Chapter 15
ANESTHESIA FOR ORTHOPEDIC SURGERY

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Care of patients undergoing orthopedic procedures requires attention to many anatomical and physiologic principles that may not be immediately apparent if one only focuses only on the proposed surgical procedure. Most patients undergoing these procedures are healthy, but they can have many other problems, depending on their age, acuity of disease, and whether their orthopedic problems are the result of congenital anomalies, syndromes or trauma. It is the responsibility of the anesthetist and other healthcare providers to provide safe care, including prevention of future injury, and a smooth, comfortable recovery from anesthesia and surgery.

In this chapter general principles, specific orthopedic procedures, and treatment options for particular orthopedic problems are discussed. As for many things in medicine, surgical and anesthetic management often includes very expensive surgical components, anesthetic agents, monitors, and appropriate specialists. Many of these vastly exceed the capabilities of the healthcare systems of some countries. Therefore, this chapter focuses on the more common, straightforward components needed to provide safe care for patients with orthopedic problems.

General principles

Patient Populations

Children of all ages, from infants with congenitally dislocated hips to young adults who are suffering from massive trauma, require orthopedic procedures. Routine preoperative assessment, including the patient's medical history and physical examination, is essential. Attention to the underlying disorders and surgical problems are important for avoiding anesthesia complications. The more we know about the patient, the more likely it is that we can prevent or reduce these complications. The mortality risk following orthopedic procedures is not as great as it is for patients with cardiac disease or those undergoing thoracic or abdominal surgery[1.] Similarly, surgery on the extremities generally has little direct impact on pulmonary function. Yet an anesthetist who is familiar with a patient's baseline cardiac and pulmonary status will be better able to anticipate potential risks of anesthetic techniques and agents, of blood loss, and of surgical manipulation on that individual patient.

Each patient should undergo a though examination before anesthesia is induced. In addition to airway, cardiac, and respiratory assessment, body habitus, including, weight, extremities, presence of limb contractures, bedsores, and other wounds must be sought and noted to determine the potential effects of anesthesia on them. Some lesions will affect positioning of the patient for surgery, and these should be known and planned for. The anesthetist should determine if the skin of a potential nerve block sites is intact, infected, or inflamed. The presence of any one of these conditions may prevent the anesthetist from using this particular technique. Extremes of weight for age increase the risk for positioning related injury. For patients with multiple trauma injuries, the extent of their various injuries and how they will affect the outcome of surgery and recovery must be evaluated. This includes the integrity of the spinal cord and the potential for further injury that may be caused by moving/positioning the patient for bag-and-mask ventilation, tracheal intubation, and surgery. If cerebral trauma or severe trauma to other organs has occurred and requires non-surgical treatment, it may be safer for the patient to delay most orthopedic procedures until the patient's other problems have been successfully treated. Visual inspection of an injured extremity may reveal massive swelling that should alert the anesthetist to the possibility of internal bleeding and the occurrence of hemodynamic instability when the surgeon incises the extremity. The presence of a femur fracture in an infant or toddler may be evidence of child abuse and should cause the anesthetist to search for other injuries. He/she should look for bruises or injuries suggestive of abuse and initiate social assistance and patient protection.

Pediatric Assessment

Neuromuscular Disease

Children with cerebral palsy often present for a variety of orthopedic procedures. It is important for the anesthetist to recognize the wide spectrum of neurologic impairment found in this patient population and to individualize the patient's care, based on her/his specific limitations. While the patient may have severely impaired motor function, her/his cognitive function may be normal. Some children have an expressive communication disability, but this does not mean they cannot understand what is being said or done. Airway reflexes, such as the gag reflex, may be minimal, which puts the child at risk for aspiration of secretions and gastric contents and for subsequent pulmonary compromise. Other anesthetic considerations for these patients include contracture-related positioning restrictions, difficult vascular access in contracted extremities, and chronic pain from muscle spasms. Seizure medications, if being taken, should be given the morning of surgery. The intravenous (IV) pharmacologic equivalent of their anti-seizure medication should be given if they cannot take their drugs orally.

