Original Article
J Vet Sci 2017, 18(2), 175-182 · https://doi.org/10.4142/jvs.2017.18.2.175

Analgesic efficacy of oral firocoxib in ovariohysterectomized cats

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The postoperative analgesic effects of firocoxib in ovariohysterectomized cats were observed. Twenty-four cats were divided into 3 groups: control (no medicine), firocoxib-1 (1 mg/kg/day) and firocoxib-3 (3 mg/kg/day). Colorado pain scale scores (CPSS), composite pain scores (CPS), and buccal mucosal bleeding times (BMBT) were recorded in blinded fashion before induction and 2, 5, 8, 24, 30, and 48 h post-operation. The average CPSS (mean ± SEM) over 2 to 48 h post-operation in firocoxib-3 (0.4 ± 0.1) was significantly lower than that of the control (0.7 ± 0.2; $p = 0.004$), but that of firocoxib-1 (0.5 ± 0.2) was not different from that of the control ($p = 0.40$). The mean CPS of firocoxib-3 was significantly lower than that of the control at 24 h post-operation ($p = 0.04$); nonetheless, there was no significant difference in mean CPS between firocoxib-1 and control groups at all intervals. BMBT and body temperature were within normal limits in all groups. However, reversible azotemia was identified in two firocoxib-3 cats at 72 h post-operation. One firocoxib-3 cat vomited once at 48 h post-operation. In conclusion, firocoxib-3 is helpful for postoperative pain control in cats; however, gastrointestinal irritation and renal function side effects may occur.

Keywords: analgesia, cats, cyclooxygenase, firocoxib, ovariohysterectomy

Introduction

Analgesic drugs are essential components of postoperative care in veterinary medicine [1]. Opioids and nonsteroidal anti-inflammatory drugs (NSAIDs) are commonly prescribed for postoperative pain control in small animal patients [18,24]. The inhibition of cyclooxygenase (COX) enzymes by NSAIDs prevents transformation of arachidonic acid to prostaglandin or other inflammatory mediators. Thus, NSAIDs are helpful for fever management and inflammation induced by injury [30]. COX-1, found in unremarkable tissues, helps produce prostaglandin, which maintains normal body homeostasis, including gastrointestinal mucosa protection, platelet aggregation, and renal blood flow [11,29]. On the other hand, COX-2, induced by injuries, has roles in producing prostaglandins and pain mediators, as well as in amplifying nociceptive pain signaling to the spinal cord and brain [14,21]. Side effects of NSAIDs are related to their specificity to inhibit COX enzymes, including COX-1 and COX-2 [27,30]. Currently, selective NSAIDs, which inhibit only COX-2, are preferable because they result in fewer side effects on kidneys and platelet aggregation [2,5] and less gastrointestinal irritation [15,27].

Firocoxib, classified as COX-2 selective, has been shown by various studies to have minimal side effects when used for pain control in dogs and horses with osteoarthritis [17,23,28]. Moreover, firocoxib is effective for acute pain control in dogs in the postoperative periods [20]. However, the effects of firocoxib in feline patients are unclear [22]. Cats have lower hepatic glucuronyl transferase activity than that in dogs, which means cats have an inadequate inability to convert drugs into an ineffective form for elimination [10,35]. A lower dosage of NSAIDs is generally recommended for use in cats compared to dogs in order to avoid side effects. One study used oral administration of firocoxib for pyrexia prevention in two cats [25]. Pharmacokinetics indicated that the time to maximal plasma concentration was 1 and 4 h, respectively, and eliminated half-life was 8.7 and 12.2 h [25]. The half-maximal inhibitory concentration ratio (the ratio of COX-1 to COX-2 activity) for firocoxib was 58 [25], suggesting that firocoxib is a COX-2 selective NSAID. Although it has been reported that oral firocoxib at a dosage of 0.75 to 3.0 mg/kg in cats helped to reduce fever without side effects [25], the effects of firocoxib

Received 25 Jan. 2016, Revised 5 Jun. 2016, Accepted 21 Jul. 2016
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pISSN 1229-845X
eISSN 1976-555X

when used for pain control in cats remain undescribed.

