

How painful are cats after neutering – a field study using multimodal analgesia with intraperitoneal ropivacaine in a neuter-return program in feral cats

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Ziel dieser prospektiven, randomisierten, verblindeten klinischen Beobachtungsstudie war die Untersuchung der Wirkung von intraperitoneal verabreichtem Ropivacain zur postoperativen Analgesie der Ovariectomie bei Kätzinnen

Während eines Kastrations-Rückführungsprogramms (trap-neuter-return program) wurden 119 Kätzinnen mit einer intramuskulären Kombination von 0,03–0,05 mg/kg Medetomidin, 7–10 mg/kg Ketamin und 0,4 mg/kg Butorphanol anästhesiert. Katzen erhielten intraoperativ 4 mg/kg Tolfenaminsäure subkutan und vor dem Verschluss der Bauchdecke entweder 2 mg/kg Ropivacain (ROPI) intraperitoneal oder Kochsalzlösung (NaCl) in gleichen Volumina. Die Schmerzen wurden eine, sechs und 20 Stunden postoperativ mit der modifizierten Glasgow Composite Pain Scale (mGCPS) und der modifizierten Colorado State University Scale (mCSU) bewertet.

Zwischen den beiden Gruppen wurde kein signifikanter Unterschied in den Schmerzscores festgestellt, jedoch waren die Schmerzscores mit beiden Schmerzskaleten sechs Stunden postoperativ signifikant höher ($p < 0,001$) im Vergleich zu einer und 20 Stunden postoperativ. Der Cut-off-Wert auf der Schmerzskala (der eine Notfall-Analgesie erforderlich machte) wurde bei 34,5 % für mGCPS und bei 39,5 % für mCSU überschritten. Katzen mit einem höheren Schmerzscores zeigten eine geringere Futteraufnahme ($p < 0,001$).

Die intraperitoneale Verabreichung von Ropivacain zeigte keine signifikante Verbesserung der postoperativen Analgesie im Vergleich zu intraperitonealer Kochsalzlösung. Die in der Praxis häufig verwendete Anästhesiekombination zur Kastration (Medetomidin, Ketamin, Butorphanol) der Kätzin, ergänzt mit einem nicht-steroidalen Entzündungshem-

Abstract

For a large-scale trap-neuter-return program 119 cats were anaesthetised with an intramuscular combination of 0,03–0,05 mg/kg medetomidine, 7–10 mg/kg ketamine and 0,4 mg/kg butorphanol. Cats received intraoperative 4 mg/kg tolfenamic acid subcutaneously and before closure of abdominal wall either 2 mg/kg ropivacaine (ROPI) intraperitoneal or saline (NaCl) in equal volumes. Pain was scored one, six and 20 hours postoperative with the modified Glasgow Composite Pain Scale (mGCPS) and the modified Colorado State University Scale (mCSU).

There was no significant difference in the pain scores between the two groups, but the pain scores with both pain scales were significant higher ($p < 0,001$ for both) six hours compared to one and 20 hours postoperative. Cut-off value on the pain scales (necessitating rescue analgesia) was exceeded in 34,5 % for mGCPS and in 39,5 % for mCSU. Cats with a higher pain score showed a lower food intake ($p < 0,001$).

Intraperitoneal administration of ropivacaine did not significantly improve analgesia compared with intraperitoneal saline. The commonly used anaesthetic combination for neutering in practice (medetomidine, ketamine, butorphanol), topped with additional non-steroidal analgesic drugs, resulted in insufficient postoperative analgesia 6 hours post-surgery in more than 1/3 of all cats investigated.

Keywords: feline, local anaesthetics, pain, pain-relieve, peritoneal splash, spay

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mer, führte bei mehr als 1/3 aller untersuchten Katzen 6 Stunden postoperativ zu einer unzureichenden Analgesie.

Schlüsselwörter: Katze, Lokalanästhetika, Schmerz, Schmerzlinderung, intraperitoneale Applikation, Kastration

Introduction

The intraperitoneal (IP) administration of local anaesthetics is recommended by the World Small Animal Veterinary Association for the pain management of cats undergoing ovariectomy as part of a multimodal analgesic approach.³⁰ It is a simple, safe, and inexpensive technique and reduces postoperative pain and the need for systemic analgesia in humans as well as in cats and dogs.^{1, 6, 9, 28, 33} Therefore, it is a very suitable approach to multimodal analgesia, which could also be carried out easily in the field and in private practice without special training.