Airway

Even if the anesthetist elects to employ regional anesthesia for the surgery, he/she must have a plan for emergently supporting the airway if this becomes necessary. Failure of blocks, local anesthetic toxicity, and other unexpected circumstances may require conversion from regional to general anesthesia and/or tracheal intubation. Trauma, especially when it is due to falls, diving, or motor vehicle accidents, may be associated with instability of the cervical spine. Inline stabilization of the neck is used during manipulation of the airway to reduce or prevent further injury to the spinal cord. Key components to this maneuver include 1) stabilization of the neck with head and neck traction by one assistant, 2) cricoid pressure by a second assistant to aide in visualization of the glottis during laryngoscopy (and possibly prevent aspiration), 3) retention of the back portion of the cervical collar to help in neck stabilization (**Figure 15-1**).

Figure 15-1: Stabilization of the Neck During Tracheal Intubation

The figure shows one assistant applying cephlad in-line traction to stabilize the neck; cricoid pressure is being applied by another assistant. The anesthetist is inserting a tracheal tube. http://web.squ.edu.om/med-Lib/MED_CD/E_CDs/anesthesia/site/content/v04/040133r00.htm

Degenerative changes, such as arthritis, scoliosis, or some congenital diseases (e.g., Klippel Feil syndrome) that involve the cervical spine may make tracheal intubation difficult. Patients with Down syndrome may have instability of cervical spines one and two. Instability of their cervical spine places such patients at potential risk for spinal cord injury if the anesthetist extends the head during mask ventilation or tracheal intubation. If the patient is able to move her/his head in

all directions before surgery without central nervous system symptoms, there should be no difficulty extending the head to intubate the trachea. Congenital anomalies of the upper spine should be detected preoperatively so that their impact on successful direct laryngoscopy can be anticipated. If advanced airway equipment is not available, such as a video-laryngoscope or a bronchoscope, laryngeal mask airways (LMA) often provide an effective airway in these urgent settings.

During positioning for surgery and during the surgical procedure the anesthetist is responsibility for protecting the patient's airway. Positioning of patients with orthopedic problems may involve dramatic suspension of the patient on fracture tables, rotation of her/his body, or turning the patient onto her/his abdomen. The anesthetist is responsible for coordinating the care team's efforts when positioning the patient and for maintaining the secured airway during the move. Fracture reduction may require the surgeon to apply sufficient tension to the affected extremity to move the patient, which may dislodge the LMA or tracheal tube.

For all patients, but especially in those who are to undergo a regional block as a component of the anesthetic, it is vital to establish baseline nerve function. Postoperative nerve injury may be secondary to a pre-existing nerve injury, intraoperative positioning of the patient, stretch or disruption of the nerve by the surgeon, or rarely by the block itself.

Pain Management

Pain is a significant component of many orthopedic surgical problems and must be evaluated preoperatively. The pain may arise from the surgical site itself or from other trauma sites. Baseline assessment of pain should determine: 1) character and location of the pain; 2) intensity of the pain; 3) things that make the pain worse; and 4) things that make it better (e.g., medications, splints, casts, immobilization of the extremity). Care must be taken to minimize pain at these sites when positioning the patient for surgery. The surgical approach for correction of the lesion is often limited by inability to place the patient in the desired position for surgery because of pain and/or other physical restrictions (contractures, etc.). This inability to position the patient appropriately may make it more difficult for the surgeon to perform the surgery.

As discussed in chapters 20 and 21, perioperative analgesic requirements for patients with chronic pain are often much greater than for patients with acute or little pain. Medications that are being given to treat chronic pain preoperatively should be continued or replaced with drugs that provide a similar degree of analgesia. Additional analgesics, either higher doses of the chronic medications or agents in different pharmacologic classes, are also required to cover the surgically induced pain. The use of several drugs to treat perioperative pain can minimize the side effects of each drug. Nerve blocks or infiltration of local anesthetics into the surgical field often provide excellent postoperative pain relief, but it must be remembered that the effects of these blocks and infiltration wear off in a finite amount of time, depending on the drug used. This

