

ULTRASOUND-GUIDED PARASTERNAL BLOCK IN A CAT UNDERGOING MEDIAN STERNOTOMY FOR PULMONARY LOBECTOMY

Massimiliano Degani, Julien Dupont, Thomas Giansetto, Stéphanie Claeys, Charlotte Sandersen

Clinical Department for Companion Animals, Faculty of Veterinary Medicine, University of Liège, Liège, Belgium

Abstract

A 3.25-kg, 1-year-old, European shorthair cat was referred for acute respiratory distress. A thoracic computed tomography revealed the presence of multiple pulmonary abscesses, and a median sternotomy for pulmonary lobectomy was scheduled. The cat was premedicated with methadone and dexmedetomidine, anaesthesia was induced with alfaxalone and maintained with isoflurane in 100% oxygen. Ultrasound-guided parasternal block was performed before surgery with ropivacaine 0.5% (total dose 3 mg/kg). Rescue analgesia was needed only during abscess debridement and lung lobectomy. Postoperative pain was assessed every hour, using the short-form Glasgow Feline Composite Measure Pain Scale. The cat required rescue analgesia (0.2 mg/kg methadone) 7 hours after the completion of the block. This case report describes the feasibility of ultrasound-guided parasternal block in a cat undergoing median sternotomy, suggesting that it can usefully be added to a multimodal analgesic plan in the perioperative period.

BACKGROUND

The purpose of this case report is to describe the successful implementation of the ultrasound (US)-guided parasternal block in the anaesthetic management of a median sternotomy in a cat.

Median sternotomy is reported as the preferred surgical approach to explore the thoracic cavity,^{1, 2} especially in case of pyothorax. In human medicine, this surgery is reported to be associated with significant postoperative pain caused by tissue injury at the level of the skin, subcutaneous tissues, bone, and cartilage.³ Sternal retractors are frequently used during surgery and produce disruptive forces, not only around the surgical site itself, but also at the costovertebral joints and more distant sites, due to rib fractures at the level of costovertebral joints, costochondritis, rib joint dislocation or nerve injury.³

Different strategies have been reported in both human and veterinary medicine to treat perioperative pain associated with thoracic surgery. Systemic opioids administration is still considered the standard analgesic therapy, but many complications are related to their use.⁴ Locoregional anaesthesia has proved to be superior to systemic opioids in terms of analgesic effect and reduction of complications.⁵ Over the last few years, two different approaches for US-guided blocks have been described to provide

analgesia during sternotomy in dogs.⁶⁻⁸ Very recently, US-guided transversus thoracis plane block has been reported in a cat with promising results.⁹ This case report aims at confirming the usefulness of the US-guided parasternal block in a cat undergoing median sternotomy.

CASE PRESENTATION

A 3.25-kg, 1-year-old, male, neutered, European shorthair cat was referred to the Small Animals Emergency Service of the University of Liege for investigation of acute respiratory distress. The day before admission to the hospital, it was presented to the referring veterinarian with expiratory dyspnoea and hyperthermia at 39.5°C. The owner reported lethargy and reluctance to move for the past 2 days. Thoracic radiographs showed pleural effusion, and thoracocentesis was performed before the cat was referred to the Small Animals Emergency Service of the University of Liege. The referring veterinarian described the pleural effusion as macroscopically purulent, but no further investigations were conducted on sampled material.

On admission, the cat was calm and alert. Heart rate (HR) was 192 beats per minute, synchronised with the regular strong peripheral pulse, the respiratory rate (RR) was 50 respirations per minute with an inspiratory dyspnoea, mucous membranes were pink, capillary refill time was less than 2 seconds, rectal temperature was 37.7°C and body condition score was 5/9. Respiratory auscultation revealed pulmonary crackles.

