Peripheral nerve injury from intravenous cannulation: A case report

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1998 Student Writing Contest Honorable Mention

The following is a case report of a patient who had an intravenous (IV) catheter inserted into her cephalic vein and thereafter sustained an injury to the superficial branch of the radial nerve.

When an IV catheter penetrates a nerve, it can cause temporary or permanent damage. After sustaining an injury, a nerve will regenerate in an attempt to reconnect with the fibers it once innervated. Recovery from nerve damage may take only weeks or a year or more. Some patients, however, may sustain lifelong damage depending on the severity of the needle stick to the nerve.

To avoid injury to peripheral nerves when inserting IV catheters, a few recommendations should be followed. First, if inserting an IV catheter in the cephalic vein, be conscious of the proximity of the superficial peripheral nerves. Second, if a paresthesia is elicited when inserting an IV catheter, withdraw the catheter immediately. Third, if a patient complains of paresthesias or numbness near the IV site, remove the IV catheter immediately. Fourth, limit the amount of probing after inserting the catheter into the skin. Finally, if nerve damage is suspected from a peripheral IV cannulation, consult a hand specialist promptly.

Key words: Intravenous therapy, nerve damage, neuroma, peripheral intravenous cannulation.

Case summary
A 45-year-old healthy woman was admitted for a biopsy of a cervical lymph node. A 20-gauge intravenous (IV) catheter was inserted into the dorsal radial aspect of the right wrist into the cephalic vein without difficulty. On postoperative day 1, the patient complained of tingling at the site of the IV catheter insertion, which also had a small-reddened raised area 1 to 2 cm in diameter. The patient also stated that when the site was touched lightly, a tingling sensation extended down to the thumb and forefinger of her right hand. The manifestations were consistent with those that would occur with an injury to the superficial branch of the radial nerve. Eight weeks postoperatively, the patient reported improvement of the injury, as the tingling sensation to the thumb and forefinger could be elicited only by direct pressure to the site of cannulation.
Introduction
Almost every patient who arrives in the operating room for a surgical procedure requires an IV line. Typically, inserting an IV catheter is viewed as a benign procedure. However, many complications may go hand in hand with IV therapy, for example, infiltration, phlebitis, venous spasm, hematoma, air embolism, and nerve, tendon, and ligament damage. Among these, nerve damage, is potentially serious as it can lead to lifelong paralysis, numbness, and deformity. This article focuses on IV therapy, the location of the peripheral nerves, injury to neurons, and recommendations to avoid nerve damage.

Discussion
Many factors govern the choice of an insertion site for IV cannulation, such as the operative site, size of vein, comfort of the patient, previous operations, and preference of the person inserting an IV catheter. Figure 1 is a diagram of the superficial veins of the arm and hand. The metacarpal veins are found on the dorsum of the hand, and catheter insertion is more painful here due to a greater number of sensory nerve endings in this area. The cephalic vein is on the radial portion of the lower arm and runs along the radial bone of the forearm. It is a large vein and easy to access. Peripheral nerve damage has been reported previously (cephalic vein), as well as in the case described herein. On the ulnar aspect of the forearm is the basilic vein that is palpated easily but must be stabilized due to rolling. The median antebrachial vein arises from the basilic vein and travels laterally across the brachial muscle. Movement of the wrist can cause this site to become infiltrated easily. Finally, the antecubital veins (median cephalic, median basilic, and median cubital), which are found in the antecubital fossa, also are available for IV cannulation.

Figure 2 is a diagram of the area where the IV was placed in the patient described in the present case report. Running alongside the cephalic vein is the superficial branch of the radial nerve. Appearing proximal to this area is the lateral antebrachial cutaneous nerve. The superficial branch of the radial nerve is particularly vulnerable to damage because of its proximity to the cephalic vein.

Other nerves besides the superficial branch of the radial nerve have been the injured by an IV needle or catheter. Damage has been reported to the medial and lateral antebrachial cutaneous nerves in the antecubital fossa, the radial and ulnar dorsal sensory branches of the hand, and the superficial branch of the radial nerve. The commonly used superficial veins in the upper extremity lie directly over peripheral nerves. The article brings to light that many sites along the peripheral nerves are prone to damage by venous puncture.

Anatomy and physiology of the peripheral nervous system. For an understanding of the events that can occur when an IV catheter penetrates a nerve,
A review of the function and anatomy of the peripheral nervous system is important. Figure 3 is a diagram of a peripheral nerve, and Figure 4 is an illustration of a peripheral nerve sheath. The neuron is the basic structural and functional component of the nervous system. It has the ability to respond to stimulation by initiating and conducting electrical signals. The neurons contain a cell body, or soma, which has dendrites attached. These dendrites act as the receptive portion of the cell. Extending down from the cell body is the axon, known as the conductive process of the neuron. The lengths of the axons vary considerably; they may be quite short, traveling only a short distance in the central nervous system, or they may be as long as a few meters. In myelinated axons, the Schwann cell wraps itself around a portion of the axon several times, pushing the cytoplasm and nucleus of the Schwann cell peripherally. The myelin sheath is composed of alternating layers of proteins and lipids that constitute the plasma membrane of the Schwann cell.

