the most common surgical procedures performed on pet dogs in the United States. For example, 31.4% of approximately 12,000 female dogs processed by Texas shelters and licensing agencies before autumn 1997 had undergone OHE (Mahlow 1999). Private veterinary clinics may therefore offer researchers a large population of animals for clinical studies of this procedure. There are several possible benefits and disadvantages associated with such collaboration (Table 1).

Pain Behavior

The pain behavior construct proposes that pain affects behavior in ways that are accessible to observers and that the magnitude of change correlates with the severity of the pain experience. Some behaviors may occur too rarely to be of much use whereas others occur at high frequency. Some may be observed within the narrow confines of a cage or run

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[1]Abbreviations used in this article: MPS, Melbourne Pain Scale; OHE, ovariohysterectomy; VAS, visual analog scales.

Table 1 Advantages and disadvantages of collaboration with a veterinary hospital

Potential advantages for investigators
   High number of ovariohysterectomy and other elective procedures done annually
   Small number of skilled surgeons responsible for all procedures
   Clients available to provide insight into postoperative behavior at home
   Clinic and home environments provide opportunity to observe more complex behaviors than is available in a typical animal housing facility
   Positive public relations perception of using a clinical study for the benefit of animals
Potential advantages for clinic
   Opportunity to participate in clinical research
   Positive public and client relations image
   Work with a skilled project technician to assist with surgery and recovery
Potential disadvantages for investigators
   Study may be performed at a location far removed from laboratory and office support
   Communication and logistic challenges associated with multiple participants
   Participants have different needs (e.g. completion of project vs. providing client service)
   Need to communicate with multiple parties may delay resolution of problems or obstacles that arise
   New ways of looking at behavior and responses to injury will be necessary
Potential disadvantages for clinic
   Modifications to physical plant required for videography
   Disruption of work flow to accommodate data collection
   Study may compete for clinic animal technician time
   Study requirements may raise issues of concern to clients

(e.g., the hourly rate of position changes) while others may be observed only in specific circumstances outside a kennel environment (e.g., the dog that adopts a new posture when begging at the dinner table after repair of a ruptured anterior cruciate ligament). These behaviors may be invoked by several mechanisms. They may be a consequence of physical impairment due to pathology. They may be protective, to prevent initiation or exacerbation of nociception. Some may be innate expressions of pain, serving to distract, comfort, or call others to the animal's aide. Others may be a learned response (coping strategy) to reduce pain.

Veterinarians and researchers concerned with animal care and welfare recognize the need for sensitive methods of assessment of animal pain. Because pain is an experience rather than an objectively quantifiable physiological response, assessment may be quite difficult. The experience of pain is highly variable across individuals, even when identical stimuli are applied under identical environmental conditions. Furthermore, the experience of pain and its behavioral consequences probably vary substantially among species. Each species lives in its own unique sensory world, and an individual's behavior is a function of complex relationships between its internal and external environments (Kantor 1958). For many species, it may be a distinct disadvantage to adopt pain behaviors that advertise disability lest they draw the attention of predators or competitors from within their own group.

Much of our current approach to animal pain is by necessity based on anthropomorphic projections of our assumptions about the signs, symptoms, benefits, and harms of the human pain experience. Although it is possible to make assumptions about the general nature of pain based on the similar physiology and pharmacology of nociception across a wide range of animal species, it may be a mistake to attempt to attach a human definition of pain to their experience. The late Dr. Patrick Wall argued that because we cannot share identical experience with other species, the phrase "pain in animals" can have no meaningful definition (Wall 1992). Instead, he suggested that it is our duty to recognize the individual's efforts to regulate its internal environment and then assist it, when we must disturb that process to help it return to normal as quickly as possible. This duty requires some understanding of the normal behavior of each species in a particular environment.

Subjective assessment of pain behavior can prove very challenging. Under many circumstances, the effect of injury or chronic disease on observable behavior in humans may correlate poorly with patient self-reports or assessments (Turk and Flor 1987). Similar disparity between observable behavior and experience may exist in other species. For example, the most severely injured dogs in our hospital intensive care unit routinely show little of the attention-getting behavior they might show their owners during times of good health when, for example, the owner accidentally steps on a foot. In animals, as in humans, the intensity of the pain experience may be greater than that predicted solely on the basis of casual observation of behavior. The absence of dramatic behavioral displays in the setting of significant trauma or illness may be a factor in undertreatment (Hansen and Hardie 1993).

