Received: 6 July 2022 | Accepted: 27 October 2023

DOI: 10.1111/eve.13918

CASE REPORT

Equine Veterinary Education BEVA AAEP

Ultrasound-guided modified subcostal transversus abdominis plane block in a foal undergoing omphalectomy

Victor López-Ramis | **Isabel Santiago-Llorente** | **Gabriel Manso-Díaz** | **Susana Canfrán Arrabé** | **Ignacio A. Gómez de Segura**

Department of Animal Medicine and Surgery, Veterinary Faculty, Complutense University of Madrid, Madrid, Spain

Correspondence: Victor López-Ramis
Email: victorlopez234@gmail.com

Summary

A 7-day-old, 60 kg, Purebred Spanish Horse filly was referred with the mare to Complutense University of Madrid, Veterinary teaching hospital for elective omphalectomy. Upon admission, clinical examination was unremarkable except for a thickening of the umbilical area. Haematology and biochemistry values were within the normal range. On abdominal ultrasound (US) examination, a well-defined, rounded (24 mm of diameter) area that contained heterogeneous material with numerous hyperechoic foci with acoustic shadowing was seen within the inner portion of the umbilical pedicle, between both umbilical arteries. Surgical correction with omphalectomy was scheduled. To provide perioperative analgesia, the transversus abdominis plane (TAP) block was considered. Under general anaesthesia, TAP block was performed in both left and right hemi-abdominal walls with a modified subcostal approach with two-site injections. A spinal needle was inserted under US guidance. During surgery, end-tidal concentration of isoflurane was maintained at 0.7%–0.9%. Surgery was completed uneventfully and no signs of nociceptive input were observed, suggesting an adequate level of analgesia. Therefore, this TAP block technique may be considered to provide analgesia for surgical procedures involving the abdominal wall in foals.

KEYWORDS

horse, abdominal wall, bupivacaine, transversus abdominis (TAP) block, ultrasound-guided regional anaesthesia

INTRODUCTION

Fascial plane blocks are locoregional anaesthetic techniques that aim to inject local anaesthetics (LA) between two easily identifiable fascial layers to block the nerves that run within this plane (Chin et al., 2021). The transversus abdominis plane (TAP) block is a fascial plane block that desensitises the nerves innervating the skin, subcutaneous tissue, muscles and parietal peritoneum of the abdominal wall (Evans & de Lahunta, 2013; Portela et al., 2014). It involves the injection of local anaesthetic into the fascial plane between the transversus abdominis muscle and either the internal oblique abdominis muscle or the rectus abdominis muscle where the ventral branches of the thoracolumbar spinal nerves are located, depending on where the anaesthetic solution is deposited (Freitag et al., 2021; Küls et al., 2020). TAP block has become increasingly popular in human medicine, as it provides intra- and postoperative analgesia for surgical procedures of the abdomen (Johns et al., 2012). Human patients provided with TAP block have decreased visual analogue scores of postoperative pain, reduced postoperative opioid requirements and reduced intra-operative inhalant anaesthetic requirements (Johns et al., 2012; McDonnell et al., 2007).

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited and is not used for commercial purposes.
© 2023 The Authors. *Equine Veterinary Education* published by John Wiley & Sons Ltd on behalf of EVJ Ltd.

In veterinary medicine, this block has been described in the cadavers of dogs, calves, ponies, horses and pigs (Baldo et al., 2018; Bruggink et al., 2012; Calice et al., 2021; Drozdzynska et al., 2017; Freitag et al., 2021; Mirra et al., 2018; Schroeder et al., 2011).

In the horse, the lateral abdominal wall comprises three consecutive muscular layers that, from lateral to medial, are the external abdominal oblique, the internal abdominal oblique (OIM) and the transversus abdominis (TAM) muscles. The fascial plane is between the OIM and the TAM. As these nerves are not typically visible with ultrasound, the injection end point for the TAP block is the fascial plane, where the ventral afferent branches of the spinal thoracic and lumbar spinal nerves run. By administering local anaesthetic into this plane, these nerves are desensitised, thus providing analgesia to the ventrolateral abdominal wall.

