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General

Regional Anesthesia for Orthopedic Surgeries: A Guide for Upper and Lower Extremity Procedures

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Purpose of the Review

Regional anesthesia has become a cornerstone in orthopedic surgeries due to its ability to provide precise, localized pain relief while minimizing the systemic risks associated with general anesthesia and opioid use. This review aims to provide a compact guide for anesthesia trainees and practicing anesthesiologists on the use of regional anesthesia techniques for upper and lower extremity procedures.

Summary

This guide outlines the main regional block options for orthopedic surgeries, detailing the targeted anatomy, common surgical indications, important adjacent structures, and potential complications for each technique. Key blocks for upper extremity surgeries include interscalene, supraclavicular, infraclavicular, axillary, and intercostobrachial blocks, while lower extremity techniques encompass femoral, adductor canal, sciatic, popliteal, and lumbar plexus blocks. Advances in ultrasound guidance have enhanced the safety and efficacy of these techniques, making them indispensable for modern anesthesiology practice. By mastering these approaches, providers can optimize patient outcomes, expand their skillset, and contribute to enhanced perioperative care in orthopedic surgery.

INTRODUCTION

Regional anesthesia offers precise pain control, reduces opioid consumption, and can enhance postoperative recovery for patients undergoing orthopedic surgery for the upper and lower extremities.[1] Key regional blocks enhance postoperative recovery by providing superior analgesia, enabling early mobilization, and reducing the likelihood of complications associated with general anesthesia, such as nausea, respiratory issues, and prolonged sedation. These benefits are particularly advantageous for patients undergoing surgeries on the upper and lower extremities, where focused nerve blocks can optimize outcomes while minimizing systemic risks. Advances in ultrasound guidance have significantly improved the safety and efficacy of these techniques, making them an essential skill for modern anesthesiologists.[1-3]

In this guide, we will discuss the essential regional anesthesia techniques for upper extremity surgeries, including interscalene, supraclavicular, infraclavicular, axillary, and intercostobrachial blocks, as well as those for lower extremity procedures, such as femoral, adductor canal, sciatic, popliteal, and lumbar plexus blocks. Each block will be analyzed in terms of its targeted anatomy, common surgical applications, and potential complications to provide a comprehensive understanding for anesthesiologists seeking to optimize perioperative pain management.

TECHNIQUES AND APPLICATIONS – UPPER EXTREMITY

1. INTERSCALENE BLOCK

Target: Roots/trunks of the brachial plexus (C5–C7)

Common Surgical Cases: Shoulder surgeries (e.g., rotator cuff repair, shoulder arthroscopy), proximal humerus fractures

Important Structures: Phrenic nerve (risk of hemidiaphragmatic paralysis), vertebral artery, recurrent laryngeal nerve

Complications: Respiratory complications (e.g., phrenic nerve block), Horner's syndrome, vascular puncture, pneumothorax

2. SUPRACLAVICULAR BLOCK

Target: Trunks/divisions of the brachial plexus

Common Surgical Cases: Mid-humerus, elbow, forearm, and hand surgeries

Important Structures: Subclavian artery, pleura

Complications: Pneumothorax, vascular puncture

3. INFRACLAVICULAR BLOCK

Target: Cords of the brachial plexus

Common Surgical Cases: Elbow, forearm, and hand surgeries

Important Structures: Axillary artery and vein, lung apex

Complications: Vascular puncture, pneumothorax

4. AXILLARY BLOCK

Target: Branches of the brachial plexus

Common Surgical Cases: Forearm and hand surgeries

Important Structures: Axillary artery, radial, median, and ulnar nerves

Complications: Incomplete block, hematoma, nerve injury, infection

5. INTERCOSTOBRACHIAL BLOCK

Target: Intercostobrachial nerve (T2 and occasionally T1, not derived from brachial plexus); used as a supplement to brachial plexus blocks

Common Surgical Cases: Medial/posterior upper arm surgeries, anterior arthroscopic port, and upper extremity tourniquet pain

Important Structures: Axillary crease

Complications: Incomplete block, infection

Important considerations of each block are also listed in Table 1 below.

TECHNIQUES AND APPLICATIONS – LOWER EXTREMITY

1. FEMORAL NERVE BLOCK

Target: Femoral nerve in the inguinal region

Common Surgical Cases: Hip fractures, total knee arthroplasty, femoral shaft fractures

Important Structures: Femoral artery, femoral vein

Complications: Hematoma, nerve injury, infection, intravascular injection

2. ADDUCTOR CANAL BLOCK

Target: Saphenous nerve and branches of the femoral nerve within the adductor canal

Common Surgical Cases: Knee surgeries (particularly total knee arthroplasty), lower leg surgeries involving saphenous nerve distribution

Important Structures: Femoral artery, femoral vein, adductor muscles

Complications: Hematoma, limited coverage (suitable for distal knee anesthesia), infection, intravascular injection

3. SCIATIC NERVE BLOCK

Target: Sciatic nerve in the gluteal region, anterior thigh approach, or posterior thigh approach

Common Surgical Cases: Hip surgery, lower leg surgeries, foot and ankle surgeries

Important Structures: Gluteal arteries, ischial tuberosity, femoral shaft and lesser trochanter

Complications: Nerve injury, prolonged motor block, hematoma, infection

4. POPLITEAL BLOCK (SCIATIC NERVE AT POPLITEAL LEVEL)

Target: Sciatic nerve proximal to its division into the tibial and common peroneal nerves

Common Surgical Cases: Foot and ankle surgeries

Important Structures: Popliteal artery and vein

Complications: Nerve injury, vascular puncture, hematoma, infection, intravascular injection

5. LUMBAR PLEXUS BLOCK (PSOAS COMPARTMENT BLOCK)

Target: Lumbar plexus within the psoas major muscle

Common Surgical Cases: Hip surgeries, knee surgeries

Important Structures: Psoas muscle, lumbar vertebrae

Complications: Epidural spread, vascular injury, retroperitoneal hematoma, intravascular injection, infection

Important considerations of each block are also listed in the Table 2 below.