The hospital and laboratory environment imposes additional challenges to assessment. These relatively sterile environments designed for human convenience restrict environmental complexity and limit the opportunities for engaging in behaviors the animal might otherwise have in a more natural environment. For example, the opportunities for behavioral diversity and complexity for dogs housed individually in a kennel or cage are very limited compared with those afforded by free access to a house, yard, and human family.

Current Veterinary Approaches to Acute Pain Behavior Assessment

Systematic attempts to evaluate clinical pain in animals were rare before the 1980s, and most relevant work in this

area has been performed since 1990. Clinical studies of acute pain in most nonrodent species have used observer-based pain rating scales patterned on similar instruments developed for use in humans, particularly for the evaluation of acute procedural pain in prelingual children. Observer-based scales that have served as templates for veterinary counterparts include the Toddler-Preschooler Postoperative Pain Scale, the Observation Scale of Behavioral Distress, and the Children's Hospital of Eastern Ontario Pain Scale (Elliott et al. 1987; McGrath 1987; McGrath et al. 1985; Tarbell et al. 1992).

Many veterinary researchers have studied analgesic treatments using some form of behavior assessment to assess analgesic effects on acute pain. In addition, some have worked to develop pain rating scales suitable for use by others in studies of pain and analgesia (e.g., Firth and Haldane 1999; Holton et al. 2001). Scales described in veterinary studies have been either verbal ordinal 3- to 5-point scales (with descriptors such as none, mild, moderate, severe), numerical (ordinal) rating scales (e.g., a 4- to 10-point scale), categorized numerical rating scales with ordinal ranking of individual behaviors within three to seven "categories" (e.g., 0-2 points assigned for various behaviors within each of several behavior categories such as vocalization, movement, respiratory pattern, and posture), or visual analog scales (VAS[1]). Verbal, numerical, categorized numerical, VAS, or a combination of two or more of these scales have been used to evaluate behavior in dogs in at least six studies of OHE or castration (Firth and Haldane 1999; Lascelles et al. 1997; Lemke et al. 2002; Slingsby and Waterman-Pearson 2000; Slingsby et al. 2001); in 13 studies of orthopedic surgery (Brodbelt et al. 1997; Budsberg et al. 2002; Conzemius et al. 1997; Day et al. 1995; Grisneaux et al. 1999; Hendrix et al. 1996; Lascelles et al. 1994; Mbugua et al. 1989; Nolan and Reid 1993; Pibarot et al. 1997; Sammarco et al. 1996; Taylor and Houlton 1984; Vesal et al. 1996); one study of auricular surgery (Buback et al. 1996); seven studies of canine thoracotomies (Conzemius et al. 1994; Pascoe and Dyson 1993; Popilskis et al. 1991; Stobie et al. 1995; Thompson and Johnson 1991; Vainio and Ojala 1994; Walsh et al. 1999); and five studies of other soft tissue and/or orthopedic surgery patients (Holton et al. 1998a,b; Mathews et al. 1996, 2001; Reid and Nolan 1991). All of these scales are characterized by reliance on subjective evaluation of behaviors whose correlation with other behavioral or physiological indicators of pain and distress has not been confirmed. The subjective nature of these instruments is revealed by the presence of significant variability of pain scores between observers (Holton et al. 1998b).

There are many reasons for intra- and interobserver variability in behavioral research, even when properly conducted. Careful selection and definition of studied behaviors are essential foundations for observational research (Lehner 1979). However, none of the studies cited here describe patient evaluation criteria in this manner, and it appears that no effort has been made to define many of the scale de-

scriptors clearly. This characteristic increases the likelihood of discordance between observers. For example, the following words may mean different things to different people and be impossible to define with enough precision to ensure good interobserver agreement: "uncomfortable" (Vesal et al. 1996); "frequent" (Conzemius et al. 1997); "calm" (Sammarco et al. 1996); "hysterical" (Sammarco et al. 1996); "responds to calm voice" (Conzemius et al. 1997; Grisneaux et al. 1999); "agitation" (Vesal et al. 1996); "crying" (Pibarot et al. 1997); "wary" (Firth and Haldane 1999); and "may not dream" (Mathews 1996).

