



CURRENT CONCEPTS IN ANAESTHESIA AND ANALGESIA FOR SHOULDER SURGERY

Anaesthesiology

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ABSTRACT

Shoulder surgery varies from simple diagnostic arthroscopy to major total shoulder arthroplasty. Patients present for shoulder surgery may be young and fit with a sports injury or elderly sick with rheumatoid arthritis need arthroplasty of the shoulder joint. Choice of anaesthesia based on the type of surgery, and the comorbidity of a patient. Management of severe postoperative pain is a major challenge for the anaesthesiologist. Regional anaesthetic techniques effectively control static as well as dynamic pain and facilitate early mobilization. However regional blocks are not free from the side effects or complications.

KEYWORDS

Shoulder surgery; anaesthesia; analgesia

INTRODUCTION:

The shoulder joint has the largest range of motion among all the joints in the human body and vulnerable to various types of injuries. Degenerative changes and neoplasms are also not uncommon. Therefore, a wide range of operative procedures from diagnostic arthroscopy to total shoulder arthroplasty is done in this region. Rich neural innervations of the shoulder joint often cause severe postoperative pain and delay the rehabilitation of patients.

The goal of an anaesthesiologist is to provide balanced anaesthesia during surgery and complete postoperative pain relief. In current clinical practice, general anaesthesia or regional nerve blocks are used separately, or in combinations. Regional anaesthetic techniques effectively control pain both at rest and on movement, reduce muscle spasms, and thus allow early mobilization and physiotherapy. General anaesthesia alone has several disadvantages including intense postoperative pain leads to delayed discharge, and a higher incidence of readmissions. Therefore most patients undergoing general anaesthesia also receive some form of regional anaesthesia.

Anatomy of the shoulder joint:

The shoulder joint or glenohumeral joint is a multiaxial ball and socket type of synovial joint. The ball is represented by the head of the humerus and the socket is formed by the small and shallow glenoid cavity of the scapula. The glenoid fossa is deepened by a fibrocartilaginous rim called the glenoid labrum.

Due to loose joint capsule and shallow glenoid fossa, it is one of the most mobile joints in the human body.¹ Static stability of the joint is provided by the joint capsule, glenohumeral ligaments and, negative intra-articular pressure. Muscles such as the long head of biceps, rotator cuff muscles, and periscapular muscles provide dynamic stability.

The shoulder joint receives blood supply via the posterior and anterior circumflex humeral arteries; branches of the axillary artery. Subscapular arteries, branches of thyrocervical trunk also contribute to the blood supply of the shoulder.²

The shoulder joint, deltoid muscle, and overlying skin receives nerve supply from;

1. Axillary nerve, branch of brachial plexus (C_5 - C_6)
2. Subscapular nerve, branch of brachial plexus (C_5 - C_6)
3. Lateral pectoral nerve, branch of brachial plexus (C_5 - C_6)
4. Suprascapular nerve, branch of brachial plexus (C_5 - C_6)
5. Supraclavicular nerves, cutaneous nerves of cervical plexus (C_3 - C_4)

All the nerves should be blocked for complete anaesthesia of the shoulder region. This can be done if a local anaesthetic agent is injected in the brachial plexus sheath at interscalene level. Local anaesthetic agent block nerve roots C_5 , C_6 , C_7 . Local anaesthetics also spread upward and block supraclavicular nerves, branches of the cervical plexus.

Surgical procedures of shoulder joints:

Surgical interventions are required in different shoulder pathology, especially those failing to respond to conservative therapy. Operative procedures range from minimally invasive arthroscopic procedures to more traditional open surgeries. Common surgical procedures of the shoulder joint are arthroscopy for impingement, arthroscopic SLAP (Superior Labrum Anterior and Posterior) tear repair, arthroscopy for shoulder dislocation, arthroscopy for release of adhesive capsulitis, rotator cuff repair surgery, acromioclavicular joint repair, surgery for fracture head of humerus, avulsion fracture of greater tuberosity of humerus, shoulder replacement surgery and biceps tendon surgery.

Open surgery is mostly performed by the anterior approach. The incision starts from just lateral to the tip of the coracoid process extends downwards up to the axillary crease.³ In shoulder arthroplasty surgery incision extends further up to the insertion of the deltoid muscle. Two ports are introduced in arthroscopic surgery. The posterior port is inserted 2 cm inferior and medial to the posterolateral corner of the acromion and the lateral port is inserted 1-2 cm posterior and 2-3 cm lateral to the anterolateral corner of the acromion. The posterior port may need local anaesthetic infiltration if, surgery is conducted under regional anaesthesia.