means that the patient will have pain, often severe, when the block is no longer effective. The anesthetist must plan for this must as part of planning for the patient's postoperative care. If the patient is going home following surgery, he/she should be told when to start oral analgesics, usually before the block wears off. To avoid toxic blood levels of local anesthetics, it is best to not exceed the stated safe total dose of drug (**See Chapters 20 and 21**). Other useful classes of analgesics include opioids, non-steroidal anti-inflammatory agents (NSAIDs), ketamine, alpha-2 agonists (clonidine), and benzodiazepines. While there is some evidence of delayed bone healing in animals that were given NSAIDs, well-designed studies in humans show this is not the case.[2] It is best for the anesthetist to determine if the surgeon has concerns about whether NSAIDs can cause delayed bone healing before giving them. Some orthopedic injuries and surgeries are complicated by neuropathic pain. Neuroleptic drugs, such as gabapentin, may help minimize this otherwise difficult type of pain. The anesthetist can play a very important role in the patient's recovery from surgery and anesthesia by working with the surgeon, nurses, family and other caregivers to ensuring that the patient is comfortable postoperatively. Patients who have little pain are more likely to participate in early mobilization and physical therapy, which facilitate recovery from surgery and prevent the complications associated with bed rest.

Regional Anesthesia

Many orthopedic procedures can be performed under regional anesthesia, including subarachnoid block (SAB) for treatment of lower extremity fractures in teenagers. Benefits of blocks include avoiding the risks of general anesthesia, improved analgesia, early ambulation, and earlier discharge from hospital.[3] Technical and other considerations for these blocks are discussed elsewhere (*http://www.nysora.com/).* Whether an epidural block or SAB is used depends on the surgical procedure, equipment and medication available, and anesthetist's skills. Physiologic changes, such as those accompanying the rapid sympathetic block following spinal anesthesia, may be profound. Being prepared to treat these changes is important. The quality of motor block and surgeon's satisfaction with operating conditions can be adjusted by the choice of local anesthetic agent (**See Chapter 21**). How long the block lasts can be controlled more easily with epidural anesthesia. Administration of preservative-free opioids or alpha-1 antagonists (e.g., clonidine) into the epidural or subarachnoid space may extend the analgesia well into the postoperative period. If opioids are used, however, the patient's condition must be carefully monitored after surgery to detect any potentially life-threatening side effects of these drugs, including apnea and cardiac arrest. Patients given subarachnoid or epidural opioids should be monitored overnight in an intensive care unit (ICU).

There are several well-established contraindications to regional anesthesia, including patient refusal of this type of anesthesia, infection at the site where the block is to be performed, and/or coagulopathy. The latter is important during performance of the block and when it is time to remove a catheter that was used for continuous infusion of local anesthetic to treat postoperative

pain. A recent publication by the American Society of Regional Anesthesia addresses these concerns. http://www.asra.com/publications-practice-advisories.php Because the incidence of temporary phrenic nerve blockade is high with intrascalene block, this block is contraindicated for patients with limited pulmonary reserve.

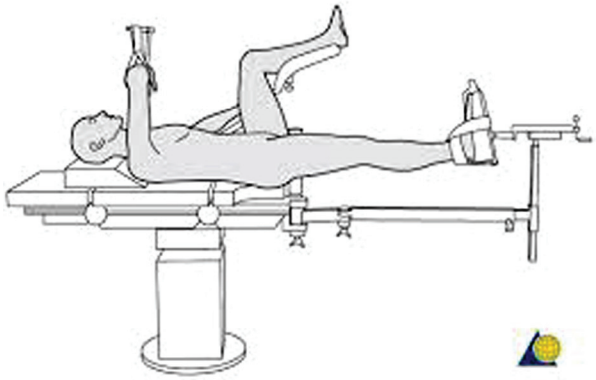
Muscle Relaxation

Neuromuscular blocking agents are used for some orthopedic procedures, often because surgeons request them to make reduction of a fracture easier. Alternatives to giving muscle relaxants, such as increased depth of anesthesia, are good options for patients who are at risk of developing complications from the use of muscle relaxants. For instance, succinylcholine must be avoided in patients who have spinal cord injury or muscular dystrophy because administration of succinylcholine to these patients can cause life-threating hyperkalemia. Patients with congenital disorders, such as spina bifida and cerebral palsy, are not at risk for developing hyperkalemia from administration of muscle relaxants. Residual neuromuscular blockade due to the use of muscle relaxants can cause respiratory compromise, hypoxemia, and hypercarbia postoperatively in any patient. This is particularly true for patients with muscular dystrophies. If the anesthetist has any concern that the patient has residual neuromuscular blockade, it is far safer to continue postoperative support of ventilation than to remove the tracheal tube and have the patient hypoventilate. Regional anesthesia or ketamine administration reduces both postoperative opioid requirements and the respiratory depression caused by these drugs.