INVESTIGATIONS

Laboratory analyses indicated haemoconcentration (haematocrit 53.3%), total proteins 60 g/L, monocytosis ($3.63 \times 10^9/L$; reference range 0.05–0.67) with neutrophil left-shift, mild hypoalbuminemia (21 g/L; reference range 22–40), hyperglycemia (9.51 mmol/L; reference range 4.11–8.84) and hyponatremia (147 mmol/L; reference range 150–165).

Thoracic point-of-care US (POCUS) showed abundant pleural effusion. A thoracostomy tube (guidewire thoracostomy tube 14 G × 20 cm; Mila International, USA) was placed at the ninth intercostal space on the left side of the thorax and allowed the collection of 150 mL of purulent pleural fluid. Analysis of the fluid revealed presence of neutrophils and intra- and extracellular bacteria. Meanwhile, the cat was hospitalised and the following therapy was initiated: amoxicillin (20 mg/kg) and clavulanic acid (Levmentin 1 g/200 mg; Laboratories Delbert, France) three times a day intravenously (IV), 1 mg/kg maropitant (Cerenia 10 mg/mL; Zoetis, Netherlands) once a day IV and 10 µg/kg buprenorphine (Vetergesic 0.3 mg/mL; Ceva, Netherlands) three times a day IV. Respiratory pattern improved and RR normalised quickly during hospitalisation, and the following day, a thoracic computed tomography (CT) demonstrated the presence of two pulmonary abscesses/granulomas on the right middle lobe and the left caudal lobe and one abscess/granuloma on the ventral recess of the caudal mediastinum, with a moderate amount of residual pleural effusion in the left hemithorax.

TREATMENT

Given the evidence of pulmonary and mediastinal abscesses/granulomas and pyothorax, a median sternotomy for multiple pulmonary lobectomies was scheduled for the day after the CT.

The cat was premedicated with 0.2 mg/kg methadone (Comfortan 10 mg/mL; Dechra, Netherlands) and 1 µg/kg dexmedetomidine (Dexmedetomidine 0.5 mg/mL; Orion Pharma, Finland) administered IV. Subsequently, an IV infusion of lactated Ringer's solution (Vetivex; Dechra, Belgium) was administered at a rate of 3 mL/kg/h. After 5 minutes of preoxygenation via a face mask, anaesthesia was induced with 2 mg/kg alfaxalone (Alfaxan Multidose 10 mg/mL; Dechra, Ireland) IV and the trachea was intubated with a 3.5-mm internal diameter cuffed endotracheal tube. The cat was placed in dorsal recumbency, connected to a small Mapleson D system (Intersurgical, UK) and allowed to breath spontaneously. Isoflurane (Isoflutek; Alivira Animal Health, Spain) was delivered in 100% oxygen (1–1.5 L/min), and vaporiser setting was adjusted to maintain end-tidal percentage of isoflurane between 1 and 1.2. A 24 G cannula was placed in the coccygeal artery to allow continuous direct arterial pressure measurement.

The ventral aspect of the thorax was clipped and aseptically prepared to perform a US-guided parasternal intercostal block, as described for dogs by Zublena et al.⁶ A 14 MHz high-frequency linear transducer (L7HDVET; Clarius, USA), connected to a touchscreen tablet (iPad Air, fifth generation; Apple, USA) was positioned longitudinally, in a parasternal position, at the level of the costochondral junction at the second intercostal space (Figure 1). Once the hypoechoic inter-fascial plane between the internal intercostal muscle and the transversus thoracis muscle was identified as target of injection, an echogenic needle (NanoLine SonoPlex STIM 22 G × 50 mm; Pajunk, Germany) was inserted caudo-cranially with an in-plane technique (Figure 2) and a volume of 0.05 mL/kg of ropivacaine diluted to 0.5% (Naropine 10 mg/mL, Aspen, Ireland) was injected into every intercostal space (six injections per side, total dose of 3 mg/kg). Successful injection was confirmed by the direct visualisation of the hydro-dissection between the internal intercostal muscle and the transversus thoracis muscle, as well as the ventral displacement of the transversus thoracis muscle and the parietal pleura.

