Regional Block Catheter Insertion Using Ultrasonography and Stimulating Catheters

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B.C.H. Tsui, S. Suresh (eds.), *Pediatric Atlas of Ultrasound- and Nerve Stimulation-Guided Regional Anesthesia*,
DOI 10.1007/978-0-387-79964-3_5

5.1 Indications, Contraindications, and Safety of Peripheral Nerve Catheter Placement

Prior to performing any procedure, the risk should be balanced against the benefit. This is particularly true in the pediatric population, where data on the efficacy and safety of peripheral nerve catheters is scarce. In general, peripheral catheters are used in children undergoing procedures that are associated with significant and prolonged postoperative pain, such as major orthopedic procedures, traction of femoral fractures, operations on congenital malformations of upper or lower limbs, and amputation, or to facilitate postoperative physiotherapy. Peripheral catheters can also be used in children to improve peripheral perfusion following microvascular surgery and to help manage chronic pain conditions.

One of the main considerations of peripheral nerve catheter placement is when there is a high risk of neurovascular injury from either the injury or surgery, for example, condylar or supracondylar fractures of the elbow. Physicians should exercise caution since there is a lack of safety data with regard to regional anesthesia in patients with preexisting neurological disorders. Another consideration is that there is continued debate regarding performing regional anesthesia in anesthetized adults. Such practice is well accepted in pediatric patients as it reduces the risk of a "moving target" and because children are often unable to communicate and differentiate between paresthesia, pain at injection site, or pressure from the injectate.

5.2 Equipment and Injectates

5.2.1 Equipment Required

5.2.1.1 Types of Catheters

1. *Non-stimulating Catheters*

The principle behind these types of catheters is the catheter-through-needle technique, in which the catheter is introduced *within* the larger-bore Tuohy needle which has been placed in proximity to the nerve. The Tuohy needle will be removed at the end of the procedure leaving the catheter in situ. Despite the concurrent use of ultrasound, catheter threading is performed essentially blind due to its small diameter. The catheter tip position is often difficult to ascertain since needle withdrawal is inevitably accompanied by simultaneous compensating advancement of the catheter. In order to facilitate threading of the catheter into the perineural space, Pajunk has designed a peripheral continuous catheter (SonoLong Curl Continuous kit, Pajunk, Geisingen, Germany) which curls immediately after exiting the needle (Fig. 5.1), allowing the tip to remain near the position of the needle tip.

2. *Stimulating Catheters*

Although it is still unclear as to whether stimulating catheters are more effective than non-stimulating catheters at positioning the catheter tip in proximity to the nerve, stimulating catheters can aid in the verification of catheter tip localization. When motor response is present at a reasonable threshold (0.5 mA), this usually signifies the correct placement of a stimulating catheter. Some stimulating needle and catheter sets, for example, the StimuCath® (Arrow International, Reading, PA, USA) with a 5 mm bare tip, may need a higher stimulation current, such as 1 mA; it should also be noted that nerve stimulation is not sensitive enough to detect intraneural placement of the catheter. Therefore, it is our recommendation that the spread of local anesthetic through the catheter tip be observed with ultrasound. Ultrasound-guided perineural catheter insertion can be technically challenging and requires a sound knowledge of sonoanatomy, good hand-eye coordination, and a competent assistant. High success rates can be obtained once these skills are acquired.

Catheters that are used in continuous peripheral nerve blocks in children are similar to those used in adults. There are four commercial varieties of catheters available with different lengths of needles required for various blocks and to accommodate the child's habitus/size. Several manufacturers now provide Tuohy needle/catheter sets specifically tailored for pediatric use.

Arrow® StimuCath (Arrow International, Reading, PA, USA)

- The insulated needle is 17G and 18G Tuohy-tipped with centimeter markings available in 4 and 8 cm (Fig. 5.2).
- The 60-cm-long catheter comes in 19G and 20G which is made more rigid by a steel stylet.
- The catheter has a female adaptor to accommodate the stimulating cable from the nerve stimulator.
- The catheter has a SnapLock™ adaptor.
- The hub of the catheter is a stimulating cable that stimulates the catheter
- The stylet has to be removed before liquid can be injected through the catheter as it is advanced for hydrodissection (see below).
- The catheter can kink if resistance is encountered during insertion.

