



Use of a quadratus lumborum block in queens undergoing ovariectomy: a randomised controlled trial

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Abstract

Objectives The aim of the study was to evaluate the perioperative analgesic effect of a quadratus lumborum (QL) block in queens undergoing ovariectomy.

Methods A total of 37 healthy queens admitted for elective ovariectomy were randomised into two groups: control (CTRL, n = 19) and QL block (QL, n = 18). All cats were premedicated with dexmedetomidine 0.005 mg/kg, alfaxalone 1 mg/kg and methadone 0.1 mg/kg IM. Under general anaesthesia, cats allocated to the QL group received a bilateral ultrasound-guided QL block with 0.4 ml/kg of ropivacaine 0.4% (3.2 mg/kg). No treatment was administered to cats in the CTRL group. Intraoperative rescue fentanyl boluses were administered if haemodynamic and/or respiratory parameters exceeded 30% of the pre-incisional values. Postoperative methadone boluses were administered based on Feline Grimace Scale scores. Demographics, baseline vital parameter values, requirement for rescue analgesia, incidence of hypotension, sialorrhoea, vomiting and dysphoria, and number of cats accepting food at 6 h after extubation were compared between groups.

Results A higher number of queens required intraoperative fentanyl in the CTRL group (14/18, 77.8%) compared with the QL group (1/19, 5.3%) ($P < 0.001$). The median total fentanyl dose was 4 µg/kg (range 0–4) in the CTRL group and 0 µg/kg (range 0–4) in the QL group ($P < 0.001$). No statistically significant difference was found between groups when comparing the number of animals requiring postoperative methadone, total methadone dose, episodes of hypotension, sialorrhoea, vomiting and dysphoria, and number of queens accepting food at 6 h postoperatively. No adverse effect or complication potentially related to the block was recorded.

Conclusions and relevance The QL block resulted in a lower intraoperative fentanyl requirement in queens undergoing ovariectomy. Further studies are needed to clarify the postoperative analgesic effect of this technique in cats.

Keywords: Locoregional anaesthesia; quadratus lumborum block; pain management; ropivacaine; ovariectomy

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Introduction

In veterinary medicine, the use of locoregional anaesthesia in small animals is constantly increasing because of its analgesic quality and opioid-sparing effect.¹ More recently, scientific interest in ultrasound-guided interfascial blocks has been progressively increasing, and several clinical studies have been published in dogs. While the literature is still scarce for cats,^{2–8} the analgesic effects of a quadratus lumborum (QL) block were recently compared with a sacrococcygeal epidural in cats undergoing ovariectomy.⁹

QL block is an interfascial locoregional technique recently described in small animals. It entails ultrasound-guided injection of local anaesthetic in the interfascial plane between the QL and psoas minor muscles.¹⁰ In a canine cadaveric study by Garbin et al,¹⁰ a dye injected within the aforementioned plane at the level of L1 resulted in a longitudinal spread from T13 to L3, with staining of the sympathetic trunk and the lumbar splanchnic nerves. In cat cadavers, different approaches have been described for QL block,^{11–13} with a significant spread from T13 to L3.

Ovarian innervation in dogs and cats is provided by the ovarian plexus. The plexus receives parasympathetic fibres from the cranial mesenteric plexus, and in some animals from the caudal mesenteric plexus as well, and sympathetic fibres from the renal and aortic plexuses.¹⁴ The skin and muscles of the abdominal wall are innervated by thoracic and lumbar spinal nerves from T9 to L4.¹⁵

In a recent randomised clinical trial involving queens undergoing ovariectomy, QL block and epidural anaesthesia were associated with a similar perioperative rescue opioid consumption.⁹

To the best of the authors' knowledge, no clinical study comparing cats receiving a QL block with a control group has been performed to date. The aim of this study was to evaluate the perioperative analgesic effect of a QL block in cats undergoing ovariectomy. Our main hypothesis is that cats require a lower perioperative opioid while receiving the block. Our secondary hypothesis is a lower incidence of nausea/vomiting and dysphoria, and earlier return of appetite, in cats receiving the block.

