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REGIONAL ANESTHESIA FOR ORTHOPEDIC PROCEDURES:

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ABSTRACT
Regional anesthesia is an integral component of successful orthopedic surgery. Neuraxial anesthesia is commonly used for surgical anesthesia while peripheral nerve blocks are often used for postoperative analgesia. Patient evaluation for regional anesthesia should include neurological, pulmonary, cardiovascular, and hematological assessments. Neuraxial blocks include spinal, epidural, and combined spinal epidural. Upper extremity peripheral nerve blocks include interscalene, supraclavicular, infraclavicular, and axillary. Lower extremity peripheral nerve blocks include femoral nerve block, saphenous nerve block, sciatic nerve block, iPACK block, ankle block and lumbar plexus block. The choice of regional anesthesia is a unanimous decision made by the surgeon, the anesthesiologist, and the patient based on a risk-benefit assessment. The choice of the regional block depends on patient cooperation, patient positing, operative structures, operative manipulation, tourniquet use and the impact of post-operative motor blockade on initiation of physical therapy. Regional anesthesia is safe but has an inherent risk of failure and a relatively low incidence of complications such as local anesthetic systemic toxicity (LAST), nerve injury, falls, hematoma, infection and allergic reactions. Ultrasound should be used for regional anesthesia procedures to improve the efficacy and minimize complications. LAST treatment guidelines and rescue medications (intralipid) should be readily available during the regional anesthesia administration.

Keywords: Orthopedic surgery, Regional anesthesia, Spinal, Epidural, Combined spinal epidural, Peripheral nerve blocks, Neuraxial blocks, Upper extremity, Lower extremity.

Introduction
Orthopedic surgery is one of the most rapidly growing surgical specialties in the world. A total of 22.3 million orthopedic surgical procedures were performed worldwide in 2017. The number of annual orthopedic procedures is forecasted to increase 4.9% annually, approaching 28.3 million surgeries by the year 2022[1]. Anesthetic techniques for orthopedic surgical procedures include general and regional anesthesia techniques. Over the past decades, regional anesthesia has become the anesthetic technique of choice for many orthopedic procedures. Regional anesthesia entails the injection of local anesthetic solution to interrupt signal transmission in peripheral nerves or spinal nerve roots that provide sensory and motor supply to operative structures.

The use of regional anesthesia for orthopedic procedures mitigates some of the complications associated with general anesthesia such as nausea, vomiting, airway trauma, hypoxia, respiratory depression, and the risk of pulmonary aspiration[2,3]. Advantages of regional anesthesia for orthopedic surgeries include superior postoperative pain control, reduction in opioid consumption, reduced opioid-associated side effects[4-12], shorter hospital stay[7,8,11-13], early initiation of physical therapy[7,11], reduced hospital readmission rate[14], higher patient satisfaction[4,11], faster recovery[15], reduced unanticipated admissions due to uncontrolled pain[16], improved intraoperative muscle relaxation, decreased intraoperative blood loss[11,12], and a reduction in postoperative urinary retention and ileus formation[8].

BLOCKS FOR LOWER EXTREMITY ORTHOPEDIC PROCEDURES

Neuraxial blocks for lower extremity procedures

Neruraxial anesthesia results in the blockade of sympathetic, motor, and sensory nerves, which leads to unopposed parasympathetic tone. Major physiologic effects of neuraxial anesthesia include hypotension, bradycardia, hypothermia, nausea and vomiting, and high neuraxial blockade leading to respiratory depression[13]. There are several benefits to using neuraxial anesthesia for lower extremity orthopedic surgery that include reduced incidence of deep venous thrombosis in patients undergoing hip and knee replacement surgery, decreased intraoperative blood loss and transfusion requirements, and improved postoperative cognition[2,3, .Decreased intraoperative blood loss is likely due to a reduction in venous pressure from the sympathetic blockade. Multiple studies have showed that neuraxial anesthesia reduces the risk of postoperative deep venous thrombosis by at least 50%[16].

Spinal anesthesia

Spinal anesthesia is used for orthopedic procedures including total knee arthroplasty (TKA) and THA. Spinal anesthesia is usually performed with the patient in the sitting position while being continuously monitored. Also, it can be performed in the lateral decubitus position when the patient's condition does not permit sitting.

The complications and adverse effects associated with spinal anesthesia include: high spinal anesthesia, inadequate or failed spinal anesthesia, nerve injury, urinary retention, postdural puncture headache, transient neurologic symptoms, infection, and spinal-epidural hematoma

Epidural anesthesia

Epidural anesthesia and analgesia can be utilized as an effective technique to either supplement general anesthesia or as the primary anesthetic approach for lower extremity orthopedic surgical procedures. Moreover, epidural anesthesia may be supplemented with peripheral nerve blockade to decrease postoperative pain. Common indications for epidural anesthesia in orthopedic surgery include THA, TKA, foot/ankle surgery, and major knee surgery.

