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ORIGINAL RESEARCH

Retrospective case-control non-inferiority analysis of ultrasound-guided erector spinae plane block in dogs undergoing mini-hemilaminectomy for intervertebral disc disease

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Background: Veterinary medicine has seen significant advancements in locoregional anaesthesia and pain management, including the emergence of the erector spinae plane (ESP) block. However, limited clinical evidence exists on its efficacy and safety.

Objectives: This study compares ultrasound-guided ESP block (ESP group) with an intraoperative intravenous ketamine infusion analgesic protocol (CRI group) in dogs undergoing thoracolumbar mini-hemilaminectomy, focusing on intraoperative opioid consumption, cardiovascular response to surgical stimulation (CR), postoperative pain scores (PS), and postoperative opioid consumption.

Methods: Retrospective, case-control, non-inferiority study conducted in a single centre. Data collected included demographics, bupivacaine dose, ESP block operator, intraoperative recorded variables (haemodynamic variables, CR, complications, rescue analgesia), pre- and postoperative analgesia, 24-hour PS and opioid administration, first food intake post-extubation and postoperative complications. Univariate and multiple regression analyses were applied.

Results: One-hundred dogs were included, 75 in the ESP group and 25 in the CRI group. Univariate analysis revealed no significant differences between treatment groups in terms of CR, PS, postoperative rescue analgesia, intraoperative and postoperative opioid consumption, or time to first meal intake. However, the multivariate regression analysis indicated that dogs receiving ketamine infusion had higher CR suspected to be nociception-related ($p = 0.036$), and higher postoperative opioid consumption ($p = 0.013$).

Conclusion: Our study suggests that ultrasound-guided ESP block is as effective as intraoperative ketamine infusion providing perioperative analgesia in dogs undergoing thoracolumbar mini-hemilaminectomy for intervertebral disc disease. ESP group showed significantly lower CR suspected to be nociception-related intraoperatively and lower postoperative opioid consumption within the initial 24 hours.

Keywords: dogs, analgesia, locoregional anaesthesia, neuroanaesthesia, erector spinae plane block, ESP, mini-hemilaminectomy

Introduction

In recent years, new ultrasound-guided locoregional anaesthesia techniques have been developed in veterinary medicine with interesting clinical applications. A combination of regional anaesthesia and systemic analgesics as part of a multimodal technique is generally accepted as the optimal approach to providing pain relief (Grubb & Lobprise 2020). Among the advantages of adding local anaesthesia to general anaesthesia is that the dose of anaesthetic agents, and the number and dose of analgesics administered perioperatively can be reduced, thus minimising their adverse effects (Grubb & Lobprise 2020).

The erector spinae plane (ESP) block is an interfascial injection of local anaesthetic between the erector spinae muscle group and the transverse processes of the thoracic and lumbar vertebrae. It targets the dorsal rami of the spinal nerves to desensitise the cutaneous area near the dorsal midline, the paraspinal muscles, the dorsal vertebral laminae, and the facet joints (Otero & Portela 2019; Evans & de Lahunta 2013; Forsythe & Ghoshal 1984). It was first described in human medicine in 2016 by Forero et al. (2016). During the following years, clinical studies and case reports of the ESP block showed it to be an easy technique to perform, having a low risk of complications and providing appropriate analgesia in many surgical procedures, from limb surgeries to cardiac or abdominal surgeries (Kot et al. 2019; Singh & Chowdhary 2018; Tulgar, Kapakli, et al. 2018; Tulgar, Kose, et al. 2018; Chin et al. 2017).

The use of ESP block in veterinary medicine is very recent. It has been described in four experimental cadaveric studies in the thoracic and lumbar regions (Cavalcanti et al. 2022; Portela, Castro, et al. 2020; Medina-Serra et al. 2021; Ferreira et al. 2019). Clinical evidence of the ESP effects in live animals undergoing spinal surgery is limited to five recent publications. These include a case report (Zannin et al. 2020), two retrospective studies where the perioperative use of analgesics and the rate of complications were evaluated and compared to traditional opioid-based intraoperative analgesia (Viilmann et al. 2022; Portela, Romano, et al. 2020), one prospective randomised blinded clinical study evaluating the analgesic effect of unilateral lumbar erector spinae plane block versus saline solution injection in dogs undergoing hemilaminectomy (Degani et al. 2023), and one prospective randomised clinical trial comparing perioperative

opioid consumption and cardiovascular complication incidence in dogs undergoing hemilaminectomy with either an ESP block or systemic opioids (Bendinelli et al. 2024).

To the authors' knowledge, there are no clinical reports that compare the perioperative analgesic efficacy between the ESP block and the intravenous (IV) ketamine infusion analgesic protocol administered intraoperatively for spinal surgery in dogs. We hypothesised that the ESP block administered preoperatively in dogs undergoing mini-hemilaminectomy for treating thoracolumbar intervertebral disc disease (IVDD) is non-inferior to an intraoperative IV ketamine infusion analgesic protocol with regards to the intraoperative opioid consumption, cardiovascular response to surgical stimulation (CR), postoperative pain scores (PS) and postoperative opioid consumption.

Material and methods

Methods, study population and inclusion/exclusion criteria

This was a single-centre, retrospective, case-control, non-inferiority study. Clinical records from December 2016 to April 2023 were searched for dogs surgically treated for thoracolumbar IVDD that received a preoperative ESP block for perioperative analgesia at Northwest Veterinary Specialists hospital. Medical records were excluded if: the intraoperative anaesthesia and/or postoperative records were incomplete; ketamine was provided preoperatively in addition to the ESP block; more than one surgery was performed in the same procedure (e.g. bilateral surgical interventions during the same surgical procedure); the dog received an ESP block via transverse approach.

The control group (group CRI) comprised 25 dogs that underwent mini-hemilaminectomy between December 2016 and April 2023, and in which a ketamine constant rate infusion (CRI) was administered, but no locoregional anaesthetic technique was used intra- or postoperatively (e.g. intraoperative extradural morphine administration).

Data collection and variable definition

Data collected included breed, age, sex, body weight, degree of neurological dysfunction at presentation (Scott 1997), indication for spinal surgery, surgical procedure, intervertebral space operated and side, number of intervertebral spaces operated, preoperative drugs and doses administered, the dose of local anaesthetic administered for the ESP block, the person performing the ESP block, surgical time, local anaesthetic injection to first incision time, CR, time of the first CR, cardiovascular complications (bradycardia and hypotension), cardiovascular complication treatment provided (IV fluid boluses, anticholinergics or sympathomimetics), total intraoperative and postoperative doses of ketamine and the total time of CRI administration, intraoperative rescue analgesia provided, rectal temperature at tracheal extubation, postoperative analgesia, 24-hour PS, postoperative total opioid administration, time of first meal offered and time of first voluntary food intake post-extubation, and incidence and nature of any complications. From the anaesthetic records the following variables were obtained and the mean and standard deviation (SD) calculated: heart rate (HR), respiratory rate (RR), systolic arterial pressure (SAP), mean arterial pressure (MAP), diastolic arterial pressure (DAP), percentage of haemoglobin saturated with oxygen in arterial blood (SpO2%), end-tidal CO2 (ET'CO2) and the end-expiratory fraction of inhalational anaesthetic agent (FE'IAA). These variables were obtained with an anaesthesia monitor (Datex Ohmeda S/5 Monitor; Datex Ohmeda, USA). The means and SD were calculated averaging the readings recorded every five minutes (min) in each animal. Pain was evaluated using the Glasgow Composite Measure Pain Scale (CMPS-SF) (Reid et al. 2007). Bradycardia was defined as a HR lower than 60 beats/min. Hypotension was defined as a MAP lower than 60 mmHg or SAP lower than 90 mmHg for at least two consecutive readings obtained at five min intervals. CR was defined as an increase in HR, SAP or MAP exceeding 20% of the prestimulus value. The prestimulus value refers to the parameter's measurement in the five minutes preceding the stimulus (Sarotti et al. 2011; Novello et al. 2008; Wynands et al.1984).