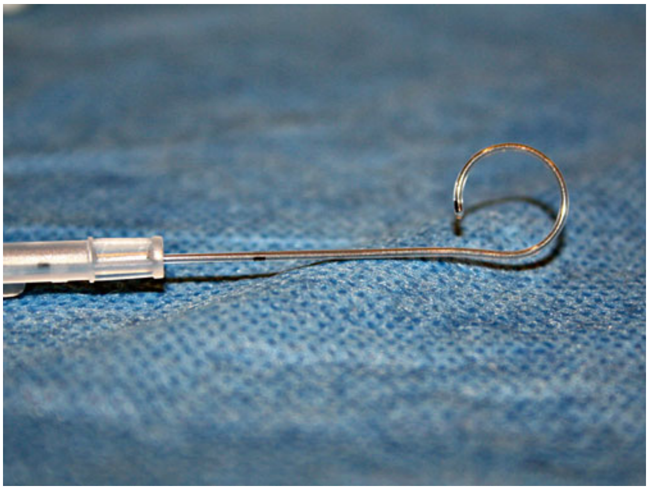

Fig. 5.1 Pajunk® SonoLong Curl

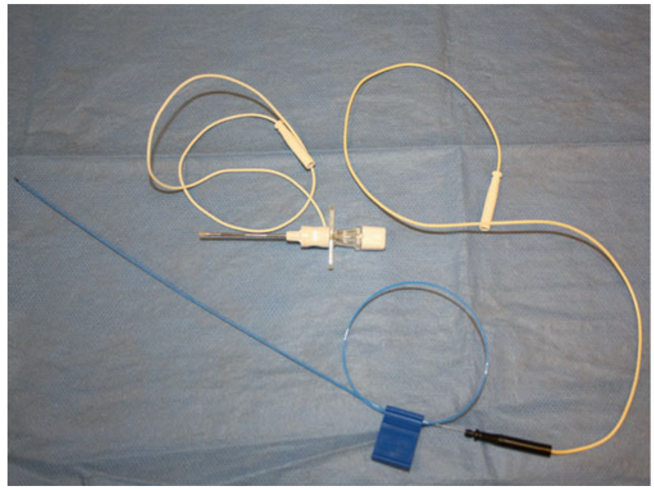

Fig. 5.2 Arrow® StimuCath

Pajunk® StimuLong Sono (Pajunk, Geisingen, Germany)

- The insulated Tuohy needles are available in 50, 100, and 110 mm lengths.
- The stimulating catheter has a gold-plated, atraumatic rounded tip with a high conductivity (Fig. 5.3).
- The catheter does not have a stylet, enabling fluid to be injected as the catheter is advanced.
- The metal coil of the catheter provides radiopacity and prevents kinking of the catheter as it meets resistance.

Pajunk® StimuLong Sono-Tsui Set (Pajunk, Geisingen, Germany)

- The insulated Tuohy needles have lengths of 50 and 100 mm (Fig. 5.4).
- The catheter design incorporates the characteristics of the StimuLong Sono catheter with two distinct features:
  – The stiffness of the catheter tip can be regulated by pushing the steel stylet forward and backward and can be locked in place by tightening or loosening a valve. This ensures atraumatic manipulation of the catheter tip.
  – Similar to the StimuLong Sono catheters, fluid can be injected through the catheter during advancement for hydrodissection.

ContiStim® Catheters (B.Braun, Melsungen, Germany)

- Life-Tech has incorporated smaller catheters (21G–24G; Prolong Micro) for pediatric use.
- The 18G, 19G, and 20G insulated Tuohy needles are available in variable lengths of 50, 100, and 150 mm.
- It has an atraumatic ball tip to reduce tissue damage and create a 360° outflow pattern.
- The catheters are said to be kink resistant.
- The fluid path/giving set connector is attached to a port for stimulation of the catheter.
- It features an EzTwist™ closure for the fluid path connector which indicates that the catheter has been securely connected.

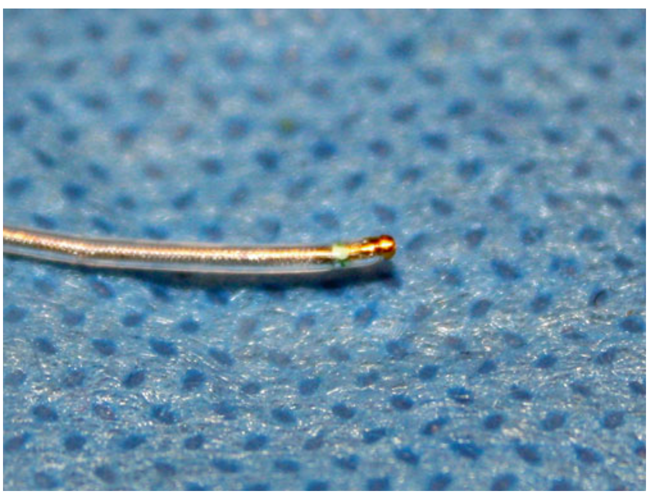

Fig. 5.3 Stimulating catheter (Pajunk® StimuLong Sono) featuring a gold-plated, atraumatic rounded tip with a high conductivity

