Day-Case Shoulder Surgery: Anesthetic Challenges

Kathryn E. McGoldrick

Abstract

The purpose of this review article is to summarize our current knowledge concerning the anesthetic management of patients having shoulder surgery in the ambulatory setting. Factors influencing anesthetic selection technique and potential complications associated with interscalene block, the beach chair position, and continuous perineural catheters are underscored. Because many of the potential complications of shoulder surgery can be devastating, a comprehensive understanding of possible pitfalls and prevention strategies is essential.

Keywords: shoulder surgery, day-case surgery, interscalene block, cerebral perfusion.

Author's address: Kathryn E. McGoldrick MD Professor and Chair, Department of Anesthesiology, New York Medical College, Valhalla, New York 10595 USA

Phone: 914-493-7693 *Fax:* 914-493-7927 *E-mail:* Kathryn_McGoldrick@nymc.edu

Introduction

Shoulder surgery has a notorious reputation for being associated with substantial postoperative pain. Hence, the use of interscalene block (ISB), in conjunction with continuous perineural catheters or other appropriate methods of postoperative analgesia, has enabled certain shoulder procedures – not merely shoulder arthroscopy – to be conducted on an outpatient basis. Many open operations, such as rotator cuff repair, Bankart procedures, and even total shoulder arthroplasty, can be performed as day-case procedures when circumstances are favorable.

In 1884, the gifted surgeon William S. Halsted of Johns Hopkins Medical School performed the first documented case of brachial plexus anesthesia under direct vision when he injected the exposed roots of the brachial plexus in the supraclavicular region with cocaine. It was not until 1911 that Hirschel performed the first percutaneous approach when he injected local anesthetic into the axillary sheath of the brachial plexus. In 1919, Mully developed a percutaneous interscalene approach to the brachial plexus that preceded by several decades the modern interscalene approach of Winnie, who used the level of the sixth cervical transverse process as the reference point for needle insertion. The ISB is ideal for proximal upper extremity procedures, such as shoulder surgery and procedures involving the upper to mid-humerus, but considerably less reliable for procedures involving the elbow, radius, ulna, wrist, and hand. Most patients have easily identifiable landmarks in the interscalene region, and the use of a nerve stimulator and/or ultrasound can facilitate successful execution of the block.

Selection of Anesthetic Technique

Although upper extremity surgical procedures are generally well suited to regional anesthetic techniques, some important caveats are deserving of mention. Some pre-existing neurological deficit may be present, and the operative site may be adjacent to neural structures, as occurs with total shoulder arthroplasty or fractures of the proximal humerus. Hence, damage to the axillary nerve and brachial plexus are not uncommon under these circumstances. Clearly, the decision to perform regional anesthesia in a patient with pre-existing neurologic deficits or who is at risk for perioperative neuropraxia should be made on an individual basis. A thoughtful, comprehensive discussion with the surgeon and patient concerning the risks, benefits, and alternatives is mandatory, and any pre-existing neurologic deficit should be meticulously documented in the medical record.

Surgery to the shoulder may be performed under regional or general anesthesia. With careful patient selection and positioning, ISB alone can provide excellent operating conditions and postoperative analgesia. Nonetheless, general anesthesia or a combination of regional and general anesthesia is frequently selected because of limited access to the patient's airway during surgery and concerns about patient comfort if the operation is expected to be of protracted duration. ISB should be approached with great caution in patients with pre-existing brachial plexopathy owing to the possibility of perioperative exacerbation of the neurologic condition. In addition, the ipsilateral diaphragmatic paresis that accompanies ISB [1] will not be well tolerated in patients with severe preoperative pulmonary compromise.

Interscalene Blockade

A carefully executed ISB is typically safe and highly effective. Auroy, in his comprehensive review of major complications associated with regional anesthesia in France, reported no instances of cardiac arrest, respiratory failure, seizures, or death in a series of 3459 ISBs. [2] Hadzic and colleagues [3] convincingly demonstrated that patients who received ISB for outpatient rotator cuff surgery bypassed the postanesthesia care unit more frequently, reported less pain, ambulated earlier, and were ready for home discharge sooner (123 vs 286 minutes) than a demographically comparable group who received fast-track general anesthesia. In addition, there were no unplanned admissions in the ISB group, but 16% of the patients who received general anesthesia required overnight admission. Not surprisingly, the ISB patients also reported greater satisfaction with their anesthetic care. Yet, for all the advantages of ISB, this technique can be associated with serious complications. These include, but are not limited to, the development of pneumothorax, Horner's syndrome, recurrent laryngeal nerve paralysis, subarachnoid/epidural injection, vertebral artery injection with "locked-in" syndrome, [4] motor nerve root injection, and cervical spinal cord injection. Although the incidence of ipsilateral phrenic nerve block in conjunction with ISB is virtually

100%, the clinical importance of this reality is generally negligible, unless the patient has severe chronic obstructive pulmonary disease, is morbidly obese, or is in an advanced stage of pregnancy.