Local anaesthetic injection to first incision time was defined as the time from the injection of bupivacaine for the ESP block to the time of the first surgical incision.

Preoperative drugs were defined as the anaesthetic or analgesic drugs given in the six hours before the first surgical incision was made (see Table II in results). The route of administration for the preoperative drugs was IV. Nonsteroidal anti-inflammatory drugs (NSAIDs), and oral analgesic drugs given in the 24 hours before the first surgical incision were also recorded.

The anaesthetist in charge of the case selected the anaesthetic and analgesic drugs and doses based on clinical presentation, demeanour, presence of comorbidities, preoperative pain score and American Society of Anesthesiologists (ASA) physical status.

After induction of anaesthesia and orotracheal intubation, anaesthesia was maintained with isoflurane vaporised in oxygen.

Ultrasound-guided ESP block

The block was performed as described by Otero and Portela (2017) and adapted for the lumbar vertebrae if the operated intervertebral space was caudal to L1 vertebra. The local anaesthetic drug used was bupivacaine (Marcain Polyamp® Steripack 0.5%, AstraZeneca UK Limited, UK). The dogs were positioned in sternal recumbency, and the skin area corresponding to the intervertebral space indicated for the surgery was previously clipped and aseptically prepared. A linear ultrasound transducer (12L-RS, 5-13 MHz; GE Healthcare, USA), connected to a portable ultrasound machine (LOGIQ e®; GE Healthcare, USA) was used. The vertebral spinous processes were counted back starting from the lumbosacral space to identify the vertebrae where the procedure was going to be performed. The transducer was then positioned parallel to the dorsal midline of the identified vertebrae and adjusted to obtain a parasagittal view of the targeted vertebral transverse process, identified as a hyperechoic convex line with posterior acoustic shadowing. A 22-gauge, 50 mm needle (Ultraplex 360®, B. Braun Medical Inc., USA) connected to a 5 ml syringe (Trojector-3®, Troge Medical GMBH, Germany) was introduced in-plane, following a cranial-to-caudal direction, through the epaxial muscles until its tip

contacted the dorsolateral aspect of the transverse process of the thoracic or lumbar vertebra, depending on which vertebra was involved in the procedure. When the needle tip was visualised at the target, bupivacaine was injected following negative aspiration. The distribution of bupivacaine was observed between the longissimus thoracic muscle and the transverse processes of the thoracic vertebrae if it was a thoracic injection and between the longissimus lumborum, iliocostalis lumborum muscles and the transverse processes of the lumbar vertebrae if it was a lumbar injection.

CRI group

Dogs in the CRI group were administered a ketamine bolus of 0.5–1 mg/kg IV at the time of induction or in the minutes preceding the initial skin incision of the surgical procedure. Subsequently, a CRI of ketamine was initiated at a dose rate of 5–10 mcg/kg/min (0.3–0.6 mg/kg/hr) and maintained during the surgery. The bolus dose and the dose rate during the surgery were elected at the discretion of the anaesthetist. Continuation of the ketamine CRI postoperatively and the time of discontinuation was decided by the anaesthetist and/or clinician in charge of the pain management of the case.

Intraoperative rescue analgesia

Intraoperative administration of analgesia using additional doses of opioid [methadone (Comfortan®; Dechra, UK), or fentanyl (Fentadon® 50 mcg/ml; Dechra, UK)] and adjuvant analgesics [dexmedetomidine (Sedadex®; Dechra, UK), medetomidine (Sedator®; Dechra, UK) and/or ketamine (Narketan®; Vetoquinol, UK)] was performed at the discretion of the anaesthetist of the case. The total dose of intraoperative analgesia was calculated by dividing the total dose administered, measured in mg (methadone and ketamine) or mcg (fentanyl, dexmedetomidine and medetomidine) by the dog's body weight in kg and by the surgical time measured in hours.

Postoperative pain management

After tracheal extubation, dogs were transferred to the intensive care unit or the progressive care ward once the patient's rectal temperature was ≥ 36.7 °C and there were no signs of pain or dysphoria. According to the standard perioperative care in our institution, anaesthetists were responsible for the postoperative analgesic plan: opioids were administered if PS was ≥ 5/20 or ≥ 6/24, and oral adjuvant analgesic and anti-inflammatory medications were adjusted at the discretion of the anaesthetist or the clinician responsible for the postoperative pain management. Pain assessment was performed at one-hour intervals until midnight the day of the surgery; subsequently, it was performed at four-hour intervals. However, modifications to the protocol were possible based on clinical judgement (e.g. PS not obtained when an animal was resting after a long period of stress). Furthermore, the total postoperative dose of analgesic drugs administered during the first 24 hours was calculated by dividing the total dose administered by the dog's body weight (units as previously described). In our institution food is offered by the kennel assistants as soon as the dog is fully awake from general anaesthesia.

Surgical procedures

The surgical technique used to treat IVDD at our institution is a mini-hemilaminectomy via a dorsolateral approach along with lateral fenestration of the affected intervertebral disc. The spinal surgery is performed with an operating microscope (Zeiss NC31, Switzerland; Zeiss NC2, Switzerland) which improves visualisation of the affected vertebral spaces and neurovascular structures.

Statistical analysis

The statistical study used R statistical software version 4.3.0 (R Core Team 2021). The sample size was calculated for the primary outcome variable (PAIN SCORE) using the pwr.t.test function of the pwr package (Champely 2020).

The normality of the variables was verified with a Shapiro–Wilk test. Homoscedasticity was studied using the Levene test. None of the studied variables met normality and homoscedasticity criteria. Because of this, robust statistical methods were chosen for reviewing them.

Firstly, a univariate analysis was conducted between treatment groups, examining several variables, including 24-hour preoperative NSAIDs administration, 24-hour preoperative oral analgesic administration, the intraoperative recorded variables, surgical time, rectal temperature at extubation, CR suspected to be nociception-related, time of the first CR suspected to be nociception-related, intraoperative opioid consumption (methadone and fentanyl), administration of intraoperative rescue ketamine bolus, PS, postoperative methadone consumption, and time of first voluntary food intake post-extubation. The yuen function for independent sample t-tests was used to perform the analysis, which included effect size and robust location measures from the WRS2 package for R (Mair & Wilcox 2020). Categorical variables were compared using the chi-square test. The trim level for the means was 0.2. The data are presented numerically as the medians (minimum to maximum).

