The rebirth of local anesthesia for carotid artery surgery

DEBORAH DAY-CORRITONE, CRNA, MS
Richmond, Virginia

The use of local anesthesia for carotid artery surgery is once again gaining in popularity. In this article, the author reviews the historical perspectives and pathological considerations of carotid artery surgery. She describes local anesthetic techniques, their advantages/disadvantages, and the anesthetic management of patients undergoing this procedure.

Over the past 25 years, the number of vascular operative procedures performed has increased remarkably. The largest increase has been in carotid endarterectomies, which have shown a rise of 260%. The safest form of anesthesia to be administered for a carotid endarterectomy has been the subject of substantial debate. Anesthesia personnel agree that the primary objectives are the maintenance of cerebral oxygenation and the prevention of cerebral ischemia.

Historical perspectives

Twenty-five years ago when carotid endarterectomies were first performed, local anesthesia was used in order to assess the neurologic status of the patient intraoperatively. Utilizing this technique, many patients were restless and unmanageable using the drugs available for sedation at that time; thus, general anesthesia gained in popularity. Several techniques were employed concomitantly with general anesthesia in order to assure adequate cerebral oxygenation.

Induced hypothermia was known to decrease cerebral oxygen requirements. Cerebral blood flow was increased temporarily by inducing hypercarbia/hypocarbia. All these techniques proved to have innate dangers.

Induced hypertension increased vascular resistance without necessarily improving tissue perfusion. An intracerebral steal of blood from ischemic areas of the brain to the contralateral hemisphere is documented with the use of induced hypercarbia. Hypocarbia shunts blood from healthy areas of the brain to more ischemic areas. The overzealous use of hypocarbia can lead to areas of focal ischemia and generalized cerebrovasoconstriction.

Attempts were made to monitor accurately the adequacy of brain oxygenation by determining jugular venous oxygen saturation. The measurement of jugular venous oxygen saturation is unreliable because of its reflection of global oxygenation and its inability to pinpoint focal ischemia. Electroencephalography monitoring under general anesthesia is difficult to interpret in the operating suite because of interference from numerous electrical sources. In addition, EEG changes are known to occur normally under general anesthesia and are not necessarily the result of cerebral ischemia.

Surgeons have disagreed on the optimal carotid artery stump pressure necessary for adequate cerebral perfusion. The suggested range of pressures varies from 25 torr to 50 torr. Retrospective studies suggest that because of patient variation,
the sole use of carotid artery stump pressures is unreliable in predicting the need for shunt placement to provide adequate cerebral perfusion.2

Carotid artery bypass shunts are used by many surgeons to maintain blood flow to the internal carotid artery during crossclamping. The shunt has many disadvantages which contribute to a technically difficult operation. (Table I.) In addition, complications resulting from shunt placement can increase patient morbidity.3 (Table II.)

The disadvantages and complications of shunt placement have led surgeons to identify those patient populations that require shunting. Assessment of cerebral function by monitoring consciousness and fine motor ability during crossclamping are the most reliable criteria in determining the need for shunt placement.2,3 Many surgeons have returned to the original technique of regional anesthesia with improved sedation in order to assess the adequacy of cerebral perfusion.4 A patient's clinical response during crossclamping far surpasses data obtained from the most sophisticated forms of brain monitoring under general anesthesia, which can actually mask the development of neurological deficits.

### Pathological considerations

Patients requiring carotid surgery often exhibit widespread vascular disease. Many patients have a history of cardiac disease and hypertension. Blood pressure fluctuations are difficult to manage under general anesthesia. Chronic carotid sinus damages may result in cardiovascular instability intraoperatively which continues into the postoperative period.

The most frequent site of occlusion is at the bifurcation of the common carotid artery. Indications for carotid endarterectomies have been a subject of controversy over the past few years. Indications vary from patients who symptomatically experience TIAs or have had a stroke to asymptomatic patients with a hemodynamically significant lesion. It has been shown that 75% of surgical pa-

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**Table I**

<table>
<thead>
<tr>
<th>Disadvantages of shunt placement</th>
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<tbody>
<tr>
<td>1. Extension of operative time for shunt placement</td>
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<tr>
<td>2. Larger surgical incision</td>
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<td>3. Partial physical obstruction of the surgical field</td>
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**Table II**

<table>
<thead>
<tr>
<th>Complications of shunt placement</th>
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<tbody>
<tr>
<td>1. Thromboembolism</td>
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<td>2. Air embolism</td>
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<tr>
<td>3. Intimal dissection</td>
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<tr>
<td>4. Shunt clotting</td>
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</table>

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**Figure 1**

Anatomy of the cervical plexus with proper needle placement for cervical plexus blockade

Patients have bilateral carotid artery occlusive disease. Widespread vascular involvement classifies patients as poor risks for general anesthesia, thus making local anesthesia, if managed properly, the safer choice.