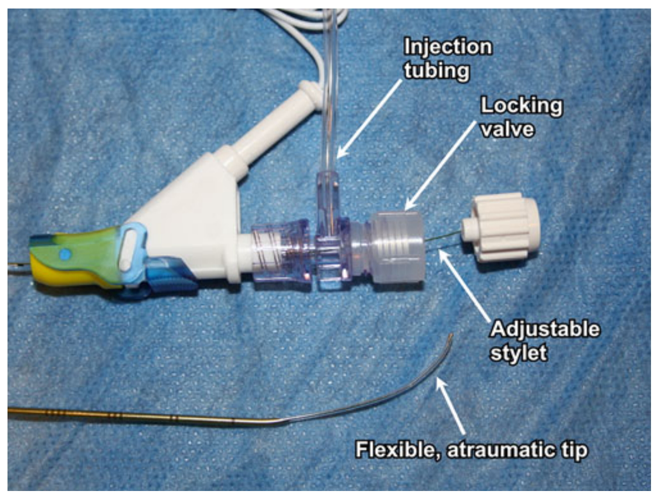

Fig. 5.4 Pajunk® StimuLong Sono-Tsui Set. Catheter tip with steel stylet to adjust stiffness. Stylet can be pushed forward or backward and can be locked in place with a valve

3. *Catheter-over-needle assembly*

- There are a few variations on this design marketed by different brands:
  – Pajunk, whose feature design is its two components, the outer catheter sheath and the flexible, non-kinkable inner catheter (Figs. 5.5 and 5.6). This assembly was initially designed and modified by Dr. Ban Tsui. The inner catheter is introduced within the outer catheter and is Luer-locked in place for injection (Fig. 5.7).
  – B.Braun, with the catheter-over-needle as a sole component (Fig. 5.8)
  – Arrow, with a catheter-over-needle with a blunt needle and a sharp injection needle for the initial puncture of the skin (Fig. 5.9).
- To position the distal end of the outer catheter in proximity to the target nerve, a 21G needle is inserted *within* the outer catheter with its distal end protruding for its electrically conductive property.
- The insertion of this catheter/needle unit is under real-time ultrasound guidance and nerve stimulation. The latter is used mainly to monitor for the absence of motor response to prevent intraneural injection.
- The distal end of the outer catheter is tapered and thin for smooth advancement within the tissue. The second component of the inner catheter is inserted *into* the outer catheter after the needle has been withdrawn.
- The main difference between this catheter-over-needle assembly and the traditional catheter-through-needle assembly is the position of the needle in relation to the catheter. In the traditional assembly, the catheter is introduced within the Tuohy needle; therefore, upon removal of the Tuohy needle, a gap is left between the skin and the catheter. In contrast, the needle in the catheter-over-needle assembly is within the outer catheter which remains in situ at the end of the procedure. This enables a tight fit between the skin and the catheter. Moreover, the inner catheter literally replaces the needle, which was initially placed in proximity to the nerve before its withdrawal. This enables the tip of the inner catheter to be in proximity to the nerve.

Several advantages of this design include:

- Simple to use with the insertion technique comparable to that of a single-shot nerve block
- Less risk of leakage from the catheter insertion site, which is particularly important in shoulder surgery where the patient is in a sitting position with a potential for surgical field contamination
- Less risk of dressing adhesive disruption
- Less risk of dislodgement
- Less cumbersome steps
- Easy visualization of the catheter, especially the catheter tip

A preassembled peripheral catheter pack is an efficient way of bringing together all the essential equipment to perform a peripheral nerve catheter. If such a pack is not available, a cart/trolley with all the necessary equipment should be prepared. The equipment required includes:

- Sterilizing solution.
- Sponges/gauze.
- Drapes.
- Lidocaine in a small syringe and 23G hypodermic needle for skin infiltration if necessary.
- Sterile ultrasound transducer cover, sterile gel, and elastic bands for transducer preparation (see below).
- Appropriately sized (gauge and length) Tuohy needle and extension tubing, nerve block catheter, or catheter-over-needle.
- 5 % dextrose in water (D5W) and appropriate syringes for hydrodissection.
- Micro-filter or giving set attachment for the injecting into the catheter.
- Appropriate dressings.
- Sterile gowns and gloves (it is recommended that full sterile procedure should be observed for peripheral catheter insertion, including a face mask, hat, sterile gown, and gloves).
- Ultrasound machine with appropriate settings.
- The nerve stimulator should be set up and ready to use for the initial placement of the needle and/or if a stimulating catheter is to be used.