LEARNING POINTS/TAKE-HOME MESSAGES

- Locoregional anaesthesia techniques should be used in patients submitted to sternotomy as part of a multimodal analgesic plan.
- The parasagittal approach of the parasternal block described in dogs can be safely applied to cats.
- Hypotension caused by systemic absorption of local anaesthetic should be considered as a potential complication after performing inter-fascial plane blocks.

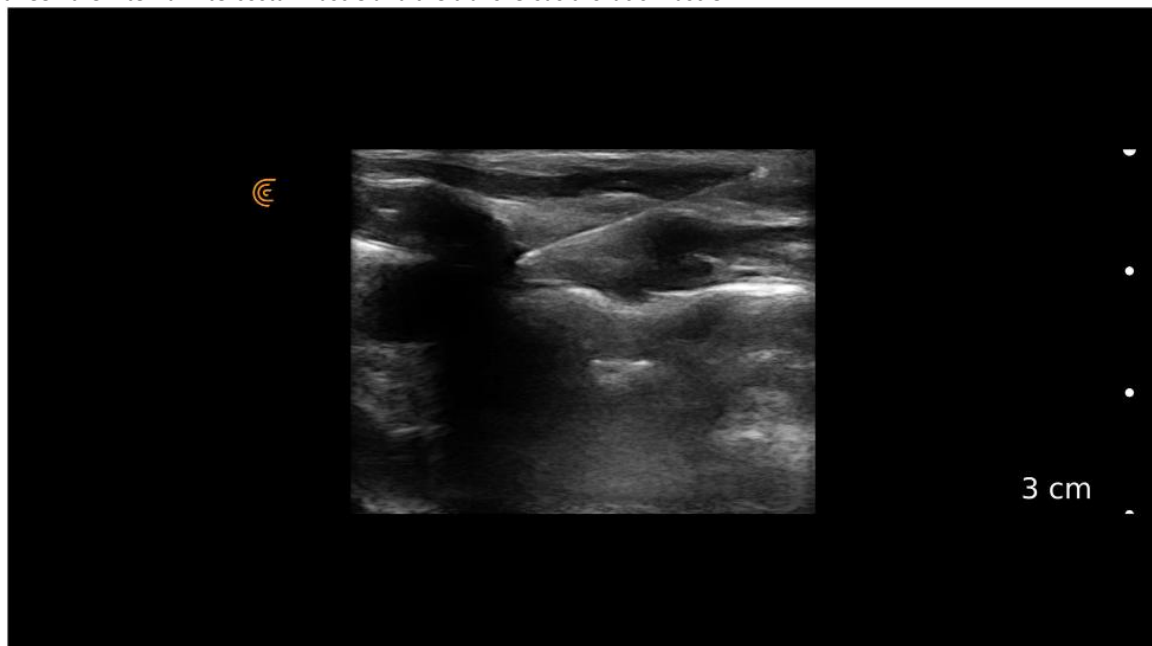
Subsequently, the cat was transported to the operating room and connected to a rebreathing system (Universal F; Kingsystem, USA). Volume-controlled ventilation (Prima 320; Penlon, UK) was applied during the whole procedure to maintain normocapnia using the following ventilator settings: tidal volume 10 mL/kg, RR 16–18 respirations per minute, inspiratory-to-expiratory time ratio 1:2, inspiratory pause 30% of inspiratory time, and positive end expiratory pressure 5 cmH₂O. Electrocardiogram, pulse oximetry, invasive arterial blood pressure, oesophageal temperature, inspired and expired percentages of isoflurane, inspired carbon dioxide partial pressure and end-tidal

carbon dioxide partial pressure were continuously monitored using a multiparameter monitor (VT9000 Multimonitor; Veterinary Technics, Netherlands) and recorded every 5 minutes. Rescue analgesia, consisting of an infusion of fentanyl (Fentadon 50 µg/mL; Dechra, Netherlands), was envisaged if HR and/or mean arterial pressure (MAP) increased during surgery by more than 20% over values recorded before skin incision.