Positioning of the Patient for Surgery

Proper patient positioning is very important for the success of orthopedic surgery because it optimizes the surgeon's view of and access to the surgical field, affects the amount of tissue perfusion and blood loss, affects the ability to obtain appropriate X-rays, and affect the ability to provide adequate patient comfort (**Figure 15-2**). It is the responsibility of each team member (surgeon, anesthetist, nurses) to check all pressure points during positioning of the patient and to do so intermittently throughout surgery. Excessive tension or pressure on extremities, eyes, ears, and genitals may lead to nerve damage or to pressure necrosis of tissues. When patients are placed in the prone position, it is especially important to prevent application of pressure to the eyes because this can lead to blindness. Exerting excessive pressure on the chest wall or abdomen (especially the abdomen) can impair ventilation. Conservation of body heat is important during the perioperative period, especially when he/she is uncovered during positioning and preparing the patient for surgery. If possible, the room temperature should be elevated during patient positioning, preparing the skin with antibacterial agents, and when performing anesthesia procedures; this will reduce heat loss and hypothermia. So will covering as much of the patient's body as possible with a plastic sheet.

Figure 15-2: Patient Positioning on a Fracture Table



This figure shows some of the positions possible on a fracture table. The arm can be suspended overhead to prevent brachial plexus injury. The legs can be positioned for surgery. Positioning on fracture table places patient at risk for injury at surgical and nonsurgical sites. www2.aofoundation.org

Radiation Exposure

Orthopedic surgeons frequently use fluoroscopy or X-rays during surgery to guide their work. While doing so is very important, it can expose both the patient and healthcare workers to radiation. Proper shielding of healthcare providers and patients with leaded devices (aprons) does this well. Radiation exposure dramatically decreases the farther a person is from the source of the radiation. If the anesthetist is fifteen feet from the X-ray machine, her/his exposure to radiation is minimal.

Blood loss

For some procedures, such as tendon transfers, closed fracture reduction, and hip stabilization, there is minimal blood loss. Other surgeries, such a spine surgery, trauma, open extremity surgeries, have a greater potential for substantial blood loss. The anesthetist can help reduce blood loss and the need for blood product administration. Recommendations have been developed for both elective and emergent surgery for patients on anticoagulants preoperatively.[4,5] http://www.uptodate.com/contents/management-of-anticoagulation-before-and-after-elective-surgery

It is important to obtain a preoperative hematocrit in patients who are expected to lose a lot of blood during surgery and in those with complex diseases, trauma, or who are at the extremes of age. Although anemia may is associated with perioperative mortality, blood transfusion also carries a risk (**See Chapter 4**).[6,7] If there is time, preoperative treatment of the anemia with iron or erythropoietin (when available) may be warranted. It is important to pay attention to

indicators of the intravascular volume status in hospitalized trauma patients and patients who are critically ill. Femur fractures or injuries that involve damage to vascular structures (e.g., disruption of blood vessels) may be associated with large unrecognized blood loss. Spinal procedures performed in the prone position are associated with lower venous pressures in the surgical site, which decreases blood loss. Hemodilution, controlled hypotension, and administration of anti-fibrinolytic agents may minimize blood loss during spinal procedures.