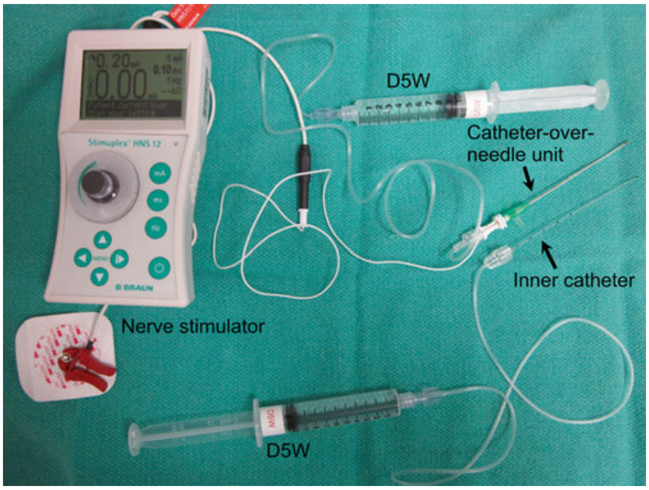

Fig. 5.5 Pajunk® catheter-over-needle assembly

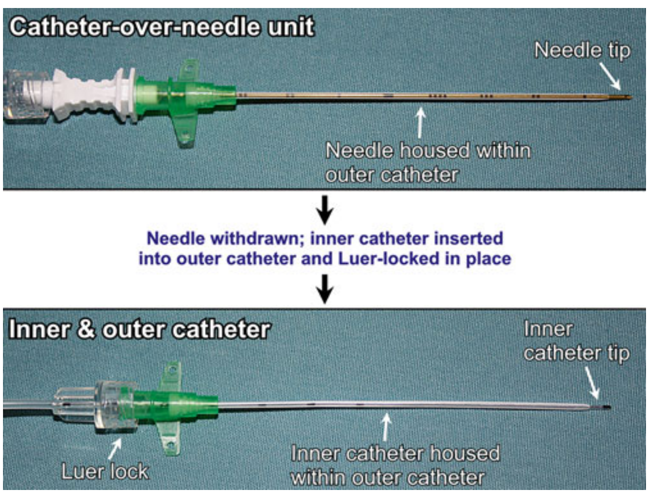

Fig. 5.6 Detail of Pajunk® catheter-over-needle components

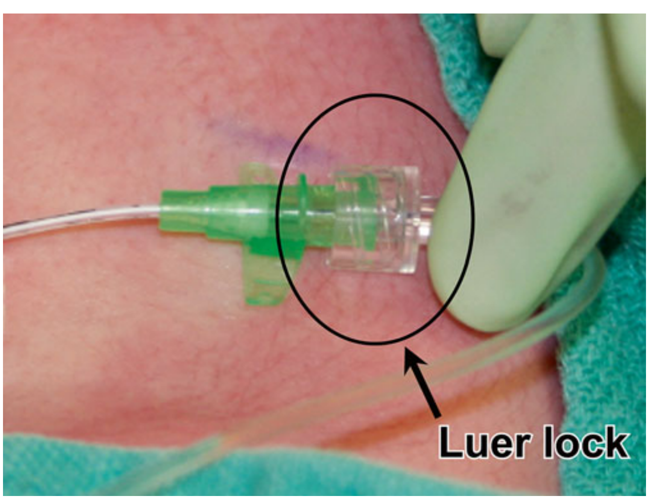

Fig. 5.7 Luer-lock holding together the inner and outer catheter

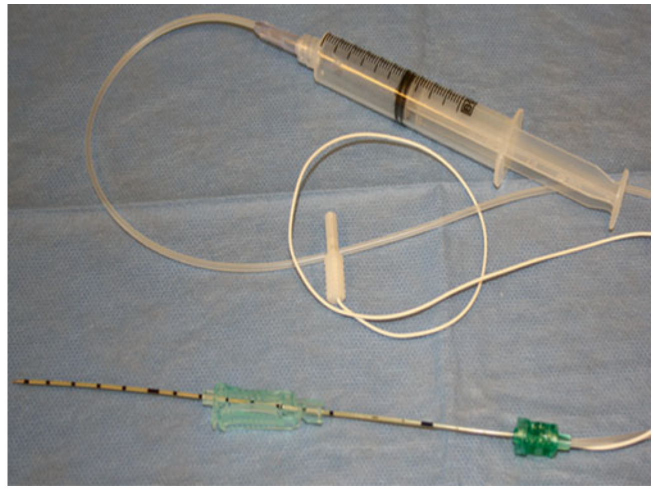

Fig. 5.8 B.Braun® catheter-over-needle assembly

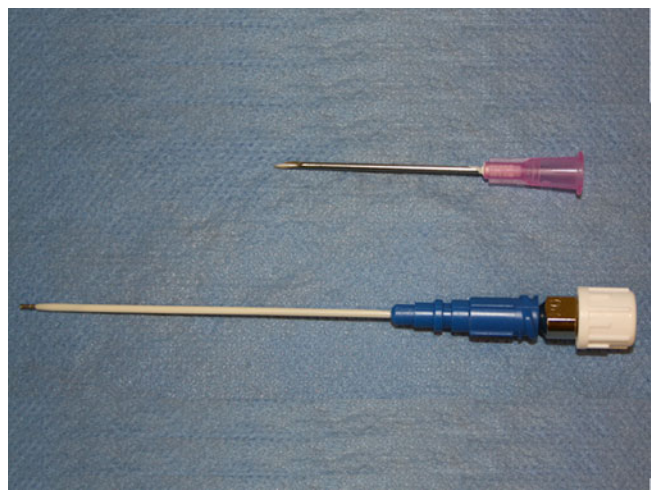

Fig. 5.9 Blunt and sharp needles from Arrow® catheter-over-needle assembly

5.2.2 Sterile Transducer Preparation

For peripheral nerve catheter insertion, it is important to have an appropriate sterile cover for the ultrasound transducer as well as for the cord so it does not contaminate the sterile field while scanning (see Chap. 4, Sect. 4.3). The following describes how to prepare a sterile transducer probe:

- Open the sterile sheath by placing two thumbs inside the sheath, and roll the length of the sheath up so that the sheath bunches up in the hand.
- Ensure plenty of sterile gel is applied on the inside of the sheath where the surface of the transducer is to be placed.
- Cover the transducer inside the sheath, and push the length of the sheath to cover the cord of the transducer (take care to avoid desterilizing the gloves).
- Pull an elastic band over the cord to hold the sheath on the cord.
- Stretch the surface of the sheath covering the transducer to avoid any air bubbles or creases before pulling an elastic band over the transducer to hold it in place. This will also minimize any sliding between the sheath and the transducer while scanning.

5.2.3 Choice of Injectates

5.2.3.1 During Catheter Insertion

To facilitate advancement of the catheter, a solution is injected through the Tuohy needle to expand the perineural space; however, the use of local anesthetics or conducting solution, such as normal saline, will abolish the capacity to stimulate. This is particularly important when stimulating catheters are used.

Hydrodissection using D5W, a nonconducting fluid, is useful for “dissecting” or “opening” of the perineural space. This facilitates catheter advancement while maintaining the ability to stimulate and may enhance the contrast at the tissue interface, potentially allowing for better visibility of both the needle and the catheter under ultrasound. Overaggressive hydrodissection is not advised since it may hinder electrical stimulation of the nerve by creating a potential mechanical barrier.

Local Anesthetics