In the older simple verbal scales, the complex experience of pain is divided into three to five categories based solely on clinical judgment of the investigator, often with little or no written instruction as to what differentiates an animal with "mild" pain from one with "moderate" or "none.". The ordinal scales represent an attempt to separate these animals more objectively but are also limited by problems of nonlinearity, arbitrary definitions, and lack of validation.

The issue of nonlinearity arises even in carefully developed scales used for clinical evaluation of humans. For example, in a perfectly linear 10-point Lickert type scale, patients with a score of 6 would experience twice as much pain as those with a score of 3, and those with a score of 8 would experience 10% more pain than those with a score of 7. However, these instruments rarely yield this level of precision as determined by other measures, particularly when the low end of the scale (0) is used to denote "no pain" (Vickers 1999). In veterinary studies, these numerical scales have not been developed systematically but rather were creations of the investigator applying arbitrary definitions to the intervals. When verbal descriptors are used, they are often based on clinical criteria used in daily practice that appear to have good content validity, yet the terms and expressions used to define each level were based simply on subjective opinions of the investigators (e.g., Buback et al. 1996; Hardie et al. 1997). Others have used 10-point ordinal scales with no word associations for each level, using only anchors such as "0 = no pain" and "10 = pain could not be worse" (Holton et al. 1998a). This example is essentially a 10-step modification of a VAS (see below), wherein the assessor simply applies a numerical value to his or her clinical impression.

In an effort to improve on the ordinal scale, some investigators have refined behavioral and physiological observations into several general categories and assigned a weighted score within each. One example is the Melbourne Pain Scale (MPS[1]) (Firth and Haldane 1999). This instrument consists of six broad categories (physiological data, response to palpation, activity, mental status, posture, and vocalization), each of which is divided into three or more levels and assigned a different numerical weight. For example, the category "mental status" contains four levels: submissive, overtly friendly, wary, and aggressive; and these levels are accorded scores of 0, 1, 2, and 3, respectively. In total, the maximum number of possible points for

pain awarded by the scale is 27. When applied by two trained observers to dogs after OHE, the highest mean score was 8.0, consistent with the notion that this procedure produces only moderate pain. The two observers involved in the original report did not view the dogs simultaneously because one worked with videotaped footage of interactions between the dog and the other observer. The high mean value of the difference in scores between the two observers for any dog at any point in time—4.5—underscores the difficulty in interpretation of the scale and the differences between live evaluations and working off videotape.

Other limitations of categorized ordinal scales become apparent when they are applied to severely injured patients. For example, before 1988, many dogs in our intensive care unit after major surgery did not receive analgesics in part because their behavior did not meet the expectations of their caregivers for painful behavior. Even if one attempted to force the administration of analgesia to similar dogs by application of the MPS (or other similar scales), some of those dogs would be assigned a low pain score because the scale would not capture the right information. For example, 2 days after limb amputation and without the use of post-

Category	Descriptor	Score
Physiological data		
a)	Physiological data within reference range	0
b)	Dilated pupils	2
c) *Choose only one:*	Percentage increase in heart rate relative to baseline	
	>20%	1
	>50%	2
	>100%	3
d) *Choose only one:*	Percentage increase in respiratory rate relative to baseline	
	>20%	1
	>50%	2
	>100%	3
e) Rectal temperature exceeds reference range		1
d) Salivation		2
Response to palpation		
a) *Choose only one:*	No change from preprocedural behavior	0
	Guards/reacts[a] when touched	**2**
	Guards/reacts[a] before touched	3
Activity		
a) *Choose only one:*	At rest- sleeping or semiconscious	**0**
	At rest- awake	1
	Eating	0
	Restless (pacing/getting up and down)	2
	Rolling, thrashing	3
Posture		
a)	Guarding or protecting affected area (includes fetal position)	2
b) *Choose only one:*	Lateral recumbency	**0**
	Sternal recumbency	1
	Sitting/standing, head up	1
	Standing, head hanging down	2
	Moving	0
	Abnormal posture (prayer position, hunched)	2
Vocalization[b]		
a) *Choose only one:*	Not vocalizing	**0**
	Vocalizing when touched	2
	Intermittent vocalization	2
	Continuous vocalization	3
Mental status		
a) *Choose only one:*	Submissive	**0**
	Overtly friendly	1
	Wary	2
	Aggressive	3

[a]Turning head toward affected area, biting, licking, scratching at the wound; snapping at handler; or tense muscles and a protective (guarding) posture.
[b]Does not include alert barking.