Umbilical remnant infection is one of the most common indications for abdominal surgery in foals (Reig et al., 2019). Omphalectomy implies the resection of the umbilical pedicle that crosses the abdominal wall. Therefore, patients undergoing this procedure might benefit from a TAP block, as it would provide regional anaesthesia while reducing the use of anaesthetics and analgesics such as opioids and thus their adverse effects.

As previously described, the transversus abdominis plane block in experimental or cadaveric studies in horses has been employed by different approaches (Baldo et al., 2018; Freitag et al., 2021; Küls et al., 2020). To the author's knowledge, this is the first description of TAP block performed in a foal using four injection points (two per hemi-abdomen).

CASE PRESENTATION

A 7-day-old, 60 kg, Purebred Spanish horse filly was referred with the mare to the Complutense University of Madrid, Veterinary teaching hospital for elective omphalectomy.

Upon admission, clinical examination was unremarkable except for a thickening of the umbilical area. The foal presented with pink mucous membranes and normal capillary refill time. Heart rate (HR, 120 beats/min), respiratory rate (fR, 30 breaths/min), rectal temperature (39°C) and normal sucking reflex were recorded. Normal borborygmi were present. Haematology and biochemistry values were within the normal range. On abdominal ultrasound examination, a well-defined, rounded (24 mm of diameter), area that contained heterogeneous material with numerous hyperechoic foci with acoustic shadowing was seen within the inner portion of the umbilical pedicle, between both umbilical arteries. The left umbilical artery was moderately thickened (15 mm) throughout its course from the umbilical pedicle to its most caudal portion, lateral to the bladder. In addition, several rounded cavitary lesions were seen at the caudal aspect of the abdomen, adjacent to the urinary bladder that might represent lymphadenopathy or abdominal abscesses.

An American Society of Anaesthesiologists physical status grade 2 was assigned to the foal. A 16-G intravenous catheter was placed percutaneously in left jugular vein and flunixin meglumine (1.1 mg/kg IV, Finadyne, MSD Animal Health), gentamicin sulphate (6.6 mg/kg IV, Genta-equine, Divasa Farmavic SA) and penicillin (30.000 IU/kg IM, Exabiopen, SYVA SAU) were administered. The foal was restrained, and premedication was provided with a combination of midazolam (0.1 mg/kg, Midazolam normon, Normon) and butorphanol (0.1 mg/kg, Butomidor, Richter Pharma) IV, producing clinically suitable sedation. The dam was sedated with butorphanol (0.01 mg/kg) IV and detomidine (0.01 mg/kg, Domosedan, Esteve Veterinaria) IV and remained present until the foal was anaesthetised. General anaesthesia was induced with ketamine (2.2 mg/kg, Ketamidor, Richter Pharma) IV to allow orotracheal intubation with a lubricated cuffed endotracheal tube (ID 14 mm). The endotracheal tube was connected to a small animal circle breathing system and anaesthesia was maintained using isoflurane (Isoflurin, Fatro) vaporised in 100% oxygen, administered to achieve a clinically suitable plane of anaesthesia. Isoflurane requirements were adjusted by assessing the foal's reflexes, eyeball position and for the absence of nystagmus. The foal was allowed to breathe spontaneously. Intravenous fluid therapy was provided at 5 mL/kg/h using lactated Ringer's solution.

A 20-G catheter was placed in left facial artery to measure invasive arterial blood pressure (systolic, SAP; diastolic, DAP; and mean, MAP, arterial pressures) and blood sampling to measure arterial blood gases (ABG) during the procedure. The blood pressure transducer was positioned at the level of the right atrium and zeroed to atmospheric pressure. The HR and rhythm (electrocardiogram), saturation of haemoglobin with oxygen in pulsatile arterial blood (SpO_2), end-expiratory carbon dioxide tension ($PE'CO_2$) and isoflurane (FE'ISO) concentrations, oesophageal temperature (T), were continuously monitored (multiparameter anaesthesia monitor, VetCare advisor) as well as glucose at the beginning of surgery and 1 h later and a ABG 30 min after induction.