There has been an exponential growth in the number of shoulder surgeries after the introduction of arthroscope during the last two decades. Patients range from young fit adults suffering from some sports injuries and planned for arthroscopic surgical repair to elderly sick patients with different co-morbid conditions, need arthroplasty surgery. Choice of anaesthesia depends upon the type of surgery and associated co-morbid conditions.

Preoperative assessment:

Patients scheduled for shoulder surgery range from young healthy adults sustaining sports injuries at the shoulder region to old patients with several comorbidities and arthritic complications at the shoulder joint. A thorough preoperative assessment is designed to assess the type and severity of different coexisting medical problems. Selection of anaesthetic technique based on type of surgery and associated comorbid conditions. Minor surgical procedures of the shoulder joint may be done under a regional anaesthesia but, for complicated surgeries of longer duration, general anaesthesia either alone or in combination with regional anaesthesia is preferred. Proper psychological preparation and premedication play a key role in the success of awake shoulder surgery under a regional block.

General anaesthesia:

General anaesthesia, regional anaesthesia, or a combination of regional and general anaesthesia may be appropriate for shoulder surgeries. The choice of the anaesthetic technique mostly depends on the wishes of the patients, the extent of the surgical procedure, and the skill of the anaesthesiologist. Minor surgical procedures of the shoulder region can be carried out under regional anaesthesia but general anaesthesia either alone or combined with regional block is required for major shoulder surgical procedures of longer duration.

Although general anaesthesia is extremely safe for shoulder surgery but often associated with intense postoperative pain leading to late discharge from the hospital and a higher incidence of readmissions.⁴ Opioid requirement following shoulder surgery is almost equal to thoracotomy operation. Poorly controlled postoperative pain causes patients dissatisfaction or even sometimes end as persistent post-surgical pain. Hence all patients receiving general anaesthesia need regional anaesthesia in some form or others. Choice of anaesthetic agents, techniques, and type of perioperative monitoring is primarily determined by the presence or absence of comorbid conditions.

Both supraglottic airway device and endotracheal tube are equally used for airway management during general anaesthesia. Endotracheal tube is preferred by some workers⁵ to prevent airway obstruction due to massive tissue oedema following extravasation of irrigation fluid of arthroscopy surgery.

Regional anaesthesia:

Regional anaesthetic techniques can be used as sole anaesthesia or can be combined with general anaesthesia. Advantages of regional anaesthesia are excellent pain relief, decreased blood loss, reduced postoperative nausea-vomiting, and faster return to normal diet and medications in the postoperative period. The use of regional anaesthesia also prevents complications of the airway, cardiovascular, and, respiratory systems usually observed with general anaesthesia. However regional anaesthetic techniques are associated with few complications such as Horner's syndrome, hoarseness of voice, local anaesthetic toxicity, ipsilateral phrenic nerve palsy, weakness of diaphragm, and other nerve injuries.⁶

Many shoulder surgeries are done under regional block alone, but major prolonged shoulder procedures are done under combined general and regional anaesthesia. Options for regional anaesthesia include intra-articular local anaesthesia, suprascapular nerve block with or without axillary nerve block, single-shot interscalene block, and continuous interscalene block.

The use of ultrasound while performing the regional block reduces the complications, local anaesthetic requirements and increases the success rate of the regional block.⁷

Interscalene brachial (ISB) plexus block:

In interscalene block, the brachial plexus is blocked at the level of the superior and middle trunks. Sometimes inferior trunk blockades remain incomplete by this approach. The classical technique of interscalene plexus block is known as Winnie technique.⁸ Winnie used paresthesia technique for the location of the brachial plexus which is subsequently replaced by nerve stimulation by a nerve locator. The use of ultrasound reduces the incidence of an incomplete block.

The classical technique of interscalene brachial plexus block:

The patient is placed in the supine position and head turned opposite to the side to be blocked. The patient is asked to elevate head and make sternocleidomastoid muscle prominent. Identify posterolateral border of sternocleidomastoid. Interscalene groove, situated between the anterior scalene and middle scalene muscle, can be located posterolateral to the posterior border of sternocleidomastoid muscle. Place two fingers on the interscalene groove and a 22 gauge short bevel needle is inserted between the two fingers at level C₆. The needle should be directed perpendicular to the skin. After location of the brachial plexus and negative aspiration test, slowly 20 ml of local anaesthetic is injected.