Regional anaesthesia can prevent the surgical stress response by blocking afferent nociceptive transmission and the consecutive inhibition of noxious input to the central nervous system (CNS).

Ropivacaine was developed as a pure S (-) enantiomer and belongs to the lipophilic local anaesthetics of the amide type. Ropivacaine is structurally closely related to bupivacaine. Compared to bupivacaine, it has a relatively rapid onset of action (10–15 minutes) and a longer duration of action (90 – 360 minutes), with a lower risk of cardiac and systemic toxicity.^{18, 26} Because of these properties, it might be preferable to use ropivacaine as an intraperitoneal local anaesthetic treatment in cats.

In cats undergoing ovariohysterectomy under inhalation anaesthesia, intraperitoneal administration of ropivacaine alone or in combination with dexmedetomidine did not show improved analgesia compared with IP saline.³² It was suspected that meloxicam and the preoperative use of an opioid masked the analgesic effects of ropivacaine.

As most cats undergoing ovariectomy are anaesthetised with injectable anaesthetics, the current study aimed to investigate the analgesic effects of intraperitoneal administration of ropivacaine in cats anaesthetised with medetomidine-ketamine-butorphanol and tolfedine. We hypothesised that pain scores would be lower in cats which receive ropivacaine.

Materials and Methods

Study design

This prospective, observational, randomised, blinded study was performed as part of a trap-neuter-return program in feral cats in Romania financed by Network for Animal Protection (Ne-

tAP) Switzerland. Animals were captured and handled with care according to the standards of the Center of Hope Veterinary Hospital Pitesca, Ilfov, Romania. Owner consent was obtained for cats of which the owner was known. All procedures were performed by experienced professionals according to the standards of NetAP Switzerland (<https://www.netap.ch>). The anaesthesia and pain scoring were performed and monitored by anaesthesia trained individuals.

Animals

A total of 211 feral female cats of unknown age were anaesthetised for this study. Cats were captured from using commercially available traps and were referred to the Center of Hope Veterinary Hospital the evening before spaying. They were kept individually in numbered cages in the same room with the same cage size, content (blanket) and setup for each cat to reduce environmental variations for the pain scoring. The cats were carefully observed from the distance for major pathologies and health concerns. The cats were fed commercial food the evening before procedure, weighed and were offered water ad libitum.

After an acclimatisation period of two hours, neurological function, gait in the cage, pupillary reflexes, state of consciousness and food consumption behaviours were assessed. Only apparently healthy non-pregnant female cats were included in the study based on visual examination as routine physical examination was not always possible.

Anaesthesia and surgery

Food was withheld for 12–14 hours prior to anaesthesia, whereas free access to water was provided. The cats were anaesthetised intramuscularly (IM) with medetomidine (Medetor 1 mg/ml ad us. vet.; D-Burgdorf-Virbac AG, Europastrasse 15, 8152 Opfikon, Switzerland), ketamine (Narkamon 100 mg/ml; Bioveta a.s, Komenského 212/12, 683 23 Ivanovice na Hané, Czech Republic) and 0,4 mg/kg butorphanol (Butomidor 10 mg/ml; Richter Pharma AG, A4600 Wels, Austria). Medetomidine and ketamine were dosed according to the dosage chart used by NetAP Switzerland (Annex I); resultant dose rates were 0,03–0,05 mg/kg medetomidine and 7–10 mg/kg ketamine. Cats that showed a reaction to surgical stimulus (increase in respiratory rate, increase in heart rate or movement) were re-injected with intramuscular ketamine to effect during surgery to ensure adequate anaesthesia.

Cats which showed during preoperative assessment any physiological abnormalities (diaphragmatic hernia, upper/

lower airway diseases) and pregnant cats were excluded from the study.

Following induction 4 mg/kg tolfenamic acid (Tolfedine 40 mg/ml; Vetoquinol AG Freiburgstrasse 255, 3018 Bern, Switzerland) and 15 mg/kg amoxicillin (Amoxycen 200 LA 200 mg/ml; SC Biotur Exim SRL, soseana Turum Magurele km 5 Judetul Teleorman, Alexandria 140003, Romania) were administered subcutaneously (SC). Monitoring included continuous measurement of peripheral oxygen saturation (SpO₂) and heart rate (HR), respiratory rate (RR), and rectal body temperature.