TREATMENT

The foal was placed in dorsal recumbency, the ventral abdominal wall was clipped and the skin was scrubbed with diluted chlorhexidine and alcohol.

The TAP block was performed in both left and right hemi-abdominal walls with a modified subcostal approach (Freitag et al., 2021) with two-site injections. Injection was performed with a spinal needle (Spinocan 22G, 40 mm, B. Braun) inserted under US guidance with a linear probe (8–12 Hz; Aplio a450, Canon Medical Systems) covered with a sterile cover containing ultrasound gel.

The transducer was initially positioned immediately cranial to the umbilicus to allow identification of the *linea alba* on a transverse plane. The transducer was then rotated 90° and positioned with a longitudinal orientation to the *linea alba* and slid approximately 10 cm lateral to midline (Figure 1c). The skin and subcutaneous tissue, RAM, TAM and peritoneum were identified.

A 22-G, 40 mm spinal needle attached to a 10 cm-long extension primed with sterile saline was inserted using an in-plane technique and

20423292, 2024, 3, Downloaded from https://beva.onlinelibrary.wiley.com/doi/10.1111/eve.13918 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [21/05/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

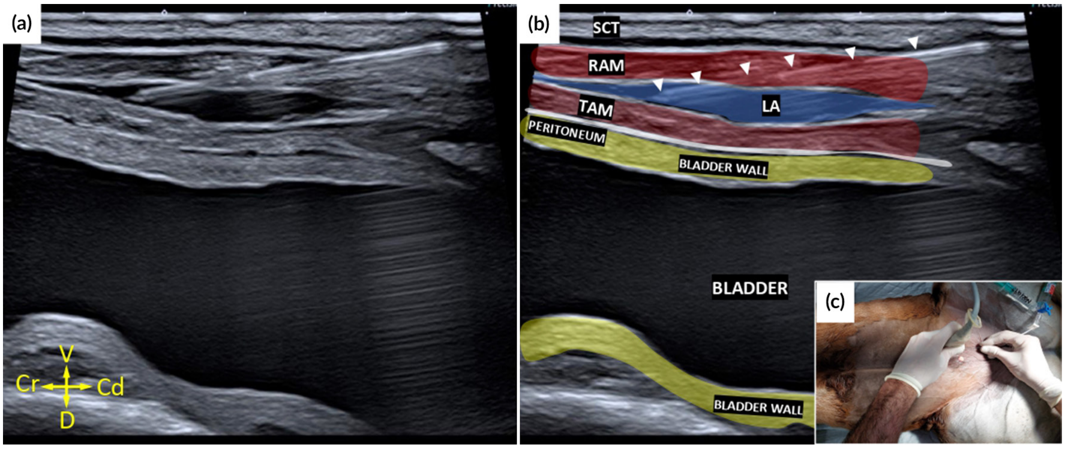

FIGURE 1 (a,b) Ultrasonographic image obtained during the injection of the local anaesthetic with the TAP block technique. Needle position (arrowheads) and hydro-dissection generated by the local anaesthetic (LA) between the rectus abdominis muscle (RAM) and the transversus abdominis muscle (TAM). (c) Image of the caudal injection point with the ultrasound transducer positioned longitudinal to the *linea alba*, 10 cm lateral to the midline and the needle inserted in-plane and advanced in a caudo-to-cranial position for the TAP block injection. Cd, caudal; Cr, cranial; D, dorsal; V, ventral.

advanced in a caudo-to-cranial direction. The needle was advanced through the skin, subcutaneous tissue and RAM until the tip of the needle was visible between the RAM and TAM. A test dose of 1 mL of sterile saline was used to confirm hydro-dissection of the transverse abdominal plane which meant that the tip of the needle was positioned correctly. Then, a total dose of 2 mg/kg (23.6 mL) of bupivacaine (Bupivacaina 0.5%, B. Braun Medical SA) diluted to a total volume of 0.64 mL/kg with sterile saline was injected (bupivacaine 0.3%). A volume of 0.16 mL/kg was injected at each of the four TAP block injection sites. Two aliquots were injected per hemi-abdomen, 10 cm lateral to midline, caudal and cranial to the umbilicus pedicle. All four LA injections caused hydrodissection creating a characteristic pocket of fluid within the fascial plane between the muscles (Figure 1a,b). At each point, the needle was advanced between the RAM and TAM fascial plane while the LA was administered slowly to improve the dispersion of the anaesthetic solution. The time taken between the TAP block and the start of surgery was 32 min, where a midline elliptical skin incision was performed at the umbilicus scar. The foal remained stable throughout the procedure. The cardiopulmonary variables HR, respiratory rate, end-tidal CO_2 and MAP remained between 75 and 90 beats/min; 20 and 36 breaths/min; 38 and 59 mmHg and 70 and 80 mmHg respectively. Blood gas analysis results was unremarkable except for a slight increase in PCO_2 (49 mmHg).

