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SHORT COMMUNICATION

Ultrasound-guided subcostal oblique transversus abdominis plane (TAP) block in canine cadavers

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Running Head: Subcostal TAP block in canine cadavers

Abstract

Objectives To describe the ultrasound-guided transversus abdominis plane (TAP) block using a subcostal oblique approach in dog cadavers and to evaluate the spread of a methylene blue solution using a multiple-injectiontechnique.

Study design Prospective, descriptive, experimental anatomical study.

Animal population Nine adult Beagle cadavers weighing 13 ±2 kg (mean ± standard deviation)

Methods Methylene blue solution (10 mL) was injected bilaterally within the fascia that overlies the transversus abdominis muscle of dog cadavers under ultrasound guidance. For each side, a total of 3 injections (3.3 ml each) were performed by the same operator. Dissection was performed by a second operator 20 minutes later. Successful nerve staining was defined as the presence of dye on the nerve with a length greater than 1 cm.

Results Ventral branches of T9, T10, T11, T12 and T13 nerves innervating the cranial abdominal wall were stained in 72%, 95%, 100%, 95% and 61% of cases, respectively. Ventral branches of L1 and L2 innervating caudal abdominal wall were stained in only 33% and 11% of cases, respectively. The dye was found only in the fascia between the transverses abdominis and the internal oblique muscles.

Conclusions and clinical relevance The ultrasound-guided subcostal oblique TAP block provided adequate staining of the sensory innervation of the cranial abdominal wall and for this reason further studies are needed to evaluate efficacy of this technique to block the nociceptive response in clinical situations.

*Keywords*Cranial abdomen, dogs,regional analgesia,subcostal oblique approach, TAP block, ultrasound guidance.

Introduction

The canine abdominal wall is innervated cranially by the ventromedial branches of T11, T12, T13 nerves andcaudally by L1, L2 and L3 nerves (Evans, 1993). The transversus abdominis plane (TAP) block is a regional anaesthesia technique designed to desensitize the nerves innervating abdominal muscles, abdominal subcutaneous tissue and parietal peritoneum. Local anaesthetic must be administered in the fascia between the internal oblique and transversus abdominis muscles where the ventral branches of the spinal nerves are located.

In human anaesthesia, several approaches for ultrasound (US)-guided TAP block have been described, such as: subcostal oblique, mid-axillary and posterior approach (Carney at al.2011). The anterior approach, also known as a subcostal oblique approach, was described by Hebbard (Hebbard 2010). This technique was developed to block ventral branches of T9 to T12 nerves in order to provide somatic analgesia for supraumbilical abdominal surgeries.

Several clinical studies have been conducted in human anaesthesia to evaluate the effectiveness of the subcostal oblique approach (Milan et al.2011; Wu et al.2013) Its analgesic efficacy and positive impact on postoperative opioid requirements have been proven during liver transplants (Milan et al.2011) and radical gastrectomies (Wu et al 2013).

In veterinary anaesthesia, the posterior approach for US-guided TAP block was described in dog cadavers (Schroeder et al. 2011; Bruggink et al. 2012). Its clinical application has also been demonstrated in one case report in a Canadian lynx (Schroeder et al. 2010) and, with some modification to the technique, in a case series of dogs undergoing surgery for mastectomy (Portela et al. 2014). To the author’s knowledge, no studies describing US-guided subcostal TAP block have been published in the veterinary literature. Thus, the objectives of the present study were:

1) Describe an ultrasound-guided subcostal transversus abdominis plane block

technique in dogs.

2) Evaluating the spread of methylene blue and individual nerve staining.

Materials and methods

Nine thawed canine cadavers (13 ±2 kg) euthanized for reasons unrelated to the present study were used. The project received ethical approval (URN 2015 1345) from the Royal Veterinary College, London.

All sonographic procedures were performed by the same operator (first author) using an ultrasound machine(S9v; Sonoscape, China) with a 25mm linear array transducer (10-6 MHz). An 18 gauge, 68mm Quincke spinal needle (BD Needle, Madrid, Spain) was used. The needle stylet was removed before starting the procedure. The needle was primed with methylene blue (Methylthionium Chloride Injection 1% w/v, Martindale, UK) and remained attached to the syringe while the block was performed.

With the cadavers in dorsal recumbency, the abdomen was clipped and spirit (surgical spirit, Vet-Way, UK) with ultrasound gel (Blue ultrasound gel, Henleys Medical, UK) was applied. The transducer was placed initially in a transverse orientation, perpendicular to the linea alba just caudal to the xiphoid process. With the transducer in this position, the following structures could be identified: lineaalba, fat within the falciform ligament, part of the rectus abdominis muscle and peritoneum.Rotating the probe by 10-15 degreeswith the marker located craniallyand therefore positioning it parallel to the costal arch and obliqueto midline, allowed visualization of the rectus abdominis muscle (RAM) and the transversus abdominis muscle (TAM). Further, a characteristic sonographic triangle formed by the two hyperechoic linear structures of the peritoneum (deep) and fascia of TAM (superficial) could be found (Figure 1). When these structures were identified, the needle was inserted from the cranial aspect of the transducer, using an in-plane technique, with a 20 ° angle, so that the tip was located in the fascial plane between RAM and TAM.