The female cats underwent ovariectomy. Data were collected in collaboration with another study investigating the effects of different recumbency positions on SpO₂.¹⁵ For the purpose of the other study the cats were randomly assigned to three different techniques (lateral recumbency with access to the flank (group lateral), horizontal dorsal recumbency with access to the linea alba (group dorsal) and dorsal Trendelenburg recumbency (angle of 70°) with access to the linea alba (group Trendelenburg)). Each technique was performed by one very experienced surgeon. Therefore, three different surgeons were involved in the study, one for each body position.

Study groups

The cats were randomly allocated to the ropivacaine (ROPI) or the control (NaCl) group. Cats in group ROPI received 2 mg/kg of 0,75 % ropivacaine and cats in group NaCl received the same volume of 0,9 % saline intraperitoneal.

Postoperative monitoring

Animals received 5,7 mg/kg praziquantel (Prazicest 56,8 mg/ml; FarmaVet S.C. Pasteur Filiala Filipești S.R.L. Str. Principa la nr 944, Filipești de Padura, Jud. Prahova, Romania) and 1 mg/kg ivermectin (Biomec 10 mg/ml; Bioveta a.s., Komenského 212/12, 683 23 Ivanovice na Hané, Czech Republic) SC during recovery.

The same single observer, unaware of the treatment group, recorded the pain scores one, six and 20 hours postoperative (measured from the end of surgery) with the multimodal Glasgow Composite Pain Scale (mGCPS) and the modified Colorado State University Feline Acute Pain Scale (mCSU). The observer was a veterinary anaesthesia resident with experience in the assessment of pain in cats using behavioural indices.

For evaluation, each cat was first observed for one minute in its cage. For the mGCPS the cat was encouraged to move around to observe its reactions and behaviour. Then, the incision and surrounding area of the abdomen was palpated using a long wood stick, and the reaction of the cat was assessed and recorded.

During each scoring, the cat was offered four pieces of food to evaluate food intake. It was noted how many pieces each

cat had eaten 30 minutes later (cat undisturbed) to exclude influence of human presence.

All cats were observed for abnormal neurological behaviour or delayed pupillary reflexes. When no abnormalities were observed, the cats were returned to their original geographic location after the last pain scoring 20 hours postoperatively.

Statistical analysis

Statistical analysis of the data was performed using the commercial software R and the package for ordinal data within R.^{14, 19} A generalised linear mixed model with an ordinal link function (i.e. ordinal mixed model) fitted with the Laplace approximation was used. As variables the scores from the different scales (mGCPS, mCSU), treatment (ropivacaine, NaCl), time (one, six, 20 hours), procedure (group lateral, dorsal, Trendelenburg), weight, re-injected ketamine dose (2–15,8 mg/kg) and food intake were selected. The level of significance was set at $p < 0,05$ for all analyses.

Results

A total of 211 female feral cats were anaesthetised with the medetomidine-ketamine-butorphanol mixture. Ninety-two cats were excluded from the study due to preoperative signs of illness (obvious respiratory problems, neurological problems), intraoperative complications (bleeding, diaphragmatic hernia), advanced gestation or due to missed scores. Finally, 119 cats were included in the study and were randomly allocated into the two treatment groups. Sixty-two cats (52,1 %) in the ropivacaine group and 57 (47,9 %) in the control group completed the study. Of these cats 37 (31,1 %) were positioned in dorsal horizontal position, 42 cats (35,3 %) in lateral recumbency and 40 cats (33,6 %) in Trendelenburg position during surgery.

Body weights of the cats enrolled in the study ranged from 1,4 to 3,7 kg ($2,5 \pm 0,5$ kg; mean \pm standard deviation). There was no significant difference between the groups regarding body weight ($p = 0,671$).

Twenty-five of 119 cats (21 %) required an additional intramuscular injection of ketamine (2 to 15,7 mg/kg), four of them twice. However, one cat was an outlier with 15,7 mg/kg and had to be re-injected at such a high dosage, because she reacted strongly during spaying and incomplete injection of the initial dose was suspected. The other cats were all re-injected with a range of 2–5,3 mg/kg ketamine.

One cat had to be intubated due to apnea following anaesthesia induction, with spontaneous breathing resuming after a few manual breaths.