Melbourne score   **4**

Figure 1 Melbourne Pain Scale (MPS) as applied to dog described in text. Bold entries indicate observations of a dog 2 days after limb amputation and without proper postoperative analgesic therapy. The dog was lying quietly, was unwilling to move, failed to eat, and appeared very depressed. Thus, careful scoring of this patient with the MPS yields a total score of only 4 points of a possible 27, suggesting minimal pain. Adapted from Firth AM, Haldane SL. 1999. Development of a scale to evaluate postoperative pain in dogs. J Am Vet Med Assoc 214:651–659.

operative analgesic therapy, a dog may lie quietly, be unwilling to move, fail to eat, and appear very depressed. If one were to apply the MPS to rate this dog's pain, observed responses would yield the results of a total MPS score of only 4 point of a possible 27 (Figure 1).

Other investigators have attempted to capture the nuances of clinical impression with other types of pain rating scales of which the observer-based VAS is the most simple example. The VAS is a 100-mm line, anchored on the left by either the number 0 or wording such as "no pain" and on the right by either the number 100 or wording such as "worst possible pain" or "worst possible pain for this procedure." The observer watches the patient for a predetermined time period, uses clinical judgment about the severity of pain, and draws a line that intersects the 100-mm VAS. The distance from the left end of the line to the intersect is then measured (in millimeters) and this number is the VAS pain score. The most obvious limitation of this scale is that it simply places a numerical value on a subjective judgment, and indeed there is significant interobserver variability with this device, even when four veterinary anesthesiologist coworkers view the same animals at the same time (Holton et al. 1998b). Furthermore, the sensitivity of the scale is limited when constructed with an upper delimiter of "the worst possible pain" and applied to conditions producing only mild to moderate pain such as ovariohysterectomy. Wording the upper delimiter to indicate "the worst possible pain *for this procedure*" yields higher scores that may better demonstrate subtle differences between observers, time points, and study subjects (Holton et al. 1998b; Lascelles et al. 1998).

A more comprehensive ordinal scale, based on a more exhaustive set of defined behaviors, has been used to teach identification of pain and response to analgesia in dogs; however, it is too cumbersome to use in clinical trials (Mathews 2000). Recently, some investigators have developed a more formalized approach to pain terminology and have proposed evaluation in a more standardized manner (Holton et al. 2001). This tool, currently undergoing refinement and validation, is a composite verbal scale that was developed in the same statistical manner as the McGill Pain Questionnaire, a keystone evaluation instrument used to communicate human pain (Melzack 1983). It represents the first serious effort to define and standardize the words veterinarians use to describe pain in dogs, and it may go a long way toward improving our ability to conduct meaningful clinical studies.

Another Approach to Behavior Assessment

Our approach is rooted in the field of ethology, which involves objective evaluation of behavior. In the early 1990s, we developed an ethogram that cataloged behavior of caged pet dogs with and without surgery (Hardie et al. 1997). The ethogram contains many discrete, operationally defined behaviors. From this list, we identified 15 behaviors and eight combinations of wakefulness and body position that occurred with sufficient frequency to be useful characterizations of their postoperative behavior. The behaviors were readily observed and coded by trained observers working with videotapes obtained for 24 hr after elective OHE. By videorecording the dogs' behavior for 24 hr, we were able to evaluate them both during carefully choreographed interactions and in the absence of humans. From this work, we demonstrated that the behaviors of caged dogs are altered by OHE, analgesia, or a combination of the two procedures in ways clearly identified by behavioral analysis (Hardie et al. 1997; Kyles et al. 1998). We also demonstrated that these variables produce significant differences in behavior during interactions with caregivers and when no observers are present. Treatment with oxymorphone or fentanyl was associated with a more rapid return to the behaviors that characterized the nonoperated, nondrug controls. Whereas behavior analysis could detect the influence of analgesia with oxymorphone or fentanyl, neither physiological measures nor subjective pain- and sedation-scoring instruments were sensitive to analgesic effects (Hansen et al. 1997; Kyles et al. 1998). This finding has been reproduced by others who have been unable to demonstrate a strong relation between physiological parameters and behavior (Holton et al. 1998a). Using a modification of an early iteration of our ethogram, another investigator found similar effects on behaviour of anesthesia, surgery, and analgesia in a dog OHE model that also demonstrated significant effects of these manipulations on plasma cortisol concentration (Fox et al. 1994, 2000).