DISCUSSION

Regional anesthesia plays a significant role in orthopedic surgical practice, offering targeted pain relief, reducing the need for general anesthesia, and minimizing reliance on systemic opioids.[4,5] The choice of regional anesthesia technique should align with the surgical site, patient-specific factors, and anticipated postoperative pain management needs. For upper extremity surgeries, the interscalene, supraclavicular, infraclavicular, axillary, and intercostobrachial blocks are essential for anesthesiologists to understand and master.[1-4] Each technique targets distinct anatomical regions of the brachial plexus, with associated risks ranging from incomplete blocks to rare but serious complications such as pneumothorax or vascular injury. Similarly, lower extremity procedures benefit from regional techniques like femoral, adductor canal, sciatic, popliteal, and lumbar plexus blocks, which provide effective analgesia while minimizing systemic side effects.[6-11]

The advent of ultrasound guidance has revolutionized regional anesthesia by enhancing precision and safety. This advancement reduces the likelihood of complications, such as nerve injury and vascular puncture, and improves block efficacy. Furthermore, adjunctive agents like dexmedetomidine and dexamethasone have demonstrated the ability to prolong block duration, contributing to improved postoperative outcomes.[12-15]

Despite the numerous benefits, regional anesthesia is not without limitations. Providers must balance the risk of complications with patient-specific anatomical and clinical considerations. Effective implementation requires not only technical proficiency but also a thorough understanding of relevant anatomy and the ability to manage potential adverse events. This guide serves as a resource for trainees and practicing anesthesiologists looking to improve their regional anesthesia techniques and understanding.

Table 1. This table summarizes the key characteristics of regional anesthesia blocks used for upper extremity surgeries. The columns detail the anatomical target, typical surgical indications, critical anatomical structures to consider, and potential complications. These blocks are highly effective for providing localized anesthesia and pain relief during upper extremity procedures.

Block	Target	Common Surgical Cases	Important Structures	Complications
Interscalene Block	Roots and trunks of the brachial plexus (C5–C7)	Shoulder surgeries, proximal humerus fractures	Phrenic nerve, vertebral artery, recurrent laryngeal nerve	Respiratory issues, Horner's syndrome, vascular puncture, pneumothorax
Supraclavicular Block	Trunks and divisions of the brachial plexus	Mid-humerus, elbow, forearm, and hand surgeries	Subclavian artery, pleura	Pneumothorax, vascular puncture
Infraclavicular Block	Cords of the brachial plexus	Elbow, forearm, and hand surgeries	Axillary artery and vein, lung apex	Vascular puncture, pneumothorax
Axillary Block	Branches of the brachial plexus	Forearm and hand surgeries	Axillary artery, radial, median, and ulnar nerves	Incomplete block, hematoma, nerve injury, infection
Intercostobrachial Block	Dermatomal innervation of the intercostobrachial nerve (medial/posterior upper arm)	Medial/ posterior upper arm surgeries, tourniquet pain	Axillary crease	Incomplete block, infection

Table 2. This table outlines the regional anesthesia blocks commonly used for lower extremity surgeries. Each row describes the targeted nerve structure, types of surgeries the block is suitable for, significant anatomical landmarks, and possible complications. These techniques facilitate effective pain management while minimizing systemic side effects during lower extremity procedures.

Block	Target	Common Surgical Cases	Important Structures	Complications
Femoral Nerve Block	Femoral nerve in the inguinal region	Hip fractures, total knee arthroplasty, femoral shaft fractures	Femoral artery, femoral vein	Hematoma, nerve injury, infection, intravascular injection
Adductor Canal Block	Saphenous nerve and branches of the femoral nerve within the adductor canal	Total knee arthroplasty, lower leg surgeries	Femoral artery, femoral vein, adductor muscles	Hematoma, limited coverage, infection, intravascular injection
Sciatic Nerve Block	Sciatic nerve in the gluteal region, anterior thigh, or posterior thigh	Hip surgery, lower leg surgeries, foot and ankle surgeries	Gluteal arteries, ischial tuberosity, femoral shaft, lesser trochanter	Nerve injury, prolonged motor block, hematoma, infection
Popliteal Block	Sciatic nerve proximal to its division into the tibial and common peroneal nerves	Foot and ankle surgeries	Popliteal artery and vein	Nerve injury, vascular puncture, hematoma, infection, intravascular injection
Lumbar Plexus Block	Lumbar plexus within the psoas major muscle	Hip surgeries, knee surgeries	Psoas muscle, lumbar vertebrae	Epidural spread, vascular injury, retroperitoneal hematoma, infection, intravascular injection

CONCLUSION

Regional anesthesia remains a cornerstone in orthopedic surgical practice, offering precise, localized analgesia that enhances patient outcomes while minimizing the systemic side effects associated with general anesthesia and opioid use. For upper and lower extremity procedures, the selection of the appropriate block should be guided by the specific surgical site, patient anatomy, and clinical considerations. Mastery of these techniques requires an understanding of the anatomy, associated risks, and potential complications to ensure safety and efficacy. Advances in ultrasound-guided approaches have refined the precision and safety of these interventions, making them indispensable in modern anesthesia practice. By adopting these techniques, anesthesiologists can improve perioperative pain management, reduce recovery times, and contribute to the overall quality of patient care in orthopedic surgeries. This guide aims to serve as a valuable resource for trainees and practitioners striving to expand their skillset and optimize patient outcomes.

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