The purpose of the present study was to investigate the proper dosage of firocoxib for postoperative pain control in cats undergoing ovariohysterectomy. The adverse effects of firocoxib on hemostasis were recorded before each operation by determining buccal mucosal bleeding times. The gastrointestinal and renal toxicities due to the use of firocoxib were assessed over three postoperative days by using clinical signs and blood chemistry.

Materials and Methods

Animals

The study involved female cats undergoing ovariohysterectomy. Pregnant cats and cats with systemic, orthopedic, or neurological problems were excluded from the experiment. Two cats from twenty-six cats that expressed a composite pain score exceeding 8 points at the baseline (38% of full composite pain scores) were considered aggressive and excluded from the experiment. The 24 enrolled cats weighted from 2.5 to 5 kg. (mean ± SEM; 3.4 ± 0.2 kg) and were 6 months to 7 years of age (3.3 ± 0.5 years old). A veterinarian performed physical and blood examinations of the cats before their operation. Each cat in the study was admitted to the hospital for at least 20 h. Food and water were restricted for 8 h before the operation. The investigation conformed to the Guide for the Care and Use of Laboratory Animals of Kasetsart University (approval No. OACKU00458), and informed owner consent was obtained for all cats.

Anesthesia and surgery

All cats underwent the same anesthetic protocol. Using a catheter placed into the cephalic vein, intravenous fluids (0.9% normal saline solution) were administered to all cats. Anesthesia was induced with propofol, 4 to 6 mg/kg intravenously, without premedication. The anesthesia was maintained with isoflurane and oxygen delivered in a semi-open rebreathing system. Isoflurane, which has hypnosis analgesic effects and is a muscle relaxant to reduce pain during anesthesia was set at 2%, an approximate 1.5 minimal alveolar concentration (MAC) during the operation [13,31]. Enrofloxacin (5 mg/kg) was administered as a prophylactic antibiotic by subcutaneous injection. The buccal mucosal bleeding times were recorded before the operation by using a surgical blade to create a 1 cm long 1 mm deep incision in the buccal mucosa. Blood from the incision was blotted using filter paper held near the incision. Ovariohysterectomy was performed via the ventral midline approach using a small incision (approximately 1 cm long) by an experienced surgeon that had been trained for over 5 years in damage control surgery. Average surgical time was 15 ± 5 min.

Treatment group

After the operation, the cats were transferred to a recovery room. Each cat was blindly randomized into one of three groups with eight cats per group. Group 1 (control group) received a sugar pill placebo, Group 2 (firocoxib-1 group) received firocoxib at 1 mg/kg [16], and Group 3 (firocoxib-3 group) received firocoxib at 3 mg/kg [25]. Group members were given their respective treatment orally 1 h before anesthesia induction. The treatments were given again at 24 and 48 h post-operation. It should be noted that all treatments were given after recording the pain scores to avoid unintentional effects on pain monitoring.

Post-surgical pain assessment

All cats were observed by the same blinded investigator during the 72 h postoperative period at intervals of 0, 2, 5, 8, 24, 30, 48, and 72 h. Assessment of postoperative pain was performed by using Colorado pain scale scores and composite pain scores. Colorado pain scale scores were determined after reviewing the pain criteria against a 4 point scale in 0.5 increments (Table 1), where 0 is no pain at all and 4 is the worst pain [12]. Composite pain scores [1] ranging from 0 to 21 were assessed using 0 as normal and 21 as the worst pain (Table 2). Composite pain score is the sum of the individual scores from 7 assessments: temperament (0–4); appearance (0–3); body posture (0–2); unprovoked behavior (0–3); interactive behavior (0–4); movement (0–2); and vocalization (0–3).