Automated Measurement of Movement: Pilot Data from Beagle Dogs

Recent advances in computer acquisition of behavioral data have facilitated collection of behavior data. For example, video and software technologies of Noldus (http://www.noldus.com) allow automated detection and description of movement, and facilitate recording of behavioral data by a trained observer coding operationally defined behaviors. This behavioral observation software (The Observer™) is widely used in studies of both animal and human behavior. The automatic video tracking system (Etho Vision™) has been most widely applied in studies of rodents and insects (Noldus et al. 2002; Spink et al. 2001). The system utilizes differences in the gray scale value of monochrome video signals to differentiate an animal from its background within a fixed field of view. Once set to identify the animal correctly, the computer can continuously track the shape and position of the two-dimensional figure, updating X,Y coordinates of its geometric center as frequently as 30 times per second (the frame refresh rate of the video camera). Data from each subject are stored in tracking files that are later analyzed using built-in statistical summary and comparison software. By frequent plotting of

position and surface area, the movement detection system summarizes the following: where each subject spends its time; its spatial relationship to objects in the environment; frequency/duration of motion; distance moved; velocity; speed moving to/from other animals or objects; and, in the case of rodents, frequency and duration of rearing. The system has been used to evaluate learning in cognitive studies of rodents that provide a learning challenge in a carefully controlled environment. For example, by combining evaluation of movement patterns and latency to correct negotiation of a water maze, new insights into the process of learning are obtained (Minichiello et al. 1999; Spink et al. 2001). The strength of this analysis is enhanced by combining movement analysis with simultaneous frequency/duration analysis of behaviors coded by a trained observer viewing the subject in real time from a time-stamped videorecording.

We have recently adopted this system for use in dogs and have collected movement data in a pilot study on 18 normal beagle dogs. The dogs were housed in 3′ × 6′ runs and videotaped first for 24 hr after only anesthesia and then 1 wk later after anesthesia and either OHE (females) or partial enterotomy (males). Twelve dogs (6 male and 6 female) were pretreated with saline placebo before surgery, and six dogs (3 male and 3 female) were pretreated with carprofen, a nonsteroidal anti-inflammatory drug. During the 24-hr recovery period, the dogs were observed simultaneously by three caretakers at hourly intervals except during the period from 10 PM to 7 AM. The caretakers were trained to evaluate the animals independently with three separate pain rating scales, including a VAS, a four-level verbal rating scale, and a categorized numerical rating scale.

The videography software was calibrated to recognize

and track the dark "saddle" marking on each beagle's torso (Figure 2). Several random 10-min time samples were selected to estimate dog movements by direct measurement using a piece of tracing paper held over the monitor screen and manually measuring the distance of each movement. A high degree of correlation (90% or better) was found between manually determined movement and movement measured by the computer system.

When the movement data were evaluated in an analysis of variance model, surgery had significant ($p < 0.05$) effects on the mean values of several relevant measured parameters over the entire 24-hr recording session. Among these, for example, were a reduction in the amount of time spent near the front of the cage (Figure 3), the total distance traveled (Figure 4), and the average speed of movement (Figure 5). For these and most other measures, administration of carprofen had no identifiable effect. Although the trained observers using published pain rating scales (a modified Glasgow Pain Scale and a VAS) could identify a surgery effect, there were no differences in pain scores between placebo- and carprofen-treated dogs.