Secondly, a multivariate regression analysis was performed aiming to study the relationship between treatment groups, the location of the lesion (thoracic vs. lumbar), and the number of intervertebral operated spaces (1 vs. ≥ 2 intervertebral operated spaces) in the CR suspected to be nociception-related, PS, intraoperative opioid consumption (methadone and fentanyl), postoperative methadone consumption, and time of first voluntary food intake post-extubation. The total intraoperative dose of methadone and fentanyl was normalised according to equivalent potencies to morphine (morphine equivalents; ME) in mg/kg using the opioid equivalency table published by The Hopkins Opioid Program (Portela, Romano, et al. 2020; Adhikary et al. 2019; Floriano et al. 2019). The results are presented as regression coefficients and *p*-values. Statistical differences were considered significant if $p < 0.05$.

Results

Three hundred and thirty-four records of dogs that underwent spinal surgery addressing IVDD were retrieved; of these, 75 case records met the inclusion criteria for the ESP group and were sufficiently complete to be included in this study, and they were

Table I: Demographic distribution of dogs undergoing mini-hemilaminectomy that received either an erector spinae plane (ESP) block (Group ESP) or intraoperative intravenous ketamine infusion analgesic protocol (Group CRI) as part of perioperative analgesic management. Data are presented as median (range) and number (percentage).

	Group ESP (*n* = 75)	Group CRI (*n* = 25)	Overall (*n* = 100)
Sex			
FE	9 (12.0%)	6 (24.0%)	15 (15.0%)
FN	16 (21.3%)	2 (8.0%)	18 (18.0%)
ME	13 (17.3%)	4 (16.0%)	17 (17.0%)
MN	37 (49.3%)	13 (52.0%)	50 (50.0%)
Age (years)			
Median [min, max]	5.00 [2.00, 11.0]	6.00 [3.00, 8.00]	5.00 [2.00, 11.0]
Weight (kg)			
Median [min, max]	8.90 [4.30, 34.2]	7.40 [3.90, 40.1]	8.50 [3.90, 40.1]
Neurological dysfunction grade			
I	3 (4.0%)	1 (4.0%)	4 (4.0%)
II	35 (46.7%)	8 (32.0%)	43 (43.0%)
III	20 (26.7%)	2 (8.0%)	22 (22.0%)
IV	9 (12.0%)	11 (44.0%)	20 (20.0%)
V	8 (10.7%)	3 (12.0%)	11 (11.0%)
Type of intervertebral disc herniation			
Intervertebral disc extrusion	67 (89.3%)	23 (92.0%)	90 (90.0%)
Intervertebral disc protrusion	8 (10.7%)	2 (8.0%)	10 (10.0%)
Location of the intervertebral disc affected			
Lumbar	26 (34.7%)	8 (32.0%)	34 (34.0%)
Thoracic	46 (61.3%)	17 (68.0%)	63 (63.0%)
Both	3 (4.0%)	0 (0%)	3 (3.0%)
Intervertebral spaces operated			
1	62 (82.7%)	19 (76.0%)	81 (81.0%)
≥ 2	13 (17.3%)	6 (24.0%)	19 (19.0%)
Mini-hemilaminectomy side			
Left	34 (45.3%)	10 (40.0%)	44 (44.0%)
Right	41 (54.7%)	15 (60.0%)	56 (56.0%)

FE: female entire, FN: female neutered, ME: male entire, MN: male neutered. Min: minimum, Max: maximum. Grade I: thoracolumbar pain with no neurological deficits, Grade II: ambulatory paraparesis, Grade III: Non-ambulatory paraparesis, Grade IV: paraplegia with intact deep pain perception in at least one limb, Grade V: paraplegia with loss of deep pain perception.

compared to the 25 cases that met the inclusion criteria for the CRI group. All the surgical procedures performed were thoracic or lumbar mini-hemilaminectomies, and they were performed by several different surgeons. All the ESP blocks were performed unilaterally on the side where the mini-hemilaminectomy was to be carried out. The results of the demographic data are given in Table I.

Descriptive statistics for preoperative drugs, and intraoperative recorded variables are presented in Tables II and III respectively. Concerning the administration of NSAIDs in the 24 hours before surgery, within the ESP group, 52/75 dogs (69.33%) received NSAIDs, while 21/75 dogs (28%) did not receive any NSAIDs. For the remaining two dogs (2.66%) in this group, there was evidence that the referring veterinarian had prescribed NSAIDs before admission to our hospital; however, information regarding the administration time could not be verified in the clinical history. The NSAIDs used in the ESP group were meloxicam in 46 dogs, robenacoxib in four dogs, and carprofen in two dogs.

In the CRI group, 15/25 dogs (60%) received NSAIDs in the 24 hours before surgery, and 6/25 dogs (24%) did not receive any NSAIDs. For the remaining four cases (16%) in the CRI group, there was evidence that the referring veterinarian had prescribed NSAIDs before admission to our hospital, but details regarding the administration time could not be confirmed in the clinical history. The NSAIDs used in the CRI group were meloxicam in 14 dogs and robenacoxib in one dog.

Regarding the administration of oral analgesia in the 24 hours before surgery, both groups received gabapentin and paracetamol. In the ESP group, 39/75 dogs (52%) received gabapentin before surgery, while 30/75 dogs (40%) did not receive gabapentin. For the remaining six dogs (8%) in this group, there was evidence that the referring veterinarian had prescribed gabapentin before admission to our hospital; however, information regarding the administration time could not be verified in the clinical history. The median (range) dose of gabapentin administered in the 24 hours before surgery in the dogs that received gabapentin in the ESP group was 22.73 mg/kg (8.33–44.12). Additionally, in the ESP group, 32/75 dogs (42.66%) received paracetamol before surgery, while 41/75 dogs (54.66%) did not receive paracetamol. For the remaining two dogs (2.66%) in this group, there was evidence that the referring veterinarian had prescribed paracetamol before admission to our hospital; however, information regarding the administration time could not be verified in the clinical history.

Table II: Data for preoperative drugs and the administered doses for dogs undergoing mini-hemilaminectomy that received either an erector spinae plane (ESP) block (Group ESP) or intraoperative intravenous ketamine infusion analgesic protocol (Group CRI) as part of perioperative analgesic management. Data are presented as median (range) and number (percentage).

