LOWER EXTREMITY OSTEOTOMIES

Surgical Specialty:	Orthopedic Surgery
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Background:

- General Considerations
  - An osteotomy of the lower extremity involves placing cuts into the bones to allow realignment. This can include reshaping, lengthening, shortening, or the correction of contractures.[1,2]
  - Lower extremity osteotomies are often necessary to preserve or improve movement/ambulation/standing, preserve a joint, and/or improve pain.[2]
  - Some pediatric conditions which may require lower extremity corrective osteotomies include coxa vara, genu valgum/varum, joint damage/deformity, trauma, etc.
  - Patients with specific neuromuscular conditions will present on multiple occasions for various orthopedic procedures.
- Patient Considerations
  - Musculoskeletal conditions are often manifestations of an underlying systemic disease. Furthermore, pre-existing patient comorbidities often influence the case complexity.[2]
  - May require a thorough, multidisciplinary, and advanced pre-operative assessment.
  - Patients with significant deformity can make airway, intravenous (IV) access, and any regional anesthesia techniques challenging.
- Associated Comorbidities/Syndromes
  - Various skeletal dysplasias, neuromuscular diseases, and metabolic bone diseases are associated with bony deformities in the pediatric population that warrant lower extremity osteotomies.
    - Cerebral palsy
    - Slipped Capital Femoral Epiphysis – obesity considerations (>50%)
    - Legg-Calve-Perthes Disease (coxa plana)
    - Muscular dystrophy
    - Mitochondrial myopathies
    - Osteogenesis imperfecta
    - Spinal Muscle Atrophy
    - Spina Bifida
    - Arthrogryposis Multiplex Congenita
    - Dwarfism
    - McCune-Albright Syndrome (fibrous dysplasia)
    - Sickle Cell Disease[2]

- Some of these conditions are also associated with hypermetabolic states, kyphoscoliosis, limb deformities, and difficult airways.[1]
- MH-susceptibility and/or rhabdomyolysis risk are also concerns depending on the underlying myopathies and can require specific anesthetics.

Anesthetic Planning:

- Pre-Anesthetic Evaluation
  - Additional testing indicated during work-up
    - Complete blood count (CBC) & Type & Screen +/- coagulation studies
    - Other studies depending on underlying conditions
      - Echocardiogram, electrocardiogram (ECG), polysomnography
  - Discussions to have with surgeon/family
    - The potential need for postoperative invasive vs. non-invasive mechanical ventilation (i.e., known, or suspected severe obstructive sleep apnea (OSA) or restrictive lung disease)
    - Possibility of blood transfusion
- Specific or Unique Room Set-Up Requirements
  - IV Access
    - Evaluate for difficult IV access
    - Two peripheral IV access catheters are recommended for osteotomies with anticipated high volume estimated blood loss (EBL)
  - Airway
    - Evaluate for a difficult airway
    - Assess need for rapid-sequence intubation (severe gastroparesis/GERD)
  - Drugs/Infusions
    - Total IV Anesthesia (TIVA) versus volatile anesthetics for maintenance per preference or medical necessity
    - Opioid-sparing techniques
      - Employ regional anesthetic blocks when appropriate
      - Multimodal analgesia
        - Nonsteroidal anti-inflammatory drugs (NSAIDs), acetaminophen, and muscle relaxants.
        - Initiation of gabapentin has fallen out of favor as it has not been shown to have any clinically significant analgesic effect in the perioperative period nor has it been shown to prevent chronic pain.[3]
    - Methadone is often considered in appropriate patients
    - Steroids
      - Dexamethasone
        - Antiemesis properties
        - Local anesthetic/regional block prolongation
        - Treatment of airway edema if multiple intubation attempts are required
    - Post operative nausea and vomiting (PONV) Prophylaxis per preference
  - Monitors
    - Standard American Society of Anesthesiologists monitors +/- arterial line
    - Consider urine output monitoring for larger EBL cases and when employing neuraxial anesthetic techniques.

