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CASE REPORT

Food/farmed animals

Bilateral ultrasound-guided lateral quadratus lumborum block in a minipig undergoing ovariectomy

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Abstract

A 2-year-old Göttingen miniature pig was presented for elective ovariectomy. After premedication with ketamine 15 mg/kg and azaperone 2 mg/kg intramuscularly, general anaesthesia was induced with propofol 1.5 mg/kg intravenously. With the animal in sternal recumbency, a 15 × 15 cm area on the dorsolateral aspect of the flank at the level of the second lumbar vertebra (L2) was clipped and aseptically prepared. Using a linear transducer, the epaxial musculature as well as the quadratus lumborum and abdominal wall muscles were identified. Then, 0.6 ml/kg of 0.25% ropivacaine was injected bilaterally at the level of L2 using a ventral-to-dorsal in-plane approach under ultrasound guidance. Anaesthesia was stable and uneventful. Predefined thresholds for nociception were not exceeded at any time. After recovery, regular pain evaluation using the Universidade Estadual Paulista (UNESP)-Botucatu pig composite acute pain scale did not indicate the need for rescue analgesia up to 4 h after the block was performed.

KEYWORDS
anaesthesia, analgesia, pigs

BACKGROUND

Fascial plane blocks are becoming increasingly popular as important components of intra- and postoperative pain management in veterinary medicine. The relative ease, rapidity, safety and low cost of performing these techniques as well as the limitations and side effects of other analgesic strategies, such as opioid administration, have made fascial plane blocks a valuable addition to multimodal analgesia regimens.[1,2] The use of fascial blocks can provide a beneficial addition to a multimodal approach to analgesia, minimising the need of anaesthetic drugs and improving patient wellbeing and recovery.

The quadratus lumborum block (QLB) is a fascial plane block that was first described in humans in 2007[3] and in animals in 2020.[4] It consists of the injection of a relatively large volume of local anaesthetic adjacent to the quadratus lumborum muscle, with the goal of desensitising thoracolumbar nerves responsible for the visceral and part of the somatic innervation of the abdomen.[5] It has been shown to provide analgesia of both the abdominal wall and viscera in humans[6,7] which constitutes it as an alternative to neuraxial techniques and as a superior technique to the transverse abdominis plane block, which provides mainly somatic analgesia of the abdominal wall.[8,9] Multiple cadaveric studies have shown the applicability of the QLB in dogs,[4,6–9] cats[10] and goats.[11] Additionally, one clinical study has proven the analgesic effectiveness of this block in dogs undergoing ovariohysterectomy,[12] and one case report showed its analgesic potential in a cat undergoing cystotomy.[13] Several approaches for this block have been reported in humans[5] and so far, lateral,[8] dorsal[6,7] and intermuscular[4,9,13] approaches have been described in veterinary medicine. However, no cadaveric or clinical studies of the use of this technique in pigs have yet been reported.

Pain management in farm animals raises a number of legal and practical challenges.[14] The existing restrictions on the drugs that can be administered to food-producing species, under EU legislation 37/2010, preclude optimal analgesic management in animals undergoing invasive procedures such as osteosyntheses or laparotomies.

This case report describes a QLB in a Göttingen miniature pig undergoing general anaesthesia for elective ovariectomy.

CASE PRESENTATION

A 2-year and 10-month-old, 53 kg, female Göttingen miniature pig (*Sus scrofa domesticus*), which was part of a group of research animals, was scheduled for elective ovariectomy.

Upon presentation, the animal was bright, alert and responsive. To facilitate physical examination and subsequent transport to the anaesthesia service, ketamine 15 mg/kg (Ketamidor 100 mg/ml, Richter Pharma AG, Wels, Austria) and azaperone 2 mg/kg (Stresnil 40 mg/ml, Injektionslösung für Schweine, Elanco Gmbh, Cuxhaven, Germany) were administered in the right trapezius muscle, which led to deep sedation. Thoracic auscultation was unremarkable, the heart rate (HR) was 68 bpm, the metatarsal pulse was regular and palpable, the respiratory frequency was 28 breaths per minute and the rectal temperature was 37.5°C. Based on the physical examination and the history of the animal, its physical status was classified according to the American Society of Anesthesiologists as I.