Collaboration with a Local Veterinary Hospital

Having validated the ability of the videography system to capture movement data from dogs, we seek to incorporate this technique into clinical studies of behavior after OHE. The pilot work described above was obtained using healthy purpose-bred beagle dogs acclimated to the runs for several months before the study. The impact of surgery on the behavior of these dogs may be significantly different from its

(A)
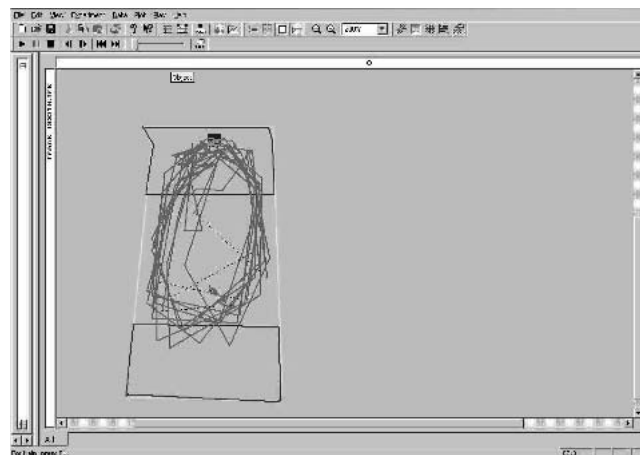
(B)

Figure 2 (A) Still image of a dog in a run overlaid with the arena definition (outside perimeter lines), zones of interest (horizontal lines), and track of 15 movements (inside, diagonal lines). All movement data is obtained from within the arena area. By dividing the arena into zones, movements within, to, and from each zone can be measured. In this example, the zone definitions allow characterization of time spent at the very front and very back of the run. (B) Still image of the path of the most recent 200 movements obtained from the dog in Figure 2A. The solid line indicates the path of motion, and the dotted line indicates missing data.
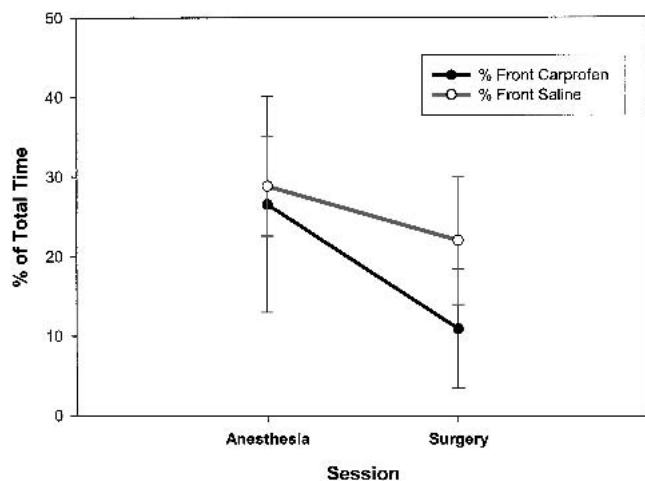
Figure 3 Effect of surgery on the percentage of the 24-hr recording session spent at the front of the cage, for both drug treatment groups. The surgery effect on this measure was significant ($p = 0.002$). For this and all other graphs, the error bars represent the 95% confidence interval for the means, and there were no differences between placebo and dogs adminsitered carprofen.

effects on animal patients brought to private practice facilities for elective surgery. To evaluate the effects of surgery on the behavior of pet dogs more accurately, we have begun a clinical study on privately owned pets brought to a private clinic in our area.

Each dog is hospitalized twice, once for surgery and once simply to board in the same kennel run for an equivalent period. The visit order is randomized to limit the effect of prior hospitalization, and the study is a repeated-measures design. During the control visit, behavior is recorded for 24 hr after a short acclimation period. This behavioral profile will serve as a basis for comparison with
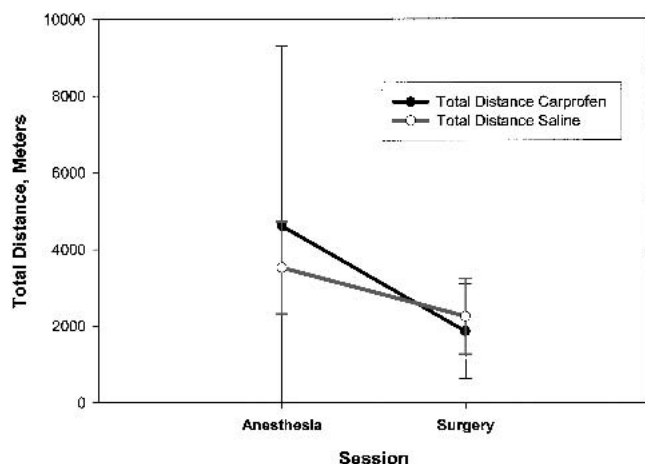