	Group ESP (*n* = 75)	Group CRI (*n* = 25)	Overall (*n* = 100)
Premedication drugs			
Methadone (mg/kg)			
Median [Min, Max]	0.200 [0, 0.400]	0.300 [0.200, 0.600]	0.200 [0, 0.600]
Cases (%)	64 (85.33%)	25 (100%)	89 (89%)
Medetomidine (mcg/kg)			
Median [Min, Max]	5.00 [0, 15.6]	5.00 [2.00, 10.0]	5.00 [0, 15.6]
Cases (%)	58 (77.33%)	16 (64%)	74 (74%)
Dexmedetomidine (mcg/kg)			
Median [Min, Max]	5.00 [0.416, 5.50]	5.00 [5.00, 5.00]	5.00 [0.416, 5.50]
Cases (%)	19 (25.33%)	7 (28%)	26 (26.0%)
Acepromazine (mg/kg)			
Median [Min, Max]	0.0050 [0.0030, 0.0200]	0.0050 [0.0030, 0.0200]	0.0050 [0.0030, 0.0200]
Cases (%)	6 (8%)	9 (36.0%)	15 (15.0%)
Diazepam (mg/kg)			
Median [Min, Max]	0.400 [0.400, 0.400]	NA [NA, NA]	0.400 [0.400, 0.400]
Cases (%)	1 (1.33%)	0 (0%)	1 (1%)
Co-induction drugs			
Midazolam (mg/kg)			
Median [Min, Max]	0.200 [0.200, 0.300]	0.250 [0.250, 0.250]	0.200 [0.200, 0.300]
Cases (%)	6 (8%)	1 (4%)	7 (7%)
Ketamine (mg/kg)			
Median [Min, Max]	1.00 [1.00, 1.00]	1.08 [0.2, 1.89]	1.04 [0.2, 1.89]
Cases (%)	1 (1.33%)	21 (84%)	22 (22%)
Lidocaine (mg/kg)			
Median [Min, Max]	NA [NA, NA]	0.400 [0.400, 0.400]	0.400 [0.400, 0.400]
Cases (%)	0 (0%)	1 (4%)	1 (1%)
Induction drugs			
Alfaxalone			
Cases (%)	41 (54.7%)	13 (52.0%)	54 (54.0%)
Propofol			
Cases (%)	34 (45.3%)	12 (48.0%)	46 (46.0%)

SD: standard deviation, Min: minimum, Max: maximum, Methadone (Comfortan®; Dechra, UK), medetomidine (Sedator®; Dechra, UK), dexmedetomidine (Sedadex®; Dechra, UK), acepromazine (Acecare®; Animalcare, UK), diazepam (Ziapam®, Domes Pharma, France), midazolam (Hypnovel®; Neon Healthcare, UK), ketamine (Narketan®; Vetoquinol, UK), lidocaine (Lidocaine Hydrochloride; Hameln Pharma, UK), alfaxalone (Alfaxan®; Jurox, UK), propofol (Propofol® Lipuro Vet, B. Braun, Germany)

The median (range) dose of paracetamol administered in the 24 hours before surgery in the dogs that received paracetamol in the ESP group was 18.70 mg/kg (9.26–45.45).

In the CRI group, 6/25 dogs (24%) received gabapentin before surgery, while 19/25 dogs (76%) did not receive gabapentin. The median (range) dose of gabapentin administered in the 24 hours before surgery in the dogs that received gabapentin in the CRI group was 31.01 mg/kg (18.35–50). Additionally, in the CRI group, 10/25 dogs (40%) received paracetamol before surgery, while 15/25 dogs (60%) did not receive paracetamol. The median (range) dose of paracetamol administered in the 24 hours before surgery in the dogs that received paracetamol in the CRI group was 15 mg/kg (9.46–71.38).

ESP block

Thirteen different operators performed the ESP blocks. Thirty-six cases were performed by an anaesthetist very familiar with the technique, the remaining 39 by anaesthetist, interns and a veterinary nurse with limited experience with the technique. ESP blocks performed by interns and the veterinary nurse were supervised by a diplomate of the European College of Veterinary Anaesthesia and Analgesia.

The median dose of bupivacaine used was 2.10 mg/kg (0.690–3.20), or 0.4 ml/kg (0.1–0.6). The median local anaesthetic injection to first incision time was 35 min (15–70).

Complications

In the ESP group 55 cases had complications intraoperatively. Forty-three (57.33%) cases only had episodes of bradycardia recorded, two (2.66%) cases had hypotension, and 10 (13.33%) cases had both bradycardia and hypotension. Of the 12 cases that had hypotension, one case was managed by decreasing the isoflurane percentage and administering glycopyrrolate, one case by decreasing the isoflurane percentage and administering ephedrine, one case by administering an IV fluid bolus and glycopyrrolate, two cases by administering an IV fluid bolus only, four cases by decreasing the isoflurane percentage only, and three cases received no intervention.

In the CRI group, 14 cases had intraoperative complications. Ten (40%) cases only had episodes of bradycardia recorded, two (8%)

Table III: Data for intraoperative recorded variables for dogs undergoing mini-hemilaminectomy that received either an erector spinae plane (ESP) block (Group ESP) or intraoperative intravenous ketamine infusion analgesic protocol (Group CRI) as part of perioperative analgesic management. Data are presented as median (range).

	Group ESP (*n* = 75)	Group CRI (*n* = 25)	*p*-value*
HR (beats/min)			
Median [Min, Max]	61.8 [36.5, 128]	69.9 [39.5, 140]	0.022
RR (breaths/min)			
Median [Min, Max]	16.5 [9.20, 26.8]	16.0 [7.40, 32.2]	0.34
SAP (mmHg)			
Median [Min, Max]	112 [83.5, 178]	118 [84.0, 191]	0.3
MAP (mmHg)			
Median [Min, Max]	84.4 [49.0, 151]	92.5 [68.3, 146]	0.33
DAP (mmHg)			
Median [Min, Max]	62.8 [36.7, 126]	68.7 [31.2, 107]	0.56
SPO2 %			
Median [Min, Max]	97.9 [93.3, 99.8]	97.3 [95.3, 99.9]	0.33
ET'CO2 (mmHg)			
Median [Min, Max]	44.5 [33.8, 57.6]	45.3 [37.1, 96.4]	0.17
Isoflurane FE'IAA (%)			
Median [Min, Max]	1.27 [0.959, 1.63]	1.21 [0.913, 1.63]	0.25
Surgical time (min)			
Median [Min, Max]	100 [45.0, 220]	115 [40.0, 200]	0.46
Rectal temperature at extubation (°C)			
Median [Min, Max]	36.8 [32.8, 39.3]	37.3 [35.2, 38.9]	0.068

HR: heart rate, RR: respiratory rate, SAP: systolic arterial pressure, MAP: mean arterial pressure, DAP: diastolic arterial pressure, SPO2 %: percentage of haemoglobin saturated with oxygen in arterial blood, ET'CO2: end-tidal CO2, FE'IAA: end-expiratory fraction of inhalational anaesthetic agent (Isoflurane). Min: minimum, Max: maximum. *Comparison between the two treatment groups

cases had hypotension, and two (8%) cases had both bradycardia and hypotension. Of the four cases where hypotension was recorded, only one case was treated by administering ephedrine.

Cardiovascular responses to surgical stimulation

In the ESP group, 62/75 cases exhibited at least one CR (82.66 %), resulting in a total of 136 recorded CR. Among these 136 CR, 72 (involving 50 dogs) displayed two consecutive readings exceeding 20% of the prestimulus value, and/or required intervention such as rescue analgesia or an increase in the isoflurane percentage, or both. The remaining 64 CR recorded were isolated instances of an increase exceeding 20% of the prestimulus value, with subsequent values similar to the prestimulus, and no intervention was necessary. The latter CR were suspected to be unrelated to nociception.