Materials and methods

This randomised controlled trial received ethical approval from the Scientific Ethics Committee of the University of Teramo, protocol number 12150, on 27 March 2023. Written consent from the owners was obtained for all the animals involved. The study included queens presented to the Veterinary Teaching Hospital at the University of Teramo, Italy for elective ovariectomy. The inclusion criteria were cats aged between 12 months and 6 years, American Society of Anesthesiologists (ASA) status 1 (based on clinical examination) and a body condition

score between 3/9 and 5/9. Animals were excluded from the study if intraoperative anticholinergic or vasoactive drugs were administered or the anaesthetic time was prolonged owing to technical complications (unrelated to the study). All the cats were admitted 24 h preoperatively to give them time to acclimatise in their kennels. Food and water were withheld 12 and 1 h before premedication, respectively.

On the morning of the surgery, the animals were equally randomised (www.randomizer.org) by the same operator (AP) into two groups: the quadratus lumborum block (QL) group and the control (CTRL) group. All the cats were premedicated with methadone 0.1 mg/kg (Semfortan; Eurovet Animal Health), dexmedetomidine 0.005 mg/kg (Dextroquillan; Fatro) and alfaxalone 1 mg/kg IM (Alfaxan Multidose; Jurox). Approximately 15 mins later, a 20G peripheral intravenous catheter was introduced aseptically into the right cephalic vein and fluid therapy with lactated Ringer's solution was started at 3 ml/kg/h. In cases showing inadequate sedation, a second intramuscular dose of alfaxalone (1 mg/kg) was administered, and catheter placement was reattempted 10 mins later. After 3 mins of pre-oxygenation (100 ml/kg/min) via an oxygen mask, general anaesthesia was induced using propofol 2–3 mg/kg (Proposure; Boehringer Ingelheim Animal Health), slowly administered intravenously to effect. Endotracheal intubation was performed 45 s after laryngeal lidocaine nebulisation (Intubeaze; Dechra) using a PVC cuffed orotracheal tube of adequate size. The queens were then connected to a paediatric Mapleson D respiratory system and general anaesthesia was maintained with isoflurane (IsoFlo; Zoetis) delivered in 100% oxygen.

For the whole duration of anaesthesia, the following vital parameters were recorded every 5 mins using a multiparametric monitor (IntelliVue MX800; Philips): pulse and heart rate (HR; based on electrocardiogram [ECG], plethysmography or clinical assessment); three-lead ECG; peripheral capillary oxygen saturation (SpO₂; probe at the level of the tongue); end-tidal isoflurane concentration (EtISO); sidestream end-tidal carbon dioxide (EtCO₂); systolic (SAP), mean (MAP) and diastolic (DAP) arterial blood pressure (oscillometric method); respiratory rate (fR); and oesophageal temperature (T). The blood pressure cuff had a width of approximately 40% of the tail circumference and was positioned at the tail base. Once the cats were positioned in dorsal recumbency, their abdomen was clipped and surgically prepared from the last rib to the cranial aspect of the wing of the ileum, and laterally to the transverse processes of the lumbar vertebrae. The two groups of cats differed with respect to the treatment received prior to ovariectomy.

QL group

The queens were turned into lateral recumbency and a QL block was performed with a lateral approach as

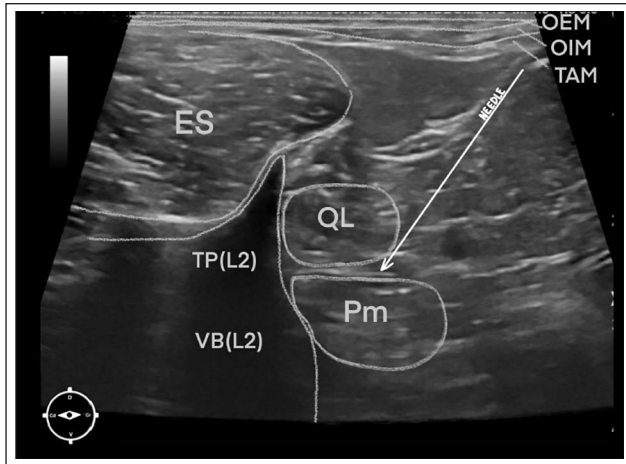


Figure 1 Acoustic window used for the QL block.

