Chapter

Axillary Block as the Sole Anesthetic for Peripherally Inserted Central Catheter Placement in an Infant with Goldenhar Syndrome

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Introduction

Goldenhar Syndrome is a phenotypically variable collection of congenital malformations stemming from the improper development of the first and second branchial arches. It is most often sporadic, but does have some familial instances [1]. Most commonly, the craniofacial abnormalities are unilateral, coining the term "hemifacial microsomia" [2]. Patients with this syndrome have an array of ocular, auricular, facial, cranial, vertebral, pulmonary and cardiac abnormalities [3]. The craniofacial abnormalities (often unilateral maxillary and mandibular hypoplasia) as well as vertebral anomalies (resulting in limited neck range of motion) combine to create very difficult airway management [3]. The respiratory system may be involved with a tracheoesophageal fistula, pulmonary hypoplasia, tracheal and subglottic stenosis or malacia, obstructive sleep apnea, and hemihypertrophy of the epiglottis [1]. Cardiovascular abnormalities range from 5-58% of patients, and most frequently include Tetralogy of Fallot, septal defects and situs inversus [4]. The combination of craniofacial, airway, pulmonary and cardiac abnormalities translate into significant anesthetic risk. Additionally, the difficult airway may become progressively worse with age, and may still occur after mandibular lengthening procedures [2].

The use of peripheral nerve blocks as the sole anesthetic in infants is uncommon but most often utilized when an anesthesiologist is trying to avoid general anesthesia, such as in a preterm infant, or a patient with unstable cardiac disease or a difficult airway. One short encounter with volatile anesthetics in an infant less than 60 weeks has not been shown to have any neurocognitive effects at five years [5]. However, patients with Goldenhar syndrome likely will have multiple reasons to undergo repetitive anesthetics. This high propensity for multiple anesthetics, plus their inherent difficult airway and possibly tenuous cardiac status suggest the use of regional anesthesia.

With the help of increasing ultrasound use and precise dosing guidelines, regional anesthesia in pediatrics has grown rapidly and safely [6]. Both neuraxial and peripheral nerve blocks are used for acute (and chronic) pain management for a wide variety of surgeries and indications. The insertion of peripherally inserted central catheters (PICC) is something that can be done awake in adults, but often requires involvement of an anesthesiologist in pediatrics. When appropriate, regional anesthesia can be utilized to avoid, or used in combination with, a general anesthetic. For lower extremity PICC placement, neuraxial anesthesia, specifically caudal anesthesia due to its longer duration over spinal anesthesia, is widely successful [7]. For upper extremity PICC placement, axillary peripheral nerve blocks are used successfully [8,9].

Described below is a medically complex infant who had an ultrasound guided (USG) axillary brachial plexus block for PICC placement.

Case Description

The patient was a 2-month old, 4.8 kg, full-term female with Goldenhar syndrome. Her congenital anomalies included right-sided cleft lip and palate, severe right lung hypoplasia with hypoplastic right pulmonary arteries and veins, dextrocardia with mediastinal shift, left-sided aortic arch with aberrant right subclavian artery creating tracheal compression, severe distal tracheomalacia, hypoplastic temporomandibular joint, micrognathia, right-sided microtia, right renal agenesis, left solitary kidney with duplicated collecting system, transverse liver, asplenia, rib anomalies and scoliosis. Her other presenting problem was significant gastroesophageal reflux for which she was gastrostomy-tube feed dependent. Pertinent history was a cardiac arrest in the operating room when she was positioned right side down for aortopexy (which was aborted at that time), and two episodes of profound bradycardia with hypotension in the pediatric intensive care unit (PICU) when she was turned to her right. Evaluations to look for the etiology of the above episodes included echocardiogram and CT angiography. The echocardiogram on right lateral decubitus position (RLDP) showed no vascular deformation/compression. The CT-angiography, done with the patient partially on RLDP, showed worsening of the tracheal narrowing from the previous 3 mm to 1 mm (Figures 1 and 2).

Figure 1: Tracheal compression, supine.

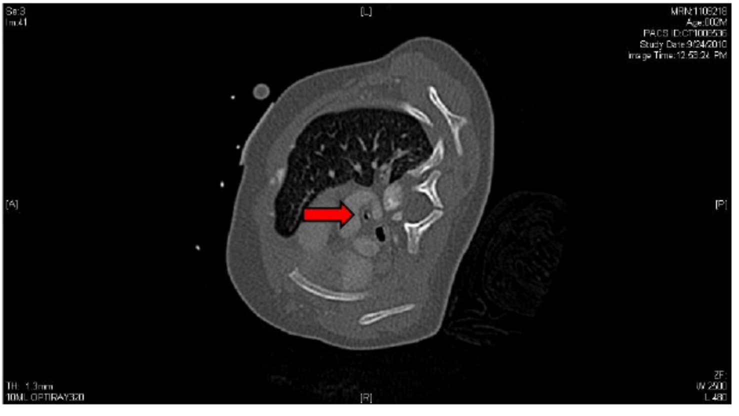

Figure 2: Further airway compression, RLDP.