Throughout the procedure, FE'ISO was maintained between 0.7% and 0.9%. Clinical assessment throughout the procedure deemed the foal to be in a stable, adequate plane of anaesthesia, unresponsive to surgical stimuli (HR or MAP increases over 1 min were below 20%) and not requiring additional analgesia or anaesthesia intraoperatively. Also, the glucose levels during the surgery did not change (196, 185, 160 and 160 mg/dL).

Total anaesthesia time was 180 min, and the surgical time was 130 min. After the surgery was completed, the foal was allowed to recover. The foal was placed in lateral recumbency, and endotracheal tube was removed once the foal regained the swallowing reflex and then a nasopharyngeal tube was placed, and oxygen provided at 5 L/min. The foal regained the sternal recumbency within 10 min after being placed in the recovery box and stood 5 min later at the first attempt (while being hand assisted by one operator). The foal was able to walk unassisted within 17 min after extubation, at which time the dam joined him.

OUTCOME

The animal recovered appetite 17 min after extubation, starting to suckle when the mare joined him. No further medical treatment was administered during the postoperative period except for flunixin meglumine, gentamicin, ranitidine and penicillin during 6 days.

No complications related to the anaesthetic or surgical techniques were observed intraoperatively or postoperatively. No additional drugs were required. No complications related to the anaesthetic or surgical techniques were observed intraoperatively or postoperatively. During the postoperative period, there were no signs of pain or discomfort, HR, RR and temperature values were within normal range, and the foal nursed every 90 min without help, urinating and defaecating adequately. Foal and mare were discharged within 6 days after surgery.

DISCUSSION

This case report suggests that US-guided TAP block using a subcostal approach was effective to provide intraoperative antinociception to the abdominal wall in a foal undergoing scheduled omphalectomy. As in dogs (Portela et al., 2014), TAP block reduces the amount of systemic analgesic and anaesthetic requirements in a balanced multimodal analgesic protocol in a foal. This technique provides analgesia for abdominal wall procedures and should be considered in the clinical setting.

20423292, 2024, 3, Downloaded from https://beva.onlinelibrary.wiley.com/doi/10.1111/eve.13918 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [21/05/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Several approaches to US-guided TAP block have been reported in human and veterinary patients (Portela et al., 2018; Tsai et al., 2017). Injection site for the TAP block in horses was first described using a single-site injection of 0.5 mL/kg per hemi-abdomen (total volume of 1 mL/kg) in the lateral abdominal wall, midway between the last rib and the most cranial aspect of the iliac crest, administering the LA between IOM and TAM (Baldo et al., 2018). Using this lateral approach in horses, successful staining of ventral branches from T17 to L1 was ascertained. However, nerves cranial to T16 were not sufficiently stained. A dorsal spread of staining was also observed in some cadavers, which could lead to femoral nerve block, potentially leading to complications during recovery from general anaesthesia. A 3-point injection approach has also been described administering the LA dye solution between IOM and TAM (0.1 mL/kg per point; total volume of 0.6 mL/kg). The LA was administered at the lateral abdominal wall 10 cm ventral to costochondral joint of the T9, T14 and T18 intercostal space and a more adequate spread pattern was observed staining all ventral branches from T8 to T18. However, block failed in 33% of the ponies (Küls et al., 2020). Recently, a modified subcostal approach was described using 2-injection points in the ventral zone of the abdominal wall. The LA was placed between RAM and TAM (0.12–0.16 mL/kg per point; total volume of 0.64 mL/kg), first midway between the xiphoid cartilage and the umbilical scar, and at a second point located in the caudal half of the abdomen between the caudal and midline thirds starting from the first injection site (Freitag et al., 2021). With this modified approach, an adequate staining of T9–T17 nerve branches was observed, comparable to the 3-point injection technique (Küls et al., 2020) without evidence of dorsal migration.

