Iatrogenic Brachial Plexopathy due to Improper Positioning during Radiofrequency Ablation

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ABSTRACT

Iatrogenic peripheral nerve injuries are a common source of postprocedural morbidity. The authors present a case report of a patient who developed brachial plexopathy from positioning during radiofrequency ablation of a renal mass. Though incidence data on the majority of iatrogenic peripheral nerve injury is scarce, there is more concrete data on iatrogenic brachial plexopathy. The incidence of brachial plexopathies is ~0.2% of all patients who receive general anesthesia, with between 7 and 10% of brachial plexopathies being iatrogenic in nature. The mechanism of injury in the majority of cases is due to stretching or compression of the nerve tissue. Treatment is largely supportive. Prevention is key in minimizing this form of patient morbidity. It is the operator's responsibility to mitigate this risk by employing proper positioning techniques and communicating closely with the anesthesia staff when applicable.

KEYWORDS: Brachial plexus, plexopathy, peripheral nerve injury, iatrogenic

CASE REPORT

A 59-year-old man with no significant past medical history underwent computed tomography (CT) after a motor vehicle accident. On that study, a solid, enhancing mass in the interpolar right kidney was discovered. Laparoscopic partial nephrectomy was then attempted, with intraoperative and gross surgical pathologic examination revealing postinflammatory changes without evidence of malignant cells. Follow-up triphasic renal CT studies revealed that the mass was still present (Fig. 1). As there was persistent concern for malignancy despite the nonmalignant surgical pathologic findings, the patient was referred to the Interventional Radiology service for ultrasound-guided mass biopsy. This biopsy revealed atypical cells with clear cytoplasm, concerning for clear cell adenocarcinoma. At this point, the patient

elected to move forward with ultrasound and CT-guided radiofrequency (RF) ablation. General anesthesia was utilized. The patient was positioned with his right arm in abduction to allow sufficient access for the RF electrode. Two 4-cm ablations were performed with a RITA XL cluster electrode (AngioDynamics, Latham, NY). Follow-up triphasic renal CT at 8 weeks demonstrated a decrease in the size of the mass, along with loss of enhancement during the nephrographic and excretory phases.

Approximately 18 months postprocedure, the patient presented with complaints of persistent right arm pain, tingling, and mild motor weakness, which he had noticed since the procedure. The patient was referred to a neurologist for further evaluation, which was felt to be consistent with brachial plexus injury. The

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Figure 1 Contrast-enhanced computed tomography scan revealing a right renal mass.

condition is normally self-limited, and treatment was entirely supportive. Through the course of several months, the patient had a gradual return of full sensation, followed by resolution of weakness with full return of motor function.

DISCUSSION

Iatrogenic peripheral nerve injuries are a well-recognized occurrence in clinical practice. Since the majority of them occur in the perioperative period, they are mostly attributed to surgeons and anesthesiologists. However, as can be seen in the case described above, they are the province of any medical specialty in which the patient's body is manipulated. There is scarce data as to the true incidence of these injuries. A study performed in England over a 7-year period demonstrated that the incidence of "major" iatrogenic peripheral nerve injuries in the perioperative period was ~10%.¹ In the case of iatrogenic brachial plexopathy, there is more concrete incidence data. Of all brachial plexopathies, the reported incidence of iatrogenic plexopathies is between 7 and 10% as described in 2 series.^{2,3} A prospective study on 421 patients undergoing coronary artery bypass grafting revealed a 5% incidence of brachial plexus injuries.⁴ A separate series performed on patients undergoing total hip arthroplasties revealed an incidence of 0.04%.⁵ Nonetheless, iatrogenic peripheral nerve injuries, and specifically brachial plexopathies, are a possibility in most operative or procedural environments.⁶

Myelinated axons, which serve as the fundamental "building block" of the peripheral nerve, are very limited in their ability to respond or withstand injury. Iatrogenic nerve injuries generally occur when the nerve is acutely subjected to stretch, compression, or ischemia.⁷ Stretching and/or compression are felt to result in

endoneurial edema and possibly rupture of endoneurial capillaries, causing small hematoma formation and ischemic injury. There is a spectrum of severity to nerve injuries, with less-severe lesions producing myelin displacement and Schwann cell damage. More-severe lesions produce axonal loss and resultant Wallerian degeneration.^{7,8}

Demyelinating lesions produce either conduction block or conduction slowing. The lesion occurs focally at the site of injury. Of the 2 outcomes of demyelination, conduction block is more severe, as the nerve impulses cannot pass through the site of the lesion. Conduction slowing is often not clinically apparent, except in cases where different degrees of slowing are present along different axons, which leads to desynchronization of nerve impulses. A prominent example of clinically symptomatic conduction slowing due to demyelination is with ulnar neuropathies originating at the elbow.⁷ In contrast to demyelination, axonal loss affects the nerve at the site of injury, as well as the axonal stump distal to the site of injury due to the mechanism described above. The functional result is conduction failure.