Injection of a liquid within the fascia created a characteristic fluid pocket which opened up the fascia while the volume of fluid increased (hydrodissection). Conversely, if the tip of the needle was placed within the muscle tissue, then spread of the injectate was chaotic and non-uniform. When the investigator was satisfied with the position of the needle, a volume of 3.3 mL of methylene blue was injected. The needle was removed and the hydrodissected fascial plane was followed caudolaterally using the ultrasound image to the point where the fluid pocket terminated. The edge of the fluid pocket was the target for needle placement for the second injection and a further 3.3mL was injected. This lateral tracking and injection was repeated once more, so that a total volume of 10 mL was administered over three points.The same procedure was performed on the contralateral side.

Twenty minutes after completion of the procedure, the second investigator(second author)performed dissection of the hemiabdominal walls. Staining of T9 to L2 nerves was assessed and recorded. The nerve was considered successfully stained when dye could be detected over a length greater than 1 cm.

Results

Eighteen hemi-abdominal walls of nine adult beagle cadavers were scanned, injected and dissected. The previously described sonographic landmarks required to perform TAP block using this approach were identified in all hemispheres. In all cadavers dye was located only in the transversus abdominal plane.

The most cranial spread of the dye was observed at the level of the T9 nerve which was successfully stained in 72% of cases. T10, T11, T12 and T13 were successfully stained in 95%

%, 100%, 95% and 61% respectively. L1 and L2 nerves were successfully stained in 33% and 11% of cases.

Discussion

The results of the present study show satisfactory spread of the dye in the cranial abdominal wall using an ultrasound-guided oblique subcostal approach. Similarly to human studies (Barrington et al 2009), the most cranial distribution of the dye in this approach was reported at the level of the ninth intercostal nerve which, in the current study, was stained in 72% of cases. The success rate of T9 to T13 nerve staining suggests that this technique could be suitable for treatment of somatic pain associated with procedures performed in the cranial abdomen such asliver surgeries (lobectomy, portosystemic shunt occlusion, cholecystectomy), gastrotomy and splenectomy.

Nerves L1 and L2 were blocked in less than one-third of the cases. One possible explanation for the lower success rate may be that the volume of dye injected was too small to spread far enough caudally. However, conflicting information regarding the influence of volume on dye spread is found in the literature. Carney et al. (2011) showed in a human study that doubling the volume of solution did not result in more extensive dye spread and that injection site rather than the volume is more important in determining spread. Contrastingly, a positive correlation was found between volume injected and dye spread in dogs (Bruggink et al 2011).Therefore, it is possible that in the present study, caudal abdominal nerves (L1, L2) could have been stained with a higher success rate if dye volume had been increased.

When we compared our datatothe Schroeder et al. study (2011), which investigated dye spread after posterior TAP approach in canine cadavers, the success rate in staining particular nerveswas significantly different between the posterior and subcostal oblique approaches. First, the most cranial spread of dye in Schroeder´s study was to the level of T11 which was stained in only 20%

of cases, whereas T11 was stained in 100% of cases using the subcostal approach. Furthermore, a more cranial spread of the dye was achieved in our study- T9 and T10 nerves were stained in 72% and 95% respectively whereas neither of these nerves were stained using the posterior approach. However, Schroeder et al. had a higher success rate and better spread of dye in the caudal abdomen- T13, L1 and L2 were stained in 100%, 90% and 30% of cases respectively, compared to this study where success rate was 61%, 33% and 11% respectively. Based on these findings, we can postulate that combining the posterior approach described by Schroeder et al. and the subcostal approach described here may be a reasonable option for long abdominal incisions extending from the pre-umbilical to the caudal abdominal region. Portela et al. (2014) who first described the clinical application of posterior TAP block for radical mastectomy in dogs, used two injection sites: cranial to the iliac crest and caudal to the last rib. It is difficult to reach a clear conclusion regarding the cranial extension of this TAP block since intercostal blocks were performed concurrently in order to block the most cranial mammary glands.

The injectatevolume of 10 mL was based on the only known previously published veterinary study (Schroeder at al. 2011) which allowed for comparison with our results. However in a clinical scenario, the decision about injected volume will be influenced by two factors: toxic dose and the final concentration of the local anaesthetic solution.One must first consider that the toxic dose should not be exceeded, and second that the local anaesthetic shouldnot be diluted below its minimumeffective concentration because sensory block may not be achieved.

Further clinical studies are needed in veterinary anaesthesia to determine the peak plasma concentration of local anaesthetics following administration for TAP block and to determine the minimum dose needed to achieve satisfactory analgesia.

The distribution of the dye in cadavers may not reflect exactly the final distribution of the local anaesthetics in clinical cases. Carney (2011) found that in humans the spread of local anaesthetics within the fascia is time-dependent (Carney at al.2011). Although this information is not as applicable to the cadaveric study, it may have significant impact on clinical efficacy of the block depending on the time elapsed between performing the block and starting the surgical procedure.

In conclusion, US-guided subcostal TAP block may provide somatic analgesia of the cranial abdominal wall in dogs. Clinical studies are needed to evaluate the efficacy of this block in providing perioperative analgesia for patients undergoing cranial abdominal surgery.

Acknowledgements

Authors’ contributions

MD: performed the US-guided TAP blocks, literature overview, manuscript preparation; PM: performed the cadaver dissection and assessment of dye spread, data collection and analysis; DN: manuscript preparation, language corrections; JV: idea provider, teacher, supervisor, manuscript preparation.

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Figure Legend

SCT- subcutaneous tissue, RAM- rectus abdominis muscle, F-fascia of the transversus abdominis muscle, TAM- transversus abdominis muscle, P- peritoneum.