Randomised trial of perioperative tramadol for canine sterilisation pain management

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Abstract
Surgical sterilisation to manage free-roaming dog populations is widely used in many countries. However, few studies have examined optimal postoperative pain management regimens at low-resource, high-throughput veterinary clinics. The aim of this study was to examine the efficacy of two intravenous analgesic regimens, preoperative administration of meloxicam and tramadol, or meloxicam alone, in free-roaming dogs undergoing sterilisation. A total of 125 dogs were included, with 64 dogs in the meloxicam-tramadol arm and 61 dogs in the meloxicam-only arm in a non-inferiority study design. Pain levels in sterilisation surgery patients were assessed at four time points after surgery using the Colorado State University Canine Acute Pain Scale, a Visual Analogue Scale and a modified version of the Glasgow Composite Measure Pain Scale – Short Form. Non-inferiority was supported for each of the main scoring outcomes using non-inferiority margins of 0.5, 5 and 0.8, respectively. One dog from the meloxicam-tramadol group and four dogs in the meloxicam-only arm required rescue analgesia, with no difference between groups (P=0.21). The study demonstrated that meloxicam was effective in controlling postoperative pain in a high proportion of dogs. The addition of tramadol alongside meloxicam treatment was not found to be of clinical benefit.

Introduction
Managing the size of dog populations is considered necessary in many countries to improve animal welfare, lower or stabilise dog populations, and reduce public health risks. The mainstay of dog population control is currently high-throughput sterilisation clinics usually run in conjunction with non-governmental organisations and/or government services, as part of Animal Birth Control (ABC) programmes.

Despite the widespread approach of sterilising dogs to control the size of their populations, few studies have been undertaken on how to optimally sterilise dogs in the field situation. Consequently, there is a limited evidence base which can guide the implementation of dog population control programmes in low-resource settings. There is a particular paucity of knowledge on how to manage postoperative pain in dogs undergoing sterilisation in low-resource, high-throughput clinics. This may, in part, be due to the challenges of assessing pain in dogs which are not used to being handled or examined.

Multimodal analgesia, defined as the administration of two or more analgesic agents that influence different parts of the pain pathway to produce a synergistic effect, can provide superior analgesia with fewer side effects. However, specific drugs can be sporadically available, or are not registered for use in companion animals or have strict legislative controls in certain countries, or may be prohibitively expensive in a low-resource setting, and effective alternative analgesia protocols are needed.

Meloxicam is a widely used NSAID and is often used in dogs undergoing sterilisation. Despite the benefit of a longer analgesic effect with NSAIDs, there is a delay in onset of clinical effect compared with opioids. A multimodal approach could therefore make NSAID use more effective. The use of tramadol has increased in recent years due to its safety profile and ease of use.
effectiveness of tramadol alone or in combination with meloxicam. Teixeira et al. found no difference between tramadol alone or in combination with meloxicam after ovariohysterectomy.

The aim of this study was to examine the efficacy of two postoperative analgesic regimens in free-roaming dogs which were undergoing sterilisation procedures. The authors hypothesised that the efficacy of meloxicam, an NSAID, used alone would not be inferior to its use in conjunction with tramadol, a synthetic analogue of codeine, in managing postoperative pain in dogs undergoing sterilisation in a low-resource, high-throughput clinic.

Materials and methods

Study design

This study was a prospective, randomised trial conducted in July–August 2017 at the Hicks International Training Centre (ITC), Goa, India, as part of their ongoing sterilisation programme. During 2017, the Hicks ITC sterilised approximately 10,000 dogs and cats following the ABC guidelines recommended by the Animal Welfare Board of India. The clinical trial methodology used was a non-inferiority design to demonstrate whether meloxicam alone would not be worse than the currently used protocol of meloxicam-tramadol in this clinic.

Study group

Free-roaming dogs without collars or identifiable owners were captured by trained technicians with nets and brought to the Hicks ITC kennels. Dogs were allowed a rest period of a few hours before surgery, during which food and water were withheld, or were operated on the day after capture following standard fasting guidelines. Each dog was individually identified with a tag at the time of capture, to assist in returning the dog to its original location by use of a geographic information system (GIS) enabled app (WVS Data Collection App, WVS; 2017). Dogs remained in the kennels for a minimum of 24 hours after surgery, dependent on the healing of the surgical wounds, as determined by a veterinarian.