LEARNING POINTS/TAKE HOME MESSAGES

- An ultrasound-guided bilateral quadratus lumborum block was feasible in a 2-year-old Göttingen miniature pig undergoing general anaesthesia for ovariectomy.
- Deposition of ropivacaine in the quadratus lumborum fascial plane provided desensitisation of the abdominal wall and viscera and resulted in a beneficial addition to the analgesic regimen in this miniature pig.
- Locoregional anaesthetic techniques can be used to aid the analgesic management in food-producing species. Further studies are necessary to determine the efficacy and suitability of the quadratus lumborum block in swine.

TREATMENT

Upon arrival at the anaesthesia service, the pig was placed on a surgical table and positioned in sternal recumbency. Oxygen was provided via a tight-fitting face mask at a flow of 4 l/min. A 20-gauge intravenous (IV) cannula (Braun Vasofix Safety, 20 G, B. Braun Melsungen AG, Melsungen, Germany) was placed in the right auricular vein and an infusion of a buffered crystalloid solution (Sterofundin ISO Infusionslösung, B. Braun Melsungen AG) was started at 7 ml/kg/h. Unsuccessful attempts to cannulate the left auricular artery were stopped after 5 min.

General anaesthesia was induced with 1.5 mg/kg of propofol (Propofol 'Fresenius' 1% mit MCT Emulsion zur Injektion oder Infusion, Fresenius Kabi Austria GmbH, Graz, Austria), administered intravenously. The trachea was intubated with an ID 11-mm cuffed PVC endotracheal tube (MarMed Entotracheal-Tube ⌀ 11.0 mm, MarMed GmbH, Germany) with a lubricated cuff. After fixation of the endotracheal tube to the snout, the cuff was inflated to a pressure of 30 cmH_2O with the help of a manometer (Ambu Disposable Pressure Manometer, Ambu A/S, Denmark) and then attached to a circle breathing system coupled to an anaesthetic machine (Leon Plus, Löwenstein Medical Hospital, Austria). Anaesthesia was maintained with isoflurane (Iso-Vet 1000 mg/g Flüssigkeit zur Herstellung eines Dampfes zur Inhalation für Tiere, Piramal Critical Care B.V., Voorschoten, Netherlands) vapourised in 40% oxygen. End-tidal isoflurane was maintained between 1.1 and 1.4 vol% throughout the procedure. Mechanical ventilation was set to a pressure-controlled mode. A peak inspiratory pressure of 12 cmH_2O and a positive end expiratory pressure of 4 cmH_2O were applied. Respiratory rate was adjusted to achieve an end-tidal carbon dioxide pressure between 35 and 45 mmHg.

Lead II electrocardiography, HR, pulse oximetry, end-tidal carbon dioxide and anaesthetic gas concentration were monitored continuously and registered every 5 min. Non-invasive blood pressure, using an appropriately sized cuff placed on the left front limb, was measured and recorded every 5 min. All parameters were measured using a multiparameter anaesthetic monitor (Philips IntelliVue MP60, Philips Medical Systems, Germany) and were recorded every 5 min. Anaesthetic depth was clinically evaluated by assessment of palpebral reflex and jaw-muscle tone.

With the animal in sternal recumbency, the tip of the right and left transverse processes of the second lumbar vertebrae (L2) were identified by palpation. Then, a 15 × 15 cm area on the dorsolateral aspect of L2 was clipped and aseptically prepared.