Epidural anesthesia is better suited for elderly patients with cardiac comorbidities that limit their ability to tolerate the sudden sympathetic blockade and the resulting hypotension associated with spinal anesthesia[17,18]. An epidural catheter may be incrementally dosed to slowly obtain an adequate surgical anesthetic level, thereby decreasing major rapid fluctuations in blood pressure[19]. Additionally, the epidural catheter can be continuously dosed during the surgery and may remain in place postoperatively for analgesic purposes[19].

With the advent of peripheral nerve blockade, the role of epidural analgesia strictly for postoperative pain has been decreasing in use. When comparing epidural analgesia with peripheral nerve blockade in patients who underwent TKA, a meta-analysis showed equivalent pain scores and morphine consumption between both groups up to 48 h postoperatively (Fowler, SJ 2008)[20]. Additionally, the use of epidural analgesia was associated with a higher incidence of urinary retention and hypotension, suggesting that peripheral nerve blockade provides equivalent postoperative analgesia with a favorable side-effect profile[21].

Serious complications of epidural anesthesia are extremely rare (0.03%), but can be potentially devastating[22]. These complications include epidural hematomas, epidural abscesses, nerve damage, infection, and cardiovascular instability[23]. Absolute contraindications to epidural anesthesia include patient refusal, local infection at puncture site, and severe coagulation disorders. Relative contraindications include sepsis, elevated intracranial pressure, anticoagulant use, bleeding disorders, fever, aortic stenosis, pre-existing neurologic injury, prior spine surgery, and placement in anesthetized individuals[24].

COMPLICATIONS OF REGIONAL ANESTHESIA

Local anesthetic systemic toxicity (LAST), is a potentially life-threatening complication that may result from unintentional intravascular injection of local anesthetic or slow absorption of an inappropriately high dose of local anesthetic injected perineurally. The ASRA publishes practice advisories for the management of patients who experience LAST[14].

The clinical presentation and speed of onset of LAST are extremely variable. Signs and symptoms of toxicity may immediately become apparent; however, they may take as long as 30 min or more to occur[15]. Symptoms typically present as a continuum; neurologic toxicity occurs at lower concentrations followed by cardiac toxicity at higher concentrations.

Early clinical signs of neurotoxicity are subjective, and include dizziness, drowsiness, perioral numbness, and tinnitus[15]. These signs may be missed if the patient is sedated or under general anesthesia. Following this, with increasing plasma concentrations, muscle twitching and tremors are observed. As blood and brain levels of local anesthetic continue to increase, generalized tonic-clonic seizures occur. Finally, generalized central nervous system (CNS) depression occurs leading to a reduced level of consciousness and coma[16].

Cardiotoxicity follows a two-step pathway[17]. In early cardiotoxicity, activation of the sympathetic nervous system results in hypertension and tachycardia. Following this, myocardial depression occurs leading to ventricular arrhythmias, conduction delays, contractile dysfunction, and eventual cardiovascular collapse. Inhibition of myocardial voltage-dependent sodium channels by local anesthetics may lead to a noticeable increase in the PR interval and QRS duration, as well as the presence of subtle T wave abnormalities[17].

Treatment of LAST begins with the recognition of the early signs and symptoms of toxicity, followed by immediate intervention including early administration of intravenous Intralipid emulsion. Intravenous Intralipid emulsion has been postulated to function by acting as a lipid sink to extract lipophilic local anesthetic from plasma and tissues[18]. It additionally functions directly on myocardial tissue by improving cardiac output[19]. Intralipid should be administered as a weight-dependent bolus followed immediately by an infusion[16]. Boluses may be repeated, and the infusion rate may be doubled if the patient continues to remain unstable[14]. The infusion should be continued for at least 15 min after obtaining hemodynamic stability[14].

CNS instability such as seizures should be appropriately managed with intravenous benzodiazepine administration or low doses of propofol[14]. Cardiovascular collapse should be managed with careful titration of intravenous epinephrine. Individual boluses of less than 1 mcg/kg should be administered to avoid ventricular fibrillation or tachycardia[14]. ACLS dosing of epinephrine (1 mg) may result in poor long-term outcomes due to the increased risk of arrhythmogenicity.

Conclusion

Regional anesthesia is one of the cornerstones of successful perioperative orthopedic management. In addition to providing superior anesthesia for orthopedic procedures, regional anesthesia provides superior analgesia with relatively fewer side effects compared to systemic analgesia modalities. Perioperative team awareness of regional anesthesia fundamentals is one essential step towards improving clinical outcomes, lowering health care costs, and sustaining higher patient satisfaction scores.

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