**Local anesthetic techniques**

*Cervical plexus block.* The cervical plexus is formed by the communication of the anterior rami of the first four cervical nerves which exit the intervertebral foramen and pass behind the vertebral artery (Figure 1). The nerves then lie in the sulci of the transverse processes, whose tubercle can be palpated posterior to the sternocleidomastoid muscle (Figure 2). The superficial cervical branches innervate the skin and superficial structures of the neck. The deep cervical branches innervate muscle and other deep structures of the lateral and anterior regions of the neck. The superficial and deep branches of the cervical plexus are blocked by injecting an anesthetic solution in close approximation to the transverse process of C2, C3, and C4. The first cervical nerve lacks a sensory branch and does not require blockade.

Cervical plexus blockade is relatively simple, once the landmarks are properly identified. The patient is positioned supine with the head turned away from the side to be blocked. The tip of the mastoid process of the temporal bone is marked. Next, the transverse process of the sixth cervical vertebrae is located and marked. This process usually is directly across from the thyroid cartilage. Once a straight line is drawn between these two landmarks, the transverse processes of C2, C3, and C4 are identified and marked (Figure 2). Needles then are introduced at a 90-degree angle to the skin through small local anesthetic wheals until their tips reach the transverse process of C2, C3, and C4 (Figure 1).

Anesthesia is obtained using tetracaine (80-100 cc of 0.15% solution), procaine (80-100 cc of 1.0% solution), or lidocaine (80-100 cc of 0.5% solution) with or without epinephrine. The onset of analgesia is usually between 5 and 15 minutes and lasts 1-2 hours. Tetracaine may have advantages over the other agents as a result of prolonged duration and rapid degradation in the blood. Bupivacaine, 0.375% solution, also has been used. How-

![Figure 2](image-url)

*Figure 2*

Anatomy with superimposed landmarks for deep cervical block

ever, consideration should be given to a possible delay of 15 additional minutes in the onset of analgesia.

Potential complications of cervical plexus blockade limit the administration to skilled practitioners. Complications of cervical plexus blocks can be seen in Table III.

**Local infiltration.** Anesthesia is accomplished using 20-75 milliliters of lidocaine, 0.5% solution without epinephrine. The anterior border of the sternocleidomastoid muscle is infiltrated from the mastoid process continuing caudally for four to five inches. Infiltration must continue through the fascial layers and deep within the carotid sheath. Additional supplementation is based on patient response. A disadvantage of this technique is the distortion of anatomy and difficulty in locating landmarks because of the volume of anesthetic infiltrated. This disadvantage is far less dangerous than those for cervical plexus blocks.

Additional intraoperative infiltration of the carotid sinus may become necessary to prevent blood pressure and heart rate fluctuations. Some surgeons insert indwelling catheters into the carotid sinus for the infiltration of supplemental local anesthetics in the postoperative period.

**Anesthetic management**

A successful local anesthetic is the result of proper sedation, total analgesia, and patient compliance. The original use of local blockade for carotid surgery met with disfavor because of patient restlessness. Preoperative assessment and patient teaching are the first vital steps in the preparation of these patients. Secondly, adequate sedation given preoperatively makes the administration of the local anesthetic less traumatic. Innovar®, 1-2 ml, has gained popularity as a preoperative medication. It can be supplemented intraoperatively with either fentanyl (Sublimaze® or droperidol (Inapsine®) based on patient need (Table IV). The anesthetist must monitor adequacy of respiratory exchange. Deep sedation is avoided so that cerebral perfusion can be assessed during crossclamping. Oxygen is administered by mask or nasal cannula.