Figure 4 Effect of surgery on the total distance traveled over 24 hr. Surgery reduced the total distance traveled for all dogs from 3.85 km to 2.14 km ($p = 0.02$).
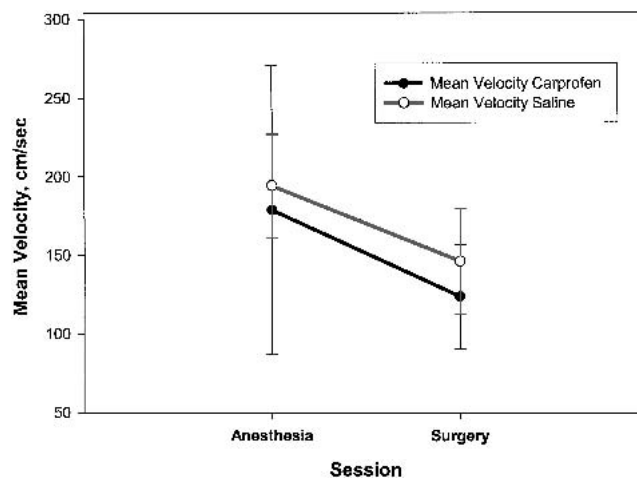

Figure 5 Effect of surgery on the average speed of all movements during 24 hr. Surgery reduced the mean speed of all dogs from 189 to 139 cm/sec ($p = 0.01$).

the profile obtained postoperatively, and we will determine which of two perioperative analgesic protocols produces less deviation from control visit behavior. At the surgical visit, the dogs will be randomly assigned to treatment with either morphine and carprofen (strong analgesic protocol) or butorphanol (weak analgesic protocol). Owners are instructed to administer oral carprofen (2 mg/kg) on an "as needed" basis up to twice daily for 3 days. Behavior evaluation consists of objectively coded behaviors previously described (Hardie et al. 1997), behaviors unique to the study environment (e.g., frequency and duration of time spent playing with toys brought from home, frequency of jumping onto an elevated bedding platform), and analysis of movement using videography.

In addition to objective behavior analysis, subjective pain scoring involves use of two previously published and described scales (VAS and MPS) and a working version of the Glasgow Pain Scale (Holton et al. 2001). Two observers (the study technician and a clinic technician) trained in the use of the scales evaluate the patients simultaneously. These evaluations take place at the times of standardized interactions after surgery.

The outcome measures for the study consist of objectively quantified behavior, subjective pain rating scores, and physiological data (heart rate, respiratory rate, arterial blood pressure, and serum cortisol determinations). In addition, owners are interviewed and data collected on their assessment of the dog's behavior preoperatively and at 3 and 7 days after release from the hospital. The questionnaires are designed to obtain information about the dog's temperament, environmental reactivity, and activity levels, as well as the total number of carprofen dosages given. Frequency analysis will be used to look for correlation between those characteristics and behavior or pain scores. This study will help us resolve lingering questions about the value of routine physiological data in this model and will provide a

more comprehensive picture of the effects of OHE and treatment with a weak or strong analgesic on movement and behavior.

Conclusion

Evaluation of pain behavior in animals may be accomplished by frequency analysis of objectively coded behaviors. The large number of surgeries performed on pet dogs in veterinary hospitals provides opportunities for clinical research that are otherwise unavailable or difficult to obtain. By evaluating client-owned pets in a representative private practice environment, we hope to obtain data that have better application to clinical and laboratory animal husbandry. Data obtained from client observations of their pets' behavior at home after surgery may also help us to increase our understanding of the impact of two fundamentally different analgesic protocols on moderately painful abdominal surgery. Automated collection of movement data, combined with objective coding of behaviors, may provide insights into the experience of acute pain in animals that are currently surmised only by observer judgment.

Acknowledgment

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