Among the dogs in the ESP group with CR suspected to be nociception-related, there were 36 cases (48%) with one CR, six cases (8%) with two CR, and eight cases (10.7%) with three CR. Out of these CR, 24 (33.33%) occurred in the first 30 min of surgery. Additionally, 25 cases (33.33%) in the ESP group did not have any CR suspected to be nociception-related.

Regarding the CRI group, 19/25 cases had at least one CR (76%), resulting in a total of 47 recorded CR. Among the 47 CR, 36 (involving 19 dogs) were suspected to be related to nociception based on the aforementioned criteria. The remaining 11 recorded CR were suspected to be unrelated to nociception.

Among the dogs in the CRI group with CR suspected to be caused by nociception, there were nine cases (36%) with one CR, four cases (16%) with two CR, five cases (20%) with three CR, and one case (4%) with four CR. Sixteen of these CR (44.44%) occurred in the first 30 min of surgery. Furthermore, six cases (24%) in the CRI group did not have any CR suspected to be nociception-related.

Intraoperative rescue analgesia

Fifty-one dogs (68%) in the ESP group required rescue analgesia during the surgery in this study. Among these cases, opioids and/or ketamine were administered intraoperatively as rescue analgesia in 38/75 (50.66%) cases. Additionally, 13/75 (17.33%) of the dogs in this group received alpha 2 adrenergic agonists only for analgesia. Within the cases that received ketamine bolus(es) as rescue analgesia (10/75; 13.33%), the median range of the ketamine bolus dose was 0.5 (0.5–1.68) mg/kg.

Similarly, in the CRI group, 18/25 (72%) of the dogs required additional analgesia other than ketamine during surgery. In 16/25 (64%) of the cases, opioids were administered as rescue analgesia intraoperatively, while 2/25 (8%) of the dogs received alpha 2 adrenergic agonists only for analgesia. Additionally, in 9/25 cases (36%), extra boluses of ketamine were administered as rescue analgesia in addition to the ketamine CRI that was maintained during the surgical procedure. The median (range) of the ketamine bolus dose in those cases was 0.5 (0.1–0.5) mg/kg.

The descriptive statistical results of the analgesia provided intraoperatively are given in Table IV.

The median (range) of the total intraoperative dose of opioids (methadone and fentanyl) after normalisation according to equivalent potencies to morphine (ME) in mg/kg, was 0 (0–1.56) for the ESP group and 0.098 (0–3.41) for the CRI group.

Postoperative management

Nineteen cases in the ESP group (25.33%) and nine cases in the CRI group (36 %) received additional sedative or analgesic

Table IV: Data for intraoperative analgesia and the total dose administered for dogs undergoing mini-hemilaminectomy that received either an erector spinae plane (ESP) block (Group ESP) or intraoperative intravenous ketamine infusion analgesic protocol (Group CRI) as part of perioperative analgesic management. Doses were calculated by dividing the total dose administered, measured in mg (methadone and ketamine) or mcg (fentanyl, dexmedetomidine and medetomidine), by the dog's body weight in kg and by the surgical time measured in hours (h). Data are presented as median (range).

	Group ESP (*n* = 75)	Group CRI (*n* = 25)	Overall (*n* = 100)
Methadone (mg/kg/h)			
Median [Min, Max]	0 [0, 0.150]	0 [0, 0.144]	0 [0, 0.150]
Fentanyl (mcg/kg/h)			
Median [Min, Max]	0 [0, 6.67]	0 [0, 1.71]	0 [0, 6.67]
Ketamine (mg/kg/h)			
Median [Min, Max]	0 [0, 1.89]	0.600 [0.117, 1.64]	0 [0, 1.89]
Dexmedetomidine (mcg/kg/h)			
Median [Min, Max]	0 [0, 2.00]	0 [0, 3.99]	0 [0, 3.99]
Medetomidine (mcg/kg/h)			
Median [Min, Max]	0 [0, 3.08]	0 [0, 4.07]	0 [0, 4.07]

Min: minimum, Max: maximum

drugs during the recovery phase, all of which were administered intravenously.

In the ESP group, eight dogs were given medetomidine, five dogs received acepromazine, three dogs received dexmedetomidine, one dog received methadone, one dog received a combination of methadone and acepromazine, and one dog received a combination of acepromazine, dexmedetomidine, and methadone.

In the CRI group, three dogs received medetomidine, two dogs received methadone, one dog received dexmedetomidine, one dog received a combination of methadone and dexmedetomidine, one dog received a combination of dexmedetomidine and paracetamol, and one dog received paracetamol only.

Regarding postoperative maintenance analgesia, in the ESP group, 31/75 (41.33%) received gabapentin, paracetamol and meloxicam, 23/75 (30.66%) received gabapentin and meloxicam, 9/75 (12%) received gabapentin and paracetamol, 4/75 (5.33%) received gabapentin and robenacoxib, 2/75 (2.66%) received gabapentin, paracetamol and robenacoxib, 2/75 (2.66%) received gabapentin and carprofen, 1/75 (1.33%) received gabapentin, paracetamol, and memantine, 1/75 (1.33%) received gabapentin, paracetamol and carprofen, 1/75 (1.33%) received paracetamol and memantine, and 1/75 (1.33%) received robenacoxib only. In the CRI group, 10/25 (40%) received gabapentin, paracetamol, and meloxicam, 7/25 (28%) received gabapentin and meloxicam, 3/25 (12%) received gabapentin and paracetamol, 1/25 (4%) received gabapentin, paracetamol, and robenacoxib, 1/25 (4%) received gabapentin, paracetamol, and firocoxib, 1/25 (4%) received meloxicam and paracetamol, 1/25 (4%) received meloxicam and tramadol, and 1/25 (4%) received gabapentin only. The rest of the data is presented in Table V.

The median (range) time for the first meal offered was three hours (1–8) across both the ESP and CRI groups. Within the ESP group, 50.7% of dogs consumed the first meal offered, compared to 48% in the CRI group. The median (range) time for the first voluntary food intake was five (1–45) hours in the ESP group and five (1–46) in the CRI group.

Table V: Postoperative maintenance analgesia data for dogs undergoing mini-hemilaminectomy that received either an erector spinae plane (ESP) block (Group ESP) or intraoperative intravenous ketamine infusion analgesic protocol (Group CRI) as part of perioperative analgesic management. Data are presented as the number (percentage) of cases that received a determined drug in each group.