The threshold for commencing a rescue analgesic procedure (*i.e.*, morphine at 0.3 mg/kg IM) was set at either a Colorado pain scale scores above 2.5 or a composite pain score above 12 at 8 h after surgery or beyond. Cats with pain scores above these limits would immediately receive the rescue analgesic drug and be excluded from the study. The presence of any adverse effects, including vomiting, diarrhea, decreased appetite, lethargy, melena, somnolence, hyperactivity, skin reactions, and constipation were recorded [26,32].

Blood examination

Blood was collected before each operation as a baseline sample and at 72 h post-operation to evaluate complete blood count, blood urea nitrogen (BUN), creatinine, alanine aminotransferase (ALT), alkaline phosphatase (ALK), total protein, albumin, and serum globulin.

Statistical analysis

The average Colorado pain scale scores and composite pain scores in each group were analyzed by using a one-way ANOVA. The difference between two groups was compared by using Dunnett's *t*-test. The adverse effects in the treatment groups were compared to the control group by using Fisher's exact test. Data are expressed as mean ± SEM values. The level of significance was considered as $p < 0.05$.

Table 1. Colorado pain scale scores* (0–4 scores) for feline patients

Score	Patient criteria	Response and palpation	Body tension
0	Quiet when attended; relaxed and resting quietly; awareness about surrounding	Not agitated by palpation of wound or surgical site, or to palpation of other body part	Minimal
1	At ease or slightly unsettled; less responsive in surroundings but will look around to see what is going on	May or may not react to palpation of wound or surgical site	Mild
2	Isolation and less responsive; quiet, losing of brightness in eyes; lay curled up or sits tucked with all legs under the body with head lower than shoulder with eyes partially or mostly closed; rough hair coat; often grooming at an area that is painful or irritating; reduced appetite, not pay attention in food	Escape if painful area is palpated or may respond aggressively; tolerates attention, may brighten up when petted as long as painful area is avoided	Mild to moderate
3	Constantly crying, growling, or hissing if left alone; May bite or chew at wound, but unlikely to move when unattended	Moans or hisses at non-painful palpation; Reacts aggressively to palpation, decisively pull away to avoid any contact	Moderate
4	Recumbent; unresponsive or unaware of surroundings, difficult to draw away from pain; acceptive of care (i.e., wild or aggressive cats will be more tolerant of contact)	May not respond to palpation; May be rigid to avoid painful movement	Severe

*Colorado pain scale score criteria were modified from previous study [12].

Results

Among the three treatment groups, there were no significant differences by cat age (means: control group, 3.1 ± 0.4 years; firocoxib-1 group, 3.5 ± 0.6 years; firocoxib-3 group, 3.3 ± 0.4 years; $p = 0.85$) or by weight (means: control group, 3.6 ± 0.3 kg; firocoxib-1 group, 3.3 ± 0.2 kg; firocoxib-3 group, 3.4 ± 0.3 kg; $p = 0.58$). In addition, average buccal mucosal bleeding times were not different among the three groups (means: control group, 50.6 ± 13.6 sec; firocoxib-1 group, 66.6 ± 13.8 sec; firocoxib-3 group, 46.3 ± 7.4 sec; $p = 0.17$; Fig. 1). All cats recovered from the anesthetic drug uneventfully.

The average baseline Colorado pain scale scores from the control, firocoxib-1, and firocoxib-3 groups were not significantly different (0.4 ± 0.2, 0.3 ± 0.1, and 0.5 ± 0.2, respectively; $p > 0.05$; Fig. 2). There were no cats in any group that expressed a Colorado pain scale score exceeding 2.5 points, thus no cat required rescue analgesia during the recovery period. There were no significant differences in mean Colorado pain scale scores (recorded up to 48 h post-operation) among the firocoxib-1, firocoxib-3, and control groups at all intervals (Fig. 2). Interestingly, average Colorado pain scale scores over the 2 to 48 h postoperative period in the firocoxib-3 group (0.4 ± 0.1) was significantly lower than that of the control group (0.7 ± 0.2; $p = 0.004$; Fig. 3). However, no significant difference was detected between average Colorado pain scale scores over the 2 to 48 h postoperative periods in the firocoxib-1 (0.5 ± 0.2) and control groups ($p = 0.40$), and no significant difference between average Colorado pain scale scores over the 2 to 48 h postoperative periods in the firocoxib-1 and firocoxib-3 groups ($p = 0.38$; Fig. 3).

