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Anesthesia Case of the Month

History

A 2-year-old 22.3-kg (49.1-lb) neutered male English Springer Spaniel was referred for surgical treatment of a left elbow joint fracture. The owner reported an acute onset of non–weight-bearing lameness in the left forelimb with no history of trauma. Swelling in the region of the left elbow joint was seen on physical examination. A lateral condylar fracture of the left humerus was evident on radiographs provided by the referring veterinarian.

Open reduction and internal fixation of the condylar fracture was scheduled for the day after admission. Results of the preanesthetic assessment were otherwise normal; therefore, the patient was classified as American Society of Anesthesiologists physical status II (mild systemic disease). The anesthesia protocol consisted of premedication with methadone (0.2 mg/kg [0.09 mg/lb], IV) in combination with acepromazine (0.01 mg/kg [0.0045 mg/lb], IV). Meloxicam (0.2 mg/kg, IV) was added for its anti-inflammatory effects as part of a multimodal analgesia protocol. General anesthesia was induced with propofol (2 mg/kg [0.9 mg/lb]) administered IV to effect (total dose, 44.6 mg). The patient was orotracheally intubated, and anesthesia was maintained with isoflurane in oxygen administered via a circle breathing system. Monitoring[a] included an ECG and measurement of oxygen saturation by means of pulse oximetry, end-tidal partial pressure of CO_2, end-tidal isoflurane concentration, and blood pressure (measured noninvasively with an oscillometric method). End-tidal isoflurane concentration was maintained at 1.3% throughout surgery. Baseline cardiorespiratory parameters included heart rate of 100 beats/min, respiratory rate of 12 breaths/min, and systolic, mean, and diastolic blood pressures of 110, 68, and 51 mm Hg, respectively. With the patient anesthetized, repeated radiography confirmed a fracture of the left lateral humeral condyle and incomplete ossification of the humeral condyle, consistent with the lack of a history of trauma.

An ultrasound-guided brachial plexus block was performed for intraoperative analgesia. The patient was positioned in right lateral recumbency for clipping and standard aseptic preparation of the lateral aspect of the left neck and shoulder area. Ultrasonographic identification of the brachial plexus was performed as previously described by Guilherme and Benigni.[1] Briefly, the ultrasound transducer was positioned in a parasagittal plane, parallel to the long axis of the first rib. The left axillary artery and vein were identified in the transverse plane, and the contributing nerves of the left brachial plexus (C6, C7, C8, and T1) were identified as circular hypoechoic structures dorsal to the axillary vessels. By means of a combination of the frequency selected and a sharpening algorithm, ultrasonography revealed a mildly hyperechoic interface at the most superficial aspect of the nerves. A 22-gauge, 7-inch spinal needle was inserted with ultrasound guidance, and ropivacaine[b] (1 mg/kg [0.45 mg/lb] diluted with sterile water to provide a total injection volume of 5 mL of a 0.45% solution) was injected.

On completion of the brachial plexus block and after standard surgical preparation of the site, the patient was moved to the operating room for surgery. One hour after the start of surgery, the patient began to respond to surgical stimuli (heart rate, 140 beats/min; respiratory rate, 19 breaths/min; and systolic, mean, and diastolic blood pressures, 140, 88, and 65 mm Hg, respectively) in a manner compatible with intraoperative nociception. Therefore, it was assumed that the brachial plexus nerve block was providing only partial analgesia, and a constant rate infusion of ketamine (10 µg/kg/min [4.5 µg/lb/min]) was started. The patient also received 2 bolus doses of methadone (0.1 mg/kg [0.045 mg/lb]) 1 hour apart, administered by slow IV injection. Because of the suspected partial brachial plexus nerve block, an additional methadone bolus was administered IV at the completion of surgery.