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The duration of surgery did not differ significantly between the groups ($10 \pm 2,0$ minutes in Trendelenburg group, $8 \pm 2,5$ minutes in flank group and $8 \pm 3,2$ minutes in dorsal group).

Surgical technique had no effect on pain score ($p = 0,32$). No differences in body weight and surgery time were present between the groups (Table 1).

Neither the number of cats re-injected with ketamine nor the dosage of ketamine showed a difference between the groups.

The total pain scores in the mGCPS ranged between zero to nine points ($2 \pm 1,95$, Figure 1). The pain scores in the mCSU ranged from zero to three ($0 \pm 0,84$, Figure 2). Forty-seven out of 119 cats (39,5%) for mCSU and 41 out of 119 (34,5%) for mGCPS showed a pain score above the cut-off value (≥ 5 for mGCPS, ≥ 2 for mCSU) at least in one of the three pain scoring time points (Table 2).

The pain scores for individual time points and scoring systems are presented in Figure 1 and 2. There was no effect of

ropivacaine on pain score. The pain scores of the mGCPS and mCSU were significantly higher at time point six compared to time point zero ($p < 0,001$) in both groups (Figure 1, 2). The pain score at time point 20 was significantly lower in mCSU ($p < 0,001$) compared to time point six (Figure 2). Overall, the pain scores increased from time point zero to time point six, and then decreased to time point 20.

Cats at time point six showed a significantly decreased food intake ($p < 0,001$). There was no difference in food intake between the two groups (Table 1). However, twenty-nine out of 47 (61,7%) of the cats that exceeded the cut-off value in the mCSU and 18 out of 41 (43,9%) that exceeded it in the mGCPS still ate the offered food.

Discussion

The results of this study showed no clinically observed benefit of intraperitoneal ropivacaine on postoperative pain when administered concurrently with systemic analgesic

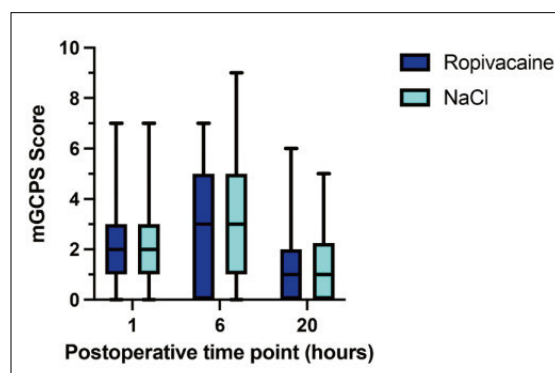


Figure 1: Pain scores in 119 cats undergoing ovariectomy treated with intraperitoneal administration of 2 mg/kg ropivacaine 0,75% or equal volume of saline solution 0,9% using a modified Glasgow Composite Pain Scale (scale 0 to 20) performed one, six and 20 hours post-surgical procedure.

Table 1: Weight (mean and minimum – maximum range), surgery time (median ± standard deviation) and food intake (median ± standard deviation) of cats undergoing ovariectomy treated with intraperitoneal administration of 2 mg/kg ropivacaine 0,75% (group ROPi; 59 cats) or equal volume of saline solution 0,9% (group NaCl; 60 cats). Treatments were splashed via syringe intraperitoneally before the surgical closure of the abdomen.

	ROPIVACAINE	NaCl	p-value
Weight (kg)	2,52 (1,1–3,5)	2,57 (1,1–3,7)	0,671
Surgery time (minutes)	8 ± 2,50	9 ± 2,72	0,073
Food (pieces)	4 ± 1,92	4 ± 1,74	0,499

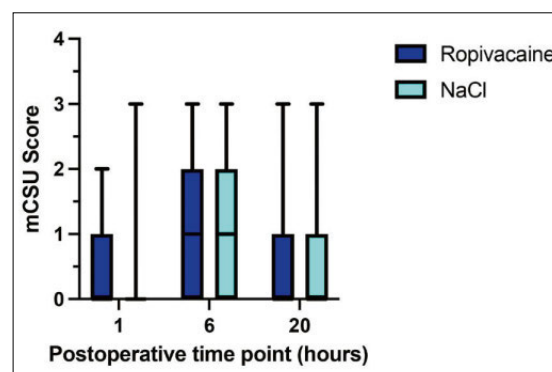


Figure 2: Pain scores in 119 cats undergoing ovariectomy treated with intraperitoneal administration of 2 mg/kg ropivacaine 0,75% or equal volume of saline solution 0,9% using a modified Colorado State University Pain Scale (scale 0 to 4) performed one, six and 20 hours post-surgical procedure.