Unlike in adults, the dose of local anesthetics is weight dependent in infants and children. In pediatric patients, after an initial bolus, the dosage recommended for continuous infusion is 0.1–0.2 mL/kg/h of either bupivacaine or levobupivacaine (0.125–0.25 %) or ropivacaine (0.15–0.2 %). The lower rates are generally used for upper extremity catheters and the higher rates for lower extremity catheters. If necessary, the infusion rate may be adjusted up to a maximum of 0.2 mg/kg/h for infants of less than 6 months and 0.4 mg/kg/h in children of more than 6 months.

5.3 Technique

When inserting peripheral nerve catheters, aseptic technique should always be observed in order to reduce the risk of infection. All the equipment should be ready as described in Chap. 1.

The key practical techniques for insertion of peripheral nerve catheters are as follows:

- An assistant who is trained in regional anesthesia with experience in monitoring pediatric patients under sedation or general anesthesia should be present. This is important not only for monitoring the child during catheter insertion but to assist with the nerve stimulator and the injectate.
- Routine monitoring such as electrocardiography, noninvasive blood pressure, pulse oximetry, capnography, and end-tidal gas monitoring (especially for those in whom anesthesia is maintained on volatile agents) is applied.
- Emergency drugs such as atropine, ephedrine, and succinylcholine are drawn up, and resuscitation drugs such as epinephrine and Intralipid are available if needed.
- There should be oxygen supply and an Ambu® bag (or Bagger) available.
- Intravenous access should be established.
- The child should either be sedated with titrated doses of midazolam and/or fentanyl or induced under general anesthetic. If nerve stimulation is used for identifying the target nerve or for the stimulating catheter, use of muscle relaxants should be avoided.
- Patient is placed in a suitable position for peripheral nerve catheter placement.
- The height of the bed and the position of the ultrasound machine should be placed in an ergonomically friendly fashion.
- Pre-procedure scanning is helpful to determine the optimal ultrasound machine settings such as gain, depth, scanning mode, and focus range. Scanning can also identify any abnormal anatomy in advance.
- Ensure all the equipment is gathered and prepared as outlined earlier in this chapter.
- The skin should be cleaned with a sterile solution and the area draped.
- The probe is covered with sterile gel which is then covered with the long sterile probe sleeve. An elastic band can be applied to minimize slipping of the sheath against the transducer and to prevent air bubbles from accumulating.