Figure 1. Positioning of the probe and of the needle, during the parasternal block: the probe was placed in a parasternal position and the needle was inserted and advanced in a caudo-cranial direction.



Figure 2. Ultrasound image of the intercostal space in the parasternal area of the cat. The tip of the needle was located between the internal intercostal muscle and the transversus thoracis muscle.



The surgery started approximately 30 minutes after having completed the parasternal intercostal block. During the median sternotomy, no increase in HR or in MAP was noticed. Once the thoracic cavity had been opened and manipulation of viscera had started, 45 minutes after execution of the block, hypotension was noticed (MAP reduced from 70 to 50 mmHg). Therefore, the expired percentage of isoflurane was reduced to 0.8% and a bolus of 5 mL/kg of lactated Ringer's solution was administered over 10 minutes. As no improvement in MAP was observed, an infusion of noradrenaline (Levophed 8 mg/4 mL; Hospira, USA) was started at a rate of 0.1 µg/kg/min and increased by 0.05 µg/kg/min every 5 minutes until MAP reached 60 mmHg (noradrenaline infusion rate 0.2 µg/kg/min).

Later, a progressive increase in HR (from 130 to 160 beats per minute) and MAP (from 70 to 95 mmHg), corresponding to an increase of 23% and 35% compared to baseline values, respectively, was registered during abscess debridement and lung lobectomy of the right middle, caudal and accessory lobes (30 mm TA vascular stapler with DST technology, Covidien, USA). Therefore, fentanyl (2 µg/kg IV) was administered and followed by an infusion at a rate of 5 µg/kg/h.

Once lobectomy was completed, an abundant lavage of the thoracic cavity was performed with warm sterile saline solution, and a new thoracostomy tube (guidewire thoracostomy tube 14 G × 20 cm; Mila International, USA) was placed at the ninth intercostal space on the right hemithorax. Fentanyl infusion rate was tapered off to 2 µg/kg/h during lavage and discontinued during closure of the sternum, achieved with a cruciate pattern using a polydioxanone suture (United States Pharmacopeia 2-0; Ethicon, USA). Isoflurane was turned off once the surgery was completed. Total anaesthesia and surgical times were 170 and 140 minutes, respectively.

OUTCOME AND FOLLOW-UP

Recovery from anaesthesia was uneventful. The cat was extubated 5 minutes after having turned off isoflurane. Vital parameters were within physiological limits, except for the temperature (36.3°C). It was transferred to the intensive care unit, where it was supplemented with oxygen via a face mask and rewarmed with a forced-air warming blanket until its rectal temperature reached 37°C. Meloxicam 0.1 mg/kg (Meloxidolor 5 mg/mL; Dechra, Netherlands) was administered IV (off-label use) 30 minutes after the end of anaesthesia. Once fully recovered, the cat appeared alert, comfortable and able to stand and move. It ate voluntarily 6 hours after extubation.

Pain was assessed every hour, starting 1 hour after extubation, using the short-form Glasgow Feline Composite Measure Pain Scale (GCMPs-Feline).¹⁰ Rescue analgesia consisting of methadone (0.2 mg/kg) was administered IV if GCMPs-Feline score was at least 5. The cat first received methadone 7 hours after the completion of the block and, from this point on, administration of methadone (0.2 mg/kg IV) every 4 hours was continued for 12 hours, before changing for buprenorphine (20 µg/kg IV) three times a day until the cat was discharged 48 hours after surgery. Meloxicam and amoxicillin and clavulanic acid were continued orally for 4 and 10 days, respectively.

DISCUSSION

This case report describes the successful implementation of the US-guided parasternal block in the anaesthetic management of a median sternotomy in a cat.