Table 2: Number of cats undergoing ovariectomy treated with intraperitoneal administration of 2 mg/kg ropivacaine 0,75% or equal volume of saline solution 0,9% that would qualify for rescue analgesia (mild to moderate pain) based on modified Glasgow Composite Pain Scale (mGCPS) and modified Colorado State University Pain Scale (mCSU) performed one, six and 20 hours post-surgical procedure.

Group	ROPIVACAINE		NaCl	
	mGCPS	mCSU	mGCPS	mCSU
Time point				
1 hour	6/62 (9,7%)	3/62 (4,8%)	4/57 (7,0%)	5/57 (8,8%)
6 hours	16/62 (25,8%)	22/62 (35,5%)	18/57 (31,6%)	21/57 (36,8%)
20 hours	2/62 (3,2%)	4/62 (6,45%)	2/57 (3,5%)	7/57 (12,3%)

agents in cats undergoing ovariectomy. Six hours postoperative, pain scores were significantly higher in both groups, reaching levels above threshold for rescue analgesia. One hour post ovariectomy the combined residual analgesic effect of tolgedine, ketamine, butorphanol and medetomidine was sufficient to provide the analgesia necessary at this time point and no effect of ropivacaine was observed. Residual sedative/anaesthetic effects of medetomidine/ketamine might mask pain related behaviour at this time point as previously described.^{2, 17} The sedative/anaesthetic properties were probably still present with the dosage of 0,03–0,05 mg/kg medetomidine and 7–10 mg/kg ketamine IM, as a duration of effect of 57–76 minutes for medetomidine-ketamine combinations has been reported.²⁵ A parallel scoring of residual sedation could eventually have been used, to judge depth of residual sedation and its effect on pain scoring.

Ketamine has analgesic properties, and the mechanism of action is based on the inhibition of *N*-methyl-D-aspartate (NMDA) type glutamate receptors in the brain.²³ The half-life of ketamine in cats is about one hour after intramuscular application.⁴ Its analgesic effects are associated with plasma concentrations ranging between 70–160 ng/ml after IM administration.⁴² In a previous study in humans, IM administration of low dose ketamine (0,44 mg/kg) provided analgesia for 90 minutes.²⁰ If we extrapolate this to cats and apply it to our study, ketamine was most likely analgesic in addition to its sedative properties in the first scoring. In the further scorings, there was probably no residual analgesic effect in our cats, since the plasma level had probably fallen below 70 ng/ml. Ketamine-based protocols can influence pain scores also via psychomotor effects. Ketamine might induce hypersensitivity to touch and noise during recovery, which may interfere with reactions noted during the pain scoring and could have a confounding effect.^{10, 29, 36} These conditions of ketamine which can occur with this protocol, especially if ketamine is re-injected, could possibly be misinterpreted as pain-induced tension and could lead to bias in the scoring. Addition of midazolam could counteract this increased muscle tone but would have resulted in a prolonged recovery period and was therefore not included.²⁴

Butorphanol is a κ -opioid receptor agonist and a μ -opioid receptor antagonist and therefore has analgesic and sedative effects.¹³ The elimination half-life in healthy animals is about 2,5 to 3,5 hours.²² The duration of antinociception (plasma concentration of >45 ng/mL) is reported to be $2,7 \pm 2,2$ hours after IM administration.⁴¹ Thus, we assume that it was still antinociceptive in the first scoring, but no longer in the further ones.

Medetomidine is a potent, selective, and specific α -2-adrenoceptor agonist with sedative and dose-dependent analgesic effects.² Peak concentration after IM administration

occurred within 30 minutes in cats and half-lives ranging from 0,97 to 1,60 hours.³⁵ It has been reported that sedation with medetomidine in cats after IM administration lasts for 90 minutes and analgesia is present for 20–50 minutes.¹⁶ Thus, we assumed that the antinociception of medetomidine is also present only in the first scoring, but no longer in the subsequent ones.