Traditional non-stimulating nerve block catheter and stimulating nerve block catheter insertion techniques

- The catheter is prepared, kept in a sterile towel, and placed on the sterile field. It must be within easy reach of the operator during the procedure.
- The Tuohy needle is attached to the extension tubing and flushed with D5W.
- Sterile gel is applied to the skin.
- The ultrasound probe is used to identify the target nerve.
- If the patient is sedated, local anesthetics can be injected to raise a skin wheal at the site of planned needle entry.
- The Tuohy needle can be inserted in plane or out of plane with respect to the probe axis.
  - When an in-plane approach is used, there is a good view of the advancement of the needle. If the nerve runs perpendicular to the needle insertion, the tip of the catheter should be placed underneath or above the nerve rather than parallel to the nerve.
  - When an out-of-plane approach is used, tissue movement can be appreciated as the needle is advanced. On sliding the probe proximally and distally from the needle insertion site, the cross section of the tip of the needle can be appreciated when the hyperechoic dot disappears and reappears as the probe is slid proximally and distally. An out-of-plane technique allows the catheter to be placed parallel to the nerve if the nerve runs parallel to the direction of needle insertion.
- For both in-plane and out-of-plane techniques, D5W can be used to hydrodissect the tissue plane to confirm the position of the needle tip, provide a space for the advancement of the catheter, and create a better contrast medium for visualization of the needle.

Methods used to confirm the catheter tip location differ between the non-stimulating and the stimulating nerve block catheters. Ultrasound can be used to help ascertain the non-stimulating catheter tip, whereas both nerve stimulation and ultrasound can be used to determine the stimulating catheter tip in relation to the nerve.

5.3.1 Confirming Catheter Tip Location with Ultrasonography

When using ultrasound to determine the location of the catheter tip, the transducer may be placed along the length of the catheter as it is aspirated, allowing movement of the column of fluid within the catheter to be observed. Injecting D5W through the catheter to expand the hypoechoic area may also help to locate the catheter tip.

If the movement of the fluid column in the catheter can be observed on aspiration but no spread of the injectate is in view, the catheter may be too deep into the tissue and may need to be pulled back. One can also use the markings along the catheter to note the depth of the catheter in the tissue.

Doppler color flow is another useful method to determine tissue movement upon injection of agitated D5W through the catheter.

As previously mentioned, it is always good practice to observe the spread of the injectate delivered via the peripheral nerve catheter to visually confirm the position of the catheter tip. This practice should be employed whether a stimulating catheter is used or not.

5.3.2 Confirming Catheter Tip Location with Nerve Stimulation

- Since the stimulating catheter is to be inserted beyond the tip of the needle, the length of the needle and the extension tubing should be noted to ensure an accurate stimulation response elicited by the catheter independent from the needle.
- The nerve stimulator should be set at 0.5 mA since a higher current not only causes discomfort to the patient but can also cause muscle twitches which displace the probe and the needle.
- When the tip of the needle is at the desired position, negative aspiration for blood should be confirmed and a small amount of D5W should be injected. It is important to observe the spread of the solution since it provides information on the location of the needle tip. If hydrodissection is not observed, the needle tip may be in an intravascular position.
- The injection of D5W should amplify the motor response.
- The extension tubing is then removed and the nerve stimulator is disconnected from the Tuohy needle.
- The catheter, with the stimulation port attached to the nerve stimulator, is inserted through the Tuohy needle.
- The catheter should be advanced beyond the tip of the Tuohy needle and the subsequent motor response observed.
- In order to place the nerve block catheter tip in proximity to the nerve, the specific motor response pertaining to the sensory distribution of the nerve should be observed.
- It is possible for the catheter to be advanced too far, causing it to coil. This can be seen by an increase in the motor response on further advancement of the catheter. If this is noted, the catheter should be pulled back until ideal motor stimulation is achieved.

5.3.3 Catheter-Over-Needle Assembly Insertion

- An appropriate length catheter-over-needle assembly is the key to success. Therefore, it is useful to perform a prescan to estimate the distance between skin puncture and the nerve.
- Both the catheter-over-needle assembly and the inner catheter should each be primed with 10 mL of D5W.
- Sterile gel is applied to the skin.
- Ultrasound probe is used to identify the target nerve.
- Local anesthetic is used to raise a skin wheal at the site of planned needle entry.
- 21G catheter-over-needle (of the chosen length) can be inserted in plane or out of plane.
- Nerve stimulator at a current of 0.2 mA can be attached to monitor for the absence of motor response. This will help to prevent intraneural needle insertion.
- As the tip of the needle is in the desired position, injection of D5W can be used to ascertain the spread. Hydrodissection with D5W or local anesthetic can be used.
- The needle is removed while the outer catheter remains in situ.
- The inner catheter is introduced within the outer catheter and is Luer-locked in place (Fig. 5.7).
- The spread of the injectate via the inner catheter tip can be confirmed under ultrasound. This is relatively easy to do since the ultrasound probe can be held at all times during the catheter insertion (with a single operator) and the inner catheter is inserted the same place as the needle which has been removed.