Randomisation and exclusion

Animals were randomised at induction to each treatment arm by the use of a precoded list, separately generated for males and females, with preprinted anaesthetic protocol and monitoring sheets. Persons responsible for the induction and monitoring of anaesthesia were not blinded to the study. Blinding was not enforced on the surgeons, but due to the high volume of surgeries and limited involvement in the anaesthesia they were unlikely to be aware of the group status of their patient during the operation.

Animals with concurrent wounds requiring treatment or other injuries identified before or during the study were excluded, as were animals with severe pruritic skin lesions. Any dogs that developed complications during surgery were excluded. Age was estimated based on tooth eruption while considering body size. Animals were considered ‘adult’ in this study if all permanent teeth had fully erupted, immature with a mix of deciduous and permanent teeth, and animals without any permanent teeth were not included in the study. Extremely aggressive dogs were excluded at the analysis stage after attempts of pain score estimation. These were dogs that would attempt to attack the observer without provocation, before handling or entering the enclosure.

Surgical procedure

Dogs were given xylazine (2 mg/kg) and butorphanol (0.1 mg/kg) intramuscularly as a premedication approximately 15 minutes before induction based on a weight estimate. After effect of the premedication, an intravenous catheter was placed in the cephalic vein, and dogs were weighed on an electronic scale to allow for accurate administration of further anaesthetics and treatments. Intravenous isotonic fluids (0.9 per cent sodium chloride) were started at a rate of 10 ml/kg/hour and continued throughout surgery under constant monitoring. These rates are higher than current general guidelines, as the majority of dogs tend to be dehydrated in hot weather conditions following the capture process. Anaesthesia was induced with intravenous diazepam (0.25 mg/kg) and propofol (1 mg/kg). All dogs were given intravenous meloxicam (0.2 mg/kg) and amoxicillin (20 mg/kg) immediately after induction. Dogs in the meloxicam-tramadol group of the trial were also administered intravenous tramadol (4 mg/kg) at this time.

Additional propofol was given intravenously (1 mg/kg), as needed, based on jaw tone, eye position and palpebral reflex, equating to an additional bolus given roughly every 7–10 minutes during surgery. This was recorded on the individual animal’s anaesthetic monitoring chart. The surgical procedure was a standard ventral midline ovariohysterectomy or open prescrotal castration performed by experienced surgeons. After surgery, animals were returned to the kennel for recovery from anaesthesia. All nine surgeons in the study were highly proficient at sterilisation surgeries, but the senior staff involved in surgical teaching at the centre were included in the ‘very experienced’ category for this study.

Assessment

Pain assessment took place at roughly two, four, six and 21 hours postsurgery by use of the Colorado State University Canine Acute Pain Scale (CSU-CAPS), a modified version of the Glasgow Composite Measure Pain Scale – Short Form (mod CMPS-SF) and a 0–100 Visual Analogue Scale (VAS). Baseline pain
assessment was not operationally possible. Any animal suspected of being in pain or which had a CSU-CAPS of 2 and above was given rescue analgesia and further pain scores were excluded from further analysis. Regular monitoring of the animals in the kennels took place outside of these specified times. Dogs in the meloxicam-only arm considered to be in pain were given subcutaneous tramadol (4 mg/kg) and dogs in the meloxicam-tramadol arm were administered subcutaneous butorphanol (0.1 mg/kg). One person (NM) assessed pain for the duration of the study to minimise variation and was blinded to the treatment group at the point of allocating a pain score.

The scoring tools are summarised in table 1 and are available in online supplementary file 1. The analysis of the CMPS-SF was modified to five questions, instead of the standard six questions, with a total score of 19 instead of the standard 24. The mod CMPS-SF excluded the question on palpation of the surgery site to assess response (question C). The CSU-CAPS is a training tool based on a visual scale of 0 (no pain) to 4 (extensive pain), with a list of visual and descriptive behavioural cues printed on the scoring sheet. The VAS was a 70-mm line from 0 (no pain) to 100 (worst pain possible) that the assessor marked based on a subjective assessment of the pain. The proportional conversion to 100 was made in the analysis. At each scoring event, the assessor also indicated on a 0–100 scale how sedated the dog was and how nervous the dog seemed. The assessor could further comment if the dog was too sedated to score or too aggressive to approach. In nervous dogs, a heavy leather glove was used to protect the assessor; the non-gloved hand was used to assess a palpation reaction where possible, although this was not included in the final analysis of the mod CMPS-SF.