The endoneurial sheath encloses the neuron and its supporting cells. This is a continuous basement membrane that is enveloped by layers of collagen. The Schwann cells from end to end are enclosed within the endoneurial tube. The perineurial sheath covers these endoneurial tubes along with the blood vessels and lymphatics that are called nerve fascicles. The final protective layer is the epineurial sheath of the peripheral nerve. The absence of the endoneurial tube in the central nervous system contributes to its inability to regenerate after nerve damage, but its presence in the peripheral nervous system makes regeneration possible.

*Types of nerve injury.* Three types of nerve injury may occur from an IV cannulation; neurapraxia, axonotmesis, and neurotmesis. The least severe injury, neurapraxia, occurs without any anatomic disruption of the nerve. The patient experiences loss of function, which usually resolves in 6 to 8 weeks due to remyelinization. Actual disruption of the axon with preservation of the epineurial and perineurial sheath occurs in an axonotmesis injury. Function may take weeks to months to a year to return. Neurotmesis is the most severe injury. The axon and nerve sheath have undergone complete transection. The nerve is prevented from appropriately regenerating due to connective tissue proliferation and scarring at the site of injury. This injury usually warrants surgical repair. Varying degrees of injury may occur from a needle stick. A needle may pass through the entire nerve and transect it or run parallel to the nerve and destroy nerve fibers.

When a peripheral nerve becomes damaged or severed, the portion of nerve that is distal to the injury begins to undergo degenerative changes. The nerve fibers and myelin are broken down by the macrophages that have invaded the area and by cells of the endoneurium. In days to weeks, the Schwann cells begin to multiply and fill the endoneurial tube of the distal stump. Simultaneously, the axon of the proximal stump begins to grow and develop new branches. These branches, if no scar tissue is present, will extend into the periphery into the original endoneurial tubes. This entire process takes weeks to months to a year, as an injured nerve is said to regenerate at approximately 1 to 4 mm/d. An important factor to remember is that years after a peripheral nerve has regenerated, the internodal length and conduction velocity of the repaired nerve are only 80% of the original values.

Specific factors govern whether a peripheral nerve will regenerate. The first is the proximity of the injury to the cell body. The closer the nerve
injury is to the cell body, the less chance the nerve will regenerate. The second factor is the type of nerve injury that occurred. Finally, the development of mass or neuroma at the injury site will impede regeneration.

- Development of a neuroma. A neuroma is a collection of Schwann cells, connective tissue cells, macrophages, and aberrant nerve fibers. The neuroma can attach itself to the proximal stump of the damaged nerve fiber, inhibiting the newly grown terminal branches of the axon from reaching their distal sites of innervation. Neuromas are troublesome because they do not allow the nerve fiber to heal, and the neuroma may generate electrical discharge. These electrical signals are transmitted as pain impulses to the central nervous system. Two cases in the literature cite patients developing these painful neuromas after nerve injury from IV insertions.

One of the clinical symptoms of a neuroma is paroxysmal pain and hyperalgesia. Dysesthesia, a burning and localized tingling pain can occur. The neuroma also may cause allodynia, which occurs when the site of injury is stroked lightly, and the patient feels increased pain or tingling to the area once supplied by the nerve. Once a neuroma develops, treatment for restoration of function is surgical removal. The proximal and distal stumps of the severed nerve are then joined.

The morbidity of peripheral nerve injuries is likely to be underreported. Such underreporting may be related to the large number of outpatient procedures. Neuman and Waxman reported that of 66 patients with peripheral nerve injury from IV cannulation for blood donation, only 41% (n = 27) of patients had symptoms the day of donation. Eleven percent (n = 7) of patients’ symptoms were not noted until months later. This delay in discovery of symptoms could explain the unknown incidence of peripheral injuries from IV cannulation.

Future recommendations. Nerve injuries can and do occur from peripheral venous cannulation. The potential seriousness of lifelong complications merits recommendations to avoid this problem. The incident described in the present case report was to the superficial branch of the radial nerve, which lies in near the cephalic vein. Due to the frequent use of this site for IV cannulation, anesthesia providers should be aware of the 2 sensory nerves in the area of the cephalic vein, as well as of the radial artery.

Further prevention strategies to avoid nerve
injury during peripheral IV cannulation are suggested. If a paresthesia is elicited on insertion of a catheter at any site, the catheter should be withdrawn immediately. If a patient complains of numbness or tingling at the IV site, remove the catheter promptly. When inserting an IV catheter, limit probing at the site. Finally, when and if nerve damage is suspected, consult a hand specialist promptly. Early recognition of nerve damage leads to the best prognosis for recovery.

REFERENCES

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