Clinical Pearls

Catheter insertion can be performed using in-plane or out-of-plane approach (see Chap. 4) with the nerve imaged in a short axis (cross-sectional view) or long axis (longitudinal view). However, if the nerve is imaged in short axis and an in-plane approach is used, the catheter should not be threaded too far beyond the Tuohy needle tip when using the traditional catheter insertion technique. Note that this is *not* an issue if the catheter-over-needle approach is used.

It seems logical to scan the nerve in a long axis and use an in-plane approach such that the catheter travels parallel to the nerve. However, it is not always easy to scan the nerve in a long axis since the course of the nerve may not be straight or it may become more superficial or deep. Therefore, it is important to apply the knowledge of anatomy when selecting the most appropriate plane to scan the nerve.

5.3.4 Securing the Catheter

It is important to secure the peripheral nerve catheter in place both for inpatient and ambulatory care. This can be done in several ways:

- Applying cyanoacrylate (e.g., Dermabond®) at the entrance site of the catheter.
- Subcutaneous tunneling before fixation with occlusive dressing.
- Securing the dressing more effectively (e.g., with Tegaderm™) by removing all of the gel before applying skin glue, such as Mastisol or cyanoacrylate glue.
- The catheter-over-needle can be secured with a normal IV dressing and a caution label, such that the catheter is clearly marked as a peripheral nerve block catheter (Fig. 5.10).

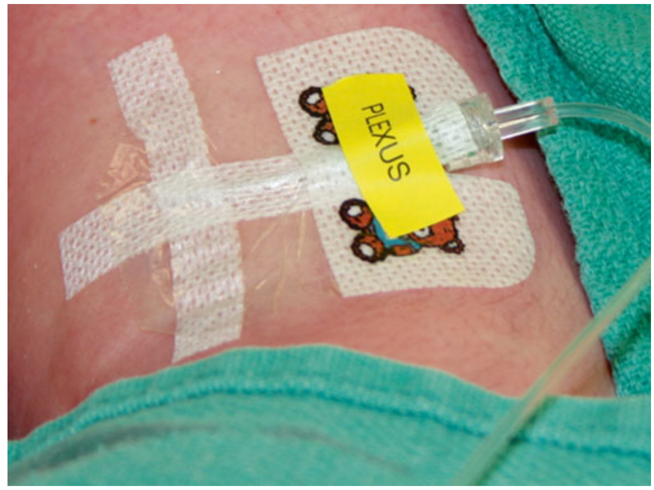

Fig. 5.10 Catheter-over-needle secured with IV dressing and clearly marked as a peripheral nerve block catheter

5.4 Examples of Common Peripheral Nerve Catheterization Procedures Used in Children

5.4.1 Infraclavicular Nerve Block Catheterization

5.4.1.1 Position

Supine with arm adducted, elbow flexed, and forearm placed on the abdomen

5.4.1.2 Transducer

SLA "hockey stick" (25 mm, 13–6 MHz) for smaller children or linear probe (38 mm, 13–6 MHz) for older/larger children

5.4.1.3 Surface Landmark

Coracoid process and clavicle

5.4.1.4 Sonoanatomy

The axillary artery is deep to the pectoralis major and minor muscles. The lateral cord of the brachial plexus lies superior to the artery, the posterior cord lies posterior to the artery, and the medial cord lies posterior and medial to the artery. The axillary vein lies just caudad to the artery.

5.4.1.5 In-Plane Approach

Place the transducer just medial to the coracoid process, caudad to the clavicle, in a longitudinal or parasagittal position. Insert a 5 cm, 18G–20G insulated Tuohy needle in a cephalad-to-caudad direction. Aim to position the catheter just next to the posterior cord and posterior to the artery. Beware of the pleura medially to the transducer.

5.4.1.6 Motor Response to Nerve Stimulation

Flexion or extension of wrist or fingers

> **Clinical Pearl**
> Sometimes the arm can be abducted 90° at the shoulder and elbow to increase visibility of the cords.

5.4.1.7 Clinical Evidence

Continuous infraclavicular brachial plexus block was described for pain control in two pediatric patients undergoing orthopedic procedures [1]. Another case report used ultrasound-guided continuous infraclavicular block to produce sympathectomy of extended duration, resulting in a long-term positive outcome in a 9-year-old with traumatic amputation of the hand [2].

5.4.2 Femoral Nerve Block Catheterization

5.4.2.1 Position

Supine

5.4.2.2 Transducer Selection

Linear probe (38 mm, 13–6 MHz) or SLA "hockey stick" (25 mm, 13–6 MHz), depending on the size of the child

5.4.2.3 Surface Landmark

Inguinal crease

5.4.2.4 Sonoanatomy

Identify the femoral artery. If the profunda femoris artery is in view, scan proximally until only one artery is present. The hyperechoic femoral nerve is lateral to the femoral artery, superficial to the iliopsoas muscle, and just deep to the hyperechoic line of the fascia iliaca.