Median sternotomy remains the preferred surgical approach to access the entire thoracic cavity and is therefore indicated for exploratory thoracotomy.^{1, 2} This surgery is associated with significant postoperative pain secondary to extensive tissue injury and application of sternal retractors. Pain associated with median sternotomy is described as severe, not only during the first postoperative hours, but also up to 1 week after surgery. An optimal perioperative analgesic management is therefore essential to guarantee comfort and improve outcome.¹¹

Although systemic opioids administration is still considered the mainstay of analgesic therapy, many complications (respiratory depression, nausea/vomiting, ileus, urinary retention, sedation, dysphoria) are related to their use.⁴

Locoregional anaesthesia has proved to be superior to systemic opioids in terms of analgesic effect and reduction of complications.⁵ In veterinary medicine, thoracic epidural,^{12, 13} thoracic paravertebral block,¹⁴ intercostal blocks¹⁵ and US-guided transversus thoracis plane block¹⁶ have been reported to provide thoracic wall analgesia.

The ever-increasing interest for locoregional anaesthesia in human medicine has extended to veterinary medicine over the last decade. Thanks to the growing implementation of US in the veterinary daily practice, inter-fascial plane blocks have been emerging in the last few years. As these blocks do not target a specific single nerve, but rather a plane where several nerve structures run through, they are considered easier to perform and relatively safe.¹⁷

Two different case series have investigated the analgesic efficacy of serratus plane block¹⁸ and erector spinae plane block¹⁹ in dogs submitted to lateral thoracotomy. More recently, another case series reported the use of erector spinae plane block in combination with a constant-rate infusion of dexmedetomidine in dogs submitted to sternotomy.²⁰ In veterinary medicine, two different approaches for US-guided blocks have been described in dogs⁶⁻⁸ to provide analgesia during median sternotomy. These techniques consist of injecting local anaesthetic (LA) in the vicinity of the distal portion of the intercostal nerves, between the internal intercostal muscle and the transversus thoracis muscle, either via a parasagittal approach⁶ or via a transversal approach.^{7, 8} The authors stated that the main advantage seems to be related to a better ventilatory profile in the postoperative period, in comparison with traditional multiple intercostal blocks, as the muscles affected by these approaches do not play a significant role in ventilation. In addition, time needed to perform these blocks should be shorter than bilateral intercostal blocks and, as they are performed with the patient in dorsal recumbency, changing the position is not necessary.⁶ Zublena and colleagues⁶ evaluated the spread of dye solution comparing two different volumes with two different numbers of injections using a parasagittal approach in canine cadavers. They concluded that a better staining of the nerves was obtained by injecting 0.05 mL/kg of solution in every intercostal space (from the second to seventh), instead of injecting 0.1 mL/kg in three intercostal spaces only (the third, fifth and seventh). Alaman and colleagues⁷ obtained similar spread with a single injection of 1 mL/kg of dye solution at the fifth

intercostal space using a transversal approach. The same authors reported that the injection of 0.5 mL/kg at two points (the third and sixth intercostal spaces) in canine cadavers achieved a consistent staining of intercostal nerves, from the second to seventh intercostal space.⁸ Currently, there are only two published case reports regarding the analgesic efficacy of the US-guided transversus thoracis plane block during median sternotomy, one in a dog¹⁶ and one in a cat.⁹ However, to the authors' knowledge, this is the first time that the approach described by Zublena and colleagues for dogs⁶ was applied in the feline species. Considering that all the cadaveric studies were conducted in dogs, it was not possible to predict if the spread of LA would be similar in cats. For this reason, the parasagittal approach combining smaller volumes with a bilateral six-point injection technique (from the second to seventh intercostal space) was deemed more reliable to extend the inter-fascial plane block to a live cat, even though multiple injections might have exposed the patient to a higher risk of complications, like pneumothorax, haemorrhage or intravascular injection.²¹ Nevertheless, none of these complications was observed during or after execution of the block.

