

Anaesthetic considerations for shoulder surgery

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The history of shoulder surgery dates as far back as the ancient Egyptian empire with 3 000-year-old hieroglyphics referring to a leverage method of shoulder reduction.¹ Since then, however, technological advancements as well as a better understanding of human anatomy have led to the advancement of surgical techniques for a wide variety of orthopaedic procedures for various shoulder pathologies.

Recent surgical advances have resulted in the development of minimal access arthroscopic procedures with resulting improvements in speed of convalescence. However, the management of severe postoperative pain remains a major challenge for many anaesthetists.²

There are numerous orthopaedic procedures in and around the shoulder. Types of surgeries include:

1. Arthroscopy of the shoulder
2. Rotator cuff repair
3. Acromioclavicular joint problems
4. Shoulder replacements
5. Biceps tendon surgery
6. Repair of fractures around the shoulder (proximal humerus, clavicular, scapular and glenoid fractures)

Anatomy of the shoulder

The shoulder is made up of three bones (humerus, scapula, and clavicle) and two joints: the acromioclavicular joint (the acromion of the scapula with the acromial head of the clavicle) and the glenohumeral joint.

The glenohumeral joint is formed by the humeral head, which fits into the glenoid fossa of the scapula, forming a flexible ball-and-socket joint. This joint has the greatest range of motion of any joint in the body. However, this large range of motion can lead to joint problems.

The articular capsule of the glenohumeral joint is strengthened by the glenohumeral ligament anteriorly and the coracohumeral ligament superiorly. Further strengthening and thickening of the capsule is provided by the transverse humeral ligament. The

rotator cuff muscles (supraspinatus, infraspinatus, teres minor and subscapularis) ensure that the humeral head is held in the glenoid cavity.³

Cutaneous innervation of the shoulder is via the cervical and brachial plexus. The cervical plexus innervates the skin anteriorly from above the clavicle till the second intercostal space, from the sternum medially to the lateral tip of the shoulder. The brachial plexus innervates the skin over the deltoid muscle, and the medial side of the arm and axilla.²

Innervation of the deeper structures of the shoulder is via suprascapular, axillary and lateral pectoral nerves (all branches of the brachial plexus).

Patient profile

There is a wide variety of patients who present for shoulder surgery, ranging from the fit, robust patient with a sports injury requiring a stabilisation procedure, to the frail, elderly arthritic patient requiring joint decompression or arthroplasty.^{2,4}

These pose different considerations with regards to the anaesthetic management.

The young fit sports professional

May suffer serious financial loss of income from neurological fall-out from regional anaesthesia or poor pressure point management.

May have a higher risk of negative pressure pulmonary oedema on emergence as they are able to produce a very large negative intrathoracic pressure.

Elderly arthritic

It is important to differentiate between rheumatoid and osteoarthritis.

Rheumatoid arthritis is a systemic disorder with both articular and extra-articular effects.

The articular effects impacting on airway and pressure-point management are relevant for the anaesthetist. The important

articular structures to take into consideration are the cervical spine, temporo-mandibular joint and the cricoarytenoid joint. The extra-articular affects all systems, either directly as a consequence of the disease or secondary to the treatment regimen the patients may be on.

There may be a higher risk of neurological fall-out from poor pressure-point management as some of the elderly patients may be frail or have weakened bones from osteoporosis.

These patients may have comorbidities with target organ damage either because of the disease or secondary to the treatment.

Therefore, a thorough history and clinical examination are vital and additional investigations will vary depending on the individual patient.

Positioning

Patient positioning for shoulder surgery mainly depends on the procedure performed, however surgeon preference and, on occasion, patient-specific concerns may also be influential. The various patient positioning with respective shoulder procedures can be seen in Table I.

Table I. Patient positioning with respective shoulder procedures⁴

Procedure	Position			
	Supine	Lateral	Beach chair	Seated
Manipulation of frozen shoulder	✓			
Arthroscopy		✓	✓	✓
Subacromial decompression	✓	✓	✓	✓
Weaver Dunn (reconstructing the acromioclavicular joint)	✓			
Shoulder cuff repair	✓	✓	✓	✓
Capsular shift (tightening of joint capsule for recurrent dislocation)	✓			
Bankart's procedure (tightening of joint capsule for dislocation)	✓			
Total shoulder replacement	✓	✓	✓	✓

The beach chair (semi-seated) position seems to be the favoured position. The major advantages of the beach chair position for the orthopaedic surgeon are access to the anterior and posterior shoulder, reduction in brachial plexus neuropathies from traction and stress, decreased injuries from port placement, easier conversion to an open procedure, better visualisation of the surgical field, easier setup and reduced operative time.^{5,6}

The concerns of the beach chair position for the anaesthetist are multisystemic.

Airway

The airway is effectively inaccessible intraoperatively.

Excessive manipulation of the shoulder can lead to displacement or loss of a poorly secured airway.

Upper-airway oedema from excessive flexion of the head can lead to potential airway compromise post extubation.

Respiration

Displacement of the abdominal contents downwards promotes greater excursion of the diaphragm during inspiration thereby aiding ventilation and minimising atelectasis.

Better perfusion of the lower zones of the lungs can potentially worsen any VQ mismatch.

Cardiovascular

Peripheral pooling of blood causes a decrease in venous return thereby reducing cardiac output.