This patient was referred to the Interventional Radiology and Anesthesiology departments for PICC placement. In the PICU, she was lying on a wedge with her body slightly tilted to the left, hemodynamically stable, breathing spontaneously with oxygen per nasal cannula, with suprasternal retractions (apparently her baseline). She had a nasogastric tube (NG) attached to a continuous suction.

She was transported with the standard monitors to the interventional radiology suite on the same position as she was at the PICU. The wedge and slight left body tilt were maintained for positioning on the procedure table. Oxygen per nasal cannula and NG tube to suction were continued. After scanning both arms, the interventional radiologist decided that a vein from the right arm would be the most suitable. The team agreed to an USG axillary block for analgesia. After doing the preoperative checklist, the right arm was abducted, and the axillary area was aseptically prepared. Using a 13-6 MHz, 25 mm transducer, the USG axillary block was done with a 25-g hypodermic needle and ropivacaine 0.5% 0.8 ml. See Figure 3 and 4 for ultrasound images. The patient was given a pacifier dipped in dextrose water. She was comfortable and did not react to the skin prep and needle puncture. No supplemental medication was necessary throughout the procedure. The central venous catheter placement took 28 minutes. She was transported back to the PICU awake and with stable vital signs. Six hours after the axillary block, she was moving both upper extremities and had no residual right arm weakness. No hematoma or bruising in the axilla was noted.

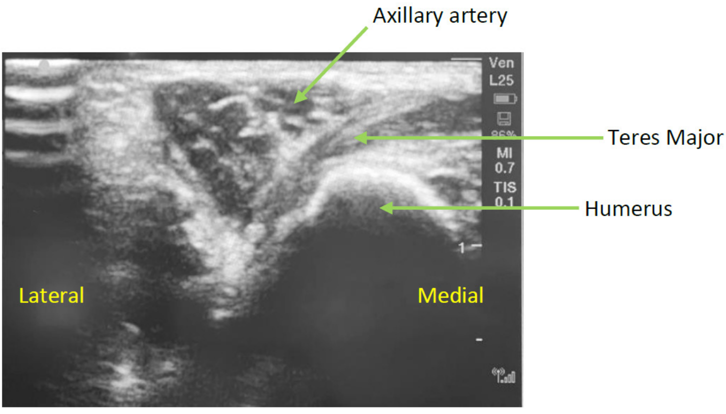

Figure 3: Ultrasound image prior to needle placement.

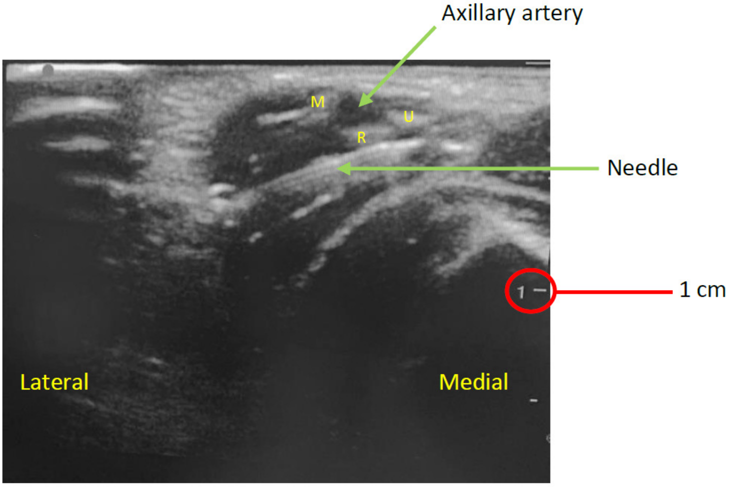

Figure 4: Ultrasound image after initiation of local anesthetic injection**.**

M = median nerve, U = ulnar nerve, R = radial nerve

Discussion

There are several anesthetic options for PICC placement in pediatric patients. Most common of these is the use of general anesthetic agents. Studies suggesting neurotoxicity of general anesthetic agents in the developing brain of animals and humans make other options for anesthetizing this patient population more enticing [10,11]. Low-dose narcotic infusion in combination with sucrose and non-nutritive sucking has been found to be effective in decreasing pain and distress in preterm infants [12]. However, it did not make PICC placement easier and faster [12]. Application of topical anesthetic cream has been shown to lessen the changes in vital signs during PICC placement in very low birth weight infants [13]. Marcatto et al. reported that there was no significant difference in the Neonatal Infant Pain Score (NIPS) of preterm neonates who had topical anesthetic during PICC placement when compared with glucose and placebo [14]. An axillary approach to the brachial plexus using anatomic landmarks has been demonstrated to be effective for PICC placement in small infants [8]. Ultrasound guidance has been shown to increase block placement success rate, shorten block performance and onset times, and require lower volume of local anesthetic in children [15]. Studies have demonstrated that ultrasound guided (USG) peripheral nerve block is associated with higher overall success rate when compared with nerve stimulation [15,16].