Similar to Colorado pain scale score results, the average baseline composite pain scores from the control, firocoxib-1, and firocoxib-3 groups were not significantly different (3.3 ± 0.7, 3.0 ± 1.1, and 3.4 ± 1.0, respectively; $p > 0.05$; Fig. 4). Mean composite pain score of the firocoxib-3 group was significantly lower than that of the control group at 24 h post-operation ($p = 0.04$). The mean composite pain scores of the firocoxib-1 group was lower than that of the control group at 8 h post-operation, although the difference was not significant. While the composite pain score of the firocoxib-1 group was less than that of the control group at 8 h post-operation, the mean composite pain scores of the firocoxib-3 group was less than that of the control group for the entire recovery period. The cats receiving firocoxib-3 and firocoxib-1 returned to normal baseline composite pain scores at 5 h and 30 h post-operation, respectively. Firocoxib-1 tended to be less effective in pain score reduction in the early portion of the recovery period. The average temperature of all three groups at 24 h post-operation was normal with no significant differences among the groups (means: control group, 37.7 ± 0.2°C; firocoxib-1 group, 37.7 ± 0.1°C; firocoxib-3 group, 37.9 ± 0.2°C; $p = 0.29$).

Complications during the recovery period were recorded after 8 h after surgery. Cats in the control, firocoxib-1, and

Table 2. Composite pain scores* for feline patients

Observation	Score	Patient criteria
Temperament	0	Friendly; approaches front of cage when door is opened; may vocalize; purrs, rubs head, may lie down; easy, relaxed attitude
	1	Friendly; approaches front of cage when door is opened; slightly cautious in interaction with observer; may trust observer with time.
	2	Confident, not friendly; but does not show any aggression; sits sternally or lies laterally; may try to escape.
	3	Mild aggressive; does not approach, but will allow observer to handle; may purr or growl; flicks tail.
	4	Outwardly aggressive; sits sternally in back of cage; may growl, hiss, or bite; cannot be handled without protection/restraint.
Appearance	0	Normal (coat, eyes, etc.)
	1	Mild changes; eyelids partially closed; ears carried abnormally
	2	Moderate changes; eyes sunken or glazed; unthrifty appearance
	3	Severe changes; eyes pale; enlarged pupils; 'grimacing'/abnormal facial expressions
Body posture	0	Lateral recumbency (total relaxation)
	1	Sternal recumbency; or sitting/standing with head up; moving
	2	Head down; abnormal position; hunched-up
Unprovoked behavior	0	Normal (eating, grooming, etc.), or calmly asleep
	1	Minor changes in behavior; awake and alert
	2	Moderately abnormal; less mobile than normal; unaware of surroundings; restless and uncomfortable; depressed
	3	Markedly abnormal; very restless; vocalizing; self-mutilating; grunting; facing back of cage; or extremely depressed
Interactive behavior	0	Normal response to handling and touching of surgical site
	1	Minimal response to handling and touching wound; pulls away when surgical site is touched; looks at wound; mobile
	2	Vocalizes when wound is touched; restless; reluctant to move
	3	Vocalizes and pulls away when wound is touched
	4	Violent reactions to stimuli; vocalizing when wound is not touched; snapping; extremely restless; or will not move when coaxed
Movement	0	Normal amount of movement
	1	Frequent position changes or reluctance to move
	2	Thrashing or motionless
Vocalization	0	Quiet
	1	Crying; responds to calm voice and stroking
	2	Intermittent crying; no response to calm voice and stroking
	3	Continuous noise that is unusual for this animal

*Composite pain score criteria were modified from previous study [6].