Local anaesthetics: Bupivacaine 0.25%-0.5%, levobupivacaine 0.25%-0.5% or ropivacaine 0.25%-0.5% can be used as single shot injection for intraoperative and postoperative analgesia

Low interscalene brachial plexus block technique:

In low interscalene brachial plexus block, the needle is inserted at a lower level than classic technique. The brachial plexus is very superficial at this location. Skin to brachial plexus distance is often less than 1 cm. Risk of puncture and damage of cervical cord and vertebral arteries is less as compared to classic technique.⁹

The patient is placed in the supine position and the head is turned towards the opposite side. The patient is asked to contract sternocleidomastoid muscle. Identify interscalene groove and place two fingers on it. A needle connected to the nerve locator is placed

between the two fingers and advanced perpendicular to the skin, slightly caudally till the motor response is achieved. After negative aspiration 15-20 ml local anaesthetic is injected.

The technique using ultrasound:

The patient is placed in the supine position and the head is turned towards the opposite side. Pillow is placed underneath the head to create adequate space for the placement of the transducer and needle. The area between the cricoid cartilage and supraclavicular fossa is scanned with a high-frequency linear transducer. Hypoechoic round images of C5 and C6 nerve roots enclosed in a fascial sheath are located. A nerve block needle is inserted either in-plane or out of plane and perpendicular to the transducer. The needle is advanced till it touches the fascia over the plexus and 15 ml of local anaesthetics is injected after a negative aspiration test.

Ultrasound helps to visualize the spread of local anaesthetic agent and thus can adjust local anaesthetic administration. Several studies prove that the use of ultrasound reduces the number of needle pricks, enhances motor block, and success rate as compared to nerve stimulation.^{10,11}

Assessment of block:

Assessment of block should be done 10 minutes after injection of local anaesthetic agent. The three components of the block should be tested separately. The motor block is tested by asking the patient to abduct and flex the arm at the shoulder region. The sensory block is assessed by assessing cutaneous sensation to cold. The joint sensation can be assessed by observing the loss of pain sensation during passive movements.

Adverse effects and complications:

The phrenic nerve is situated very close to brachial plexus at the level of C5/C6. Therefore the phrenic nerve is often blocked following interscalene block. Mostly healthy individuals remain asymptomatic following a unilateral phrenic nerve block. Intercostals and accessory muscles usually compensate and able to maintain normal tidal volume.¹² However patients with comorbidities especially COPD, and obesity may develop respiratory embarrassment or failure following interscalene block. Bilateral interscalene block should never be performed.

Spread of local anaesthetic to surrounding structures may cause ipsilateral blockade of recurrent laryngeal nerve and/or cervical sympathetic nerve leading to hoarseness of voice and Horner's syndrome. Horner's syndrome is characterized by ipsilateral ptosis, miosis, nasal congestion, and anhidrosis. Spontaneous recovery occurs after few hours.

Severe hypotension, bradycardia, and syncope have been reported following interscalene block. Epidural and intrathecal injection of local anaesthetics can produce serious neurological complications.

Incidence of severe neurological complications is high in anaesthetized or heavily sedated persons. Although the use of ultrasound has reduced such complications but interscalene block should be performed before the induction of general anaesthesia.¹³

Continuous Interscalene Brachial Plexus Block:

Single-shot interscalene block (SSISB) effectively provides anaesthesia and analgesia for shoulder surgery during the intraoperative and immediate postoperative period. Single-shot interscalene block of brachial plexus provides postoperative analgesia up to 8 hours, reduces opioid consumption and, postoperative nausea and vomiting. The use of adjuvants with local anaesthetics prolongs the duration of action but severe pain may persist up to 48 hours or more following major shoulder surgery. Continuous interscalene brachial plexus block (CISB) is preferred to provide pain relief throughout the postoperative period. Evidence suggests that continuous interscalene brachial plexus block provides superior analgesia compared to single-shot analgesia following major shoulder surgery.¹⁴ Use of continuous interscalene block reduces opioid consumption, improves rest and dynamic pain, and reduces risk of PONV up to 48 hours.¹⁵ Patients with total shoulder arthroplasty achieved a greater range of motion on their first postoperative day.¹⁶ Complications and side effects of continuous interscalene block are same as single shot interscalene block. About 10% of patients, who received CISB complained of dyspnoea. CISB is technically more difficult than SSISB. Catheter is very easily dislodged, and difficult to secure in proper plane.

