Stimulator-Guided Supraclavicular Block as an Anesthetic Option for Above-Elbow Amputation in an Infant

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Abstract

The supraclavicular block is effective in providing surgical anesthesia for upper limb surgery. The safety profile is improved with the use of a nerve stimulator to locate the brachial plexus. Above-elbow amputation in infants is commonly done under general anesthesia, however, the presence of certain comorbid conditions may increase the risk of mortality. We report the use of a nerve stimulator-guided supraclavicular block with sedation, to carry out transhumeral amputation for an 11-week-old female infant who had gangrene of her left forearm. The subclavian perivascular approach was used to perform the block. A mixture of 0.5% bupivacaine and 2% lidocaine in adrenaline was administered to achieve surgical anesthesia. The onset of the block was 5 min. A total of 2 mg of midazolam was used for sedation. The infant had a successful block. There was no block-related complication. We suggest that nerve stimulator-guided supraclavicular block in infants is feasible and safe.

Keywords: Amputation, nerve stimulator, supraclavicular block, surgical anesthesia

Introduction

Amputation refers to the surgical removal of a limb or tissue. It is a procedure that is rarely carried out in infants except when indicated. In this index patient, the amputation of the arm was required due to gangrene arising from accidental intra-arterial cannulation. The infant had a transhumeral amputation, which involves amputation at any level from the supracondylar region of the humerus distally to the level of the axillary fold proximally preserving as much length as possible.[1] This document provides a suggested approach to the anesthetic management of an 11-week-old infant who developed gangrene of the left forearm.

Case Report

An 11-weeks-old female infant was admitted into the pediatric ward for weight loss, fever, and cough. There were associated oliguria and seizures while on admission. A provisional diagnosis of sepsis was made. Blood and urine samples were taken for investigation while the child was commenced on broad-spectrum antibiotics. On the 3rd day of admission, the intravenous (IV) cannula in the left forearm was observed to be in tissue with associated swelling of the arm. The arm remained swollen and subsequently became cold with discoloration. Gangrene of the left forearm was observed 2 days later.

Examination revealed an acutely ill-looking small for age baby who was febrile (37.8°C–39°C), pale, and mildly dehydrated. There was gangrene of the left forearm about 8 cm from the fingertip. The left hand was cold and not mobile. The left radial and ulnar arterial pulsations were absent. Her right pulse was palpable but thready. Her heart rate (HR) was 160 beats per min. Respiratory rate was 45 cycles per min with associated flaring of alae nasi and intercostal recession. Bilateral basal crepitations were audible on auscultation. Oxygen saturation (SpO_2) was 77% in room air and 94% on intranasal oxygen at 1 L/min. Weight was 4.5 kg.

The investigation results prior to surgery are shown in Tables 1 and 2.

Doppler ultrasonogram of the left forearm showed features of left arterial occlusion starting from the distal brachial artery down to the left arm. The ejection fraction was 57%. The child

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was managed for sepsis complicated with acute kidney injury and gangrene of the left forearm. The managing team decided to carry out above-elbow amputation aimed at preventing the spread of the gangrene and removing the focus of infection.

She was assessed as American Society of Anaesthesiologist Class IV. One pediatric unit of blood was grouped and cross-matched for the surgery. Fasting guideline was observed. Hypokalemia and metabolic acidosis were corrected with IV potassium chloride and bicarbonate. General anesthesia (GA) was an available option, but due to the presence of chest infection, sepsis, and acute kidney injury, we opted for a safer option in order to reduce the chances of intra- and postoperative complications. The parents were offered a supraclavicular brachial plexus block with sedation. Informed consent was obtained from the infant's parents.

The infant was transferred to the theater and laid supine on the theater table. The baseline vital signs were noted (HR = 140 bpm, blood pressure [BP] = 90/40 mmHg, and SpO_2 = 94% on intranasal O_2). The drugs for resuscitation and GA were drawn and labeled. The infant was sedated with fentanyl 1 μg/kg and midazolam 0.1 mg/kg stat. An oropharyngeal airway was inserted into the mouth. The landmark was identified as a point posterior to the middle of the left clavicle, immediately lateral to the pulsation of the subclavian artery. This location was marked with a sterile pen. The cleaning of the infant was done using povidone-iodine.

A 50 mm short-beveled insulated needle with a 0.5-mm active tip was connected to a nerve stimulator (Plexygon®, Vygon, Rue de Paris, Ecouen, France) set at a current of 1.5 mA with a frequency of 1 Hz and pulse duration of 0.1 ms. The positive electrode of the nerve stimulator was connected to an electrocardiogram lead placed on the left arm. The block needle was inserted through the skin at an angle of 30°–45° in a caudal and lateral direction [Figure 1]. The needle was inserted to a depth of 0.5 cm, and flexion of the forearm was observed. The needle was manipulated until the stimulating current was 0.5 mA. At this point, 1.5 mL of 0.5% bupivacaine and 1.5 mL of 2% lidocaine in adrenaline 1:200,000 were injected after aspiration for blood or air using a 5-mL syringe. The onset of the block was 5 min. This was confirmed by the absence of response to pinprick using a blunt needle and absence of response to surgical stimulation. Intraoperatively, a total of 2 mg of midazolam was used for sedation (aliquots of 0.5 mg). Ramsey sedation score of 4 was achieved during the procedure. Intraoperative BP ranged between 100/70 and 80/60 mmHg. The pulse rate ranged between 120 and 130 bpm. SpO_2 ranged between 96% and 98%, with oxygen through nasal prongs at 2 L/min.