firocoxib-3 groups exhibited decreased appetite (37.5%, 25%, and 50%, respectively). The decrease in appetite in the control group did not differ significantly from those in the firocoxib-1 and firocoxib-3 groups ($p = 0.59$ and 0.61, respectively). One cat from the firocoxib-3 group vomited once at 48 h post-operation (12.5% of the group). No significant differences were found among the treatment groups for hemogram and serum biochemistry for hepatic injury (ALT and ALK) at baseline or at 72 h post-operation. Blood chemistry results for renal function (BUN and creatinine) were within normal limits in the control and firocoxib-1 group at baseline and at 72 h post-operation. There were 2 cats with reversible azotemia after surgery in the firocoxib-3 group, resulting in a significant increase in average BUN and creatinine level at 72 h post-operation over those at baseline (Table 3).

Discussion

Firocoxib has been used successfully for postoperative pain control in dogs, but its effectiveness for pain control in cats has not been previously described. In the present study, we tested the postoperative analgesic effects of oral administration of firocoxib at 1 mg/kg and 3 mg/kg doses in cats after undergoing ovariohysterectomy. The results of the present study indicate that cats receiving 3 mg/kg firocoxib had lower postoperative pain scores (both Colorado pain scale scores and composite

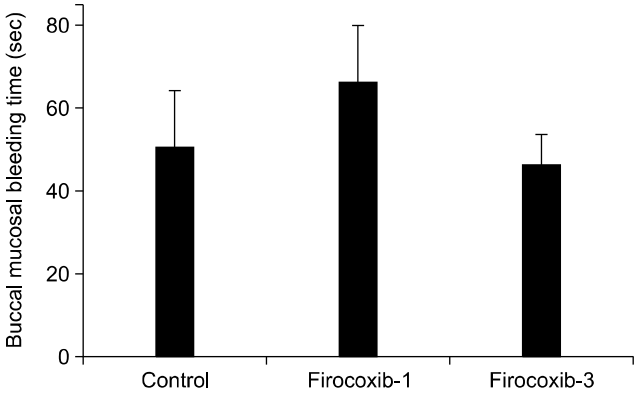

Fig. 1. Average buccal mucosal bleeding times of control, firocoxib-1, and firocoxib-3 groups.

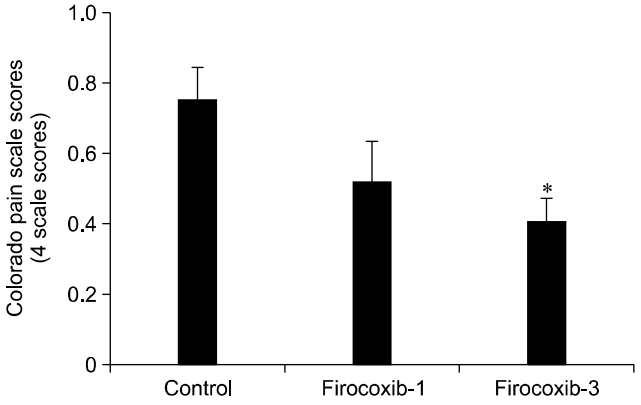

Fig. 3. Average Colorado pain scale scores over the 2 to 48 h post-operation of control, firocoxib-1, and firocoxib-3 groups. *$p < 0.05$ *vs.* control.

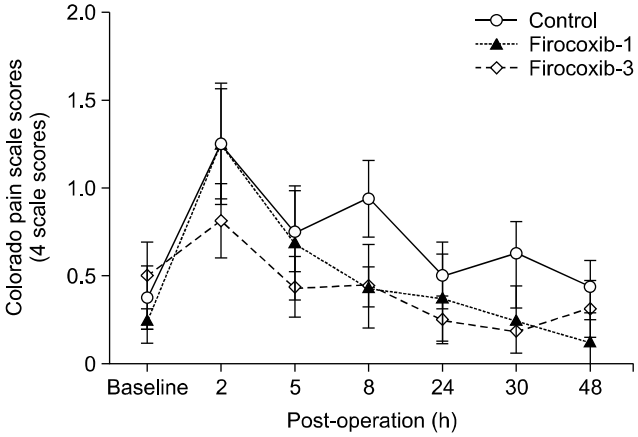

Fig. 2. Colorado pain scale scores of control, firocoxib-1, and firocoxib-3 groups. Differences were not significant among control, firocoxib-1, and firocoxib-3 groups.