Technique:

The patient is positioned as in the single-injection technique. A 5 cm long 22 gauge short beveled needle attached to a nerve stimulator is inserted at a slightly caudal angle and advanced until the brachial plexus twitch is elicited at 0.2–0.5 mA. Fix the position of the needle and the catheter is slowly inserted 3 cm beyond the tip of the needle and fixed to the skin. Catheter placement may be done under ultrasound guidance. Catheter insertion may be performed either in-plane or out-of-plane according to operator preference. Placement of the catheter in the interscalene groove is much more challenging due to the shallow position of the brachial plexus and difficulties in stabilizing the needle during catheter advancement.

Before administration of the local anaesthetic agent, the catheter must be carefully checked for intravascular placement by administering 2–3 ml of 1% lignocaine with adrenaline. Although overall complications are low, catheter malposition or dislodgement is not uncommon. Anchor dressing or tunneling has been used to prevent dislodgement. Commonly used local anaesthetics such as levobupivacaine and ropivacaine are administered in slow infusion at lower concentrations to avoid the motor block. The infusion rate is set at 8 ml per hour with boluses of 2 ml once per hour. Additional bolus dosage may be given as and when required.

Contraindications:

Absolute contraindications are rare, and include patients refusal, coagulopathy, infection at the site of injection and patient vital capacity less than 1 liter. Relative contraindications are contralateral phrenic nerve palsy and contralateral pneumothorax.¹⁷

Selective peripheral nerve blocks:

Suprascapular nerve block provides an alternative option to interscalene block for postoperative analgesia following major shoulder surgery. The quality of analgesia is inferior to interscalene block but superior to intra-articular infiltration. The suprascapular nerve provides 70% of the sensory supply to the shoulder region. The remaining 30% sensory supply is provided by axillary and lateral pectoral nerves. Therefore suprascapular nerve block in combination with axillary nerve block provides superior shoulder joint analgesia.^{18,19} Pain related to stretching of joint capsule persists and may be blocked by local port infiltration during surgery. Advantages of suprascapular plus axillary nerve block are the absence of phrenic nerve palsy and respiratory distress. Suprascapular and axillary nerve blocks do not prevent unwanted motor blocks of the lower half of the upper limb. Suprascapular and axillary nerve blocks are also preferred in patients with limited respiratory reserve.

Disadvantages of suprascapular and axillary nerve blocks are; requirement of two separate deep injections and higher incidences of incomplete block.

Suprascapular nerve block:

The suprascapular nerve is a mixed motor and sensory nerve. It originates from the superior trunk C5 and C6. Sometimes it also receives fibers from C4. The suprascapular nerve passes beneath the omohyoid muscle and passes deep to the superior transverse scapular ligament. The suprascapular nerve exits through the scapular foramen into the supraspinous fossa and finally, it divides into small branches and provides sensory and motor innervations to muscles of the shoulder girdle. The suprascapular nerve can be blocked by the anterior approach just above the clavicle or it may be blocked by the traditional method at the suprascapular notch.^{20,21} The suprascapular block by anterior approach is a suitable alternative to interscalene brachial plexus block with lower chances of concomitant phrenic nerve block. Advantages of anterior approach as compared to traditional approach are;

- Suprascapular block by anterior approach is more superficial (5-10 mm) than traditional approach at suprascapular notch (20-40 mm).
- The suprascapular notch may be difficult to locate due to its variable morphology. Sometimes it may be absent. Therefore the traditional method is not much used.

Anterior technique suprascapular nerve block: It is also called proximal suprascapular nerve block. Patients are placed in supine position with head turned to the opposite side. Block is preferred under ultrasound guidance but a land-mark based method with nerve stimulation is also used.

A high-frequency linear transducer probe is placed just proximal to the

supraclavicular fossa. The suprascapular nerve is located as a round hypoechoic structure deep to the inferior belly of the omohyoid and lateral to the superior trunk of the brachial plexus. A short beveled 22 gauge, 5 cm long needle is selected for this block, and by out-of-plane or in-plane approach, needle is advanced 2-3 cm depth to reach the target. Five to fifteen milliliters of local anaesthetic is deposited deep to omohyoid muscle but superficial to the prevertebral fascia.