A left brachial plexus catheter was placed at the completion of surgery in an attempt to maintain adequate analgesia. The brachial plexus was again identified by means of ultrasonography. A stab skin incision was made with a No. 11 scalpel blade dorsal to the ultrasound transducer, and an 18-gauge, 8-cm Tuohy needle (1.30 X 88 mm; 18 gauge and 3.5 in) was advanced until the tip was evident on the ultrasound image adjacent to the nerve roots of the left brachial plexus **(Figure 1)**. A 1 mg/kg dose of ropivacaine diluted to a total concentration of 0.22% (3 mL of ropivacaine plus 7 mL of saline [0.9% NaCl] solution) was injected, producing a fluid pocket surrounding the left brachial plexus, immediately adjacent to the identified nerve roots. A 20-gauge, 100-cm-long epidural catheter[c] was then advanced into the fluid pocket, and the Tuohy needle was withdrawn. With the same needle, a subcutaneous tunnel was created extending from the

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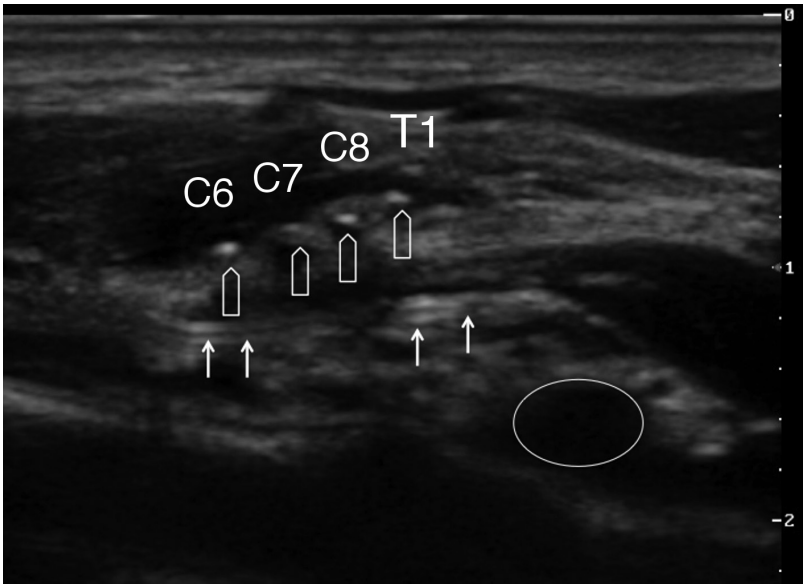

Figure 1—Ultrasonographic image of a 2-year-old neutered male English Springer Spaniel illustrating placement of a brachial plexus catheter for postoperative locoregional analgesia after open reduction and internal fixation of a left humeral condyle fracture. The patient was anesthetized and positioned in right lateral recumbency; the ultrasound transducer was located in a parasagittal plane, parallel to the long axis of the first rib. After identification of the left brachial artery (circle) and the C6, C7, C8, and T1 nerve roots of the left brachial plexus (open arrows), a 20-gauge, 100-cm-long epidural catheter[c] (white arrows) was inserted via a subcutaneous tunnel and secured in place.

catheter entrance site to the dorsal midline. The catheter was advanced through this tunnel and secured to the skin with butterfly tape and simple interrupted sutures.

The patient recovered from anesthesia without apparent complications. Sensory and motor blockade were tested by applying the tips of blunt hemostatic forceps to the skin below the left elbow joint and applying gentle finger pressure on the surgical incision. Responses to these tests were negative, compared with responses for the contralateral limb. Postoperative analgesia was provided with 10 mL of 0.22% ropivacaine administered every 6 hours via the indwelling brachial plexus catheter. Local anesthetic volume and concentration were calculated to achieve sensory blockade of all brachial plexus nerve roots.[2] The dog was evaluated for signs of pain before each dose of ropivacaine with the short-form Glasgow Composite Measure Pain Scale (CMPS-SF)[3] for dogs (a score of 0 represents no pain; a score of 24 represents unbearable pain). On the day of surgery, the patient's CMPS-SF score was 1 each time it was evaluated. The dog appeared comfortable and, 2 hours after extubation, started to bear weight on the operated limb. Meloxicam administration (0.1 mg/kg, SC, q 24 h) was continued during the postoperative period. On the basis of the low (≤ 3) pain scores, periodic assessments of sensory and motor blockade, and the dog's apparent comfort, postoperative rescue analgesia (ie, opioid administration) was not provided during the period of ropivacaine administration via the brachial plexus catheter.

