Complications of Regional Anesthesia

Nerve Injury and Peripheral Neural Blockade

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Nerve injuries have been described as clinical, anatomic, or laboratory findings, consistent with damage to discrete elements of the peripheral nervous system.¹ This rather broad definition of nerve injury has several important implications. For example, a patient may develop a subjective sensory or motor deficit (“clinical findings”) although there are no laboratory tests or studies that confirm the injury actually exists. Alternatively, although a study or test may reveal an abnormality (“laboratory findings”), the patient may not perceive sensory or motor deficits.

The significance of the nerve injury often depends on three factors. The first is the quality and severity of the sensory or motor deficit. This may range from mild dysesthesias that are barely noticeable, to severe pain, numbness and weakness that may interfere with activities of daily living. The second is the duration of the clinical symptoms. Most of nerve injuries reported with peripheral nerve blockade are transient phenomena. However, long term, permanent injuries have been reported, and can be devastating. The third factor is the patient in whom the nerve injury occurs. Some injuries may be no more than a mild nuisance to an elderly individual, but a catastrophe to a professional athlete or musician. Most published studies do not elaborate on the patient characteristics of those suffering nerve injuries. Therefore, it is important to consider any degree or duration of symptomatic nerve injury as potentially significant.

Incidence of Nerve Injuries

There have been numerous studies evaluating the incidence of nerve injury utilizing various regional anesthetic techniques. One technique that has been widely studied is brachial plexus blockade. Table 1 outlines some of these studies.

It is interesting to note the wide range in the incidence of nerve injury reported. In those studies relying on chart review or self-reporting,²,³,⁴,⁵,⁶ the incidence of nerve injury is significantly lower than in those studies using prospective questioning and direct follow-up.⁷,⁸

As seen from these reports, the closer investigators look, the more frequently problems are encountered. This hypothesis is taken to the extreme in a recent study.¹⁰ Over 50% of patients performed worse in sensitive objective neurologic assessments (such as 2-point discrimination) following hand surgery under brachial plexus blockade. Many of the patients who performed worse were unaware of any neurologic impairment. In one sense, these deficits may be manifestations of nerve injuries; however, the significance of the deficits is probably negligible.

Furthermore, the timing of follow-up is important. Symptoms of nerve injury may not become clinically apparent for several weeks post-operatively. Due to the effects of post-operative pain, swelling, or dressings patients may not notice a mild or moderate deficit for some period of time. Borgeat¹⁰ found several patients whose symptoms did not first present until two to three weeks following surgery.

It is also important to point out that most of the nerve injuries reported in the aforementioned studies resolved within the first several days; only the very rare occurrence was de-

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Table 1.

<table>
<thead>
<tr>
<th>Investigator</th>
<th>Approach</th>
<th>Number</th>
<th>Incidence</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auroy (2)</td>
<td>Mixed</td>
<td>21,278</td>
<td>0.004%</td>
<td>Anesthesiologists Report</td>
</tr>
<tr>
<td>Schroeder (3)</td>
<td>Mixed</td>
<td>330</td>
<td>0.6%</td>
<td>Retrospective Chart Review</td>
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<tr>
<td>Horlocker (4)</td>
<td>Axillary</td>
<td>1,614</td>
<td>0.4%</td>
<td>Retrospective Chart Review</td>
</tr>
<tr>
<td>Stan (5)</td>
<td>Axillary</td>
<td>996</td>
<td>0.7%</td>
<td>Surgeon Referral</td>
</tr>
<tr>
<td>Fanelli (6)</td>
<td>Mixed</td>
<td>1,821</td>
<td>1.3%</td>
<td>Surgeon Referral</td>
</tr>
<tr>
<td>Urban (7)</td>
<td>Mixed</td>
<td>508</td>
<td>14%</td>
<td>Direct Follow-up</td>
</tr>
<tr>
<td>Borgeat (8)</td>
<td>ISB</td>
<td>521</td>
<td>14%</td>
<td>Direct Follow-up</td>
</tr>
<tr>
<td>Hartung (9)</td>
<td>Axillary</td>
<td>178</td>
<td>11%</td>
<td>Direct Follow-up</td>
</tr>
</tbody>
</table>

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Neurotoxicity is dose and concentration dependent in isolated and patient reaction. Be done gently with particular attention to the ease of injection and orientation of the needle in causing nerve injuries. Intraneural injection of local anesthetics may cause increased pressure within nerves. This in turn may compromise neural blood flow. Epinephrine affects neural blood flow in experimental models. Theoretically this may initiate or potentiate peripheral nerve injuries.