	Group ESP (*n* = 75)	Group CRI (*n* = 25)	Overall (*n* = 100)
Gabapentin	73 (97.3%)	23 (92.0%)	96 (96.0%)
Paracetamol	45 (60.0%)	16 (64.0%)	61 (61.0%)
NSAIDs			
None	10 (13.3%)	5 (6.6%)	15 (15.0%)
Firocoxib	0 (0%)	1 (4.0%)	1 (1.0%)
Robenacoxib	7 (9.3%)	1 (4.0%)	8 (8.0%)
Carprofen	3 (4.0%)	0 (0%)	3 (3.0%)
Meloxicam	54 (72.0%)	19 (76.0%)	73 (73.0%)
Other drugs			
Memantine	2 (2.66%)	0 (0%)	2 (2%)
Tramadol	0 (0%)	1 (4.0%)	1 (1.0%)

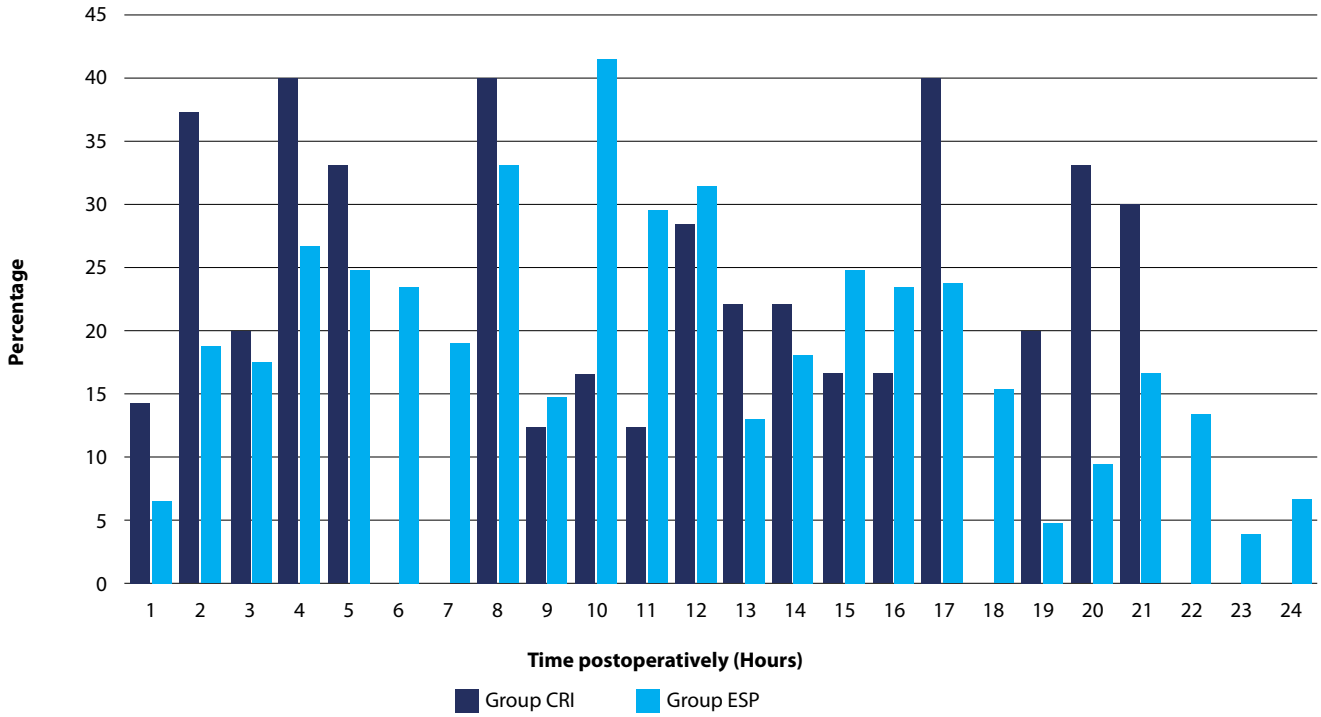
Postoperative pain scores

In the ESP group, the median and range of all PS performed was two (0–10). A high PS value, defined as ≥ 5/20 or ≥ 6/24, was observed in 122 recordings (19.5%). During the 24-hour postoperative period, the hours that registered the highest PS were 8, 10, and 12. During these hours, the recorded PS values were categorised as high PS in ≥ 30% of the recordings (see Graphic 1).

Similarly, in the CRI group, the median and range of all PS performed was two (0–10), and a high PS value was observed in 35 recordings (20%). However, the hours with the highest PS during the 24-hour postoperative period differed from those in the ESP group. Specifically, hours 2, 4, 5, 8, 17, 20, and 21 had ≥ 30% of the recorded PS scoring ≥ 5/20 or ≥ 6/24. PS data is displayed in Graphic 1.

Postoperative rescue analgesia

In the ESP group, postoperative rescue analgesia was provided in 54/75 cases (72%). The remaining 21 cases (28%) did not receive any rescue analgesia (ketamine or opioids) during the



Graphic 1: Comparison of the percentage of high postoperative pain scores (⩾ 5/20 or ⩾ 6/24) per hour of dogs that underwent mini-hemilaminectomy and received either an erector spinae plane (ESP) block (Group ESP) or intraoperative intravenous ketamine infusion analgesic protocol (Group CRI) as part of perioperative analgesic management.

first 24 hours after surgery. A total of 158 methadone injections were given, and the median (range) number of methadone injections administered for all dogs in the ESP group was two (0–6). The median (range) of the postoperative methadone dose administrated in the first 24 hours after surgery for all dogs in the ESP group was 0.40 (0–1.50) mg/kg. One dog in the ESP group, which received ketamine as rescue analgesia intraoperatively was placed on a ketamine CRI postoperatively receiving a total of 5.7 mg/kg during the 24 hours after surgery.

In the CRI group, 17/25 dogs (68%) received postoperative ketamine CRI. The median (range) dose of ketamine administered during the 24 hours after surgery in this group was 3.27 mg/kg (0–7.20), with a median duration of ketamine CRI maintenance being 840 minutes (0–1440). Additionally, 18/25 dogs (72%) in this group received additional opioid rescue analgesia. A total of 70 methadone injections were administered, and the median (range) number of methadone injections for all dogs in the CRI group was three (0–6). The median (range) postoperative methadone dose administered in the first 24 hours after surgery for all dogs in the CRI group was 0.60 (0–1.8) mg/kg. Only three cases (12%) in this group did not receive any ketamine or opioid analgesia during the first 24 hours after surgery.

Postoperative complications

Postoperative complications were reported in 17% of the cases in our study. In the ESP group there was regurgitation in four cases, diarrhoea in four cases, and vomit and hypersalivation were reported in two cases each. In the CRI group, diarrhoea was reported in two cases, haematuria in two cases, and difficulty expressing the bladder requiring sedation was reported in one case.

Results of statistical analysis

The univariate analysis of intraoperative recorded variables revealed that only HR showed a significant difference between the groups (p = 0.022); patients in the CRI group were more likely to have a higher intraoperative HR compared to the ESP group. The univariate analysis revealed no significant differences between treatment groups for the rest of the studied variables. These include 24-hour preoperative NSAIDs administration, 24-hour preoperative oral analgesic administration, CR suspected to be nociception-related, time of the first CR, intraoperative opioid consumption, postoperative methadone consumption, surgical time, rectal temperature at extubation, PS, time of first voluntary food intake post-extubation and administration of intraoperative rescue ketamine bolus. However, the last one exhibited a trend towards significance (p = 0.05), indicating a potential increase in intraoperative administration of rescue ketamine bolus in the CRI group compared to the ESP group. The p-values for the remaining intraoperative recorded variables included in the univariate analysis are provided in Table III. The p-values of the rest of the variables studied in the univariate analysis are provided in Table VI. For the multivariate regression analysis, the authors decided not to include the HR variable despite its statistical significance. This decision was made due to observed multicollinearity between the covariate HR and the other variables during statistical analysis.