"Locked-in" syndrome describes a state in which selective supranuclear motor deefferentiation in the brainstem produces paralysis of all four extremities and lower cranial nerves without interfering with consciousness. This reversible form of "locked-in" syndrome is thought to result from an ISB that, instead of being directed medially, dorsally, and caudally, was misdirected too far medially, producing injection into the vertebral artery. The motor paralysis prevents the subjects from communicating with words or with body movement. Vertical eye movements and blinking are the only motions that the patient can perform. The combination of tetraplegia and aphonia may cause the anesthetist to assume that the patient is unconscious when such is not the case. With proper support that includes oxygenation, ventilation, vasopressors, and oral reassurance of the patient, this condition will resolve completely when the block recedes.

Benumof has reported four cases of cervical cord damage when ISB was performed on patients under general anesthesia.[5] All four patients developed total spinal anesthesia, with apnea and dilated pupils, and subsequently sustained extensive permanent loss of bilateral cervical cord function. Magnetic resonance imaging documented syrinx formation in the cervical cord at a level consistent with the clinical presentation. Benumof emphasized that administering general anesthesia before performing ISB is contraindicated. It is critically important that the patient be aware and cooperative in order to ensure ongoing communication between the anesthesiologist and the patient to prevent dangerous misplacement of the needle. The neck is really "tiger territory," containing a number of vital structures that can easily be in harm's way when a needle is advanced. In addition, Benumof underscored the relative proximity of the brachial plexus and cervical spinal cord to the skin, particularly in thin individuals, and recommended that ISB should be performed with needles <1.5 inches in length.[5]

Positioning Issues

Two thirds of arthroscopic and open shoulder procedures in the United States are done in the beach chair position (BCP). Compared with the lateral decubitus alternative, the BCP offers the advantages of lack of brachial plexus strain, superb intra-articular visualization, and ease of conversion to an open approach if needed. There are, however, complications associated with the BCP. The Bejold-Jarisch reflex, for example, may be triggered by venous pooling associated with the sitting position.[6] Severe hypotension and bradycardia can ensue as a result of the venous pooling and heightened cardiac contractile state (induced by the effects of epinephrine in either the ISB solution or the local anesthetic infiltrated by the surgeon, or both). The decreased venous return to the heart stimulates receptors in the left ventricle that produce a cardiovascular depressor reflex, resulting in reflex arterial vasodilation and vagally-mediated bradycardia. Restoration of venous return, replacement of volume deficits, and an appropriate vasopressor usually remedy the hemodynamic effects of this reflex. It has been suggested that the likelihood of the Bejold-Jarish reflex occurring can be diminished by the prophylactic administration of beta blockers,[7] but there is not universal agreement about the efficacy of this approach.

Of grave concern are the cases of catastrophic neurologic outcomes that have been associated with the beach chair position.[8] Although there is academic debate about whether the cerebral circulation functions as a siphon or waterfall,[9] there is increasing consensus that the lower limit of cerebral autoregulation is questionable and may be substantially higher than the traditionally cited cerebral perfusion pressure of 50 mmHg. It is feared that the blood pressure recorded in the arm with the patient in the BCP may seriously overestimate the pressure in cerebral vessels. Hence, it is prudent to apply a mathematical correction for the hydrostatic gradient. The recommended correction is 2 mmHg for every inch of vertical displacement.10 Hence, for a small patient in the semi-recumbent position, the external auditory canal may be approximately 11 inches above the mid-point of a blood pressure cuff on the upper arm. If mean arterial pressure as measured by the cuff is 65 mmHg, the mean arterial pressure at the external auditory canal would be only 43 mmHg.