ES = erector spinae muscle; OEM = external abdominal oblique muscle; OIM = internal abdominal oblique muscle; Pm = psoas minor muscle; QL = quadratus lumborum muscle; TAM = transverse abdominal muscle; TP(L2) = transverse process of the second lumbar vertebra; VB(L2) = body of the second lumbar vertebra

previously described.^{11,13} A high frequency (7–12 MHz) ultrasound linear array probe (LA523; Esaote) was positioned parallel to the last rib at the level of the transverse process of L2, with the marker oriented dorsally. Once the QL and psoas minor muscles were identified (Figure 1), a 50 mm echogenic needle (Stimuplex; B Braun) was introduced ventral to the probe and advanced in plane with the ultrasonographic beam in a dorsocranial direction until its tip reached the interfascial plane between the two muscles. After negative aspiration and injection of a small test volume (0.3 ml) of anaesthetic solution, and once hydrodissection of the plane was visualised, 0.4 ml/kg of ropivacaine 0.4% (Ropivacaine chloralhydrate; Galenica Senese) was injected. The block was performed bilaterally, and the total dose of local anaesthetic used was 3.2 mg/kg. All the injections were performed by the same anaesthetist (AP) within a maximum of 5 mins. The animals were subsequently transferred to the operating room.

CTRL group

Cats allocated to this group did not receive any treatment and were transferred to the operating room immediately after abdominal clipping and surgical preparation.

Ovariectomy

After a surgical scrub, ovariectomy was performed in all patients by the same surgeons (ADG and FC) via coeliotomy (incision of approximately 2 cm caudal to the umbilicus), using a surgical hook.

A target EtISO of 1.5% was used before the first incision, and subsequently adjusted based on clinical

evaluation of the anaesthetic depth (absence of palpebral reflex, jaw tone and movement, and ventral rotation of the globes). Values of HR, fR, SAP, MAP, DAP, T, EtCO₂ and EtISO recorded before the towel clamps were positioned were used as the baseline. In the case of prolonged apnoea or severe hypoventilation (EtCO₂ >50 mmHg), manual ventilation with a controlled peak pressure (not exceeding 8 mmHg) was started to restore and maintain normocapnia (EtCO₂ in the range of 28–35 mmHg). In the case of hypotension (MAP <65 mmHg), anaesthetic depth was assessed and EtISO lowered when possible. When the plan of anaesthesia was deemed adequate, a bolus of crystalloids (8–10 ml/kg IV, lactated Ringer's solution; Baxter Healthcare), atropine (0.02–0.04 mg/kg IV, Atropine sulfate; ATI) or ephedrine (0.05 mg/kg, Efedrina solfato; Galenica Senese) were administered based on clinical evaluation. Fentanyl 0.002 mg/kg IV (Fentadon; Eurovet Animal Health) was administered as a rescue analgesic treatment if an increase from the baseline value ≥30% was recorded for any of the following parameters: HR, fR, SAP or MAP. After extubation, the queens were transferred to their kennels and kept hospitalised for postoperative pain assessment.

The study was considered concluded 8 h after extubation. All the cats received meloxicam (0.1 mg/kg IV, Meloxidolor; Le Vet Beheer) at the end of the study, before being discharged. Postoperative pain was assessed using the Feline Grimace Scale¹⁶ at the following time points: 30 mins before premedication; after extubation (as soon as the animals were deemed conscious); and then at 1, 2, 4, 6 and 8 h after extubation. In any animals with a pain score ≥4/10, methadone (0.1 mg/kg IV) was administered. A small amount of food was offered to all the queens 6 h after extubation. During the entire postoperative period, any episode of dysphoria, sialorrhoea or vomiting was recorded.

For blinding purposes, the investigators involved in the study were divided into three teams: preoperative (AP, AB, SP); intraoperative (CR, GC); and postoperative (DR, RB). Only the members of the first team were aware of the group allocation. All the others were not; they had to wait for the animals in the operating room or in the kennels, and the treatment group was not disclosed during the handover.

Statistical analysis

A sample size calculation was performed using a Fisher's exact test with power of 0.8, α of 0.05, and an estimated proportion requiring rescue analgesia intraoperatively of 0.2 in the QL group and 0.7 in the CTRL group (G*Power version 3.1.9.6; University of Düsseldorf). This being the first clinical study testing this block in cats, the chosen proportions were based on data retrospectively collected from the same institution. Data normality was assessed using the Shapiro–Wilk test. Normally