In the multivariate regression analysis for CR suspected to be nociception-related, a significant difference was found between the ESP group and CRI group. The CRI group was associated with increased CR suspected to be nociception-related (regression coefficient = 0.496; p = 0.036). Also, significant differences between the ESP group and CRI group were found in the

Table VI: Results of the univariate and multivariate regression analyses, presenting regression coefficients and corresponding *p*-values.

Univariate analysis						
24-hour preoperative NSAIDs administration			*p*-value		1	
24-hour preoperative gabapentin administration			*p* -value		0.6	
24-hour preoperative paracetamol administration			*p* -value		0.9	
CR suspected to be nociception-related			*p* -value		0.17	
Time of the first CR suspected to be nociception-related			*p* -value		0.4	
Intraoperative opioid consumption			*p* -value		0.26	
Intraoperative rescue ketamine bolus administration			*p* -value		0.05 •	
PS			*p* -value		0.17	
Postoperative methadone consumption			*p* -value		0.34	
Time of first voluntary food intake post-extubation			*p* -value		0.41	

Multivariate regression analysis						
		CR suspected to be nociception-related	**PS**	**Intraoperative opioid consumption**	**Postoperative methadone consumption**	**Time of first voluntary food intake post-extubation**
CRI group	**Regression coefficient**	0.496	-0.210	0.1580	0.2576	2.339
	***p*-value**	0.036 *	0.64	0.07880	0.013 *	0.273
Thoracic lesion location	**Regression coefficient**	-0.336	-0.959	-0.2056	-0.1818	-1.731
	***p*-value**	0.118	0.02 *	0.01299 *	0.052 •	0.374
≥ 2 intervertebral operated spaces	**Regression coefficient**	-0.1409	0.498	-0.0588	-0.1702	-5.051
	***p*-value**	0.610	0.34	0.57732	0.158	0.046 *

CR: cardiovascular response to surgical stimulation, PS: postoperative pain scores, NSAIDs: Nonsteroidal anti-inflammatory drugs. *: significant result ($p < 0.05$) • : result indicating trend towards significance. (Statistical significance was determined at $p < 0.05$.

multivariate regression analysis for postoperative methadone consumption, where the CRI group was linked to higher postoperative doses of methadone (regression coefficient = 0.2576; $p = 0.013$). Regarding intraoperative opioid consumption, PS, and time of the first voluntary food intake post-extubation, no differences were observed between treatment groups.

The results of the multivariate regression analysis investigating the correlation among lesion location (thoracic vs. lumbar) revealed that dogs undergoing thoracic spinal surgery were more likely to have lower intraoperative opioid consumption (regression coefficient = -0.2056; p = 0.01299), lower PS (regression coefficient = -0.959; p = 0.02), and also presented a trend towards significance in the postoperative methadone consumption (regression coefficient = -0.1818; p = 0.052), indicating a potential lower postoperative methadone dose administration in dogs operated in the thoracic region. No significant differences were observed in this variable concerning CR suspected to be nociception-related and the time of the first voluntary food intake post-extubation.

In the multivariate regression analysis evaluating the number of intervertebral operated spaces (1 vs. ≥ 2 intervertebral operated spaces), it was found that dogs operated in ≥ 2 intervertebral spaces were more likely to eat the first voluntary meal earlier (regression coefficient = -5.051; p = 0.046). No significant differences were found in this variable related to CR suspected to be nociception-related, PS, intraoperative opioid consumption, and postoperative methadone consumption. The regression coefficients and *p*-values of multivariate regression analyses are provided in Table VI.

The first section of the Table VI shows the outcomes of the univariate analysis between treatment groups [dogs undergoing mini-hemilaminectomy that received either an erector spinae plane (ESP) block (Group ESP) or intraoperative intravenous ketamine infusion analgesic protocol (Group CRI) as part of perioperative analgesic management] for 24-hour preoperative NSAIDs administration, 24-hour preoperative oral analgesic administration (gabapentin and paracetamol), CR suspected to be nociception-related, time of the first CR suspected to be nociception-related, intraoperative opioid consumption (total intraoperative dose of methadone and fentanyl normalised according to equivalent potencies to morphine), administration of intraoperative rescue ketamine bolus, PS, postoperative methadone consumption, and time of first voluntary food intake post-extubation. The second section of the table shows the outcomes of the multivariate regression analysis. This analysis explores the correlation among treatment groups (ESP group vs. CRI group), lesion location (thoracic vs. lumbar), and the number of operated intervertebral spaces (1 vs. ≥ 2) in relation to CR suspected to be nociception-related, PS, intraoperative opioid consumption (total intraoperative dose of methadone and fentanyl normalised according to equivalent potencies to morphine), postoperative methadone consumption, and time of first voluntary food intake post-extubation.)

Discussion

In dogs undergoing thoracolumbar mini-hemilaminectomy, the ESP block is not less effective than an intraoperative IV ketamine infusion for perioperative analgesia. This suggests that the ESP block could be a valuable component of a multimodal analgesic approach. Besides, the ESP block offers several benefits such as ease and simplicity of the technique (requiring only a single preoperative injection instead of continuous infusion), and a low risk of complications. Additionally, some differences were found between treatment groups, suggesting potential advantages of the ESP block over the intraoperative ketamine infusion for dogs undergoing thoracolumbar mini-hemilaminectomy. The multivariate regression analysis revealed significant differences between both groups in the CR, with the ESP group exhibiting a lower intraoperative CR suspected to be nociception-related. Furthermore, a trend towards a higher number of intraoperative administrations of rescue ketamine boluses was noted in the CRI group. This suggests that anaesthetists employing intraoperative IV ketamine infusion for perioperative analgesia are likely to be more inclined to use ketamine boluses for rescue analgesia rather than opioids, a trend that aligns with expectations.

The univariate analysis revealed that the HR in the CRI group was significantly higher. The authors propose two potential explanations for this finding. Firstly, it could be linked to the sympathetic stimulant effects of ketamine in the CRI group; alternatively, it might be associated with an elevated level of nociception in this particular group.

Clinical impression and our study results suggest that the ESP block was effective in the majority of cases (haemodynamic variability, FE'IAA); however, the data shows that the technique has some logical limitations. Firstly, the ESP block is a relatively new technique, and it could be considered still under development; therefore, a small percentage of block failures is expected. Secondly, the area desensitised does not provide anaesthesia within the spinal canal (Otero & Portela 2019; Evans & de Lahunta 2013; Forsythe & Ghoshal 1984). Individual inspection of our raw data showed that 66% of the CR potentially related to nociception occurred more than 30 min after the skin incision. At this point, the surgeon is likely to be working within the spinal canal, outside the area of effective block. Similar findings have been reported in two recent studies conducted by Viilmann, Drozdzynska and Vettorato (2022) and Bendinelli et al. (2024). Finally, the ESP block is applied unilaterally. On occasions, the area of skin where the incision is made could be innervated by multiple spinal nerves (dermatome overlapping), which could be ipsilateral to the operated side or partially or totally innervated by a spinal nerve from the contralateral side. This situation might increase the possibility of nociception during the initial skin incision and skin closure. Making the skin incision slightly towards the side where the block was performed could potentially prevent unwanted CR. The CR events were easily controlled with low doses of methadone or an alpha 2 adrenergic agonist, and overall, the technique provided good cardiovascular stability. In order to confirm our impressions, more studies comparing CR between ESP block and conventional systemic analgesia for spinal surgeries are required.