Tourniquets

Use of a tourniquet during extremity surgery reduces blood loss and improves the surgeon's ability to see the surgical site. The recommended inflation pressure for an upper extremity tourniquet is 50mmHg above systolic pressure; the recommended inflation pressure for the lower extremity is 100mmHg above the patient's systolic pressure. A tourniquet that is inflated for more than 120 minutes frequently causes significant discomfort in awake patients. Release of the tourniquet for several minutes reduces this discomfort. Appropriate selection of analgesics or sedatives for treatment of tourniquet pain must take into consideration its transient nature. Giving large doses of narcotics for this purpose is inappropriate. Prolonged periods of tourniquet inflation are not recommended because this may lead to permanent ischemic injury to nerves, muscle, and skin. After two hours of cuff inflation, transient metabolic changes including lactic acidosis, myoglobin release, and hyperkalemia may occur as a result of tissue ischemia. If the tourniquet must be used for longer, it should be deflated for 10-15 minutes and then re-inflated. Regional blocks, including nerve blockade of the region beneath the tourniquet, may reduce tourniquet-induced pain but not the nerve injury.

Infection Prevention

The anesthetist can take crucial steps during anesthesia to decrease the risk of infection. This is particularly important for patients with orthopedic injuries because infections can be devastating in these patients and may require weeks of antibiotic therapy to treat the infection. Open fractures should get priority on the surgical schedule to reduce/prevent infections from occurring. Recognition and management of preoperative infections, such as urinary tract infections and ear infections, reduce surgical site infections.[8,9] Administration of antibiotics within one hour before the surgical incision also reduces the number of perioperative infections. The antibiotics are re-dosed every 4-6 hours during long cases. The basic principles of hand washing, wound care, and sterile technique are critical for preventing infections.

Trauma

Patients with multiple trauma and orthopedic injuries present several additional challenges to the anesthetist. These patients frequently have full-stomachs, which put them at risk for vomiting and aspiration of their gastric contents. Trauma and the narcotics used to treat pain delay gastric

emptying. Spinal cord injury should always be considered as possibly present in trauma patients. As stated above, further spinal cord injury must be prevented during airway management and positioning of the patient for surgery. Surgical or medical management of traumatic injury to the brain, thorax, or abdomen may take precedent over repair of the patient's orthopedic injuries. Open repair of pelvic fractures is often accompanied by large blood loss. Consequently, blood products should be available before the start of surgery (**See Chapter 4**). Packing the pelvis with sponges and external fixation of the bone to prevent further injury may be the safer initial management of this injury. Discussion between the surgeon, anesthetist, and other caregivers is essential to decide on the best management of the patient with multiple-trauma.

Venous Thrombosis

Lower extremity injury, surgery, and bed rest place patients at risk for venous thrombosis and pulmonary embolus. The morbidity and mortality from pulmonary embolus is very high. Excellent pain control and early ambulation lessen the patient's risk of developing venous thrombosis. However, the benefits of giving anticoagulants to prevent or treat venous thrombosis must be weighed against the risks of causing increased surgical bleeding.

Casts

Splinting or casting extremities is a frequent component of orthopedic surgery. For most children, these procedures are performed while the patient is anesthetized. Young children who are awake may not tolerate the noise cause by a cast saw; some patients are concerned that the saw will injure them. The eyes of the patient and anesthetist and all sterile surgical equipment should be protected from particulates and dust arising from cutting the cast. Some children are not happy when they awaken and find that they are cannot move because of a cast. They should be warned before surgery that they will be in a cast and unable to move normally. If the child cries a lot and is in distress after surgery, it is important to ensure that this is not the result of residual surgical pain, the pain from a tight cast, or the exothermic reaction caused by some cast materials. Young patients, especially infants, are frequently placed in lower body or spica casts as part of the treatment of congenitally dislocated hips. It may be necessary to repeatedly turn the patient while the cast is being applied, frequently while he/she is being balanced on a small cast table (**Figure 15-3**). The anesthetist is often the only one watching the patient during this time. Therefore, it is up to her/him to: 1) secure the airway and maintain adequate ventilation; 2) prevent stretch of the upper extremity and brachial plexus; 3) ensure that the cast does not restrict excursion of the chest and abdomen and interfere with breathing; 4) keep the patient warm while he/she is uncovered during application of the cast.

Figure 15-3: Application of a Spica Cast

The figure shows a patient on a Spica cast table. Notice that he is elevated above the surgical table and somewhat precariously suspended on the cast table. The anesthetist is protecting the airway to prevent accidental tracheal extubation. Photograph Courtesy of Mohamed Diab, MD.