The posterior technique of suprascapular nerve block: This is also known as the traditional technique of suprascapular nerve block. The patient is asked to sit down on the table and to place his hand on the contralateral shoulder and thus to move the suprascapular nerve and scapula laterally away from the thorax.

The scapula spine, coracoid process, and acromion are used as anatomical landmarks for suprascapular nerve block by posterior approach. A linear ultrasound transducer placed in a coronal plane over the suprascapular fossa with a slight anterior tilt. The transducer is placed in such a way that it is perpendicular to the line joining the coracoid process and the acromion. The supraspinatus and trapezius muscles and the bony fossa underneath can be identified. Adjust the angle of the ultrasound transducer in a cephalo-caudad direction to visualize the suprascapular nerve and artery. A 22-gauge, 80-mm short beveled needle is inserted either in-plane or out of the plane to reach the suprascapular nerve and local anaesthetics is injected.

By posterior approach, the suprascapular nerve is blocked more distally. Therefore axillary block is also essential with suprascapular nerve block for shoulder analgesia.

Axillary nerve block:

The axillary nerve is formed as a terminal branch of the posterior cord, at the lateral border of the subscapularis. It winds towards the posterior aspect of the surgical neck of the humerus. The point at which the axillary nerve is blocked, situated on the posterior surface of the humerus as it passes through the quadrilateral space.

The most reliable approach is to image the posterior surface of the humerus on its long axis. This provides a short-axis view of the circumflex artery and the axillary nerve. The artery is the most reliable landmark, and local anaesthetics is injected adjacent to the circumflex artery, on the posterior surface of the humerus.

Side effects and complications:

Suprascapular nerve block directly at suprascapular notch is associated with a higher incidence of pleural puncture. Accidental deposition of local anaesthetics on the omohyoid or supraspinatus muscle may cause myotoxicity.

Intra-articular analgesia:

Local anaesthetics with or without opioids are injected into the joint space at the end of the surgical procedure. This procedure is usually done by the surgeon. Local anaesthetics may be injected as a single-shot or as a continuous infusion using an epidural catheter placed at the subacromial bursa. Results of intra-articular deposition of local anaesthetics are mixed. It effectively controls postoperative pain following minimally invasive shoulder surgery but has limited effects on major shoulder surgical procedures. Probably intra-articular local anaesthetics is not the gold standard analgesia but it offers a simple, useful and low-risk analgesic technique after less painful shoulder surgery.²²

Side effects: Chondrotoxicity has been linked to intra-articular infusion of local anaesthetics agents. However, there is little evidence to support any significant chondrotoxicity following single shot local anaesthetic injection in the intra-articular space.

Summary:

In modern anaesthesia practice general anaesthesia, brachial plexus block, or nerve blocks is used for shoulder surgery. Choice of anaesthetic technique is primarily determined by the types of surgical procedures and co-morbid conditions of the patients. General anaesthesia is preferred in major open surgical procedures of the shoulder. Arthroscopic surgical procedures are usually done under regional anaesthesia.

Shoulder surgery without regional anaesthesia is associated with severe postoperative pain and high opioid consumption. Therefore, different regional anaesthetic techniques are practiced to provide

optimum postoperative pain relief. For less painful procedures, intra-articular local anaesthesia with opioids may be adequate but for more painful procedures interscalene brachial plexus is preferable. Single-shot interscalene block reduces rest pain up to 8 hours and patients undergone major shoulder surgery often experience significant pain after wearing off the effect of single shot interscalene block. Continuous interscalene plexus block for at least 48 hours optimize postoperative pain relief. Interscalene block causes significant lung function impairment due to phrenic nerve palsy. However, it does not cause desaturation or delay in discharge from the post-anaesthesia care unit.

Suprascapular nerve block alone has limited value for shoulder analgesia but the combination of suprascapular nerve and axillary nerve blocks can be an acceptable alternative to interscalene block. Suprascapular plus axillary nerve blocks are considered as the first choice for patients with severe respiratory disease. Intra-articular local anaesthetic injection with or without opioids is mostly used following arthroscopic procedures but, carries a risk of iatrogenic chondrolysis.

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