A recent study using near-infrared spectroscopy explored the incidence of cerebral oxygen desaturation events in the BCP compared with the lateral decubitus position.[11] All patients underwent shoulder arthroscopy and received standardized general anesthesia, with or without an ISB. A strict protocol required that the bispectral index be kept between 40 to 60, the end-tidal carbon dioxide tension between 30 to 34 mmHg, and the mean arterial pressure within 20% of baseline. An episode of cerebral desaturation was defined as cerebral oxygen saturation ≥20% below baseline or ≤55% for >15 seconds. Hemodynamic variables were said to be "similar" in each group. Importantly, however, the authors did not apply a hydrostatic correction for blood pressures recorded in the BCP. Not surprisingly, the cerebral oxygen saturation was lower in the BCP group during the entire intraoperative period. Moreover, there were no episodes of cerebral oxygen desaturation in the lateral decubitus group, whereas an incidence of cerebral desaturation of 80.3% was noted in the BCP patients. There was also a 7-fold higher incidence of nausea and vomiting in patients who experienced cerebral desaturation, raising the possibility that this was a manifestation of reduced cerebral perfusion. Fortunately, no obvious neurologic complications were detected despite substantial reductions in cerebral oxygenation in the BCP group.

Other Complications

Not every complication encountered with shoulder surgery is necessarily related to ISB or to the BCP. Certainly, some complications may have a surgical etiology. Inadvertent extra-articular placement of irrigation fluid, for example, can produce tracheal compression and airway obstruction. Unintentional intravascular placement of irrigation fluid can produce pulmonary edema. Pneumothorax, pneumomediastinum, subcutaneous emphysema, and fatal air embolism have been associated with shoulder procedures. As mentioned, there is a high incidence of neurologic injury related to shoulder surgery per se and the positioning required for operative exposure and manipulation.

The incidence of serious nerve injury related to ISB is extremely low. Most injuries directly attributable to needle damage cause self-limiting neuropraxias, which typically resolve in 1 to 3 months.

Finally, it should be mentioned that idiopathic brachial plexitis (also known as brachial plexus neuropathy or acute brachial radiculitis) has been identified following shoulder surgery with ISB.[12] Diverse etiologies include infection, trauma, and pregnancy. An autoimmune –mediated mechanism has been suggested, and it has also been hypothesized that surgery may activate dormant virus in the plexus tissue. The condition is characterized by intense pain, paresthesias, and a mixed motor and sensory defect with asymmetric involvement. The bilateral nature of the condition argues against a block-related etiology. Fortunately, after several months the condition improves and recovery is usually complete by one year.

What Is the Role of Ultrasound?

Regional anesthesia is both an art and a science. Advanced technology in the form of nerve stimulation and ultrasound is helping to make regional anesthesia more of a science compared with the days when the clinician had to rely solely on elicitation of paresthesias to perform peripheral nerve blocks. Many contemporary clinicians use nerve stimulation in combination with ultrasound when performing regional anesthesia. One of the first reports of the use of ultrasound in regional anesthesia was in 1989 by Ting and Sivagnanaratnam. [13] Nerve stimulation allows one to identify which nerve one is approaching (and if it is a nerve), and ultrasound allows one to see the advancing needle approach the targeted nerve. Although some investigators have reported that block placement speed [14,15] and success rates [15] with assorted peripheral nerve blocks assisted by ultrasound are improved in direct comparison with nerve stimulation alone, Liu16 reported a more equivocal picture for ISB. More than 200 adult patients having ambulatory shoulder surgery under ISB were studied and their neurologic outcomes were tracked at one week and again at four to six weeks. The use of ultrasound resulted in fewer needle passes (1 versus 3, $P<0.001$) and better motor block at 5 minutes. However, there was no difference in block performance time, block failures, patient satisfaction, and the incidence/severity of postoperative complications in the ultrasound vs. the nerve stimulation group. Consistently, however, studies are showing that ultrasound reduces the volume of local anesthetic necessary for successful ISB.[17]

Continuous Perineural Catheters

Certain procedures, such as total shoulder arthroplasty, can be extremely painful, and hospitalization may be required for adequate pain control. Interscalene perineural catheters, kept in place for up to 4 days after surgery, and attached to a ropivacaine infusion pump have enabled patients to be discharged sooner and with less pain than patients whose postoperative pain is treated with narcotics. [18] Continuous perineural catheters are not without complications, which can include catheter dislodgment, intravascular injection, and infection.[19] Patients who go home with continuous perineural catheters must be educated about potential risks associated with an insensate extremity, and they must be taught about pump function and understand the signs of local anesthetic toxicity. Further, they must have someone at home who can provide assistance and who can communicate via telephone should problems arise.

