ISSN: 2378-3656

Sen et al. Clin Med Rev Case Rep 2017, 4:163
DOI: 10.23937/2378-3656/1410163
Volume 4 | Issue 4
Open Access

Clinical Medical Reviews and Case Reports

CASE SERIES

Continuous Bilateral Brachial Plexus Blockade for Acute Pain Control in Patients with Bilateral Upper Extremity Traumatic Injuries: A Review of Five Cases

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Abstract

Study objective: Brachial plexus catheters are typically placed to provide regional anesthesia to the shoulder, arm, forearm, wrist and hand. However, there are risks associated with catheter placement including infection and local anesthetic toxicity.

Study design: In this study we discuss five case scenarios where we felt bilateral brachial plexus blocks were appropriate and, if performed with caution, the benefits would outweigh the risks. Each of these patients suffered severe bilateral upper-extremity traumatic injuries, requiring multiple surgical procedures and debridement's while inpatient on the trauma service. These patients were chosen because of the need for pain control during their hospital stay, the appropriateness of these particular techniques, and a lack of absolute contraindications to these techniques.

Conclusions: In carefully-selected patients, bilateral brachial plexus catheters can be used safely and effectively to control pain secondary to traumatic injuries to the upper extremities. These catheters are a potentially valuable tool as part of a multimodal pain control regimen, with the goal of achieving adequate pain management, while limiting opioid use.

Keywords

Bilateral brachial plexus catheter, Bilateral perineural catheter, Trauma, Bilateral upper extremity injury

Introduction

Bilateral brachial plexus blocks are a form of regional anesthesia and serve as an alternative to general anesthesia for surgeries involving the arm, forearm, wrist or hand. Complications such as diaphragmatic paralysis, pneumothorax, and local anesthetic toxicity are associated with brachial plexus blocks [1-8]. Other complications that have been described include hemothorax and Horner's syndrome [1,9]. While many of these are self-limiting and clinically insignificant when performed unilaterally, the consequences could be severe if they were to occur bilaterally. There is an increased risk of (LAST) after the words local anesthetic systemic toxicity associated with bilateral procedures [6-8]. Use of ultrasound for placing brachial plexus blocks have been associated with a lower incidence of complications, as well as more effective delivery of local anesthetic to the target [2-4,8]. In this case series, we discuss five scenarios where we felt that bilateral brachial plexus perineural catheters were appropriate, and if performed with caution, the benefits would outweigh the risks.

Design

This case series is a retrospective review of 5 subjects undergoing bilateral brachial plexus catheter placement for pain control following traumatic bilateral upper extremity injuries. The study was approved by the Louisiana State University Health Sciences Center Shreveport Institutional Review Board (FWA#00000653,

Citation: Sen S, Franklin ME, Koyyalamudi VB, Cornett EM, Fox CJ (2017) Continuous Bilateral Brachial Plexus Blockade for Acute Pain Control in Patients with Bilateral Upper Extremity Traumatic Injuries: A Review of Five Cases. Clin Med Rev Case Rep 4:163. doi.org/10.23937/2378-3656/1410163

Received: February 02, 2017; **Accepted:** April 18, 2017; **Published:** April 20, 2017

Expiration Date: 08/2021, IORG#0000109 IRB, IRB Registration# IRB00000178) on 9/18/2014 and written informed consent was obtained from each patient.

Setting

These procedures were performed at a tertiary academic medical institution and a trauma one center.

Interventions

Bilateral brachial plexus continuous infusion catheters were placed by ultrasound guided supraclavicular or infraclavicular approaches. The supplies used included an Arrow Stimu Cath, 20 G catheter, Teleflex Medical, Kernen, Germany.

Case Series

All brachial plexus blocks in this case series were performed under strict aseptic precautions with the aid of real-time ultrasound imaging. Standard ASA monitors were utilized during the procedure. The site of the block was prepped and draped, and the skin at needle insertion was anesthetized with 1% lidocaine. A 17 G, 3.5 inch Tuohy needle was used to perform these blocks and a 19 G, 60 cm stimulating catheter was inserted to various depths and desired position was confirmed with ultrasound. All catheters were secured in place with dermabond, steristrips, mastisol, tegaderm and a statlock securing device. All injections through the catheters was incremental and subjected to intermittent aspiration (Table 1).

Case 1: Bilateral supraclavicular catheters

The first patient is a 31-year-old male who suffered severe bilateral upper extremity degloving injuries and traumatic amputation of fingers of both hands after an artillery shell firework exploded in his hands.

The patient was emergently taken to the operating room for wound debridement and irrigation under regional anesthesia. Under ultrasound guidance, bilateral supraclavicular catheters were placed and 30 ml of 0.5% ropivacaine was injected through each catheter. The patient had complete surgical anesthesia of both forearms and hands for the surgical procedure. Infusions of 0.2% ropivacaine was started in the post anesthesia care unit at 6 ml/hr on each side. He underwent two more irrigation and debridements of both hands performed under regional anesthesia. Both catheters were again injected with 30 ml of 0.5% Ropivacaine before each subsequent procedure. The patient had an uneventful hospital course, and the catheters were removed on catheter day 6 prior to discharge.