In this case report, the direction of the needle was modified. Previously in cadavers (Freitag et al., 2021), the needle has been introduced in a dorsal-to-ventral direction and upon reaching the fascial plane between RAM and TAM, the total dye solution was injected at this point. Alternatively, we have introduced the needle in a caudo-to-cranial direction to allow LA administration while advancing the needle to dilate the fascial plane, potentially reducing the volume of LA employed (Chen et al., 2018). We also used two injection points, but unlike the blockade described by Freitag, both cranial and caudal injection points to the umbilicus were performed.

There are several LA options available for veterinary cases, where lidocaine, mepivacaine and bupivacaine are commonly used in horses. However, these drugs differ in the duration of sensory blockade. To provide a longer duration of analgesia, bupivacaine was chosen in this case report. Bupivacaine provides sensory blockade for approximately 3–8 h in horses (Doherty & Valverde, 2006a). When selecting fascial regional techniques that require large volumes of LA solution to block large anatomical areas, dilution of the LA is required to prevent toxic levels. However, excessive LA dilution may result in a failure to achieve a sensory block or reduce the blockade duration. In this case, bupivacaine was diluted to 0.3% with sterile saline, above a previously reported concentration of 0.125% for TAP block in ponies (Küls et al., 2020) while remaining below maximum recommended dose for horses (2 mg/kg) (Rioja, 2015).

An additional advantage of nociceptive blockade is the reduction in anaesthetic requirements. In horses, the minimum alveolar concentration (MAC) of isoflurane has been reported between 1.31% and 1.64% (Steffey et al., 1977, 2000). Although with individual variations also involving the effect of other drugs administered for sedation or analgesia, movement prevention during surgical procedures may require concentrations 30% greater than the MAC (Doherty & Valverde, 2006b). In the present case, although considering the foal was premedicated with midazolam and butorphanol, isoflurane concentrations were maintained between 0.7% and 0.9%, which means a reduction of the average equine MAC for isoflurane around 30%–40%. However, a limitation of this study was that pain scores were not assessed and thus the actual extent of postoperative pain relief was not ascertained. Recently, a measuring tool for the assessment of pain in foals has been developed (van Loon et al., 2020).

Despite being considered a simple locoregional anaesthesia technique, some complications have been described in human medicine (Taylor et al., 2013), such as intravascular injection, requiring ascertaining of negative aspiration before injecting the LA, or LA systemic toxicity. Lacerations with the needle to enlarged liver/spleen have also been reported (Farooq & Carey, 2008), and correct position of the needle should be ensured to avoid entering the abdominal cavity. In this case (Figure 1a,b), the bladder was full facilitating piercing of the peritoneum with the needle. Transient femoral nerve block palsy has also been described (Manatakis et al., 2013). Dorsal spread of the anaesthetic solution has been observed in equine cadavers, which could lead to femoral nerve block (Baldo et al., 2018). A more ventral approach is likely to prevent this complication (Freitag et al., 2021). The TAP block-derived complications are low and preventable in human medicine (Salaria et al., 2017; Taylor et al., 2013). However, in veterinary medicine, more studies are required to ascertain the actual rate of complications when using this technique.

In conclusion, a modified subcostal approach for TAP block may be useful as part of a multimodal anaesthetic approach in foals undergoing elective omphalectomy.

AUTHOR CONTRIBUTIONS

V. López-Ramis and I. Santiago-Llorente were responsible for the case management and preparation of the article. G.M. Diáz was responsible for obtaining ultrasound images and critical review of the article. S.C. Arrabé and I.A. Gómez de Segura were responsible for the preparation and critical review of the article. All authors gave their final approval of the article.