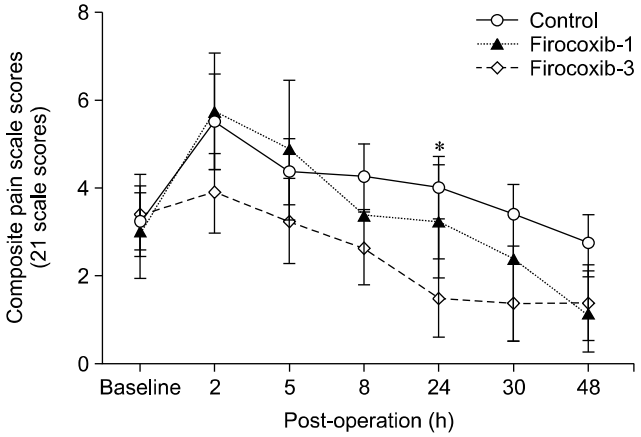

Fig. 4. Composite pain scores in cats after ovariohysterectomy at 0 (baseline), 2, 5, 8, 24, 30, and 48 h post-operation. *$p < 0.05$ control *vs.* firocoxib-3 at 24 h post-operation.

Table 3. Hemogram and blood chemistry analysis of cats in the present study (mean ± SEM)

Blood profile	Control		Firocoxib-1		Firocoxib-3		Reference range
	H0	H72	H0	H72	H0	H72	
PCV(%)	39.9 ± 2.6	37.2 ± 1.7	36.4 ± 2.2	34.5 ± 1.8	33.8 ± 1.6	35.1 ± 1.6	30–45
WBC ($\times 10^3/\mu L$)	9.1 ± 0.5	17.7 ± 3.1	9.14 ± 1.4	13.4 ± 1.0	11.6 ± 1.2	17.2 ± 2.1	5.5–19
Platelet ($\times 10^3/\mu L$)	243 ± 15	299 ± 37	215 ± 54	216 ± 45	229 ± 66	292 ± 70	200–700
BUN (mg%)	21.4 ± 1.2	24 ± 2	20.9 ± 0.7	20.0 ± 2.1	22.9 ± 1.1	45 ± 13*	15–35
Creatinine (mg%)	1.4 ± 0.1	1.4 ± 0.0	1.3 ± 0.1	1.3 ± 0.1	1.3 ± 0.1	2.2 ± 0.6*	1.0–2.2
ALT (IU/L)	38.4 ± 5.3	43.1 ± 4.6	69.8 ± 14.2	51.9 ± 5.0	52 ± 6.1	48 ± 3	28–76
ALK (IU/L)	26.1 ± 3.3	21.6 ± 1.2	34.3 ± 5.9	25.4 ± 4.7	46.6 ± 13.1	36.9 ± 7.3	0–62
Protein (gm%)	7.1 ± 0.4	7.3 ± 0.1	6.8 ± 0.1	7.2 ± 0.2	7.0 ± 0.3	7.6 ± 0.2	5.8–7.8
Albumin (gm%)	2.7 ± 0.2	3.2 ± 0.1	3.3 ± 0.1	3.5 ± 0.1	3.1 ± 0.1	3.4 ± 0.1	2.6–4.2
Globulin (gm%)	4.3 ± 0.3	4.1 ± 0.2	3.6 ± 0.1	3.7 ± 0.2	3.9 ± 0.3	4.3 ± 0.2	2.9–7.7

H0, baseline value; H72, 72 h post-operation value; PCV, packed cell volume; WBC, white blood cell; BUN, blood urea nitrogen; ALT, alanine aminotransferase; ALK, alkaline phosphatase. *$p < 0.05$ compared to baseline.

pain scores) than those in the control group. The firocoxib-3 group also had lower pain scores than cats receiving firocoxib-1, but the difference in scores between those groups was not statistically significant. The buccal bleeding times were comparable among the control, firocoxib-1, and firocoxib-3 groups. Side effects noted in the study included vomiting (one cat in the firocoxib-3 group) and azotemia (two cats in the firocoxib-3 group).