Case 2: Bilateral infraclavicular catheters

The second patient was a 26-year-old female who suffered an open fracture of the left radius, open fractures of the right radius and ulna, and bilateral compartment syndrome of the forearms, for which she had undergone multiple surgical procedures. Bilateral infraclavicular catheters were placed post-operatively for pain management and 20 mL of 0.5% ropivacaine was injected through each catheter. The patient reported an immediate relief in pain after catheter placement. Infusion of 0.2% ropivacaine at 8 ml/hr was started on each side. The following day, the rate was increased to 10 mL/hour. The right infraclavicular catheter was removed on catheter day 3 due to concern for possible intravascular migration of the catheter after blood was aspirated prior to injecting a bolus through the catheter. There were no clinical signs of local anesthetic toxicity. The left infraclavicular catheter was removed on catheter day 7.

Case 3: Left Supraclavicular catheter and right Supraclavicular catheter

The third patient was a 41-year-old male who suffered bilateral degloving injuries of the hands in a work-related accident. The left infraclavicular catheter was placed and 20 ml of 0.5% ropivacaine was injected through the catheter. Subsequently, a right supraclavicular catheter was inserted and 10 mL of 0.5% ropivacaine was then injected through the catheter. The catheters were attached to continuous infusions, each delivering 0.2% ropivacaine at 6 mL/hour. The patient had a very dense motor block and the catheters were clamped the following day and the motor function returned with 2 hours. The infusion was restarted. On catheter day 3 the infusions were increased to 8 mL/hour. On catheter day 4, the right supraclavicular catheter tip was noted to have dislodged and was removed. The left infraclavicular catheter was removed on catheter day 5.

Case 4: Bilateral supraclavicular catheters

The fourth patient was a 52-year-old female who sustained bilateral injuries to the hands secondary to a workplace blast injury. On day 4 of her hospital stay,

Table 1: Case 1-Case 5 patient details.

Case	Age/Sex	Type of catheter placed	Duration of catheter placement	Complications
Case 1	31/m	Bilateral Supraclavicular	6 days	none
Case 2	26/m	Bilateral Infraclavicular	3 days right/7 days left	Right sided catheter - possible intravascular migration
Case 3	41/m	Left Infraclavicular/Right Supraclavicular	5 days (left)/4 days (right)	Right catheter tip dislodged and removed
Case 4	52/f	Bilateral Supraclavicular	9 days	none
Case 5	20/m	Bilateral Infraclavicular	5 day	none

bilateral supraclavicular catheters were placed. Ten milliliters of 0.5% ropivacaine was injected through each catheter. An infusion of 0.2% ropivacaine was started at a rate of 8 mL/hour on each side. The catheters were removed on catheter day 9 with no adverse events.

Case 5: Bilateral infraclavicular catheters

The fifth patient was a 20-year-old male who suffered bilateral hand injuries in the workplace when he got both hands stuck in a printing press. Supraclavicular blocks and intercostobrachial nerve blocks were placed for surgical anesthesia. On postoperative day 1, bilateral infraclavicular catheters were placed and an infusion of 0.2% ropivacaine was started at 7 mL/hour on each side. On catheter day 4, a 20 mL bolus of 0.5% ropivacaine was given through each catheter for surgical anesthesia with good effect. The following day, the catheters were removed uneventfully.

Discussion

Brachial plexus blockade has been demonstrated to be a valuable tool in upper-extremity pain control. Bilateral brachial plexus blocks while not unheard of are rarely described in the literature. Frequently cited reasons for performing these techniques judiciously include complications such as a pneumothorax, diaphragmatic paralysis and need for larger doses of local anesthetic increasing the risk of LAST. [1-8].

The phrenic nerve arises from the spinal nerves of C3, C4 and C5, descends across or through the anterior scalene muscle and enters the chest where it innervates the diaphragm [10]. Due to anatomic proximity to the brachial plexus, phrenic nerve involvement is a potential complication of a brachial plexus block, especially the interscalene block. It can result in subjective dyspnea secondary to ipsilateral hemi-diaphragmatic paralysis and therefore should be performed with caution in patients with significant pulmonary disease. Studies have shown a 100% incidence of hemi-diaphragmatic paralysis following an interscalene block with nerve stimulation [11-13]. Decreasing local anesthetic volume and the use of ultrasound has been shown to reduce the incidence of phrenic nerve blockade following an interscalene brachial plexus block [14,15]. Approximately 1/3rd of patients may develop hemi-diaphragmatic paralysis following an ultrasound guided supraclavicular brachial plexus block with 30 ml of 0.5% ropivacaine [16]. The same study showed the incidence with infraclavicular brachial plexus blockade to be much lower at with only 1 patient out of 32 (incidence 3%) developing paresis of the diaphragm. However, such phrenic nerve blockade is transient, and patients can compensate by increasing their respiratory rate and it is not clinically significant in patients without pulmonary disease [13,16,11]. Thus, it is quite evident that bilateral blocks of the brachial plexus may lead to bilateral phrenic nerve blockade and complete paralysis of the diaphragm. However, in our case series, we have demonstrated that utilizing ultrasound guidance bilateral brachial plexus catheters, either supraclavicular, infraclavicular or a combination can be utilized for surgical anesthesia or pain management without causing bilateral paresis of the diaphragm. It is important to note that all the patients in this case series, did not present with any pulmonary disease or respiratory insufficiency. Additionally, the use of ultrasound may have allowed us to more precisely place the catheter in the infero-medial aspect of the plexus in close proximity to the 1st rib and subclavian artery thereby minimizing the spread of local anesthetic towards the vicinity of the phrenic nerve as it passes in close approximation to the anterior scalene muscle.