At six hours postoperatively, the effects of various analgesic drugs used for intra- and postoperative analgesia (butorphanol, ketamine, medetomidine) had decreased significantly and recorded pain scores were higher than at one and at 20 hours post-surgery. Six hours after surgery the drugs seem no longer to provide sufficient analgesia to prevent pain scores above rescue analgesia thresholds in cats in both groups, although ropivacaine effect was expected to last 6 hours based on data in other species.

Pharmacokinetic data of ropivacaine in humans and dogs show a peak concentration after 30 min and a pure local anaesthetic effect for 6 hours after intraperitoneal administration.^{27, 28} Because other local anaesthetics such as intraperitoneal instillation of bupivacaine have comparable effects in cats and dogs, ropivacaine was also expected to have similar analgesic effects in cats.^{6, 28} Except for their longer duration and lower cardiotoxic effect, ropivacaine and bupivacaine share the same properties (same pKa and protein binding).⁸ Therefore, it is difficult to explain why IP bupivacaine but not ropivacaine should be analgesic in cats.

The differences in vasoactive effects between bupivacaine and ropivacaine might influence the uptake and thus the effect of the two drugs.^{21, 40} As there are to the authors knowledge no cat specific studies, the magnitude of this effect in cats remains to be tested. As the pharmacokinetics of ropivacaine in cats have not yet been studied, the effects of ropivacaine may not be comparable to those in humans or dogs due to species-specific differences in cats.

Based on data in humans and dogs, the assessment time points in our study were chosen in such a way that the first assessment was performed when the maximum effect of ropivacaine was expected and the second after 6 hours, when the effect of the local anaesthetic was expected to be still present.

Interestingly, a comparable study using an inhalation anaesthesia protocol could also not show a significant difference between intraperitoneal ropivacaine administration and the control group.³² Local infiltration of the incision site with ropivacaine in cats decreased intraoperative isoflurane requirements, but also failed to offer additional benefit postoperatively in cats undergoing ovariohysterectomy.¹² On the other hand, beneficial postoperative analgesic effects with intraperitoneal instillation of bupivacaine were shown in cats, using the same method as described in the present

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study.⁵ These authors observed a trend for lower pain scores in the dynamic interactive visual analogue scale (DIVAS) and the multidimensional composite pain scale (MCPS) with intraperitoneal bupivacaine or subcutaneous meloxicam when compared with a control group. Cats that had received intraperitoneal bupivacaine needed less rescue analgesia and it was concluded that it provided analgesia after ovariohysterectomy.⁶ Another study evaluated intraperitoneal administration of bupivacaine versus a combination of dexmedetomidine and bupivacaine in cats, and again both improved analgesia compared with the control group.³² In dogs, there are several studies confirming an analgesic effect of bupivacaine and ropivacaine.^{11, 28, 31} But it is worth mentioning, that despite the recognised analgesic effect of ropivacaine in dogs, 41 % of dogs also required rescue analgesia.²⁸ Therefore, it is important to emphasise that intraperitoneal instillation of a local anaesthetic cannot be considered as a sole analgesic technique, but only as part of a multimodal analgesia, and that postoperative pain should be assessed on a case-by-case basis and treated individually.

In the present study, the degree of pain was evaluated using two scoring systems – the modified Glasgow Composite Measure Pain Scale (mGCPS) and the modified Colorado State University Feline Acute Pain Scale (mCSU). The mGCPS is a valid and reliable multidimensional pain scale and has been widely used for postoperative pain assessment.³⁹ The mCSU is in comparison a simpler and more concise tool with a description-based scaling system with accompanying pictures to help assess visual degrees of pain intensity. Palpation of the surgical site can be omitted, which is an advantage in feral cats that often show aggressive reactions to this manipulation.³⁷ This scale has only undergone reliability testing, the validity still must be proven.

We used two pain scales to increase the force of expression. In addition, we also wanted to investigate whether the non-validated scale mCSU provides comparable values and thus enables a reliable statement comparable to the validated score mGCPS. As the two scores provided very comparable values, it can be assumed that the mCSU can also be reliably used to assess pain in cats. It must be mentioned, however, that neither of the two scales, and rather no pain scale, has been validated in feral cats. The greater stress, feral temperament and more difficult interaction with feral cats can greatly influence assessment via the scales, highlighting the importance of specific validation of the scales for feral cats.