Peripheral nerve blocks of the brachial plexus provide excellent anesthesia and analgesia for upper extremities procedures. The 4 main types of brachial plexus nerve blocks include the interscalene, supraclavicular, infraclavicular and axillary nerve blocks. An interscalene nerve block targets the brachial plexus at the level of the roots, specifically C5 and C6, in the interscalene groove (in between the anterior and middle scalene muscles). This block is excellent for shoulder surgery in its anesthetic coverage, but does have significant side effects such as ipsilateral diaphragmatic paralysis and Horner's syndrome. The supraclavicular block, performed at the level of the trunks/divisions of the brachial plexus, is often called the "spinal of the arm". This is because of its extensive coverage from the shoulder to the fingers after one injection due to the tightly organized brachial plexus [17]. However, this is a non-compressible site (in case of hematoma formation) and has the increased risk of a pneumothorax due to its close proximity to the lung apex. An infraclavicular block is located inferior to the clavicle at the level of the cords of the brachial plexus. This block is ideal for surgeries of the elbow, forearm or hands, but can be challenging with the steep angle required for approach as the plexus lies deep to the pectoralis major and minor muscles.

An axillary peripheral nerve block targets the brachial plexus at the level of the terminal branches, specifically the radial, median, ulnar and musculocutaneous nerves. Less often discussed, other terminal branches involved in this block (and important for PICC line placements) are the medial cutaneous nerves of the arm and forearm, branching close to the ulnar nerve from the medial cord (18). Traditionally, the median nerve is located superolateral to the axillary artery, the radial nerve is posterior or posteromedial and the ulnar nerve is medial [19]. These exact positions are variable, but the nerves are consistently located around the axillary artery [20]. Therefore, while not always able to appreciate the nerves directly on USG, one can deposit local anesthetic circumferentially around the axillary artery with reliable success. However, if the musculocutaneous distribution is required, it will often require a separate injection as it is typically located laterally to the artery in the fascial plane between the brachialis and the biceps muscles. The axillary block is arguably the safest of all the brachial plexus blocks, as it is nowhere near the lung or pleura, it is a superficial block (helpful for accidental hematoma formation or for visibility in obese patients – especially when compared to less compressible areas such as the infra- and supraclavicular blocks) and it is located away from the phrenic nerve avoiding any pulmonary involvement [19]. In addition to the analgesia and motor block of the upper extremity creating a suitable field for the proceduralist, axillary blocks (as well as any of the brachial plexus blocks) have the added benefit of inducing vasodilation of blood vessels secondary to sympatholytic effect on the endothelium [21,22]. Specifically, helpful for PICC line placement is vasodilation of the small basilic and cephalic veins [9). Axillary blocks have been historically used during acute ischemic events of the upper limb to successfully restore blood flow [23].

As this is a relatively superficial block, a linear high frequency ultrasound probe will facilitate the clearest image. Typical needles used for injection would include a 21- or 22-gauge, 5 cm or 10 cm short bevel needle for adolescents or adults. Or, for neonates and infants, a 25- or 27-gauge hypodermic needle is more than adequate. Local anesthetic options are vast, depending on preferences for onset time and duration of sensory or motor blockade needed. Ropivacaine is commonly used in pediatric patients due to the preferential cardiotoxicity profile (compared to bupivacaine) [24]. During an axillary nerve block, the shoulder is abducted with the elbow bent at 90 degrees to allow access for ultrasound probe placement in the axilla. The operator scans in the axilla until the axillary artery is appreciated, ideally lying superficial to the bright fascia of the teres major muscle which creates a helpful backstop to the injection of local anesthetic [19]. To confirm identity of the nerves, it is best to trace them proximally and distally on the arm, however, this is not required for block success. Ideally, the nerve block can be done in two passes of the needle. The first pass will include a small injection around the musculocutaneous nerve, followed by continuing further to inject deep (posterior) to the axillary artery. Then, the operator can withdraw the needle enough to redirect superficial to the artery to ensure complete perivascular spread. A classic upper extremity PICC line, depending on which vein will be accessed (basilic or cephalic veins), will require inclusion of the musculocutaneous nerve, medial cutaneous nerve of arm and forearm and radial nerve.

Patients with Goldenhar syndrome present with oral, tracheal, pulmonary, cardiac and central nervous system abnormalities that may significantly influence the choice of anesthesia. The potential for a difficult airway in these patients is a prime consideration. For a medically complex patient with a potentially difficult airway and a very high risk of aspiration like our patient, a technique that would avoid or at least minimize these problems and at the same time allow for a safe and quick PICC placement is most appropriate. This case demonstrates that USG axillary block, without general anesthesia, can be a safe and effective anesthetic technique for PICC placement in critically ill infants.

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