No significant increase in HR or in MAP was recorded during the sternotomy, suggesting that the block provided an effective antinociceptive effect. Although the cat was premedicated with a combination of dexmedetomidine and methadone, the authors feel that these drugs could not have ensured absence of nociception during this phase of the surgery. In the authors' institution, blind infiltration of LA next to the distal end of the intercostal nerves, as described in human medicine,²² is usually performed by the surgeon. Nevertheless, its efficacy is variable and intraoperative infusions of analgesic drugs are almost invariably required. However, there is a lack of evidence from the literature to state that IV administration of dexmedetomidine and methadone is insufficient to provide adequate analgesia for sternotomy in cats.

During surgery, hypotension was successfully treated by reducing the expired percentage of isoflurane, administering a bolus of lactated Ringer's solution and infusing noradrenaline.

This complication could have been associated with the manipulation of intrathoracic viscera and inadvertent compression of vessels, with consequent reduction of venous return, cardiac output and arterial blood pressure.²³ Hypotension might also have been related to systemic absorption of ropivacaine administered for the parasternal block. In human medicine, intercostal nerve blocks are associated with higher plasmatic concentrations of LA compared with other locoregional anaesthesia techniques.²⁴ In authors' opinion, considering that the parasternal block was performed in the same anatomical region, it is not possible to exclude that systemic absorption of LA could not have been substantial in this cat. In human medicine, studies showed increased plasma concentrations of LA after performing inter-fascial plane blocks, potentially leading to toxic effects, even with doses regarded as safe.²⁵⁻²⁷ Systemic absorption of ropivacaine might therefore have contributed to the hypotensive episode observed during the procedure, even if the dose (3 mg/kg) did not exceed the recommended level in veterinary literature.²³⁻²⁸ However, to the authors' knowledge, plasma concentrations and pharmacokinetics of ropivacaine have never been investigated in cats following any locoregional anaesthesia technique.

Later, an increase of HR and MAP was registered once surgeons started abscess debridement and lung lobectomy. Although manipulation of intrathoracic viscera could not be ruled out as a contributor to

these haemodynamic changes,²³ the authors most likely attributed them to the sympathetic response to nociception as HR and MAP increased concurrently.

Recovery from anaesthesia was fast and uneventful, and the comfort of the cat was deemed satisfactory, especially in the first hours after surgery. It was evaluated for pain every hour starting 1 hour after extubation, and the GCMPS-Feline scores were less than 5 for the first 7 hours. This finding confirms that the block was also effective in preventing pain in the postoperative period and reduced the total opioids consumption, as reported in human medicine.^{29, 30} Indeed, the cat would probably have received at least one additional dose of methadone if postoperative pain therapy would have been instituted in a systematic manner. The duration of the analgesic effect is consistent with the reported duration of action of ropivacaine (between 5 and 8 hours) in the veterinary literature.³¹

Based on this case report, the US-guided parasternal intercostal block appears to represent a valuable adjunct to provide analgesia in the perioperative period for cats submitted to median sternotomy. Cadaveric studies and randomised clinical trials are needed to determine anatomical characteristics, technique of injection, optimal volume and spread of the LA to improve the understanding of this locoregional technique in cats.

AUTHOR CONTRIBUTION

Massimiliano Degani, Julien Dupont, Thomas Giansetto and Charlotte Sandersen were involved in clinical management of the case. Massimiliano Degani, Julien Dupont, Thomas Giansetto, Stéphanie Claeys and Charlotte Sandersen were involved in data treatment, interpretation and preparation of the manuscript.

CONFLICT OF INTEREST STATEMENT

The authors declare they have no conflicts of interest.

ETHICS STATEMENT

By signing the admission form, owners gave written informed consent for the collection of data from their cat and its publication in an anonymised format. Ethical review and approval were not required for the animal study, because this case report has been written using data collected in a clinical setting. No research has been performed on the patient.

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ORCID

Massimiliano Degani <https://orcid.org/0000-0002-4375-8407>

Julien Dupont <https://orcid.org/0000-0002-0857-1903>

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