

## Anesthesia/Analgesia Case Assessment

In collaboration with the American College of Veterinary Anesthesia and Analgesia (ACVAA)

# Severe hypotension in a dog undergoing persistent right aortic arch correction surgery after serratus plane block

**Keywords:** serratus plane block, hypotension, dog, thoracotomy, persistent right aortic arch

### History

A 6-month-old 18.8-kg intact female Golden Retriever was presented to the Internal Medicine Service of the University of California-Davis Veterinary Medical Teaching Hospital (VMTH) for evaluation of chronic regurgitation. Findings from the physical examination were normal, and neck and thoracic radiographs revealed the presence of a vascular ring anomaly. The patient was referred to the Small Animal Soft Tissue Surgery Service for further evaluation. An echocardiogram revealed an unremarkable heart with no evidence of any additional congenital defects. Blood work analysis revealed a normal CBC, potassium level of 4.9 mmol/L (reference range, 3.6 to 4.8 mmol/L), phosphorus level of 7.3 mg/dL (reference range, 2.6 to 5.2 mg/dL), total protein level of 5.2 g/dL (reference range, 5.4 to 6.9 g/dL), globulin level of 1.5 g/dL (reference range, 1.7 to 3.1 g/dL), and ALP level of 154 IU/L (reference range, 14 to 91 IU/L).

The dog was presented to the Anesthesiology Service for a thoracic CT and thoracotomy. The dog was assigned an American Society of Anesthesiologists physical status of 3 (on a scale from 1 [healthy] to 5 [moribund]) and was premedicated with hydromorphone (0.05 mg/kg, IM), maropitant (1 mg/kg, SC), and pantoprazole (1 mg/kg, IV). Approximately 25 minutes after premedication, a 20-gauge, 4.7-cm catheter was placed both in the right cephalic and left lateral saphenous veins. After preoxygenation, anesthetic induction was achieved with alfaxalone (0.5 mg/kg, IV, titrated to effect) and midazolam hydrochloride

(0.25 mg/kg, IV). Endotracheal intubation was achieved with an 11-mm-internal-diameter tube under direct visualization with a laryngoscope. General anesthesia was maintained with isoflurane delivered in oxygen with an out-of-circle precision vaporizer through a circle-breathing system, and lactated Ringer solution (LRS; 5.0 mL/kg/h, IV) was administered during the procedure. A multiparameter monitor (Datex-Ohmeda; GE HealthCare) was used to record end-tidal carbon dioxide and isoflurane concentration, peripheral oxygen saturation of hemoglobin as measured by pulse oximetry, esophageal temperature, and ECG. Doppler sphygmomanometry was used to measure indirect systolic arterial pressure. Due to hypoventilation (end-tidal carbon dioxide, 57 mm Hg), intermittent positive pressure ventilation was initiated. The CT revealed a persistent right aortic arch with secondary esophageal constriction via the ligamentum arteriosum, an aberrant left subclavian artery potentially contributing to the esophageal constriction, and an anomalous brachiocephalic trunk.

A 22-gauge, 2.5-cm-long catheter was placed in the dorsal pedal artery for direct arterial blood pressure and intermittent arterial blood gas measurements. After the hair was clipped and the left hemithorax was scrubbed, an ultrasound-guided deep serratus plane block (SPB) was performed with 0.4 mL/kg volume of 0.25% bupivacaine (2.5 mg/mL; maximum dose, 2 mg/kg). A 15- to 6-MHz linear ultrasound transducer (Edge II ultrasound system; Sonosite Inc) was positioned perpendicularly over the fourth and fifth ribs at the level of the shoulder joint. The ribs, cutaneous trunci, latissimus dorsi, serratus ventralis thoracis, and external intercostal muscles were identified. A 20-gauge, 6.25-cm-long spinal needle was inserted in plane with the ultrasound beam in a caudocranial direction, and the tip was positioned in the fascial plane between the serratus ventralis and external intercostal muscles between the fourth and fifth ribs (**Figure 1**). After aspiration, a small amount of bupivacaine was injected to visualize the hydrodissection of the correct fascial plane. Once confirmed, the whole volume was injected, and the spread of the drug was observed (**Figure 2**).