Table 1: Full blood count result of the infant

Investigation	Result
White blood cell count	15.9×10^9 cells/mm^3
Neutrophil count	95.9%
Lymphocyte count	2.7%
Platelet count	357,000 cells/L
Packed cell volume	17%, 34.5% (posttransfusion)

Table 2: Serum chemistry result of the infant

Investigation	Result on admission	Result after 2/52
Na^+	141 mmol/L	132 mmol/L
K^+	2.6 mmol/L	5.1 mmol/L
HCO_3^-	5 mmol/L	21 mmol/L
Cl^-	114 mmol/L	96 mmol/L
Urea	85.6 mg/dL	49.8 mg/dL
Creatinine	2.8 mg/dL	0.45 mg/dL
Albumin	37 g/dL (normal range=35-50)	
Random blood sugar	216 mg/dL	

The index patient had a transhumeral amputation at the supracondylar level. Equal anterior and posterior skin flaps were fashioned at 4 cm from the level of the intended bone section. Each flap was half of the diameter of the arm at that level. The brachial artery was identified, doubly ligated, and divided just proximal to the level of bone section. The median, ulnar, and radial nerves were identified, pulled, and transected at a higher level so as to retract proximally to the end of the stump. The muscles of the anterior and posterior compartments were divided distally to the level of the intended bone section. Flaps were retracted proximally, and the periosteum was incised circumferentially and retracted proximally at about 4 cm above the elbow joint. The bone was divided at this level and the distal end smoothened with a rasp [Figure 2].

The flaps were trimmed and carried across the end of the bone. The fascia was sutured with Vicryl 3/0. A plastic tube was inserted deep into the flaps for suction drainage. The skin was closed with interrupted nonabsorbable sutures. The wound was cleaned with chlorhexidine and dressed with povidone-iodine-soaked gauze. The estimated blood loss was 20 mL, and the infant was administered 40 mL of normal saline. The duration of surgery was 45 min, while the duration of anesthesia was 55 min. The duration of anesthesia was assessed using the time of start and end of anesthesia recorded on the anesthetic chart.

Postoperative vital signs showed a respiratory rate of 40 cpm, pulse rate of 120 bpm, and BP of 107/60 mmHg. Postoperative analgesia was supplemented with IV paracetamol 15 mg/kg every 6 h. The infant was transferred to the recovery room and subsequently to the pediatric ward. The drain was removed after 48 h, and sutures were removed after 2 weeks [Figure 3].

Discussion

Nerve stimulator-guided technique is commonly used for upper limb surgery in the adult population but rarely used in infants in this environment. The supraclavicular block results in anesthesia of dermatomes C5 through T1, and it has been described as the "spinal anesthesia" of the upper limb.[2]

Figure 1: Intraoperative image of the infant during block placement

Figure 2: Intraoperative image of the infant's arm during bone division

Figure 3: Postoperative image of the infant's arm

Several studies have investigated the use of nerve blocks for surgical anesthesia in infants. In a study done by Rukewe *et al*.,[3] the lowest age in for which a nerve block was used for upper extremity surgery in a tertiary hospital in Southwest Nigeria was 2 years. A French survey reported that regional anesthesia in infants accounted for 1% of the total anesthesia caseload.[4] Amiri and Espandar.[5] successfully performed supraclavicular brachial plexus blocks in children between the ages of 6 months and 6 years in their study. These studies showed that though supraclavicular block in infants was uncommon, it had been previously used successfully for surgical anesthesia. The decision to use supraclavicular brachial plexus block with sedation for this 11-week-old infant was taken after critically analyzing the risk–benefit ratio compared to GA.

The mixture of lidocaine and bupivacaine used to perform this block allowed the patient to get the benefit of a shorter onset and longer duration of action. The local anesthetic mixture used in this report was similar to that used by Rukewe *et al*.[3] who studied regional anesthesia for upper limb surgery in 145 patients. Other researchers have also suggested the use of a 1:1 mixture of 2% lidocaine in adrenaline and 0.5% bupivacaine for the performance of supraclavicular brachial plexus block.[6,7] In this index patient, the supraclavicular block provided adequate analgesia and enabled us to avoid the use of nonsteroidal anti-inflammatory agents and strong opioids postoperatively.

The supraclavicular block is not entirely risk-free, however there was no complication observed in this case report. Complications such as pleural puncture, pneumothorax, nerve injury, and Horner's syndrome have been documented after supraclavicular block though they are infrequent when performed by an anesthesiologist with appropriate training, skill, and sound judgment.[4,6,7] The complication occurs predominantly with the use of the paresthesia technique.[8] The anesthetic technique used in this report was site-specific and thereby caused minimal disruption in the cardiorespiratory system of the patient.[9,10] This advantage was necessary, especially since the infant had numerous comorbidities. A limitation of this report was the administration of fentanyl to the infant before block placement. The fentanyl increased the chance of deepening the sedation with the risk of possible airway loss. However, equipment for airway management and GA was available in the theater.

Conclusion

Peripheral nerve block in combination with sedation is rarely used in infants. In situations where GA is associated with increased risk of morbidity and mortality, nerve stimulator-guided supraclavicular block can be used to safely provide surgical anesthesia for upper limb surgery in infants.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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