Pain score readings were excluded from the analysis after animals were given rescue analgesia and if their sedation score was above 70 at the time of reading. This resulted in a null hypothesis of \( H_0 : \mu_M - \mu_{MT} \geq \delta \), and the alternate hypothesis \( H_1 : \mu_M - \mu_{MT} < \delta \), with \( \mu_M \): mean score meloxicam-only; \( \mu_{MT} \): mean score meloxicam-tramadol; and \( \delta \): predefined margin of non-inferiority. The non-inferiority margins were set for clinical relevance taking into account the resolution of the scores and current literature. Non-inferiority was defined by a margin (\( \delta \)) of 0.5 for the CSU-CAPS, 5 for the VAS and 0.8 for the mod CMPS-SF. After adjustment in a best fit model, non-inferiority was then interpreted as a tramadol group outcome estimate upper 95 per cent confidence interval of less than the determined margin, \( +\delta \). The secondary outcomes, propofol rate and proportion of rescue analgesia, were compared between groups, taking sex and age into account in the statistical models, and a P value of 0.05 was used to test significance.

### Table 1. Measurement tools for pain, nervousness and sedation scores

| Outcome measure                                      | Type                | Score       |
|------------------------------------------------------|---------------------|-------------|
| Colorado State University Canine Acute Pain Scale    | Multifaceted behaviour descriptive scale | 0–4         |
| Visual Analogue Scale, pain                          | Numerical linear scale | 0–100       |
| Modified Glasgow Composite Measure Pain Scale – Short Form | Multifaceted behaviour descriptive scale | 0–19        |
| Visual Analogue Scale, sedation                      | Numerical linear scale | 0–100       |
| Visual Analogue Scale, nervousness                   | Numerical linear scale | 0–100       |

**Analysis**

Patient and surgical factors were compared between groups at the univariate level with a Student’s t test for continuous data (weight, anaesthetic and surgery times), and chi-squared test or Fisher’s exact test for categorical data (sex, age, body condition score (BCS), skin condition and surgeon experience) as appropriate. All data analyses were conducted within the R statistical software environment. The primary outcomes measured were mean CSU-CAPS, mod CMPS-SF and VAS scores, and the secondary outcomes were the required maintenance propofol rate during surgery and proportion of rescue treatments. The propofol rate was defined as the milligrams of propofol used per 10 kg bodyweight per minute anaesthesia time (mg/10 kg/minute). Linear mixed-effects models were used to estimate the primary outcomes. Individual patients were added to the model as random effects. The full list of cofactors included patient factors (sex, weight, age, BCS and skin condition), surgical factors (anaesthesia time, surgery time and experience of surgeon) and situational score factors (time of pain scoring, nervousness and sedation at scoring). After initial exploration of the models, model fit was assessed using Akaike’s Information Criterion (AIC), and the best model which included age, sex and time of scoring was presented. Final model parameters were calculated with restricted maximum likelihood (REML) in the nlme package. The propofol rate and rescue proportion did not have a repeated measures structure and were estimated using general linear models following a similar variable selection protocol.

This study was based on the hypothesis that excluding tramadol in the analgesia protocol was not inferior to the use of tramadol under standard treatment. This resulted in a null hypothesis of \( H_0 : \mu_M - \mu_{MT} \geq \delta \), and the alternate hypothesis \( H_1 : \mu_M - \mu_{MT} < \delta \), with \( \mu_M \): mean score meloxicam-only; \( \mu_{MT} \): mean score meloxicam-tramadol; and \( \delta \): predefined margin of non-inferiority. The non-inferiority margins were set for clinical relevance taking into account the resolution of the scores and current literature. Non-inferiority was defined by a margin (\( \delta \)) of 0.5 for the CSU-CAPS, 5 for the VAS and 0.8 for the mod CMPS-SF. After adjustment in a best fit model, non-inferiority was then interpreted as a tramadol group outcome estimate upper 95 per cent confidence interval of less than the determined margin, \( +\delta \). The secondary outcomes, propofol rate and proportion of rescue analgesia, were compared between groups, taking sex and age into account in the statistical models, and a P value of 0.05 was used to test significance.
Sample size was estimated on the CMPS-SF as the most restrictive of the pain scales using data obtained in the pilot study. A non-inferiority margin of 0.8 and an sd of 1.7, at 80 per cent power and 5 per cent significance level, would have required a sample size of 56 animals per arm. Losses were expected at 10–15 per cent.