### Table III

**Complications of cervical plexus blocks**

1. Intraspinal puncture
   - Cord injury
   - High spinal anesthesia
2. Phrenic nerve paralysis
   - Respiratory depression
3. Laryngeal nerve damage
   - Hoarseness
4. Intravascular injection
   - Toxic reaction
   - Arterial spasms
5. Hematoma formation
6. Cervical sympathetic block
7. Carotid sheath compression
8. Unilateral vagal nerve blockade

### Table V

**Signs of cerebral deterioration during crossclamping**

1. Confusion
2. Hemiparesis
3. Unconsciousness
4. Seizures

### Table VI

**Hazards of recovering from general anesthesia**

1. Airway obstruction
2. Laryngospasm
3. Hypoventilation
4. Coughing
5. Aspiration
6. Disorientation/agitation

### Table IV

**Benefits of hand-held toy during carotid surgery**

<table>
<thead>
<tr>
<th>Patient action</th>
<th>Intervention</th>
<th>Benefit</th>
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<tbody>
<tr>
<td>Squeezes toy with increased frequency to signal discomfort</td>
<td>Additional local anesthesia injected</td>
<td>Return of patient comfort</td>
</tr>
<tr>
<td>Squeezes toy at intervals determined by anesthetist</td>
<td>Additional fentanyl administered as needed</td>
<td>Prevention of oversedation</td>
</tr>
<tr>
<td>Fails to squeeze toy on command during crossclamp</td>
<td>Adjust sedation with droperidol as indicated</td>
<td>Prevention of irreversible brain ischemia</td>
</tr>
<tr>
<td></td>
<td>Artery unclamped; brain reperfused</td>
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*October/1985*
The patient is placed on the operating table with foam mattress padding. The table is flexed at the hip and knee joints to ensure maximum patient comfort. A toy squeaker is placed in the contralateral hand to assess fine motor function, especially during crossclamping. Periodically, the patient is asked to squeeze the toy. This has several benefits, as shown in Table IV.

The most critical period during carotid surgery is crossclamping. When the artery is clamped, an accurate assessment of the neurologic status is now possible. If the patient tolerates the crossclamp, surgery proceeds. However, if the patient exhibits signs of cerebral deterioration within four minutes of crossclamp, the clamps are removed and the brain is reperfused. Signs of cerebral deterioration clearly indicate that the patient requires shunt placement for adequate perfusion during crossclamping (Table V).

Postoperatively, the patient is aroused easily and observed for neurologic deficits. The blood pressure must be closely monitored and maintained below systolic values of 200 torr. Anesthetists must avoid lowering blood pressures aggressively with vasodilators, since rebound strokes can occur.

**Advantages/disadvantages**

As with all types of anesthesia, regional blocks for carotid endarterectomies have advantages coupled with disadvantages. The foremost advantage is patient safety. Under local anesthesia, the surgeon is able to identify those patients who will require shunt placement intraoperatively. Patients classified as poor surgical risks are able to avoid the hazards of recovering from general anesthesia (Table VI). For many patients, local anesthesia decreases the magnitude of operative stress by removing the worry associated with general anesthesia.

There may be less extensive preparation and less need for expensive invasive monitoring. This leads to the conclusion by Gabelman and Associates that local anesthesia reduces total hospital costs by 29% for endarterectomies, an important consideration given the cost-containment focus of today. This cost reduction is accomplished by simpler administration, less equipment, a shorter operative period, a decrease in the complexity of postoperative care (including intensive care), and a shorter hospital stay.

Among the disadvantages to the local technique are patient anxiety regarding intraoperative awareness, patient fatigue intraoperatively, and movement during the intricate surgical procedure. There is a time limit with local anesthesia, and the surgeon may feel rushed. This technique requires extensive patient education and rapport between the surgeon and the anesthesia practitioner.

**Conclusion**

Local anesthesia blockade for use during carotid endarterectomy is gaining popularity once again. Anesthesia practitioners agree that adequate perfusion and oxygenation are paramount during carotid crossclamping. The best criteria for assessing cerebral blood flow comes from the continuous neurologic monitoring of the conscious patient. Medical costs are rising rapidly, and each of us is charged with the responsibility of providing the safest, least expensive anesthetic care to our patients. Properly administered local anesthetics, combined with intraoperative vigilance, can meet these goals.

**REFERENCES**


**AUTHOR**

Deborah Day-Corritone, CRNA, MS, graduated from the University of Michigan School of Nursing, Ann Arbor. She received a Bachelor of Science degree and Master's degree in Anesthesia from Wayne State University, Detroit, Michigan.

At the time this paper was written, she was didactic and clinical instructor at Mount Carmel/Mercy College School of Anesthesia for Nurses in Detroit. She also served as acting curriculum coordinator for the school. Currently Mrs. Corritone is employed with a private anesthesia group in Richmond, Virginia.

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