Without changing the position of the animal, a 13-6 MHz linear transducer (MicroMaxx HFL38/13-6, SonoSite, Bothell, USA) attached to an ultrasound (US) machine (SonoSite MicroMaxx Ultrasound System, SonoSite, Bothell, USA) was first placed on the tip of the right transverse process, in a transverse orientation to the spine (Figure 1). An alcohol-based solution was used for acoustic coupling. The marker of the US transducer was oriented to the dorsal midline. The scanning depth and gain were adjusted to obtain an optimal image of the tip of L2, identified as a hyperechoic straight line located at 8 cm depth, running diagonally on the screen, and with an acoustic shadow underneath. The epaxial musculature as well as the quadratus lumborum and abdominal wall muscles were identified. A pre-filled echogenic needle (SonoPlex STIM, 22 G × 100 mm, PAJUNK Medical Produkte, Germany) was inserted in-plane (Figure 2) and advanced ventrodorsally through the lateral aspect of the abdominal wall until its tip was in close contact with the tip of the transverse process of L2. After confirming negative blood aspiration and lack of resistance to injection, 31.8 ml (0.6 ml/kg; 1.5 mg/kg) of 0.25% ropivacaine (Ropinaest, 7.5 mg/ml, Gebro Pharma, Austria) was injected under US observation. The same procedure was repeated on the contralateral side. The total time to perform the block was 12 min. Five minutes after the block, the pig was turned into dorsal recumbency, and the skin of the abdomen was prepared for laparotomy via midline incision. Surgery started 60 min after the block was performed.

Immediately after the change in recumbency, non-invasive blood pressure measurement decreased from a mean arterial pressure (MAP) of 65–40 mmHg. To treat hypotension, fluid therapy was increased to 10 ml/kg/h, and a constant rate infusion of noradrenaline (Noradrenalin Orpha 1 mg/ml, Orpha-Devel Handels und Vertriebs GmbH, Purkersdorf, Austria) was started at 1.0 μg/kg/min, which resulted in a rapid increase of MAP to 100 mmHg within the following 5 min. Noradrenaline was gradually reduced to 0.25 μg/kg/min while maintaining normotension. At this point, an arterial cannula could be placed in the right metacarpal artery, and invasive blood pressure was measured and recorded until the end of the procedure.

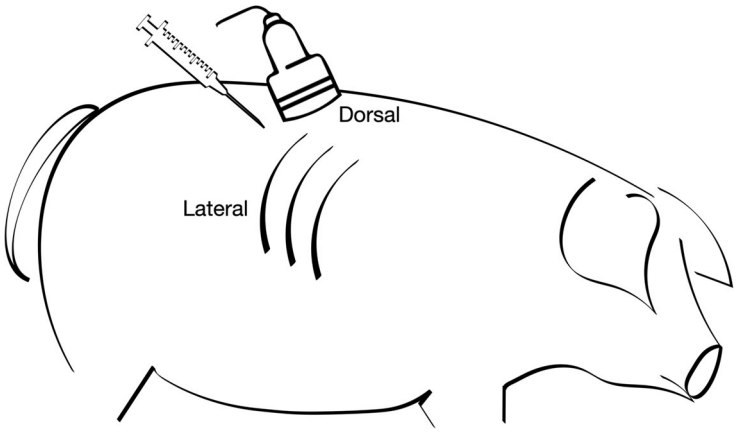

FIGURE 1 Position of ultrasound probe and needle at the level of the second lumbar vertebrae