        - Central Venous Pressure (CVP) monitoring is typically not necessary without underlying cardiac disorder; however, a central line may be considered if it is the only option to secure IV access.
    - Blood Transfusion Preparation & Blood Loss Minimization
        - The need for blood transfusion is a true consideration; therefore, a type and screen is recommended (preferably preoperatively if there is a recent transfusion history).
        - Blood should be made readily available when considering the following:
            - Any high EBL procedures, such as those dealing with the proximal femur or pelvis.
                - A heavy EBL is anticipated in these cases due to dense vasculature within the pelvis and proximal femur as well as the inability to use a tourniquet.[4]
            - Any bilateral procedures
            - Those patients who have underlying anemia and/or coagulopathy.
        - Blood salvage should be used whenever possible, but this is not helpful with smaller patients.
        - Controlled hypotension (requires discussion with the surgeon) can be employed to minimize blood loss
        - Tourniquets
            - Occlude blood flow proximally with external pressure to provide a more optimal surgical field while also minimizing blood loss.[1]
            - Reperfusion causes the abrupt removal of anaerobic metabolites from the area, resulting in a transient increase in end-tidal carbon dioxide, potassium, and a reduction in blood pressure.[1]
        - Antifibrinolytic therapy
            - Tranexamic acid (TXA) bolus followed by infusion is the most common and is associated with a reduction in the need for blood transfusion.[4]
            - Clinician preferences, patient risk factors, and institutional protocols may vary – discuss with the surgeon
    - Pediatric intensive care unit (PICU) bed availability
        - Evaluate the anticipated need for postoperative mechanical ventilation

Intraoperative Considerations:

- Induction
    - Address the following: difficult airway, tracheostomy dependence, and aspiration risk
- Positioning
    - Supine positioning is most common, but lateral is possible.
    - Positioning can be challenging due to deformities and contractures.
    - Patients often have extremely low body fat percentages and are at risk of pressure-related injuries.
- Maintenance
    - Assess the need for a "non-triggering anesthetic"
    - Otherwise, drugs as above
- Hemodynamic/Physiologic goals
    - Temperature maintenance
        - Many patients with neuromuscular diseases have poor temperature regulation and low body fat percentage. Thus, aggressive perioperative

temperature maintenance is important, especially if large volume blood loss is anticipated.
    - For lengthier procedures, those with predictable larger volume blood loss, or with neuraxial anesthesia, consider urine output monitoring.
    - Venous & arterial access
        - Consider a fluid warmer and assess the need for arterial lines and acquire good venous access with peripheral IVs as stated above.
- Surgical Considerations
    - Regional & Neuraxial Anesthesia Techniques
        - Lumbar erector spinae plane and certain peripheral nerve catheters allow for the regional technique to be continued beyond discharge.[5,6]
        - Ensure that the planned regional anesthetic technique is appropriate for the patient and the surgery being performed, which may require a preoperative discussion with the surgeon.
            - Evaluate the risk of compartment syndrome, the location of the incision relative to coverage, as well as location of the catheter dressing relative to the sterile field.[6,7]
- Emergence/Disposition
    - Patients at an increased risk of aspiration (gastroparesis and/or severe gastroesophageal reflux) should be extubated awake.
    - Patients with severe developmental delay may not reliably follow simple commands. Ensuring enough time for drug metabolism, appropriate end-tidal CO_2, and strong respiratory effort is imperative to ensure a safe and successful extubation and avoid reintubation.
- Post-op Care
    - Disposition to acute care floor versus intermediary unit versus pediatric intensive care unit (PICU)
        - Assess underlying pulmonary function and severity of pulmonary disease.
    - Pain management
        - If performing a continuous regional technique or epidural, ensure nursing staff is familiar with local anesthetic infusions, accessibility to intralipid, and availability of continuous monitoring of vital signs.
        - Intermittent rescue IV opioid analgesia and opioid patient-controlled analgesia (PCA) should also be considered for postoperative analgesia.
        - Acute pain service to assist with regional block/neuraxial, PCA management, and the timely transition to oral pain meds

Case-Specific Complications/Pitfalls

- Difficult intubation due to syndrome, contractures, prior trach scarring, or subglottic stenosis.
- Increased risk of pulmonary complications
    - Acute on Chronic Respiratory Failure
        - Patients with central +/- obstructive sleep apnea are at increased risk of extreme sensitivity to sedating medications and opioid analgesic agents
        - Assess the need for postoperative ventilation in advance and plan for PICU admission
    - Pulmonary Hypertension
        - Pre-existing due to cardiac history, pulmonary fibrosis, and/or restrictive lung disease
    - Bronchospasm

        - Increased secretions and underlying pulmonary disease increase the risk of bronchospasm
- Acute intraoperative blood loss
    - Ensure crossed blood is available and blood salvage technology is employed when possible.
    - Use of tourniquets is encouraged when applicable

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