The data on postoperative PS indicate that both groups have a median value below the threshold for analgesic intervention. In the ESP group, the highest PS were observed at hours 8, 10, and 12. This is not surprising considering that bupivacaine hydrochloride's duration of action is typically reported to be between 4 to 12 hours (Grubb & Lobprise 2020; Campoy & Read 2013).

While we did not observe any statistically significant differences in PS recordings between the groups, our multivariate regression analysis revealed a significant difference in the total opioid consumption during the first 24 hours after surgery, which was significantly lower in the ESP group. This suggests that the efficacy of the ESP block potentially reduced the need for additional rescue analgesia postoperatively. In our study, methadone was given pro re nata (PRN) when the PS exceeded the recommended analgesic intervention level ($\geq$ 5/20 or $\geq$ 6/24) (Reid et al. 2007). Therefore, the difference between the total opioid consumption and the PS could indicate misclassification in some pain assessments or treatment choices based on the personal preference of the anaesthetist or clinician in charge of the patient's care. It is worth noting that the CMPS-SF demonstrated improved accuracy in evaluating pain; however, it is not entirely immune to misclassification (Dugdale et al. 2020). Low postoperative opioid administration is a desired situation, as these drugs can cause various side effects such as excitement, vomiting, reduced gastrointestinal motility, sedation, and respiratory depression in dogs (Pascoe 2000). In human medicine, opioid-sparing strategies, including locoregional analgesic techniques, have been employed in enhanced recovery after surgery programmes (Diz 2023). These programmes aim to improve the quality of perioperative care, promoting faster recovery and preserving functional capacity in patients (Armstrong et al. 2017; Ljungqvist et al. 2017; Dietz et al. 2019; Elsarrag et al. 2019; Smith et al. 2020).

In the CRI group, we observed a more varied occurrence of high PS compared to the ESP group. This could be attributed to the retrospective nature of the study and the heterogeneity of the postoperative analgesic protocols. The authors speculate that the ESP block may provide better and more predictable analgesia in the postoperative period compared to the CRI group.

It is believed that hypotension might have negative consequences for the injured spinal cord (Martirosyan et al. 2011). In dogs undergoing cervical spinal surgery for intervertebral disc extrusion, perioperative hypotension has been related to major complications, including neurological deterioration (Rossmeisl et al. 2013). In the present study, we observed that in both groups MAP was generally maintained above 80 mmHg with only a few episodes of transient hypotension that responded well to treatment. This may contribute to improved neurological and anaesthetic outcomes.

In the study performed by Portela, Romano et al. (2020), dogs that received a preoperative ESP block were less likely to require pharmacological interventions to treat cardiovascular complications such as bradycardia or hypotension compared to an opioid-based analgesia protocol. In the present study, we found similar results in the ESP group; only 6.66% of the dogs

required anticholinergic, sympathomimetic or fluid boluses during surgery. This value is lower than in other studies of dogs undergoing spinal surgery with conventional opioid-based anaesthetics (Bruniges & Rioja 2019; Dixon & Fauber 2017; Fenn et al. 2017).

Another finding from the multivariate regression analysis was that dogs in both treatment groups with thoracic lesions exhibited lower intraoperative opioid consumption and lower PS. Additionally, they showed a trend towards significance, suggesting lower postoperative methadone consumption compared to dogs with lumbar lesions. This could be explained by the larger area dissected in the lumbar surgical approach compared to thoracic spinal surgeries for IVDD. This must be borne in mind when deciding the analgesic management of the patient. This hypothesis gains further support when examining the data from dogs operated in the lumbar spine. The medians for CR suspected to be nociception-related, intraoperative opioid consumption, postoperative methadone consumption and PS in both groups were very similar: 1 vs. 1 for CR suspected to be nociception-related, 0 vs. 0.067 ME/kg/h for intraoperative opioid consumption, 0.4 vs. 0.6 mg/kg for postoperative methadone consumption, and 2 vs. 2 for PS, for the ESP group versus the CRI group, respectively. When focusing only on the ESP group, an alternative hypothesis arises regarding the potential impact of morphological variations in the thoracic and lumbar vertebrae on block efficacy, as discussed in previous studies (Portela, Romano, et al. 2020). Another plausible consideration is that the technique utilised in the present study is less optimal for the lumbar spine compared to the transversal approach reported by Medina-Serra et al. (2021). However, to the authors' knowledge, no cadaveric studies have evaluated and/or compared the distribution of dye/local anaesthetic in the dorsal branches of the spinal nerves of the lumbar spine using the technique employed in the present study with any other techniques (e.g. transversal approach) up to the present moment.

Our study has several limitations. The retrospective design meant that the administration of anaesthesia and analgesia was not standardised, which could have influenced the results. Multiple anaesthetists with varying levels of experience in ultrasound-guided ESP block were involved, and they had discretion in determining the volumes and concentrations of local anaesthetic used. This variability may have affected the effectiveness of the ESP block and our results, even though less experienced personnel were supervised by more experienced individuals during the block execution. Rescue analgesia intra- and postoperatively was administered based on the judgment of the attending anaesthetist or veterinary clinician in charge of the postoperative care of the animal, but there is a possibility that some pain events were missed or misinterpreted, particularly considering the differing levels of experience among clinicians.

The potential inhalant and analgesic-sparing effects of the ESP block may have been obscured because no standardised efforts were made to administer the lowest possible doses of inhalational anaesthetics and analgesic drugs. Additionally, the exclusion of any parenteral analgesic drugs administered more than six hours prior to surgical incision may have influenced the results. During the procedure, dogs received two opioids with different potencies, necessitating conversion to ME for analysis. Although the method used for equating opioid potency was developed for human use, its reliability in dogs is uncertain, still it has been employed in previous veterinary studies (Portela, Romano, et al. 2020; Floriano et al. 2019).

Conclusion

In conclusion, the present study suggests that the perioperative analgesic effect of ultrasound-guided ESP block is comparable to intraoperative IV ketamine infusion in dogs undergoing thoracolumbar mini-hemilaminectomy for IVDD. Furthermore, the ESP block group showed reduced CR suspected to be nociception-related during the surgery and lower opioid consumption during the first 24 hours postoperatively, as revealed by the multivariate regression analysis.

Conflict of interest

The authors declare they have no conflicts of interest that are directly or indirectly related to the research.

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No funding was received for this study.

Ethical approval

Due to the retrospective observational nature of the study, ethical review and approval were not required. Written informed consent was obtained from every owner of the patients participating in the study at the time of admission for using anonymised medical data for research proposes. No identifying patient data was included in the present study.

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