Compartment Syndrome

Perfusion of an extremity may be impaired if bleeding or swelling occurs and increases the pressure within confined facial-muscle areas. Loss of distal pulses and, at times a decrease in oxygen saturation (SaO_2), may herald the onset of a compartment syndrome. The ischemia that results from the increased pressure in the compartment is usually very painful. One clew that this is happening is the need for excessive amounts of analgesics, requirements that far exceed those usually anticipated for the type of surgery that was done. It has been suggested that regional anesthesia or patient controlled analgesia can delay the recognition of compartment syndrome, but this usually is not the case. If there is the potential for developing a compartment syndrome following surgery, lower concentrations of local anesthetics can be used for the block. Prompt recognition of a compartment syndrome, relief of the increased pressure, and restoration of perfusion are mandatory if massive metabolic changes, muscle breakdown, and permanent nerve injury are to be prevented.

Surgical Sites

Spine

Surgical procedures to correct curvature of the spine (scoliosis) are the most complex of orthopedic operations. The curvature is often the result of a neuromuscular disorder or other degenerative disease. The cause of scoliosis in an otherwise healthy patient is often unknown (idiopathic). Readers are referred to other publications for in depth discussions of the anesthetic management of patients for posterior spinal fusion.[10]

http://bja.oxfordjournals.org/content/99/1/86.full

Specific concerns for spinals surgery include the patient's cardiopulmonary status, blood conservation, prevention of spinal cord injury, and pain management. The extent of pulmonary compromise correlates with the degree of spinal curvature and rib cage distortion. Patients with severe curvature, especially those with neuromuscular disorders, may have minimal pulmonary reserve and need prolonged ventilator support post-repair. Blood loss tends to be greater in patients with neuromuscular disorders. Blood conservation techniques, previously mentioned, are particularly important during spinal surgery for patients with neuromuscular disorders. These include proper positioning of the patient and control of her/his arterial blood pressure. Spinal cord function can be compromised if the surgeon put tension on the spinal cord while trying to reduce the curvature and when he/she is placing the hardware to keep the spine in the desired position. Devastating paralysis can result from excessive tension on the spinal cord. Maintenance of systemic blood pressure within each patient's normal range is important at this point of the operation. Keeping the patient warm is also necessary, because hypothermia can reduce blood flow to the spinal cord and add to any injury from other causes. Postoperative vision loss is a rare but devastating complication of surgery performed with the patient in the prone position. Risk of this occurring is increased by prolonged surgical times, large volume fluid administration, and having the head in a dependent position relative to the heart. Pain management should employ the multimodal approach (**See Chapter 20**), including infiltration of local anesthetics into the surgical site. The patient may have had chronic pain as part of her/his presenting surgical scenario and required a significant amount of drugs to treat the pain. This may make providing adequate analgesia for these patients difficult following surgery.

Shoulder Surgery

Anesthetic concerns for shoulder surgery include: 1) the patient's baseline neurologic status; 2) assuring airway and anesthesia circuit security during surgery; and 3) monitoring the patient's hemodynamic status with the patient in the sitting position. Intrascalene blocks (**See Chapter 21**) provide effective intraoperative and postoperative pain relief. However, the surgery is done in close proximity to the brachial plexus and sometimes patients awaken with a brachial plexus

injury. When this occurs, it is necessary to differentiate whether the injury is due to an uncommon transient or long-term injury to the plexus that was caused by the nerve block, or whether it is due to the surgery itself. The long-term outcomes may be very different. During this surgery, care must be taken to assure security of the airway and anesthesia circuit. The operating table is often rotated away from the anesthetist, making it difficult for her/him to see the circuit and tracheal tube connections. When the surgeon places traction on the shoulder, the connections between the anesthetic circuit and the tracheal tube may inadvertently separate. When this occurs, hypoxemia may occur in apneic patients. Because the surgical site is above the level of the heart, there is an increased risk that a venous air embolus (VAE) may occur. Although echocardiography and precordial Doppler monitoring are the most sensitive means of detecting VAE, changes detected with more commonly used monitors may give evidence of this serious clinical situation. These include sudden decrease in $ETCO_2$, decreased systemic arterial blood pressure, new machinery type cardiac murmur, and rhythm disturbances or ischemic changes.