Twenty-four hours after surgery, the patient developed signs of Horner syndrome (ptosis and miosis of the left eye); therefore, the volume of 0.22% ropivacaine administered every 6 hours was decreased from 10 to 7 mL. After 4 hours, signs of Horner syndrome had resolved and did not recur. No other complications were noted.[4]

Thirty-six hours after surgery, during a short walk with the dog out of its kennel, the brachial plexus catheter became dislodged and consequently was removed. The CMPS-SF score was assessed 4 and 8 hours after catheter removal and was 1. The dog then developed severe lameness (CMPS-SF score, 5), and buprenorphine (0.02 mg/kg [0.009 mg/lb], IV, q 6 h) was added to the analgesic protocol. The patient remained comfortable during the remainder of the postoperative hospitalization period and was discharged 3 days after surgery with a prescription for meloxicam (0.1 mg/kg/d, PO) for 5 days. On follow-up examination 1 month after surgery, the patient had improved clinically. Follow-up radiography of the left elbow showed evidence of fracture healing.

Question

Can intermittently administered locoregional analgesia alone provide adequate postoperative analgesia for small animal surgical patients? How can differential blockade (ie, analgesia without nerve paralysis) be achieved?

Answer

Local anesthetic agents such as ropivacaine provide analgesia through reversible blockade of the sodium channels in nerve membranes, preventing the conduction of action potentials and hence blocking the transmission of painful stimuli.[5] However, the effects last for only a few hours. Therefore, to achieve analgesia during the postoperative period (typically several days), repeated or continuous local anesthetic administration close to the nerve is mandatory.[6] In the patient of the present report, we placed a perineural catheter to facilitate repeated administration of ropivacaine. The patient also received meloxicam (0.2 mg/kg the first day and then 0.1 mg/kg, PO, q 24 h) perioperatively for its anti-inflammatory and analgesic effects as part of a multimodal analgesic protocol. Good-quality postoperative analgesia, as determined with the CMPS-SF for dogs, was achieved for 36 hours (until the catheter was inadvertently dislodged), and no opioid rescue analgesia was needed during that period. Moreover, we achieved subjectively good

sensory blockade without complete paralysis of the affected limb. Local anesthetic type and concentration may influence which nerve fibers are blocked. Sensory blockade alone is achieved if the nerve fiber is exposed to a low concentration of local anesthetic, whereas a higher concentration can produce motor blockade.[7] Ropivacaine and bupivacaine have been compared to evaluate which has superior differential blockade effects, but the results are equivocal.[8,9]

Discussion

Effective analgesia is essential for surgical patients during surgery and in the postoperative period. Pain is well recognized as an important factor that can increase the incidence of surgical site infection and have other deleterious effects on recovery if not appropriately managed. Perineural catheters for peripheral nerve blocks are currently used in human patients to control postoperative pain.[5] Reported advantages include a decreased need for systemic analgesics (including opioids, which have been associated with adverse effects such as nausea and vomiting), highly effective analgesia facilitating early ambulation and introduction of physical therapy in the immediate postoperative period, and a relatively low incidence of complications.[9] Perioperative pain management through administration of local anesthetics and anti-inflammatory drugs may prevent chronic pain and windup mechanisms (ie, increased sensitivity of spinal cord neurons resulting in increased pain sensation).[10–12] The use of an indwelling catheter placed in the brachial plexus area has been described for continuous or repeated administration of local anesthetics to treat pain in dogs.[13,14] In these case reports, the catheter was placed by means of a peripheral nerve stimulator to locate the appropriate position for the tip of the catheter. Additionally, 2 recent reports[4,15] describe ultrasound-guided brachial plexus blocks in dogs. These studies did not evaluate ultrasound-guided catheter placement.