Several pain scores of cats postoperatively exceeded the cut-off value (≥ 5 for mGCPS, ≥ 2 for mCSU) for rescue analgesia in the mGCPS (in 34,5 %) and mCSU (in 39,5 %). The study was observational, and the aim was to mimic conditions in private practices where this protocol is often used. Moreover, these results show that in many cats neutered with such or similar protocols, analgesia is not suffi-

cient. Therefore, for ethical reasons, it should be emphasised that multimodal and best validated pain scales (mGCPS, mCSU) should be applied and/or additional multimodal analgesia is necessary in more than 30 % of cats with such anaesthetic management. We assume that pain in cats is often underestimated in practice. Possible reasons for this are the lack of training in pain recognition, the change of environment and the limited availability of pain assessment tools in this species. Despite considerable progress in veterinary pain management, pain is often still undertreated in animals.³⁸ Understandably, availability of drugs will affect the choice of anaesthesia and analgesia protocol.

Cats with pain scores above the cut-off value also had a significantly lower food intake ($p < 0,001$). It can be concluded that food intake is negatively correlated with pain. However, 61,7 % of the cats that exceeded the cut-off value in the CSU and 43,9 % that exceeded it in the mGCPS still ate the offered food. This may indicate that non-domesticated cats have much stronger primal instincts, so they probably refuse food later than a domesticated cat that has never had to fight for its food. This suggests that food refusal seems to be a less sensitive parameter in pain assessment in a wild cat than in a domestic cat. Or the other way around, if a non-domesticated cat does not eat, this could be a clear indicator of pain.

A potential limitation of this study is the difficulty of pain scoring in feral cats. The differentiation between pain, fear, and temperament is particularly difficult in this category of cats.^{7, 34} It must be emphasised that stress produced by hospital environment, which might alter the behaviour of cats and influences pain scores, is likely to be more pronounced in feral cats.

In addition, to ensure a stable anaesthesia, 25 of 119 (21 %) cats had to be re-injected with ketamine, which further led to different states of alertness of the cats at the first pain scoring, which could lead to major bias, but the number of cats that had to be re-injected with ketamine and the dose of ketamine was not different between the groups.

The age of the cats was not known and therefore it is not certain that we discovered age related differences, however this seems unlikely considering the high number of animals tested.

The different surgical techniques performed by three different surgeons are another limitation of the study. However, the surgeons were very experienced ones and the technique had no statistically significant effect on the pain scores and should therefore be negligible.

With our intramuscular anaesthetic protocol, it would probably have been more optimal to perform the first scoring two or three hours postoperatively, to minimise the effects

of sedatives/anaesthetics used on the pain scoring. Therefore, inconvenient timing of scoring is a possible reason for lack of detected differences between the groups one hour post-surgery, but not for the other time points. Because this study was a field study in which many cats were neutered in a short period of time, more frequent scoring was logistically not possible and due to the stress susceptibility of the feral cats also not considered as an option.

Conclusions

Ropivacaine was infiltrated intraperitoneally as part of a multimodal pain management of cats undergoing ovariectomy. The pain scores one, six and 20 hours post-surgery showed no significant difference between the groups. It remains to be tested if intraoperative intraperitoneal splash of 2 mg/kg ropivacaine has any effect in cats between one and 6 hours after ovariectomy under medetomidine-ketamine-butorphanol anaesthesia with supplemental tolfedine. Also, higher dose rates of ropivacaine should be tested in future studies.

As pain scores six hours postoperatively exceeded the cut-off value necessitating rescue analgesia in more than 1/3 of cats tested, optimised analgesia protocols must be developed to prevent suffering of cats in veterinary practice, where postoperative pain scoring is not yet common standard.

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Conflict of interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Legends

Legend Figure 1, 2: Data are presented as a boxplot with the median and the 10 %- and 90 %-quartile, the whiskers present minimum and maximum values.

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La douleur chez les chats après la stérilisation : une étude de terrain utilisant l'analgésie multimodale par ropivacaïne intrapéritonéale dans le cadre d'un programme de stérilisation et de remise en liberté des chats harets.

L'objectif de cette étude clinique prospective, randomisée, en aveugle et d'observation était d'étudier les effets de la ropivacaïne administrée par voie intrapéritonéale pour l'analgésie postopératoire chez des chats harets femelles subissant une ovariectomie.