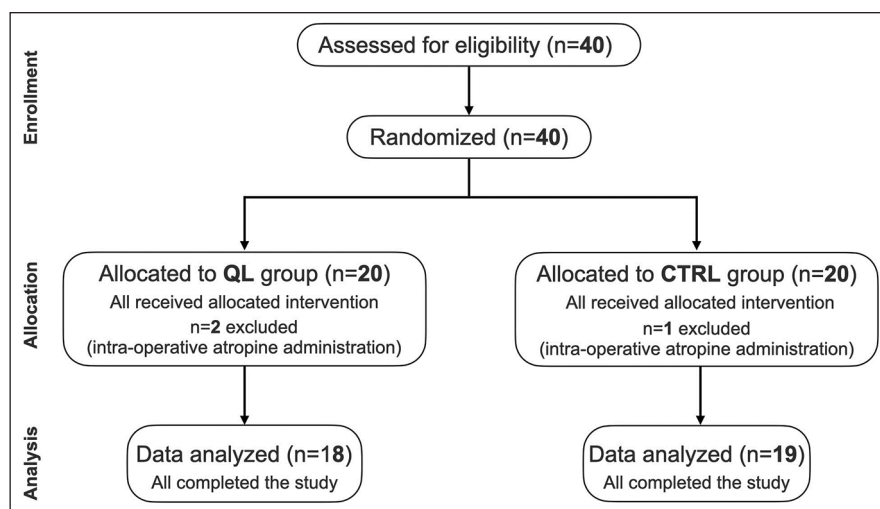


Figure 2 CONSORT flow diagram showing the enrolment, allocation and analysis phases of the randomised controlled trial

distributed data are presented as mean $\pm$ SD, whereas the non-normally distributed values are expressed as median (range).

Fisher's exact test was used to compare the number of queens per group requiring rescue analgesia in the intra- and postoperative periods, the number of animals requiring a second dose of alfaxalone, the incidence of intraoperative hypotension and postoperative dysphoria, sialorrhoea or vomiting, and the number of animals accepting food 6h after extubation. The Student's *t*-test was used to compare age, weight, time from premedication to first incision, baseline HR, SAP, MAP and T, and median intraoperative EtISO. The Mann-Whitney U-test was used to compare baseline *f*R, median intraoperative EtCO₂, surgical time and total rescue dose of fentanyl and methadone between groups.

A statistical analysis was performed using SPSS Statistics version 29.0.1.0 (IBM). *P* < 0.05 was considered statistically significant.

Results

A minimum required sample size of 18 queens per group was determined. Forty domestic shorthair queens were recruited between 15 May 2023 and 18 July 23 and divided into the two groups. After the exclusion of three cats owing to the need for intraoperative atropine administration (treatment of hypotension), data were available and analysed for 19 subjects in the CTRL group and 18 in the QL group (Figure 2).

No statistically significant difference was found between the groups for age, weight, time from premedication to first incision, surgical time, baseline HR and *f*R, intraoperative EtCO₂, baseline SAP, MAP and T, and intraoperative EtISO (Table 1). None of the subjects required assisted ventilation.

One queen per group required a second dose of alfaxalone during the premedication phase (*P* > 0.999). In none of the cats receiving the block was a second test dose of 0.3 ml of local anaesthetic necessary, as the tip of the needle was always correctly positioned at the first attempt. Therefore, the actual volume injected did not change between sides and different subjects. There was no statistically significant difference in the incidence of hypotension between the groups (1/20 [5%] subjects in the CTRL group and 2/20 [10%] in the QL group; *P* > 0.999). The number of animals requiring intraoperative rescue analgesia was higher for the CTRL group, at 14/18 (77.8%) cats, compared with 1/19 (5.3%) cats in the QL group (*P* < 0.001). Similarly, the median total dose of intraoperative fentanyl required was 4 µg/kg (range 0–4) in the CTRL group and 0 µg/kg (range 0–4) in the QL group (*P* < 0.001). No statistically significant difference was found between groups when comparing the number of animals requiring postoperative analgesia, the postoperative total dose of methadone, episodes of sialorrhoea or dysphoria, and number of animals accepting food at 6h after extubation (Table 2). Vomiting was not recorded for any of the animals.

No adverse effect or complication potentially related to the QL block was recorded in any of the animals at any time point.