**Results**

**Patients**

A total of 125 dogs were included in the study, with 64 dogs in the meloxicam-tramadol arm and 61 dogs in the meloxicam-only arm. Ten dogs were also originally enrolled that were later excluded from the study. Two females were excluded after surgery due to complications within surgery (haemorrhage following ligament slippage) and two males for moderate pre-existing wounds that were not seen at the time of induction. These animals were monitored postsurgery and given additional analgesics as required. A further six dogs were excluded (one female, five males) for excessive aggression to the assessor at all time points. This could not be evaluated before the trial and resulted in the handler being unable to palpate or evaluate movement at the majority of time points in a valid way. There was no difference in exclusion rates between analgesic groups for the aggressive dogs (P=0.44).

In the study population, there was no difference between treatment groups for sex (P=1.0), age (P=0.23), weight (P=0.35), BCS (P=0.12) and skin disease (P=0.53) (table 2). The average estimated weight of animals was 12.7 kg (sd 4.4), and the majority of dogs were considered adults based on dentition and body size (80 per cent). There was no difference in surgery time or anaesthetic duration between the treatment groups (table 2). In a preliminary analysis, there was no indication of a difference in outcomes between treatment groups when examining males and females separately.

**Primary outcomes**

Pain scores were assessed on average at two, four, six and 21 hours after the end of surgery. The average pain score per time point is represented in figure 1, and there was a decreasing trend towards the 21-hour point. Over all time points in the meloxicam-only group, the mean score for the CSU-CAPS was 0.6 (sd 0.4), the VAS was 9.3 (sd 7.8) and the mod CMPS-SF was 2.0 (sd 1.4). In the meloxicam-tramadol group, this was 0.6 (sd 0.4), 8.7 (sd 7.7) and 2.0 (sd 1.4), respectively.

Pain scores were excluded from the analysis when the animal was too sedated to score; 3.8 per cent of the scoring points were excluded and this was not different between groups (P=0.66). The mean sedation score was 11.2 (sd 16.6) and the mean nervousness score was 25.0 (sd 18.4). Table 3 presents these figures per group.

The final statistical models are presented in online supplementary file 2. All models for primary outcomes accounted for group, sex, age, nervousness and hours postsurgery, with the individual patient as a random effect. The VAS model included weight; the final model for mod CMPS-SF included sedation, and an interaction term for treatment group and hours postsurgery. Over all time points the meloxicam-only group had a treatment effect CSU-CAPS score that was 0.04 higher (95 per cent CI −0.05 to 0.12, P=0.36) than the

| Factor | Meloxicam-only | Meloxicam-tramadol | P value | Test |
|--------|----------------|--------------------|---------|------|
| Sex, n(%) |                |                    |         |      |
| Female | 32 (50.00)     | 31 (50.82)         | 1.00    | Chi-squared test |
| Male   | 32 (50.00)     | 30 (49.18)         |         |      |
| Age, n(%) |                |                    |         |      |
| Adult  | 48 (75.00)     | 52 (85.25)         | 0.23    | Chi-squared test |
| Juvenile | 16 (25.00)   | 9 (14.75)          |         |      |
| Weight (kg), Mean (sd) | 12.31 (4.69) | 13.05 (4.18)       | 0.35    | Student’s t-test |
| Body condition score, n(%) | | | |
| Underweight | 23 (35.94) | 17 (27.87)         | 0.12    | Fisher’s exact test |
| Healthy | 38 (59.38)     | 44 (72.13)         |         |      |
| Overweight | 1 (4.69) | 1 (1.64)           |         |      |
| Skin condition, n(%) | | | |
| No disease | 56 (87.50) | 50 (81.97)         | 0.53    | Fisher’s exact test |
| Mild | 8 (12.50)      | 10 (16.39)         |         |      |
| Moderate | 0 (0.00)   | 1 (1.64)           |         |      |
| Surgery time (minutes), Mean (sd) | 31.14 (19.68) | 32.36 (19.68) | 0.73 | Student’s t-test |
| Anaesthetic time (minutes), Mean (sd) | 61.55 (28.56) | 59.41 (33.67) | 0.70 | Student’s t-test |
| Surgeon experience, n(%) | | | |
| Very experienced | 45 (70.31) | 48 (78.69)         | 0.39    | Chi-squared test |
| Less experienced | 19 (29.69) | 13 (21.31)         |         |      |
| Extreme aggression, n(%) | | | |
| No | 64 (96.97)     | 61 (93.85)         | 0.44    | Fisher’s exact test |
| Yes | 2 (3.03)       | 4 (6.15)           |         |      |
The VAS score treatment effect was 0.92 (95 per cent CI −0.66 to 2.51, P=0.25) higher and the mod CMPS-SF score effect was 0.09 (95 per cent CI −0.42 to 0.59, P=0.73) higher than the meloxicam-tramadol group. This resulted in support of non-inferiority for meloxicam-only when evaluated against a predeclared non-inferiority margin for the outcomes; specifically the upper 95 per cent confidence interval was below the delta of 0.5, 5.0 and 0.8 for each outcome, respectively (figure 2).