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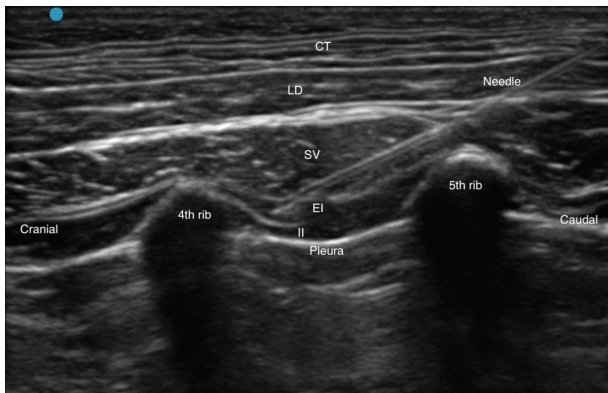
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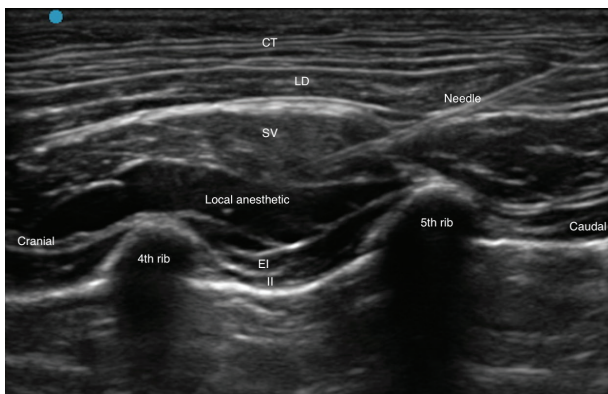
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**Figure 1**—Ultrasonographic anatomy of serratus plane block in a 6-month-old 18.8-kg intact female Golden Retriever undergoing left lateral thoracotomy for surgical resection of the ligamentum arteriosus to address persistent right aortic arch. CT = Cutaneous trunci muscle. LD = Latissimus dorsi muscle. SV = Serratus ventralis thoracic muscle. EI = External intercostal muscle. II = Internal intercostal muscle.



**Figure 2**—Deep serratus plane block illustrating hydrodissection of fascial plane between the serratus ventralis thoracic and external intercostal muscles in a 6-month-old 18.8-kg intact female Golden Retriever undergoing left lateral thoracotomy for surgical resection of the ligamentum arteriosus to address persistent right aortic arch. CT = Cutaneous trunci muscle. LD = Latissimus dorsi muscle. SV = Serratus ventralis thoracic muscle. EI = External intercostal muscle. II = Internal intercostal muscle.

The patient was moved to the operating theater for a left lateral thoracotomy. Over the next 10 minutes, the systolic arterial pressure decreased to 80 mm Hg. Since the heart rate was 68 beats/min, a 0.01-mg/kg dose of atropine was administered IM with the expectation to increase cardio output and subsequently arterial blood pressure. Approximately 15 to 20 minutes after the block was performed, the first direct arterial blood pressure measurement revealed a mean arterial pressure (MAP) of 39 mm Hg.

**What is your diagnosis and intervention plan? Why did the dog become severely hypotensive?**

## Case Management and Outcome

Hypotension in this dog likely resulted from either sympathetic blockade or systemic toxicity from the local

anesthetic. When severe hypotension was noticed, the vaporizer setting was reduced from 1% to 0.2%, a 10-mL/kg LRS fluid bolus was administered, and intermittent positive pressure ventilation was discontinued. At this time, the end-tidal isoflurane concentration was 0.7%. Dopamine infusion was initiated at a rate of 10  $\mu\text{g}/\text{kg}/\text{min}$ , which was increased to 15  $\mu\text{g}/\text{kg}/\text{min}$  over the next 5 minutes. Minimal improvement was noticed in the arterial blood pressure, and a norepinephrine infusion was initiated at a rate of 0.5  $\mu\text{g}/\text{kg}/\text{min}$  and another 10-mL/kg LRS fluid bolus was administered. The rate of LRS administration was increased to 10 mL/kg/h. Due to reduced anesthetic depth, a 5-mg bolus of alfaxalone was administered IV. Blood pressure returned to normal range over the next 10 minutes.