CONFLICT OF INTEREST STATEMENT

No conflicts of interest have been declared.

FUNDING INFORMATION

None.

20423292, 2024, 3, Downloaded from https://beva.onlinelibrary.wiley.com/doi/10.1111/eve.13918 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [21/05/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

ETHICS STATEMENT

No ethical approval required for this case report.

ORCID

Victor López-Ramis https://orcid.org/0000-0003-2847-2969
Gabriel Manso-Díaz https://orcid.org/0000-0002-8548-669X

REFERENCES

Baldo, C.F., Almeida, D., Wendt-Hornickle, E. & Guedes, A. (2018) Transversus abdominus plane block in ponies: a preliminary anatomical study. *Veterinary Anaesthesia and Analgesia*, 45, 392–396.

Bruggink, S.M., Schroeder, K.M., Baker-Herman, T.L. & Schroeder, C.A. (2012) Weight-based volume of injection influences cranial to caudal spread of local anesthetic solution in ultrasound-guided transversus abdominis plane blocks in canine cadavers. *Veterinary Surgery*, 41, 455–457.

Calice, I., Kau, S., Knecht, C., Otero, P.E. & Menzies, M.P.L. (2021) Combined caudal retrocostal and lateral ultrasound-guided approach for transversus abdominis plane injection: a descriptive pilot study in pig cadavers. *PLoS ONE*, 16, e0248131.

Chen, Y., Shi, K., Xia, Y., Zhang, X., Papadimos, T.J., Xu, X. et al. (2018) Sensory assessment and regression rate of bilateral oblique subcostal transversus abdominis plane block in volunteers. *Regional Anesthesia and Pain Medicine*, 43, 174–179.

Chin, K.J., Versyck, B., Elsharkawy, H., Gomez, M.F.R., Sala-Blanch, X. & Reina, M.A. (2021) Anatomical basis of fascial plane blocks. *Regional Anesthesia and Pain Medicine*, 46, 581–599.

Doherty, T.J. & Valverde, A. (2006a) Local anesthetics. In: Doherty, T.J. & Valverde, A. (Eds.) *Manual of equine Anaesthesia and analgesia*. Oxford: Blackwell Publishing, pp. 154–165.

Doherty, T.J. & Valverde, A. (2006b) Inhalational anesthetics. In: Doherty, T.J. & Valverde, A. (Eds.) *Manual of equine anaesthesia and analgesia*. Oxford: Blackwell Publishing, pp. 149–153.

Drozdzynska, M., Monticelli, P., Neilson, D. & Viscasillas, J. (2017) Ultrasound-guided subcostal oblique transversus abdominis plane block in canine cadavers. *Veterinary Anaesthesia and Analgesia*, 44, 183–186.

Evans, H.E. & de Lahunta, A. (2013) Chapter 17: spinal nerves. In: *Miller's anatomy of the dog*, 4th edition. St. Louis, MO: Saunders Elsevier, pp. 611–657.

Farooq, M. & Carey, M. (2008) A case of liver trauma with a blunt regional anesthesia needle while performing transversus abdominis plane block. *Regional Anesthesia and Pain Medicine*, 33, 274–275.

Freitag, F.A.V., Amora, D.S., Jr., Muehlbauer, E., Dornbusch, P.T., Machado, M., Montiani-Ferreira, F. et al. (2021) Ultrasound-guided modified subcostal transversus abdominis plane block and influence of recumbency position on dye spread in equine cadavers. *Veterinary Anaesthesia and Analgesia*, 48, 596–602.

Johns, N., O'Neill, S., Ventham, N.T., Barron, F., Brady, R.R. & Daniel, T. (2012) Clinical effectiveness of transversus abdominis plane (TAP) block in abdominal surgery: a systematic review and meta-analysis. *Colorectal Disease*, 14, 635–642.

Küls, N., Trujanovic, R., Otero, P.E. & Larenza-Menzies, M.P. (2020) Ultrasound-guided transversus abdominis plane block in Shetland ponies: a description of a three-point injection technique and evaluation of potential analgesic effects. *Journal of Equine Veterinary Science*, 90, 102994.