In conjunction with a general anaesthetic, the accompanying vasodilation leads to a decline in systemic vascular resistance (SVR), resulting in a more significant drop in venous return and cardiac output.

Anaesthetic technique

Anaesthetic technique can vary from a sole general or regional anaesthetic (with or without sedation) to a combination. Patient, surgical and anaesthetic factors influencing the use of regional anaesthetic can be seen in Table II.

Table II. Patient, surgical and anaesthetic factors influencing regional anaesthesia

Patient factors
Comorbidities
Anticoagulation therapy
Patient preference and refusal for a regional
Surgical factors
Surgical procedure
Preference of the orthopaedic surgeon
Early mobilisation (catheter placement)
Anaesthetic factors
Intraoperative and postoperative analgesic requirements
Avoidance or minimising usage of opioid analgesics
Ability of the anaesthetist with regional techniques

General anaesthesia in the non-supine patient can be managed with a supraglottic airway, however an endotracheal tube may be preferred as the risk of dislodgement or loss of the airway can be negated. However, in rheumatoid patients with posterior or vertical atlanto-axial subluxation direct laryngoscopy should be avoided, and a video laryngoscope or a fibre optic bronchoscope should be used to secure the airway.

Advantages and disadvantages of anaesthetic techniques can be seen in Table III.

Table III. Advantages and disadvantages of anaesthetic techniques

	General anaesthesia (without regional)	General anaesthesia (with regional)	Regional anaesthesia (with or without sedation)
Advantages	<ul style="list-style-type: none"> • Suitable for all procedures • Better surgical conditions, i.e. no patient movement • No complications from regional • Onset of surgical time quicker 	<ul style="list-style-type: none"> • Better surgical conditions, i.e. no patient movement • Good intra- and postoperative analgesia 	<ul style="list-style-type: none"> • Better haemodynamics • No need for specialised monitors • Good intra- and postoperative analgesia • Minimal risk of intraoperative pressure sores
Disadvantages	<ul style="list-style-type: none"> • Vasodilation thereby reduction of SVR and preload • The risk of intraoperative pressure sores • Need for opioid analgesics 	<ul style="list-style-type: none"> • Not indicated for all procedures • Vasodilation thereby reduction of SVR and preload • The risk of intraoperative pressure sores 	<ul style="list-style-type: none"> • Not suitable for all procedures • Increased chance for patient discomfort, particularly with longer procedures • Potential for patients to move, thereby increasing surgical time or risking contamination of surgical site • Failure of regional

Monitoring

The haemodynamic consequences of the beach chair and seated position have a significant impact, potential morbidity and increasing medical costs. Severe or prolonged hypotensive episodes can result with the patient having inadequate cerebral perfusion leading to ischaemia, hypo-perfusion to the kidneys resulting in acute kidney injury, and inadequate supply of blood to the myocardium resulting in cardiac ischaemia.

The use of invasive blood pressure monitoring by means of an arterial line may be advantageous for some patients, as complications from routine placement do occur. Complications from arterial lines are indicated in Table IV.

Table IV. Complications from arterial lines⁷

Occlusion
Pseudo-aneurysm
Sepsis
Haematoma
Bleeding at puncture site
Abscess
Cellulitis
Median nerve paralysis
Thrombosis
Air embolus
Accidental intra-arterial injection
Arteriovenous fistula

The use of a global cerebral oxygen saturation monitor by non-invasive means such as INVOS™ may negate the potential complications from arterial lines. However, it is costlier and does not monitor renal or coronary perfusion for those at risk.

In young healthy patients, the use of non-invasive blood pressure monitoring in the upper limb is reasonable.

Interscalene block

The interscalene block is a popular choice for numerous surgical procedures of the shoulder. It is a suprascapular brachial plexus block, in the neck, between the anterior and middle scalene muscles. Ideally the block should be done with ultrasound guidance as it minimises complications. Complications from

interscalene blocks are shown in Table V. The use of a peripheral nerve stimulator may provide an additional benefit, however, patient comfort may be compromised.

Table V. Complications of interscalene blocks⁸

Ipsilateral phrenic nerve block resulting in hemi-diaphragmatic paralysis
Horner’s syndrome
Recurrent laryngeal nerve block
High epidural or total spinal
Pneumothorax
Direct injection into the vertebral artery or vein
Bezold-Jarisch reflex resulting in severe hypotension and bradycardia
Nerve damage
Local anaesthetic toxicity

Selective suprascapular and axillary nerve block

An alternative regional technique is the use of a suprascapular and axillary nerve block. Potential advantages of this approach over the interscalene block are:

1. Lower incidence of motor blockade
2. Potential reduction in complications (phrenic nerve paralysis in particular)

However, it may take longer to perform (as individual nerves need to be identified) and may provide less analgesia as compared with the interscalene block.⁹

Conclusion

A thorough history and clinical examination is vital for any patient coming for shoulder surgery and additional investigations will vary depending on the individual patient. Patients should be well informed about the options of the available anaesthetic techniques, the positioning during surgery, and potential complications that may arise.

The anaesthetic technique should be decided with the patient and surgeon and individualised for each patient taking into account the procedure, positioning, patient profile, comorbidities, current treatment, perioperative analgesia, and potential perioperative complications.

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