In most cases of iatrogenic nerve injury, the onset of symptoms is abrupt. From a physical exam standpoint, it is difficult to differentiate axonal loss from demyelinating conduction block immediately after onset of symptoms, as they both result in failure of nerve impulse conduction. Both injury types result in significant symptoms, including motor weakness and loss of sensation, depending on the nerve type that is compromised. Axonal loss can also affect unmyelinated axons, resulting in dysfunction of pain and temperature sensation.⁷

The difference between demyelinating conduction block and conduction failure secondary to axonal loss is in the amount of time required for recovery, or in rare cases, whether recovery occurs at all. In demyelinating injuries, recovery takes several weeks as remyelination occurs. In axonal loss, recovery can often take several months. This is due to the prolonged period over which axonal regeneration occurs; estimated at ~1 mm per day. In the most severe cases of nerve disruption, axonal regeneration may be impossible.⁸

Of all iatrogenic peripheral nerve injuries, damage to the brachial plexus is the most common, and will be the focus here. Anatomically, the brachial plexus consists of 5 nerve roots (C5–T1). These combine to form 3 trunks (upper, middle, and lower), followed by six divisions (three anterior and three posterior), 3 cords (lateral, medial, and posterior), and subsequently terminal nerves (axillary, musculocutaneous, median, ulnar, and radial). Clinically, it is most convenient to separate the brachial plexus into supraclavicular and infraclavicular components, where the former refers to roots and trunks and the latter to cords and terminal nerves.^{7,9}

The brachial plexus is particularly prone to injury due to its superficial location, as well as its relative

immobilization proximally by the vertebrae and prevertebral fascia and distally by the axillary fascia. Furthermore, compression of the brachial plexus between the ribs and the clavicle at the level of scalene muscles has been implicated, as has stretching the plexus across the humeral head.⁸ Several factors predispose patients to brachial plexus injuries, including arm abduction of 90 degrees or greater, extension of the upper extremity, external rotation of the upper extremity, contralateral head rotation, and use of Trendelenburg positioning. The former 3 factors are thought to result in injury by the humeral head acting as a fulcrum across which the plexus stretches. Contralateral head rotation stretches the plexus at the level of the vertebrae and adjacent fascia. Trendelenburg positioning results in injury by caudal force on the humeral head by either shoulder or wrist restraints. This force in turn results in downward traction on the plexus and resultant stretching.⁸⁻¹⁰ The occurrence of brachial plexus injuries, and indeed all peripheral nerve injuries, is likely promoted by the loss of neural feedback to the patient while anesthetized.

Injuries to the supraclavicular component of the brachial plexus are by far the most common, and typically present with weakness, sensory loss, and paresthesias. They most often affect an upper trunk distribution; though occasionally affect all 3 trunks. When the latter is the case, mid and lower trunk injuries resolve quickly, whereas involvement of the upper trunk persists.^{9,10} Infraclavicular plexus lesions are not common, and will not be discussed here.

Perhaps the most crucial component of diagnosing brachial plexus as well as other peripheral nerve injuries lies in physician awareness of these entities and how they present. This can be complicated by several factors, including but not limited to potent analgesia that is common in postprocedural care, incisional pain if applicable, and lack of patient awareness. As with most medical problems, a detailed history and physical exam is critical to diagnosis and in excluding other etiologies. For example, delayed onset of symptoms suggests etiologies other than iatrogenic injuries, where symptom onset is abrupt. If a neurologic deficit is discovered, then neurologic consultation is indicated. Electromyography serves as an important adjunct in evaluation of these injuries, and can be helpful in evaluating whether an injury is chronic or acute. Nevertheless, diagnosis remains by exclusion; therefore, physician awareness remains a vital component in proper management of these lesions.⁸

Management of peripheral nerve injuries, including brachial plexopathy, is largely supportive. Analgesics are used for pain, with medications such as gabapentin playing a role in treating more severe neurogenic pain. Motor defects can be treated with physical therapy to maintain joint laxity, range of motion, and prevent contractures. Occasionally, surgical exploration and

nerve grafting plays a role in certain peripheral nerve injuries, though is not a mainstay in management of brachial plexus injuries.⁸ Typically, injuries resolve in several weeks after the procedure, consistent with the more common demyelinating conduction block type of injury. In rarer cases, symptoms persist for several months, suggesting that axonal loss has taken place.⁷

The operator's primary goal with these injuries should be one of prevention. Several strategies exist to minimize the risk of these injuries: reduction in arm abduction, extension, and external rotation; maintaining the head in neutral position; and proper shoulder padding in the Trendelenburg position.⁸ Using these recommendations, one group was able to reduce the incidence of brachial plexus injuries to 0.02% over 15,000 procedures.¹⁰ Yet another strategy that has been proposed is frequent limb repositioning to decrease the likelihood of brachial plexus stretching.⁸ From these steps, it is clear that brachial plexus injuries can be avoided in most cases by using the above-described preventative measures.

CONCLUSION

In conclusion, peripheral nerve injuries, and specifically brachial plexopathy, are common and mostly avoidable negative consequences of patient malpositioning during procedures. Though they have been classically attributed to surgeons and anesthesiologists, the advent of longer, more complex interventional radiology procedures requires that the interventional operator have knowledge of these entities. The primary goal is prevention by taking several of the above-described protective measures. In the case that a peripheral nerve lesion does occur, the operator must be aware of the possibility so that diagnosis can be swift, and appropriate consultation can be sought.

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