Monitoring the expression of postoperative pain in cats is challenging because both stress and pain can affect a cat's behavior [7,34]. In cats, the assessment of surgical wounds by touching may provide a better assessment of pain than that from observation [6]; therefore, visual analog scores were not used in the present study. Both Colorado pain scale scores and composite pain scores were chosen to detect pain expression in the cats [1]. Although comparisons of the specificities of the Colorado pain scale scores and composite pain scores in the cats were not evaluated in this study, the application of both of these monitoring methods is likely to increase sensitivity for pain detection in cats [6].

Confounding factors that may have affected the results of the present study include the use of preanesthetic drugs and variation in patient temperament. Various preanesthetic drugs provide strong additional analgesic properties and may interfere with an experiment. We chose isoflurane, which has a hypnosis analgesic effect, to reduce pain during anesthesia, whereas morphine was selected as a rescue analgesic drug for cats expressing moderate to severe pain [31]; the latter drug was not needed. Patient temperament also may have been a confounding factor because the evaluation of feline pain scores is partly based on temperament. Patients with severe anxiety probably would have higher pain scores than those who remain calm. Randomized control trials before surgery are important to reduce the confounding effect of behavior on pain assessment [3]. In the present study, since behavior may affect pain score measurement, cats with baseline composite pain scores greater than 8 (38% of the full composite pain scores) were considered aggressive and were excluded from the study. Moreover, there were no significant differences in the baseline Colorado pain scale and composite pain scores among the groups. In addition, cats that experienced pain with a composite pain scores greater than 12 (57% of the full composite pain scores) would have undergone a rescue analgesic procedure by administration of morphine and would have been removed from the study [1]. However, in this experiment, there were no cats requiring rescue analgesia during the recovery period. The reason for the absence of a need for rescue analgesia is probably due to an efficient neutering technique that uses a small incision (usually less than 2 cm long) performed by a highly experienced veterinarian via midline coeliotomy, a procedure that has been shown to be associated with fewer complications that those arising from flank laparotomy [9].

Firocoxib is classified as a COX-2 selective inhibitor and has been studied by various researchers as an analgesic medicine for post-operation pain control and for osteoarthritis management in dogs. There are a limited number of studies on firocoxib use in cats. One study evaluated the safety of using firocoxib in cats by administering a dosage of 0.75 to 3 mg/kg and indicated that firocoxib is effective for pyrexia control with minimal side effects [25]. It is well known that the safety margin for the use of NSAIDs in cats is relatively lower than that for dogs [10,35]. In the present study, 1 or 3 mg/kg dosages of firocoxib were chosen, while the dose recommendation for dogs is 5 mg/kg for pain control. Administration of 3 mg/kg firocoxib significantly lowered the average Colorado pain scale scores and composite pain scores compared to the scores of the control group. However, although the cats that received 1 mg/kg firocoxib had lower Colorado pain scale scores and composite pain scores than those of the control group, the difference between the groups was not statistically significant. It is likely that 1 mg/kg firocoxib is not as effective for postoperative pain control as that from 3 mg/kg firocoxib. It should be noted that in all groups at three days post-operation, both the Colorado pain scale and composite pain scores had declined toward the baseline scores. Based on the present results, it is likely that ovariohysterectomy causes mild to moderate pain that lasts only for three days.

Some NSAIDs may interfere with blood clotting and may increase the risk of bleeding in patients undergoing surgery. The effect of firocoxib on bleeding disorders in cats has not been reported. Previously, it has been shown that a firocoxib dosage of 1 mg/kg was effective and inhibited production of PGE_1 and PGE_2 from the duodenal mucosal membrane [16]. Interestingly, at 1 mg/kg of firocoxib there was no effect on serum TXB_2 level, which is important for platelet function [16]. In the present study, buccal mucosal bleeding times in the control group were compared with those in the firocoxib-1 or firocoxib-3 groups; there was no significant difference detected. The results suggest that the dosages of firocoxib used in the present study did not interfere with the pathway that controls platelet function and blood coagulation.