Dans le cadre d'un programme de piégeage, de stérilisation et de remise en liberté à grande échelle, 119 chattes ont été anesthésiées par une combinaison intramusculaire de 0,03 à 0,05 mg/kg de médétomidine, 7 à 10 mg/kg de kétamine et 0,4 mg/kg de butorphanol. Les chats ont reçu en peropératoire 4 mg/kg d'acide tolfénamique par voie sous-cutanée et, avant la fermeture de la paroi abdominale, 2 mg/kg de ropivacaïne (ROPI) par voie intrapéritonéale ou du sérum physiologique (NaCl) en volumes égaux. La douleur a été évaluée une, six et 20 heures après l'opération à l'aide de l'échelle de Glasgow de la douleur composite modifiée (mGCPS) et de l'échelle modifiée de l'Université d'État du Colorado (mCSU).

Il n'y avait pas de différence significative dans les scores de douleur entre les deux groupes, mais les scores de douleur avec les deux échelles de douleur étaient significativement plus élevés ($p < 0,001$ pour les deux) six heures par rapport à une et 20 heures postopératoires. La valeur seuil des échelles de douleur (nécessitant une analgésie de secours) a été dépassée dans 34,5 % des cas pour le mGCPS et dans 39,5 % des cas pour le mCSU. Les chats ayant un score de douleur plus élevé ont présenté une prise alimentaire plus faible ($p < 0,001$).

L'administration intrapéritonéale de ropivacaïne n'a pas amélioré significativement l'analgésie par rapport à une solution saline intrapéritonéale. La combinaison anesthésique couramment utilisée en pratique pour la stérilisation (médétomidine, kétamine, butorphanol), complétée par des médicaments analgésiques non stéroïdiens supplémentaires, a entraîné une analgésie postopératoire insuffisante 6 heures après la chirurgie chez plus d'un tiers des chats étudiés.

Mots clés : félin, anesthésiques locaux, douleur, soulagement de la douleur, instillation intra-péritonéale, stérilisation

Dolore risentito dai gatti dopo la castrazione – uno studio sulla castrazione dei gatti selvatici sotto analgesia multimodale con ropivacaina intraperitoneale

Lo scopo di questo studio clinico prospettico, randomizzato, in cieco e osservazionale è stato quello di indagare gli effetti della ropivacaina somministrata per via intraperitoneale per l'analgesia post-operatoria dell'ovariectomia nelle gatte selvatiche femmine. Durante un programma di trappole, sterilizzazione e restituzione, 119 gatti sono stati anestetizzati con una combinazione intramuscolare di 0,03–0,05 mg/kg di medetomidina, 7–10 mg/kg di ketamina e 0,4 mg/kg di butorfanolo. I gatti hanno ricevuto 4 mg/kg di acido tolfenamico per via sottocutanea intraoperatoria e 2 mg/kg di ropivacaina (ROPI) per via intraperitoneale o soluzione fisiologica (NaCl) in volumi uguali prima della chiusura addominale. Il dolore è stato valutato dopo una, sei e 20 ore dopo l'intervento utilizzando la Glasgow Composite Pain Scale modificata (mGCPS) e la Colorado State University Scale modificata (mCSU).

Non sono state riscontrate differenze significative nei punteggi del dolore tra i due gruppi, ma i punteggi del dolore erano significativamente più alti ($p < 0,001$) in entrambe le scale del dolore a sei ore dopo l'intervento rispetto a una e 20 ore dopo questo. Il valore di cut-off della scala del dolore (che richiedeva un'analgesia d'emergenza) è stato superato nel 34,5 % per il mGCPS e nel 39,5 % per il mCSU. I gatti con un punteggio di dolore più alto hanno mostrato una minore assunzione di cibo ($p < 0,001$).

La somministrazione intraperitoneale di ropivacaina non ha mostrato alcun miglioramento significativo dell'analgesia postoperatoria rispetto alla soluzione fisiologica intraperitoneale. La combinazione di anestetici frequentemente utilizzata nella pratica per la castrazione (medetomidina, chetamina, butorfanolo), integrata con analgesici non steroidei aggiuntivi, ha dato luogo a un'analgesia insufficiente in più di 1/3 dei gatti studiati 6 ore dopo l'intervento.

Parole chiave: gatto, anestetici locali, dolore, sollievo dal dolore, applicazione intraperitoneale, castrazione

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How painful are cats after neutering – a field study using multimodal analgesia with intraperitoneal ropivacaine in a neuter-return program in feral cats

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