Table 3  Scores and outcome measures averaged over all time points

| Factor                        | Meloxicam only | Meloxicam-tramadol | P value | Test   |
|-------------------------------|----------------|--------------------|---------|--------|
| CSU-CAPS, Mean (sd)           | 0.6 (0.44)     | 0.6 (0.39)         | 0.53    | Student’s t test |
| VAS pain, Mean (sd)           | 9.3 (7.64)     | 8.7 (7.69)         | 0.40    | Student’s t test |
| Mod CMPS-SF, Mean (sd)        | 2.0 (1.41)     | 2.0 (1.35)         | 0.89    | Student’s t test |
| Propofol rate (mg/10 kg/minute) Mean (sd) | 0.6 (0.31)     | 0.7 (0.33)         | 0.51    | Student’s t test |
| Rescue analgesia n(%)         | 60 (93.75)     | 60 (98.36)         | 0.37    | Fisher’s exact test |
| Too sedated to score n(%)     | 4 (6.25)       | 1 (1.64)           |         |        |
| No                            | 60 (93.75)     | 60 (98.36)         | 0.37    | Fisher’s exact test |
| Yes                           | 4 (6.25)       | 1 (1.64)           |         |        |
| VAS sedation, Mean (sd)       | 11.4 (17.04)   | 11.1 (16.19)       | 0.82    | Student’s t test |
| VAS nervousness, Mean (sd)    | 25.2 (19.75)   | 24.7 (16.85)       | 0.78    | Student’s t test |

Average score or outcome measure per group, showing P-value result from univariate test.
CSU-CAPS, Colorado State University Canine Acute Pain Scale; mod CMPS-SF, Modified Glasgow Composite Measure Pain Scale – Short Form; VAS, Visual Analogue Scale.
From the three statistical models for pain scores, CSU-CAPS, VAS and mod CMPS-SF, male dogs were more likely to have lower pain scores (P<0.01) and nervous dogs were more likely to have higher scores (P<0.001). Younger animals were also more likely to have lower CSU-CAPS and mod CMPS-SF scores (P<0.01).

**Secondary outcomes**

The average propofol rate was 0.6 mg/10 kg/minute (sd 0.3) during surgery. The propofol rate was −0.05 mg/10 kg/minute (95 per cent CI −0.16 to 0.06) lower in the meloxicam-only group, and there was no statistical support for a treatment difference between groups (P=0.38).

Clinicians could rescue an animal at any time after surgery when deemed necessary. At the pain score monitoring time points, a score of greater than 2 on the CSU-CAPS was further used as a guide to indicate a rescue treatment was needed. Five dogs (4.0 per cent, 95 per cent CI 1.4 to 9.6) required rescue treatment after surgery, one dog from the meloxicam-tramadol group and four dogs in the meloxicam-only arm. There was a 4.2 (95 per cent CI 0.6 to 85.1) times higher risk of rescue analgesia being needed in the meloxicam-only group; however, there was no statistical evidence supporting a difference between the groups (P=0.21) when taking sex and age into account. Four female dogs and one male dog required rescue analgesia and were rescued between 3.5 and 7.5 hours after surgery. Behavioural descriptions of these dogs at the pain assessment included reluctance to move, painful movement and constant vocalising.

**Discussion**

The main finding of this study was that meloxicam was effective in controlling postoperative pain in a high proportion of dogs neutered in a low-resource setting. The addition of tramadol alongside meloxicam treatment was not found to be of clinical benefit. The management of free-roaming dog populations remains important in many countries, with surgical intervention the mostly widely used and accepted approach. Sterilisation surgery is costly and logistically challenging, with limited research as to what constitutes best practice under low-resource, high-throughput settings. Optimising postoperative analgesia regimens in surgical sterilisation programmes is critically important for patient welfare and to ensure community support for ongoing interventions.