The canine brachial plexus is formed by the sixth, seventh, and eighth cervical spinal nerves and the first thoracic spinal nerve. Contributions can also arise from the ventral branch of the fifth cervical spinal nerve and the second thoracic spinal nerve.[1] An effective nerve block is dependent on the precision of local anesthetic delivery to the target nerve root. Individual anatomic variations and operator experience make performing this local block challenging, leading to variable efficacy or partial blockade. Ultrasonographically, the brachial plexus can be identified in dogs by following the origin of the nerve roots from the neural foramina of the cervical vertebrae until formation of the brachial plexus cranial to the first rib.[1] Other previously reported approaches for performing ultrasound-guided brachial plexus blocks include the ventral axillary[15] and the paravertebral approach.[4]

A suggested advantage of the use of ultrasonography versus nerve stimulation for location of the brachial plexus is the relatively easy identification of anatomic landmarks and visualization of the catheter as it is advanced into position, minimizing the risk of accidental vascular puncture and potential neurologic complications that may result from intraneural injections. Another potential advantage in patients with trauma such as fractures is that pain during catheter placement is minimized, avoiding movements evoked by application of the peripheral nerve stimulator to an injured limb. Malher and Reece[14] did not report signs of discomfort during use of electrostimulation in a dog with open fractures; however, analgesia and sedation were provided by means of administration of meperidine (7 mg/kg [3.2 mg/lb]) before the procedure. Disadvantages of ultrasound-guided techniques are the need for ultrasound equipment of sufficient quality to identify the detailed structures of the brachial plexus and the operator experience required. Currently, there are no studies available comparing the accuracy and success of the 2 techniques described for brachial catheter placement in veterinary patients.

In the patient of the present report, we chose ropivacaine over other amide-based local anesthetics because it offers a relatively long duration of action[8,9] and fewer cardiotoxic effects, compared with other long-lasting local anesthetics such as bupivacaine.[9,16] The dose used for repeated administration (1 mg/kg, q 6 h) was calculated in an effort to minimize the risk of systemic toxicosis, and the drug was diluted to a low concentration (0.22%) in an effort to achieve sensory blockade (myelinated fibers of afferent sensory type A δ fibers or unmyelinated sensory C fibers).[11,12] It became apparent intraoperatively that the volume injected before surgery was not sufficient to completely block the brachial plexus. For this reason, and on the basis of a previous study[2] in which a minimum effective anesthetic volume of 0.3 mL/kg (0.14 mL/lb) was necessary to achieve complete brachial plexus block in dogs, the 1 mg/kg dose administered during the postoperative period was diluted to a concentration of 0.22% (3 mL of ropivacaine in 7 mL of saline solution).

In the patient of the present report, we believe that the sensory block provided effective postoperative analgesia as demonstrated both by consistently low pain scores and the lack of requirement for rescue opioid administration. Pain scales are semiquantitative measures of pain in veterinary patients and should be used with caution; however, the CMPS-SF has been previously validated for use in dogs.[17] Degree of motor blockade was assessed with periodic assessment of conscious proprioception in the affected limb and slow leash walking. No additional clinical interventions were required to prevent motor blockade.

Transient Horner syndrome developed during the postoperative period in the patient described in the present report. We suggest that in this dog, the injected volume of ropivacaine (10 mL) was sufficient

to diffuse to areas beyond the brachial plexus such as the stellate ganglion, producing the clinical signs (ptosis and miosis). In this patient, the clinical signs resolved after 4 hours, and a subsequent decrease in the volume of drug injected apparently prevented recurrence. This transient adverse event was described previously as a complication of paravertebral plexus block in a dog,[18] with resolution of clinical signs after drug absorption.

In the patient of the present report, the brachial plexus catheter became dislodged after 36 hours. We suggest that creation of a longer subcutaneous tunnel may facilitate more secure suture fixation and decrease the risk of premature dislodgement with resultant early termination of locoregional analgesia when placing brachial plexus catheters in dogs.

Footnotes

a. S/5 multiparametric monitor, GE Medical, Hatfield, Hertfordshire, England.
b. Naropin, AstraZeneca plc, London, England.
c. Espocan epidural catheter, B. Braun Medical Ltd, Sheffield, South Yorkshire, England.

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