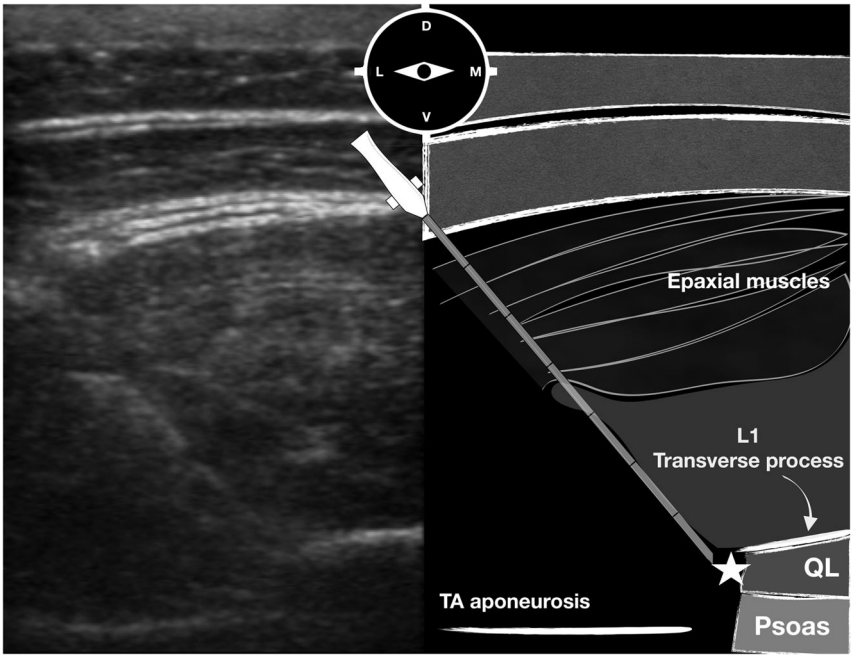

FIGURE 2 Sonoanatomy and needle position for performing the lateral quadratus lumborum block in the pig

Before the skin incision, baseline values for HR, respiratory rate and MAP pressure were obtained by averaging three measurements, 5 min apart. Baseline values were HR of 63 bpm, respiratory rate of 12 breaths per minute and invasive MAP of 100 mmHg. A 20% increase in either HR and/or MAP was defined as thresholds for nociception and analgesic intervention. Fentanyl 5 μg/kg IV was planned for rescue analgesia.

Timepoints for skin incision, opening of the abdominal cavity, removal of right and left ovaries as well as closure of the abdominal wall were noted. Throughout the procedure, HR and MAP did not exceed the predefined nociceptive thresholds.

At the end of surgery, isoflurane administration was discontinued, and the pig was positioned in sternal recumbency. Eight minutes afterwards and after returning to spontaneous ventilation, the animal's trachea was extubated.

Total surgical and total anaesthesia times were 65 and 170 min, respectively.

OUTCOME AND FOLLOW-UP

The animal was recovered in sternal recumbency in a comfortable crate. The rectal temperature at the beginning of recovery was 37.1°C; therefore, an infrared heating lamp was used as a warming method. The UNESP-Botucatu pig composite acute pain scale (UPAPS) was used for postoperative pain evaluation (Table 1).[15] A score of 6 points or above on the UPAPS was deemed as the cut-off for rescue analgesia.

Ten minutes after extubation, the pig started to move. The abdomen appeared soft, and there was no reaction to palpation of the surrounding area of the surgical incision. Nineteen minutes after extubation, the animal made a first attempt to stand, and although it was reactive to noise, it still showed no reaction to palpation of the surgical area. The pig was able to stand 30 min after extubation. The animal was breathing slowly and regularly and did not vocalise. Palpation of the abdomen or surrounding area of the wound still elicited no reaction. The animal showed interest in food but did not eat (UPAPS = 5). One hour after extubation, the pig was still slightly drowsy but moved around the crate. Palpation of the surgical site still produced no reaction by the animal (UPAPS = 4).

Two hours after extubation (4 h after the block), the pig was fully awake and looked very comfortable. It did not vocalise, looked alert and was wiggling its tail. Palpation of the abdomen proved rather difficult, with the animal becoming increasingly defensive towards manipulation, but

TABLE 1 Score for the UNESP-Botucatu pig composite pain scale at different time points after extubation

Time after extubation	Criterion (score)						Total score
	Posture	Interaction and interest in surrounding	Activity	Appetite	Attention to affected area	Miscellaneous behaviour	
30 min	Normal (0)	Only interacts if stimulated; interested in surroundings (1)	Moves with less frequency (1)	Anorexia (3)	None (0)	None (0)	5/16
60 min	Normal (0)	Only interacts if stimulated; interested in surroundings (1)	Moves normally (0)	Anorexia (3)	None (0)	None (0)	4/16
120 min	Normal (0)	Interacts; interested in surroundings (0)	Moves normally (0)	Anorexia (3)	None (0)	Wags tail (1)	4/16
180 min	Normal (0)	Interacts; interested in surroundings (0)	Moves normally (0)	Hyporexia (2)	None (0)	None (0)	2/16

Note: UNESP-Botucatu pig composite pain scale from Ref. 15.

touching the surrounding area of the wound with a stick did not result in any defensive behaviour or signs of discomfort (UPAPS = 4).