Manatakis, D.K., Stamos, N., Agalianos, C., Karvelis, M.A., Gkiaourakis, M. & Davides, D. (2013) Transient femoral nerve palsy complicating "blind" transversus abdominis plane block. *Case Reports in Anesthesiology*, 2013, 874215.

McDonnell, J.G., O'Donnell, B., Curley, G., Heffernan, A., Power, C. & Laffey, J.G. (2007) The analgesic efficacy of transversus abdominis plane block after abdominal surgery: a prospective randomized controlled trial. *Veterinary Anaesthesia and Analgesia*, 104, 193–197.

Mirra, A., Von Rotz, A., Schmidhalter, M., Moser, L., Casoni, D. & Spadavecchia, C. (2018) Ultrasound-guided lateral and subcostal transversus abdominis plane block in calves: a cadaveric study. *Veterinary Anaesthesia and Analgesia*, 45, 384–391.

Portela, D.A., Romano, M. & Briganti, A. (2014) Retrospective clinical evaluation of ultrasound guided transverse abdominis plane block in dogs undergoing mastectomy. *Veterinary Anaesthesia and Analgesia*, 41, 319–324.

Portela, D.A., Verdier, N. & Otero, P.E. (2018) Regional anesthetic techniques for the pelvic limb and abdominal wall in small animals: a review of the literature and technique description. *Veterinary Journal*, 238, 27–40.

Reig, L.C., Were, S.R. & Brown, J.A. (2019) Short-term outcome and risk factors for post-operative complications following umbilical resection in 82 foals (2004-2016). *Equine Veterinary Journal*, 51(3), 323–328.

Rioja, E.G. (2015) Local anaesthetics. In: Grimm, K.A., Lamont, L.A., Tranquilli, W.J., Greence, S.A. & Robertson, S.A. (Eds.) *Veterinary anaesthesia and analgesia*, 5th edition. Iowa: Willey Blackwell, pp. 332–357.

Salaria, O.N., Kannan, M., Kerner, B. & Goldman, H. (2017) A rare complication of a TAP block performed after caesarean delivery. *Case Reports in Anesthesiology*, 2017, 1072576.

Schroeder, C.A., Snyder, L.B.C., Tearney, C.C., Baker-Herman, T.L. & Schroeder, K.M. (2011) Ultrasound-guided transversus abdominis plane block in the dog: an anatomical evaluation. *Veterinary Anaesthesia and Analgesia*, 38, 267–271.

Steffey, E.P., Howland, D., Jr., Giri, S. & Eger, E.I. (1977) Enflurane, halothane, and isoflurane potency in horses. *American Journal of Veterinary Research*, 38, 1037–1039.

Steffey, E.P., Pascoe, P.J., Woliner, M.J. & Berryman, E.R. (2000) Effects of xylazine hydrochloride during isoflurane-induced anesthesia in horses. *American Journal of Veterinary Research*, 61, 1225–1231.

Taylor, R., Pergolizzi, J.V., Sinclair, A., Raffa, R.B., Aldington, D., Plavin, S. et al. (2013) Transversus abdominis block: clinical uses, side effects, and future perspectives. *Pain Practice*, 13, 332–344.

Tsai, H.C., Yoshida, T., Chuang, T.Y., Yang, S.F., Chang, C.C., Yao, H.Y. et al. (2017) Transversus abdominis plane block: an updated review of anatomy and techniques. *BioMed Research International*, 2017, 8284363.

van Loon, J., Verhaar, N., van den Berg, E., Ross, S. & de Grauw, J. (2020) Objective assessment of acute pain in foals using a facial expression-based pain scale. *Animals*, 10, 1610.

How to cite this article: López-Ramis, V., Santiago-Llorente, I., Manso-Díaz, G., Arrabé, S.C. & Gómez de Segura, I.A. (2024) Ultrasound-guided modified subcostal transversus abdominis plane block in a foal undergoing omphalectomy. *Equine Veterinary Education*, 36, e85–e89. Available from: https://doi.org/10.1111/eve.13918

20423292, 2024, 3, Downloaded from https://beva.onlinelibrary.wiley.com/doi/10.1111/eve.13918 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [21/05/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License