Understanding the importance of surgical pain and the benefit of its control has increased in recent years, and there is now a wide range of analgesics available. Despite adverse events related to NSAID use, placebo-controlled trials have shown reasonable safety in healthy dogs when used for short time periods at the recommended dosage. Meloxicam is widely used, and its postoperative analgesic properties have been demonstrated in several surgical scenarios. This study provides further support for the analgesic efficacy of meloxicam by demonstrating that meloxicam
provided good poststerilisation analgesia in free-roaming dogs.

A second important finding in this study was that the removal of tramadol from the analgesia protocol did not lead to a clear increase in pain scores. In a study by Delgado et al., tramadol treatment was effective in some dogs, suggesting that the tramadol effect is individually variable. There are differences in the metabolism of tramadol in human beings, and it is plausible that there are metabolic differences between dogs. Gruet et al. used a 20 per cent non-inferiority margin for a trial comparing meloxicam and robenacoxib. However, the margins in this study were chosen based on the resolution of the scales and what may be considered a clinical difference. Considering the resolution of these pain scales, the variability of the pain behaviours and the authors’ chosen non-inferiority margins, it is plausible that a small treatment effect by the additional tramadol might not be seen. Even so, it is encouraging that an NSAID, as the primary analgesic in addition to the premedication, is effective at controlling the majority of the pain experienced by the patients undergoing sterilisation.

This study did point to a possible higher analgesic requirement in females compared with male dogs, regardless of treatment group, in contrast to a previous pain behaviour study in dogs. Ovariohysterectomy is considered a more invasive surgery, and higher pain scores were seen in female dogs with a larger proportion of rescue analgesia required. Younger dogs were also likely to have lower pain scores. This could be due to less tissue trauma, especially in females, as younger dogs in these settings tend to have less fat, allowing easier visualisation of the surgical field.

Pain in human beings is considered a personal experience, and in animals the authors’ interpretation of animals in pain is based on behavioural characteristics. A limitation of this study was that it was not possible, for logistical reasons, to obtain baseline pain scores for individual comparisons of behaviours. Furthermore, the dogs in this study were mostly free-roaming dogs, which were less used to human handling and interaction. Therefore the act of assessing pain in these animals was likely to produce a stress response unrelated to pain but showing parallel behaviours, confounding scoring tools. Reporting of the successful use of these tools in free-roaming dogs has been limited. It was seen in this study that free-roaming dogs often responded differently than expected from pet animals, such as more stoic behaviour (eg, minimal movement or response), or conversely over-reaction to stimuli (eg, vocalising at approach), depending on individual learned circumstances. Assessments of dogs were felt to be more reliable when considering all the behaviours in the context of the disposition of the dogs towards human interaction. Also, one assessor was used for all dogs in this study to minimise the variation of interpretation of these behaviours, even though there may have been inherent bias by that observer. The authors acknowledge that almost all canine pain assessment tools have been validated on client-owned animals. Further work is required to more completely validate these measures on free-roaming dogs.

Multiple pain scales were used in this study due to predicted difficulties with handling free-roaming dogs, in particular palpation of the surgical site. The CMPS-SF has been used in a number of studies to monitor postoperative pain and relies on palpation of the area around the wound as a key indicator. Palpation was only attempted in 75 per cent of the dogs, and this was not enforced in the study protocol as the authors could not justify the risk of a bite from a dog with an unknown history in a rabies endemic area, for the purpose of research. Restraint beyond soft handling with a leather glove was not used, to minimise influence on a valid palpation response. However, fearful dogs tended to show overt responses with any handling, for example, tense abdomen or snapping, leading the authors to believe that palpation is an unreliable indicator in these conditions. It was therefore decided to exclude this question from the CMPS-SF. Furthermore, the authors did not attempt algometry for the same reasons. A pain evaluation tool, specific for difficult-to-handle dogs that may be fearful of human contact, would assist veterinarians in managing postsurgical pain in these settings.

Under the conditions of this study as part of a comprehensive anaesthesia protocol, both a meloxicam-tramadol combination analgesic and meloxicam alone provided good analgesia for routine sterilisation surgery in the majority of free-roaming dogs. Older and female dogs had higher pain scores, emphasising the need to monitor and manage surgical pain in these populations particularly closely.

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Competing interests None declared.

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