Discussion

Based on the findings of this study, the QL block appears to have an intraoperative opioid-sparing effect in queens undergoing ovariectomy. Similar findings can be found in a recent canine case series in which the QL block has shown promising results as part of a multimodal analgesic plan in bitches undergoing opioid-free laparotomic ovariohysterectomy.⁸

Table 1 Descriptive statistics

Variable	CTRL (n = 19)	QL (n = 18)	P
Age (months)	24 ± 12	19 ± 10	0.203
Weight (kg)	3.3 ± 0.55	3.07 ± 0.67	0.254
Time from premedication to first incision (mins)	47 ± 12	53 ± 8	0.084
Surgical time (mins)	33 (18–45)	28 (18–60)	0.408
Baseline HR (bpm)	124 ± 16	119 ± 16	0.332
Baseline fR (breaths/min)	20 (16–26)	20 (10–25)	0.753
EtCO ₂ (mmHg)	36 (29–38)	35 (29–39)	0.845
Baseline SAP (mmHg)	113 ± 12	117 ± 12	0.188
Baseline MAP (mmHg)	76 ± 14	76 ± 8	0.936
Baseline temperature (°C)	38.1 ± 0.3	38.2 ± 0.3	0.263
EtISO (%)	0.8 ± 0.9	0.8 ± 0.7	0.241

Data are mean ± SD or median (range)

CTRL = control group; EtCO₂ = end-tidal carbon dioxide; EtISO = end-tidal isoflurane concentration; fR = respiratory rate; HR = heart rate; MAP = mean arterial pressure; QL = quadratus lumborum block group; SAP = systolic arterial pressure

Table 2 Total amount of intraoperative and postoperative rescue analgesia and recovery quality

Variable	CTRL (n = 19)	QL (n = 18)	P
Intraoperative rescue	14/19 (77.8)	1/18 (5.3)	<0.001
Intraoperative fentanyl (µg/kg)	0 (0–4)	4 (0–4)	<0.001
Postoperative rescue	4/19 (21.1)	1/18 (5.6)	0.340
Postoperative methadone (mg/kg)	0 (0–0.2)	0 (0–0.2)	0.425
Dysphoria	1/19 (5.3)	0/18	>0.999
Sialorrhoea	2/19 (10.5)	2/18 (11.1)	>0.999
Food accepted at 6 h post-extubation	16/19 (84.2)	14/18 (77.8)	0.618

Data are n (%) or median (range)

CTRL = control group; QL = quadratus lumborum block group

The technique used in the present study for this block is not the only one described to date. In 2020, Argus et al¹⁷ published a case report of a QL block performed with a dorsal approach in a cat undergoing cystotomy. In this case, the animal required a single dose of rescue analgesia perioperatively, and the volume of local anaesthetic used (0.3 ml/kg) was lower than that in the present study. Because of the paucity of available clinical data, it is unclear whether the approach used (position of the transducer, direction of the needle and chosen target point) could have any influence on the success or the extension of the block. It is also unclear whether there is any linear correlation between the injected volume of local anaesthetic and the longitudinal spread, as this has never been investigated in a small animal model. The volume used in the present study is the same as used by Dos-Santos et al and Polo-Paredes et al.^{9,11,13} In the first of these studies, the ventral branches of the first three lumbar vertebrae were stained in 6/8 subjects, the ventral branches of T13 in 2/8 and the sympathetic trunk from T13 to L3 in 7/8 cadavers. In the second study, the ventral branches of the spinal nerves from T11 to L3 (consistently at the level of

the first three lumbar nerves) and the sympathetic trunk from T9 to L5 (consistently from T12 to L3) were stained by the dye injection.

Based on these findings, it is reasonable to expect desensitisation of part of the abdominal wall and the caudal abdominal viscera in cats receiving a QL block. In fact, in dogs and cats, the ovaries can receive sympathetic innervation from spinal segments from T9 to L4, with intraspecific anatomical variations.^{14,18} This mismatch between the maximum spread of the local anaesthetic and the extension of the ovarian innervation may explain the need for rescue analgesia in 1/19 queens in the QL group, although other potential reasons for this finding could be a complete or partial failure of the blockade (intramuscular injection) or some heterogeneity in the spread patterns obtained. It is also unclear whether the spread of a dye in a cadaveric model is a valid predictor of the spread of local anaesthetics in a clinical setting, and where exactly the nociceptive stimuli originate from during traction of the ovarian ligament. In the light of this combination of factors, the interpretation of a difference in intraoperative rescue treatment requirements between groups is