Summary

Shoulder surgery can present many challenges for the patient, the surgeon, and the anesthetist. Regional anesthesia has many advantages in this setting, but is not devoid of risk. Proper patient and procedure selection is crucial to the success of regional anesthesia. Contraindications include patient refusal, excessive anxiety, serious mental illness, coagulation abnormalities, infection at the injection site, an uncooperative surgeon, and an unskilled anesthetist. When success is elusive, the clinician should not let ego stand in the way of a prudent decision to abandon one's efforts in favor of general anesthesia.

References

1. Urmey WF, Talts KH, Sharrock NE. One hundred percent incidence of hemidiaphragmatic paresis associated with interscalene brachial plexus block as diagnosed by ultrasonography. ***Anesth Analg*** 1991;**72**:498–503.
2. Auroy Y, Benhamou D, Bargues L, et al. Major complications of regional anesthesia in France: the SOS regional anesthesia hotline service. ***Anesthesiology*** 2002;**97**:1274–1280.
3. Hadzic A, Williams BA, Karaca PE, et al. For outpatient rotator cuff surgery, nerve block anesthesia provides superior same-day recovery over general anesthesia. ***Anesthesiology*** 2005;**102**:1001–1007.
4. Durrani Z, Winnie A. Brainstem toxicity with reversible locked-in syndrome after interscalene brachial plexus block. ***Anesth Analg*** 1991;**72**:249–252.
5. Benumof J. Permanent loss of cervical spinal cord function associated with interscalene block performed under general anesthesia. ***Anesthesiology*** 2000;**93**:1541–1544.
6. D'Alessio JG, Weller RS, Rosenblum M. Activation of the Bezold-Jarisch reflex in the sitting position for shoulder arthroscopy using interscalene block. ***Anesth Analg*** 1995;**80**:1158–1162.
7. Liguori GA, Kahn RL, Gordon J, et al. The use of metoprolol and glycopyrrolate to prevent hypotensive/bradycardic events during shoulder arthroscopy in the sitting position under interscalene block. ***Anesth Analg*** 1998;**87**:1320–1325.
8. Cullen DJ, Kirby RR. Beach chair position may decrease cerebral perfusion: catastrophic outcomes have occurred. ***APSF Newsletter*** 2007;**22(2)**:25,27.
9. Lanier WL. Cerebral perfusion: err on the side of caution (editorial). ***APSF Newsletter*** 2009;**24(1)**:1,3–4.
10. Drummond JC, Hargens AR, Patel PM. Hydrostatic gradient is important:blood pressure should be corrected (letter). ***APSF Newsletter*** 2009;**24(1)**:6.
11. Murphy GS, Szokol JW, Marymont JH, et al. Cerebral oxygen desaturation events assessed by near-infrared spectroscopy during shoulder arthroscopy in the beach chair and lateral decubitus positions. ***Anesth Analg*** 2010;**111**:496–505.
12. Tetzlaff JE, Dilger J, Yap E, Brems J. Idiopathic brachial plexitis after total shoulder replacement with interscalene brachial plexus block. ***Anesth Analg*** 1997;**85**:644–646.
13. Ting PL, Sivagnanaratnam V. Ultrasonographic study of the spread of local anesthetic during axillary brachial plexus block. ***Br J Anaesth*** 1989;**63**:326–329.
14. Williams SR, Chouinard P, Arcind G, et al. Ultrasound guidance speeds execution and improves quality of supraclavicular block. ***Anesth Analg*** 2003;**97**:1518–1523.
15. Sala-Blanch X, De-Andres J. Image-guided techniques for peripheral nerve blocks. ***Curr Opin Anesth*** 2004;**17**:409–415.
16. Liu SS, Zayas VM, Gordon MA, et al. A prospective, randomized, controlled trial comparing ultrasound versus nerve stimulator guidance for interscalene block for ambulatory shoulder surgery for postoperative neurological symptoms. ***Anesth Analg*** 2009;**109**:265–271.
17. McNaught A, Shastri U, Carmichael N, et al. Ultrasound reduces the minimum effective local anaesthetic volume compared with peripheral nerve stimulation for interscalene block. ***Br J Anaesth*** 2011;**106**:124–130.
18. Ilfeld BM, Vandenborne K, Duncan PW, et al. Ambulatory continuous interscalene nerve blocks decrease the time to discharge readiness after total shoulder arthroplasty: a randomized, triple-masked, placebo-controlled study. ***Anesthesiology*** 2006;**105**:999–1007.
19. Capdevila X, Jaber S, Pesonen P, Borgeat A, Eledjam JJ. Acute neck cellulitis and mediastinitis complicating a continuous interscalene block. ***Anesth Analg*** 2008;**107**:1419–1421.