5.4.2.5 In-Plane Approach

Place the transducer just below the inguinal crease. Insert an appropriately sized insulated Tuohy needle (e.g., 5 cm, 18G–20G) lateral to the femoral nerve. The needle shaft and tip should be in view. Aim to place the catheter just deep to the femoral nerve on its medial aspect.

5.4.2.6 Out-of-Plane Approach

As with the in-plane technique, place the transducer just below the inguinal crease. Insert an appropriately sized insulated Tuohy needle perpendicular to the transducer. Only the cross section of the needle shaft can be seen. Aim to place the needle tip just deep to the fascia iliaca. Hydrodissection will help to confirm that the injectate is introduced at the correct tissue layer and will also help to open up the space. Advance the catheter 1–3 cm beyond the needle tip, depending on the age and size of the child, so that it lies parallel to the nerve.

5.4.2.7 Motor Response to Nerve Stimulation

Sartorius and midline "dancing of the patella" (quadriceps) twitches are both accepted.

> **Clinical Pearl**
> If two branches of the femoral nerve are observed after hydrodissection, aim for the deeper branch.

5.4.2.8 Clinical Evidence

The evidence supporting the use of femoral nerve catheter in children is limited. There is a recent case report on its use in intractable pain from a chronic dislocated hip in a 12-year-old girl [3].

5.4.3 Sciatic Nerve Block Catheterization

5.4.3.1 Subgluteal Approach

Position
Lateral

Transducer
Linear probe (38 mm, 13–6 MHz)

Surface Landmark
Greater trochanter and ischial tuberosity

Sonoanatomy
Identify the acoustic shadows cast by the greater trochanter and the ischial tuberosity. The sciatic nerve is in cross section lateral to the long head of the biceps femoris muscle.

In-Plane Approach
Place the transducer with one end on the greater trochanter and the other end on the ischial tuberosity. Insert an appropriately sized insulated Tuohy needle (e.g., 5 cm, 18G–20G) perpendicular to the probe. Aim to place the needle tip just above the sciatic nerve, and advance the catheter 1–3 cm beyond the needle tip, depending on the age and size of the child.

Motor Response to Nerve Stimulation
Plantar flexion or dorsiflexion of the foot

> **Clinical Pearls**
> The current of the nerve stimulator needs to be increased as the catheter is advanced.
> Rotating the Tuohy needle 90° sometimes allows for better advancement of the catheter.

Clinical Evidence
Compared with other blocks, there are more clinical studies and case reports on continuous subgluteal sciatic nerve blocks in children for correction of congenital defects, orthopedic oncology surgery, osteotomy, and amputation [4, 5]. Each has demonstrated successful results with minimal side effects.

5.4.3.2 Popliteal Approach

Position
Lateral

Transducer
Linear probe (38 mm, 13–6 MHz)

Surface Landmark
Knee crease

Sonoanatomy
The sciatic nerve at the popliteal region is just medial to the biceps femoris muscle. Be aware of the popliteal vessels just medial and anterior to the sciatic nerve. Scan proximally and distally to identify where the sciatic nerve divides into the tibial nerve and the common peroneal nerve.

Out-of-Plane Approach
Place the transducer just above the knee crease; the sciatic nerve is usually divided at this point. Scan proximally until the sciatic nerve has just divided. Insert an appropriately sized insulated Tuohy needle (e.g., 5 cm, 18G–20G) perpendicular to the probe and aim to place the needle tip at a point when the sciatic nerve just split. The catheter can then be advanced 1–3 cm beyond the needle tip, depending on the age and size of the child.

Motor Response
Plantar flexion or dorsiflexion of the foot

> **Clinical Pearl**
> It is better to direct the catheter cephalad to enable its proximal placement along the sciatic nerve.

Clinical Evidence
There are prospective studies and case reports demonstrating the efficacy of continuous popliteal sciatic nerve blocks [6–9]. One study also demonstrated reduced adverse effects compared to epidural analgesia [10]. A recent study evaluating the adverse effects of continuous peripheral nerve block found a significant association of persistent insensate extremity with continuous popliteal nerve block [11]; however, this could be secondary to the volume and concentration of local anesthetic used in this confined perineural space. Ilfeld et al. [12] reported a lower incidence of insensate extremity in adults with a lower infusion rate of local anesthetic, such as 4 mL/h of 0.4 % ropivacaine.

5.5 Summary

Continuous peripheral nerve catheters have been shown to help aid in pain control, especially in managing challenging cases in the pediatric population. Ultrasonography enables visualization of the spread of injectate in real time, while stimulating catheters use the principles of physics to guide their placement. The catheter-over-needle technique increases the precision of catheter tip placement without the need for over-feeding the catheter. With these recent technological advancements, the risk of peripheral nerve catheter placement in anesthetized children is relatively low.

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