challenging. The bilateral blockade of part of the lumbar sympathetic chain is another important aspect to consider. In fact, in queens receiving the block, the absence of sympathetic response and the lower need for rescue analgesia could be due to the effect of the local anaesthetic on sympathetic fibres, rather than on nociceptive afferences. There is evidence of a lower requirement for perioperative analgesics in humans receiving drugs that inhibit the sympathetic system administered in the intraoperative period,¹⁹ making this intertwinement between nociception and autonomic nervous system a fascinating grey area. Interestingly, in the present study, the percentage of queens within the QL block group requiring intraoperative rescue analgesia was lower than reported in a recent randomised controlled trial involving a similar population of queens.⁹ When comparing the QL block technique between the present study and the aforementioned trial, the only difference is the local anaesthetic used and its concentration; in the clinical trial by Dos-Santos and colleagues,⁹ the local anaesthetic used was 0.25% bupivacaine, whereas 0.4% ropivacaine was used in the present study because of its lower cardiotoxic potential.^{20,21} From a pharmacological point of view, although the potency of the concentration of ropivacaine used in the present study is supposed to be higher, thus theoretically resulting in a higher density of blockade, studies investigating the clinical impact of different local anaesthetics and concentrations in cats are currently lacking. Therefore, no firm conclusion about this difference can be drawn.

When comparing the groups in terms of the amount of postoperative methadone received, no statistical difference was found. There are several possible interpretations for this finding. First, this study might be underpowered for this outcome, as the sample size was calculated based on the proportion of animals requiring rescue analgesia intraoperatively. A second hypothesis is that there may be a residual analgesic effect of the methadone administered as premedication, at least during the first few postoperative hours when the surgical pain is supposed to be at its highest intensity.^{22,23} Another explanation is that the block exerts its main effect on the sympathetic innervation of the ovaries and produces just a partial somatic anaesthesia/analgesia of the abdominal wall. Interestingly, the queens requiring postoperative methadone were the same queens requiring intraoperative fentanyl. This finding is suggestive of some QL blocks resulting in inadequate anaesthetic and analgesic coverage, although we cannot exclude their complete failure with absolute certainty.

As observed in animals receiving local anaesthetics for neuraxial anaesthesia, a blockade of the sympathetic system can result in regional vasodilation and decreased arterial blood pressure, most likely due to a decrease in preload and stroke volume.^{9,24,25} In the present study, despite the likely blockade of part of the sympathetic chain in all subjects, it is interesting to note the lack of

difference between the groups in terms of the presence of hypotension.

This clinical trial has several limitations. For ethical reasons, we decided not to include a sham control group, which would have further minimised potential sources of bias. Only animals in the QL group received the injection, and some small lesions at the insertion point of the needle could have been visible after the handover from one team to another, affecting the blinding. Nevertheless, apart from a few cases showing some self-limiting minimal bleeding from the skin (cleaned during the final prepping, immediately after the block), no permanent lesions were visible once the queens were positioned on the surgical table. Also, notwithstanding the well known advantages of using non-steroidal anti-inflammatory drugs in the immediate postoperative period, it was decided when designing this study to postpone the administration of meloxicam to 8 h after extubation. Although this was planned in order not to mask the effect of the block, it can be considered a deviation from the clinical standard of care, and therefore a limitation.

As previously mentioned, this study was most likely underpowered for secondary outcomes, such as postoperative methadone requirement, sialorrhoea, vomiting and cats accepting food 6 h after extubation; therefore, results regarding these data should be interpreted with caution. Moreover, although the sample size was calculated, it still remains a relatively small number and the results may not be the same in a larger or different population.

Conclusions

Use of a QL block resulted in lower intraoperative fentanyl requirements in queens undergoing ovariectomy. Further studies are needed to clarify the postoperative analgesic effect of this technique in feline patients.

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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Ethical approval The work described in this manuscript involved the use of non-experimental (owned or unowned) animals. Established internationally recognised high standards ('best practice') of veterinary clinical care for the individual patient were always followed and/or this work involved the use of cadavers. Ethical approval from a committee was therefore not specifically required for publication in *JFMS*. Although not required, where ethical was still obtained, it is stated in the manuscript.

Informed consent Informed consent (verbal or written) was obtained from the owner or legal custodian of all animal(s) described in this work (experimental or non-experimental animals, including cadavers, tissues and samples) for all

procedure(s) undertaken (prospective or retrospective studies). No animals or people are identifiable within this publication, and therefore additional informed consent for publication was not required.

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