Three hours after extubation (5 h after the block), manipulation of the pig was hindered by its defensive behaviour, but the animal still looked comfortable and did not show any signs of discomfort (UPAPS = 2). Meloxicam (Metacam 5 mg/ml, Boehringer Ingelheim Vetmedica GmbH, Germany) 0.4 mg/kg was administered intramuscularly, as well as buprenorphine 10 μg/kg IV, as a programmed rescue analgesia protocol.

DISCUSSION

This is the first report of the successful use of the QLB in a Göttingen miniature pig undergoing elective ovariectomy.

Neuraxial techniques are widely used to provide analgesia to the abdominal cavity and caudal body in food-producing animals. Fascial plane blocks have been shown to have advantages over neuraxial techniques: target planes are usually superficial compared to epidural or paravertebral blockades, resulting in easier visualisation and identification and less risk of puncturing sensitive structures. Furthermore, fascial plane blocks usually produce limited autonomic nervous system blockade. Despite limited research being available regarding the safety of fascial plane blocks in both, humans and animals, no severe complications have been reported, unlike neuraxial techniques.[2] In humans, the most commonly reported complications with QLB are lower limb weakness, hypotension and formation of haematoma, but there is also a potential risk for systemic local anaesthetic toxicity and needle trauma.[5]

The block performed in this case report was described in multiple cadaver studies in dogs, cats and goats, and its efficacy was shown in a study in dogs and a case report in a cat.[4,6–13] Three approaches have been described so far in veterinary medicine. In the intermuscular approach, local anaesthetic is administered between the quadratus lumborum and the psoas muscles. In the dorsal approach, local anaesthetic is administered between the dorsal aspect of the quadratus lumborum muscle and the vertebral body. Lastly, in the lateral approach, local anaesthetic is injected between the lateral aspect of the quadratus lumborum muscle and the aponeurosis of the transversus abdominis muscle.[8,12] The lateral approach is reported to show further cranial staining of the sympathetic trunk compared to the other two approaches, potentially improving the efficiency of the block.[8] In humans, the lateral approach is also considered safer compared to the dorsal approach, given its relative superficiality,[5] and identification of the relevant anatomical structures is reported to be easier compared to the intermuscular approach.[4,8] Due to the depth of the target structures in this animal and the limited tissue penetration of the linear transducer, the most applicable approach possible in this case was the lateral approach. Even though the transverse process of the first lumbar vertebrae is the described target for this technique, an injection at this level was inaccessible due to the last ribs of the animal obstructing target visualisation, needle introduction and handling. Therefore, the authors chose to access the interfascial plane at the level of the second lumbar vertebra.

The volume used in this case is in the higher range of the reported volumes used in cadaveric studies.[4,6–8,10–12] A recent study compared the use of 0.3 and 0.5 ml/kg in canine cadavers and demonstrated greater staining with the latter.[7] Marchina-Goncalves et al. used 0.6 ml/kg/side and demonstrated adequate staining of the target nerves. Also, in children, QLB is generally performed using 0.5 ml/kg/side.[6] Based on evidence in the current literature and personal clinical experience in dogs and cats, we therefore decided to use a volume of 0.6 ml/kg/side.