The effects of firocoxib administration on pyrexia control were also assessed in the present study. The body temperature of the cats was monitored during preoperative and postoperative periods, and no pyrexia was detected in any of the groups. Previous research indicates that firocoxib is a good pyrexia control medicine that protects against pyrogen-induced fever. In the present study, ovariohysterectomy induced only minimal inflammation and did not cause fever in the treatment groups. The role of firocoxib for fever control induced by inflammation may require further study.

The side effects of firocoxib in cats were also monitored in this study. There were two cats (25%) in the firocoxib-3 group with elevated creatinine and BUN levels compared to those in the preoperative period. Cats in the firocoxib-1 group did not

show any obvious side effects. Some cats in the firocoxib-1 group had decreased appetite after surgery, but the incidence did not differ significantly from that in the control group. Vomiting was identified in one cat (12.5%) in the firocoxib-3 group at 48 h after surgery. However, because urinalysis was not recorded, we cannot determine whether the cause of vomiting was a renal or gastrointestinal side effect of firocoxib.

Blood pressure monitoring is essential for detection of hypotension that can occur during general anesthesia. Hypotension occurring during surgery can lead to insufficient blood flow to kidney, especially in cats with pre-existing disease [4,33]. The present study included healthy cats undergoing ovariohysterectomy and a preanesthetic blood check did not detect existing renal disease in any of the cats. It is essential for veterinary practitioners to increase the awareness that monitoring blood pressure during surgery can improve standard care for patients, especially for animals with pre-existing renal conditions [4]. Although the present study did not monitor blood pressure in all cats, intravenous fluid was given to all cats during the perioperative period. It should be noted that inhibition of cyclooxygenase enzyme by NSAIDs may lead to a significant reduction of renal blood flow due to the suppression of vasoactive prostaglandin synthesis. Two cats in the firocoxib-3 group with azotemia responded well to fluid therapy and the animals recovered without other complications.

Firocoxib has been shown to be highly effective and acceptable to control pain and inflammation due to osteoarthritis in canines. It also has been used effectively for postoperative pain control. In previous research, none of the healthy dogs presented clinical side effects; moreover, they had normal buccal mucosal bleeding times, no blood in their feces, and a normal gastrointestinal tract. In addition, no significant differences in blood profiles were detected between treatment and control groups [8,27]. However, researchers administrating firocoxib to treat osteoarthritis in geriatric dogs for 90 days reported diarrhea, vomiting, dark feces, and anorexia [19]. Cats with osteoarthritis may require a long-term use of analgesia. In the present study, firocoxib at a 1 mg/kg dosage was administered for 3 days without obvious side effects, and the 3 mg/kg firocoxib dose did produce gastrointestinal and renal side effects. Regardless, the application and dosage of firocoxib for long-term use in cats warrants further study.

In conclusion, the present study provides evidence that the selective COX-2 drug firocoxib is useful for postoperative pain control in cats. A firocoxib dose of 3 mg/kg provided better postoperative pain control than that from a firocoxib dose of 1 mg/kg; however, the gastrointestinal and renal function side effects detected at the higher dose of firocoxib might outweigh the pain control benefit. Based on our results, short-term use of the lower dose of firocoxib (1 mg/kg) is recommended for cats.

Acknowledgments

The authors thank the study's surgeon, Dr. Darut Kingkand, and staffs at Praholyothin 48 Small Animal Hospital for their efforts during the study, including the provision of animal care. Also, the authors thank Kasetsart University Veterinary Teaching Hospital, Bangkhen campus, for providing technical support. This study was supported by grants from the National Research Council of Thailand and the Kasetsart University Research and Development Institute (KURDI).

Conflict of Interest

The authors declare no conflicts of interest.

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