Upper Extremity Surgery

Most major surgical procedures on the upper extremity are performed under general anesthesia, but regional anesthesia, supplemented by sedation or general anesthesia, is also used. The block selected for upper extremity surgery depends on the surgical site, the need for a tourniquet during surgery **See Chapter 21**), the patient's disease, and the anesthetist's experience. (**Table 15-1**) For brief wrist or hand surgery a Bier block with infiltration of local anesthetic is an option.

http://www.nysora.com/techniques/3071-bier-block.html.

Table 15-1: Blocks for Upper Extremity Surgery

Block Type	Area Covered by Block	Potential Complication
Intrascalene	Shoulder	Injection of drug into the phrenic nerve, epidural space, vertebral artery, or into the subarachnoid space – spinal anesthetic
Supraclavicular	Upper and lower arm	Pneumothorax, phrenic nerve block
Infraclavicular	Elbow, hand	Intravascular injection
Axillary	Distal arm to elbow	Hematoma, infection
Bier Block	Hand	Cardiovascular compromise if tourniquet is released too rapidly

Hip Surgery

Orthopedic surgery for treatment of hip fractures is one of the most common surgical procedures done in many countries. The patients are frequently elderly and have multiple medical problems that must be considered and understood by the anesthetist before surgery. If not contraindicated by the patient's coagulation status, regional anesthesia is often the anesthetic of choice because it eliminates the need for general anesthesia and the risk of general anesthesia-related cognitive impairment following surgery. Subarachnoid, epidural, or lumbar plexus blocks are suitable for hip surgery. These blocks can also be used for repair of congenital or developmental abnormalities of the hip, depending on the patient's age. Some surgeons want controlled hypotension during hip surgery to minimize blood loss. But it is usually best to maintain the blood pressure within 20% of the patient's baseline pressure to minimize ischemic injury to the heart, brain and other organs. *Fat emboli* following trauma to long bones or from the surgery its self may be deposited in the pulmonary capillary bed and cause an inflammatory reaction. Pulmonary embolism is usually diagnosed when the patient has difficulty breathing and problems with oxygenating (low SaO_2), changes in her/his mental status when awake, and a petechial skin rash. These symptoms are often become apparent 12-to-72 hours after the injury (when the patient is going to surgery) or after surgery. The anesthetist should suspect this diagnosis when the patient develops unexpected respiratory problems in the perioperative setting. Respiratory support and bone stabilization are necessary to reduce/prevent fat embolization. *Deep vein thrombosis* or *pulmonary embolism* are significant causes of morbidity and mortality for patients undergoing major hip and lower extremity surgery. Risk factors include advanced age, cancer, previous venous thromboembolism (VTE), and prolonged immobility. Prophylactic anticoagulant therapy is recommended for the patient at risk for VTE. Effective postoperative analgesia often allows these patients to be mobilized early, which decreases the occurrence of thrombosis and embolism.

Lower Extremity

Previously mentioned anesthetic considerations for orthopedic surgeries apply to procedures performed on the lower extremities as well. Careful patient assessment, proper patient positioning, blood conservation, employment of regional anesthetic techniques, pain management, and VTE prevention are included. Central neuroaxial, femoral, sciatic, lumbar plexus, or more peripheral blocks can be beneficial. Regional anesthesia is thought to reduce the development of phantom limb pain when amputating all or part of an extremity. Pain due to muscle spasm after lower extremity surgery can be substantial, and benzodiazepines can be used to reduce this discomfort.

Summary

Anesthetists are presented with numerous challenges in patients undergoing orthopedic surgery. This patient population and the extent of the surgery vary significantly. A coordinated, dedicated

team effort by the anesthetist, surgeon, and nurses is required. The surgical procedure is just one step to recovery from the initial problem. Many other problems that occur are under the control of the anesthetist, and proper planning for the anesthetic and its delivery can affect recovery from both anesthesia and surgery. Attention must be paid to underlying disorders, infection control, pain management, and respiratory care. Nerve blocks for upper/lower extremity provide excellent postoperative pain relief and shorten hospital stays.

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