The use of locoregional techniques in food-producing animals is ultimately limited by the permission to administer available drugs. Procaine is the only local anaesthetic that is licensed to be used in food-producing swine in the European Union (EU 37/2010). Although the short duration of action of procaine would have limited the effectiveness of the technique described in this case report, it might still represent a viable technique to provide intraoperative analgesia in pigs undergoing short procedures involving the mid and caudal abdomen. The case presented here, however, involved an animal that was part of a research project; therefore, treatment was not limited by legislation. Additionally, the short duration of procaine would not have provided sufficient perioperative analgesia. Ropivacaine used in a QLB has been shown to provide analgesia of the abdomen and surgical site in dogs for up to 4 h after surgery.[12] In order to guarantee the best possible postoperative care for this animal, ropivacaine was used in this case.

A combination of ketamine and azaperone was used for the immobilisation of the animal, as it represents the standard

protocol for sedation of swine at our facility. Ketamine, a non-competitive N-methyl-D-aspartate (NMDA)-receptor antagonist, was shown to produce profound analgesia even at subanaesthetic doses.[17] However, the analgesic effect of ketamine seems to vary between anatomic regions of the body and species, with poor visceral analgesia in most species.[18] The analgesia provided by ketamine could potentially affect the evaluation of the QLB. However, the degree of analgesia appears to vary among anatomic regions of the body and among animal species (visceral analgesia appears to be poor in most animal species, while peripheral analgesia is strong in cats but poor in pigs).[18] Even minor surgery in pigs cannot be performed without eliciting purposeful movement unless ketamine is supplemented with a strong sedative and/or analgesic.[19] Furthermore, 2 h had already passed since the injection of ketamine at the time of the skin incision, deeming any residual analgesic effect of ketamine unlikely.

Pain evaluation after recovery proved to be difficult. Currently, no gold standard exists for the evaluation of pain in pigs, and most studies rely on behavioural changes, such as spontaneous 'pain related' behaviour, change in posture, escape/avoidance behaviour or variation to normal behaviour.[20] The UPAPS, which represents the only validated pain scale in pigs to date,[15] was chosen to evaluate pain in this case, despite limitations in interpretation due to altered behaviour in the immediate postoperative phase. A score of 6 points or above was deemed as the cuff-off point for rescue analgesia by the authors. In our case, the highest score was 5 at 30 min after extubation due to a lack of activity and food intake. Programmed rescue analgesia was administered to the animal at 5 h after the block was performed due to the reported duration of the QLB using ropivacaine in dogs.[12]

In conclusion, QLB was a feasible and relatively easy technique to perform in this pig undergoing ovariectomy, and it could be considered as an alternative to other analgesic techniques. However, further experimental and clinical investigations are necessary to prove the effectiveness of QLB in pigs.

AUTHOR CONTRIBUTIONS

Case management: Moriz Ettore Klonner and Natali Verdier. *Investigation*: Moriz Ettore Klonner and Natali Verdier. *Writing original draft*: Moriz Ettore Klonner and Natali Verdier. *Reviewing and editing*: Moriz Ettore Klonner, Natali Verdier and Pablo E. Otero.

CONFLICT OF INTEREST

The authors declare they have no conflicts of interest.

FUNDING INFORMATION

The authors received no specific funding for this work.

ETHICS STATEMENT

The case presented here involves a research animal undergoing a necessary medical procedure unrelated to the research experiment. Consent for the performance of the block was obtained from the veterinarian responsible for the animal.

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MULTIPLE CHOICE QUESTION

The quadratus lumborum block can be used to provide analgesia of which body area?

POSSIBLE ANSWERS TO MULTIPLE CHOICE QUESTION

A. Thoracic wall
B. Abdominal wall only
C. Lower hind limb
D. Inguinal region
E. Abdominal wall and viscera

CORRECT ANSWER

E. Abdominal wall and viscera

Explanation: What is the area of the body desensitised by the QLB?

The QLB affects the last thoracic (T12–13) and the first lumbar (L1–3) spinal nerves. In addition, the local anaesthetic is distributed caudocranially, involving the sympathetic trunk, celiac, and major and minor splanchnic ganglia. Thus, as mentioned earlier, it promotes the desensitisation of the abdominal wall innervated by the blocked nerves and the abdominal organs innervated by the ganglia.