The use of ultrasound guidance to directly visualize relevant structures has also been shown to improve performance of brachial plexus blocks in a variety of ways. Lower volume of local anesthetic is required to achieve an adequate block, the quality of the block is better, the procedure itself is associated with less discomfort, and the incidence of complications as described such as hemidiaphragmatic paralysis and LAST is lower. The result is a more efficient procedure and better patient satisfaction [1,3,8,17-19].

Local anesthetic systemic toxicity (LAST) can occur with excessive administration of a local anesthetic, accidental intravenous injection or due to rapid absorption of the drug used. Though its incidence is less than 0.2% [20], LAST can be difficult to treat and is potentially fatal. Prevention of LAST during all regional anesthetic procedures is paramount [21]. No single intervention can reliably eliminate the risk of LAST, although aspiration before injection of the local anesthetic and the use of an intravascular marker such as epinephrine, reduces the likelihood of accidental intravascular injection [21]. Ultrasound guided nerve blockade has been shown to reduce the incidence of LAST by virtue of lowering the incidence of unintended vascular puncture [22]. The use of ultrasound in our series of patent's may have reduced the possibility of LAST by allowing for visualization of vasculature in relation to the needle tip.

Case reports resulting in hematoma after brachial plexus blocks have been described in the literature. A case report by Howell, et al. described the occurrence of hematoma in the neck following neurostimulation-guided interscalene block [23]. A separate case reported a massive hemopneumothorax following a supraclavicular brachial plexus block [23,24] in a patient who was heparinized [24]. Additionally, we found one case in the literature of massive hemothorax following a supraclavicular block. This block was performed with the paresthesia technique for needle localization [9]. One notable study which reported complications of supraclavicular blocks, had an 8.8% incidence of hematoma formation [25]. However, it should be noted that the authors of these studies did not perform their blocks utilizing ultrasound guidance [23-25], which has been shown to significantly reduce the rate of complications of these procedures [4,9]. Overall, hematoma is an extremely rare complication, particularly when ultrasound guidance is utilized [4].

In our case series, we had one instance of suspected intravascular migration of a catheter after three days and one instance where a catheter was had dislodged after four days. Jenkins, et al. reported delayed migration of an interscalene catheter into the intrapleural space. The authors removed the catheter, and there were no clinically significant complications from this event [26]. In the two cases of catheter migration in this case series, it was decided that the patient's pain had improved to the point that it could be reasonably controlled with Intravenous narcotics and multimodal analgesia and that it was not necessary to replace the catheter. In these patients, there were no clinically significant complications from catheter migration. Although there was no imaging obtained to confirm the location of catheter tip, the catheters were removed. There were no adverse incidents associated with removal of the catheters.

In this case series, we utilized both infraclavicular and supraclavicular catheters for pain control. Traditionally, it has been thought that the supraclavicular approach may offer some advantages in the quality of pain control, due to the more compact arrangement of the brachial plexus [27]. Infraclavicular approach is considered more appropriate for placing a perineural catheter, because local musculature provides a more firm hold on the catheter [2,28,29]. Few studies have compared supraclavicular and infraclavicular brachial plexus catheters. Marianao, et al. in a randomized controlled trial, concluded that infraclavicular brachial plexus catheters provided superior analgesia when compared to supraclavicular brachial plexus catheters [28]. However, in another randomized control trial, no significant differences in sensory blockade, pain scores or satisfaction was reported between the two techniques [27]. In our case series, the decision was influenced in certain instances by accessibility (for example presence of a cervical collar limiting supraclavicular fossa access) and body habitus (for example a high body mass index making infraclavicular needle tip visualization more difficult).

Conclusion

In conclusion, we believe that, in carefully-selected patients, bilateral brachial plexus blocks and bilateral brachial plexus continuous perineural catheters can be safely and effectively used to control pain secondary to traumatic injuries to the upper extremities. They are a potentially valuable tool as part of a multimodal pain control regimen, with the goal of achieving adequate pain management, while limiting opioid use and thus, limiting the long-term complications that can be associated with it.

Acknowledgements

The authors would like to thank Adrian Windham, LPN and Mike Green, LPN for their continued technical support.

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