Intermittent positive pressure ventilation with positive end-expiratory pressure was initiated once the pleura was dissected. Norepinephrine infusion was reduced to 0.3  $\mu\text{g}/\text{kg}/\text{min}$  over the next 45 minutes, and dopamine was discontinued. When the norepinephrine infusion was briefly stopped to load the new norepinephrine syringe, a drop of approximately 20 mm Hg in MAP was observed. The infusion was started again at 0.5  $\mu\text{g}/\text{kg}/\text{min}$  and was reduced to 0.3  $\mu\text{g}/\text{kg}/\text{min}$  over the next 10 minutes. Since the arterial blood pressure was now normal, the LRS infusion rate was reduced back to 5 mL/kg/h. The norepinephrine infusion ranged from 0.2 to 0.3  $\mu\text{g}/\text{kg}/\text{min}$  for the rest of the intraoperative period, and the MAP remained between 70 and 95 mm Hg. The end-tidal isoflurane concentration varied between 0.5% and 1.3% as determined by the anesthetist to maintain an appropriate depth of anesthesia. At the end of the surgery, the patient was transported to the ICU for recovery. After extubation, the norepinephrine infusion was discontinued, and the patient maintained normal arterial blood pressure.

## Comments

It is imperative to provide good-quality analgesia to patients undergoing thoracotomies not only intraoperatively but also to ensure appropriate dynamic respiratory muscle function in recovery and chronic pain prevention. The SPB, a fascial plane block locoregional analgesia technique, was recently described in dog cadaver studies.<sup>1,2</sup> Both superficial<sup>2</sup> and deep<sup>1</sup> SPB techniques were evaluated and seemed to provide effective analgesia in dogs undergoing thoracotomies.<sup>3</sup> The cadaver studies showed a dye spread over the first 6 intercostal spaces when volumes of 0.3, 0.6, and 1 mL/kg were used. A single injection of 0.4 mL/kg of bupivacaine was used to perform the deep SPB in this dog. Intraoperatively, the dog was maintained on a low inhalant concentration, did not require any rescue analgesia, and did not demonstrate significant nociception as assessed by changes in heart rate and arterial blood pressure, all suggesting that the block was effective.

The spread of injectate in the fascial plane of a cadaver and live animal could be quite different.<sup>2</sup> Acute drop in arterial blood pressure in this dog may have resulted from the spread of the drug volume to the

left sympathetic chain since the vaporizer setting was not increased and no other drug was administered that could have resulted in observed hypotension. To provide effective analgesia for a lateral thoracotomy performed at the level of the fourth intercostal space, it is desirable to have spread of the local anesthetic to cover the second through seventh intercostal spaces. Since the block was effective in this dog, it is possible that the local anesthetic volume, in addition to covering the lateral cutaneous branches of intercostal nerves, may have spread to the sympathetic chain over these intercostal segments on the left side, as the serratus ventralis thoracic muscle originates from the facies serrata on the dorsomedial scapula and inserts on the first to seventh or eighth ribs. Sympathetic innervation of splanchnic vasculature in the dog is anatomically derived from the thoracolumbar spine with high thoracic origin of the sympathetic vasoconstrictor fibers.<sup>4</sup> Sympathetic blockade results in increased compliance of the splanchnic vasculature leading to pooling of blood and decrease in stroke volume and arterial blood pressure.

Another possible explanation is systemic toxicity from bupivacaine. Although aspiration was performed before injecting bupivacaine, muscles in this region are very vascular, which may have contributed to rapid systemic absorption of local anesthetic drug.<sup>5</sup> The total amount of bupivacaine used was below the toxic dose, but since the plasma concentration of the drug was not measured, the possibility of systemic toxicity cannot be ruled out. Fluids and vasopressor therapy improved the patient's blood pressure, and intervention with intralipid was not considered.

Due to lack of consistency in the technique, use of different drugs and volumes, and lack of any pharmacokinetic and substantial clinical safety data, the type and incidence of complications remain unknown with SPB. It is a recently introduced technique, and it

is imperative to be mindful of and to critically evaluate any adverse effects that may arise following the use of this locoregional technique.

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## Disclosures

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