There are several case reports of nerve injury in the setting of hematoma formation in the upper and lower extremities. Nerve compression from an expanding hematoma may cause temporary or permanent neural deficits.

There are two primary techniques used in performing peripheral nerve blocks. They are the paresthesia and nerve stimulator techniques. Other alternatives such as “facial clicks” and ultrasound-guided approaches are rarely used, and little data exists on their safety and efficacy. The data regarding the safety of the paresthesia technique versus the nerve stimulator technique with regard to the development of nerve injury is extremely limited. In a non-randomized study, Urban and Urquart noted a higher incidence of nerve injuries in patients undergoing interscalene blockade using a nerve stimulator (8.1%) compared with the paresthesia technique (2.5%). However, of the patients that experienced a posterior shoulder paresthesia (as opposed to a deltoid, arm, or hand paresthesia), 13% experienced persistent postoperative dysesthesias.

Several studies have compared different techniques of brachial plexus blockade using the axillary approach with respect to the development of nerve injury. No one technique has been shown to be safer than others. Whether this data can be extrapolated to other peripheral blocks is questionable. It is clear that pain upon injection is associated with an elevated risk of nerve injury.

It has been suggested that, by definition, a paresthesia technique involves direct needle-nerve contact, while a nerve stimulator technique avoids direct contact. Two recent studies place this theory in question. These studies involved eliciting a paresthesia with a needle, then connecting that needle to a nerve stimulator. In one study, 23% of patients did not generate a twitch with a nerve stimulator set at a current <0.5mA. The other study found similar results. Taken together, these reports place into doubt anatomic relationships between needles and nerves during various techniques of peripheral nerve blockade.

**Blocks in Patients who are Asleep**

Auroy noted in the nerve injuries that occurred during PNB, all were associated with either a paresthesia or pain during injection. These warning signs are invaluable tools in preventing significant injuries. In a very sobering report, Benu-
lence block using a nerve stimulator, under general anesthesia or heavy sedation. These patients developed permanent neurologic deficits secondary to intra spinal cord injections of local anesthetic. Benumof concluded, “general anesthesia is a relative contraindication for interscalene block.”

Several other reports of severe nerve injury following brachial plexus blocks involved patients experiencing sharp pain upon injection of local anesthetic.23,24 The lesson taken from these reports is the way to minimize the chance of causing a nerve injury is to maintain an awake and alert patient when performing peripheral nerve blocks no matter what technique is used. Furthermore, only experienced “hands” should be performing the actual injection of local anesthetic.

The one exception to this rule may be in the pediatric population. Giaufre et al25 report that peripheral nerve blocks in pediatric patients under general anesthesia carry a very low risk of developing nerve injuries. In this population, the benefits of a regional anesthetic must be weighed against the potential risks of placing a needle near nerves of anesthetized patients.

Evaluation and Management of a Neuropraxia

There is no clear-cut algorithm for the management of a postoperative nerve injury. Most often, symptoms are first noted and referred as an anesthetic complication by our surgical colleagues during the postoperative visit. For the majority of patients, a single reassuring phone call is all that is required. During the call, take the opportunity to evaluate the extent and severity of the symptoms. Most frequently, residual dysesthesia or hypoesthesia is reported. If the symptoms are mild and not interfering with the patient’s activities, then simple reassurance is in order. Symptoms of neurologic injury resolve in 4–6 weeks in 92–97% of patients and in over 99% by 1 year.7,8 Instruct the patient to call you directly if symptoms worsen or do not improve. If symptoms interfere significantly with daily activities, or persist beyond a few weeks, neurologic consultation and testing should be considered.

REFERENCES

4. Horlocker TT, Kufner RP, Bishop AT, et al. The risk of persistent pares-