Chapter 14
Orthopedics II

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A 6-year-old girl is scheduled for a Pemberton osteotomy for developmental dislocation of the hip (DDH). She is otherwise well, in first grade, and, although a little nervous, very conversational.

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Preoperative Evaluation

Questions

1. How common is this form of hip dysplasia? How does it occur? Is it an isolated finding, or should you expect syndromic associations? Risk factors? What is the goal of the surgery?

2. How is this disorder treated at various ages? Why?

3. Do you require any preoperative lab work? What are the risks/benefits?

Answers

1. Developmental dysplasia of the hip (DDH) refers to abnormal development of the acetabulum, femur, labrum, and capsule. At late gestation, femoral head grows more rapidly than the acetabular cartilage so that at birth the femoral head is less than 50% covered. The acetabulum is at its most shallow and most lax in order to maximize hip ROM which facilitates the delivery process. After several weeks, acetabular cartilage develops faster than the femoral head, which allows progressively more coverage. The femoral head becomes displaced from the acetabulum in the perinatal period, which results in abnormal development of the hip joint. It is more common in females, firstborn children, and breech deliveries. Despite the routine use of Barlow's test (posteriorly dislocatable hip) in the newborn exam, less than 2% of infants with DDH will have a positive Barlow's test. The vast majority of unstable hip examinations improve by age 2 months (60% at 1 month; 88% at 2 months). Several neuromuscular syndromes such as meningomyelocele, arthrogryposis, and cerebral palsy can be associated with hip dislocation. Children who are prepubertal or pubertal are at risk for slipped capital femoral epiphysis (SCFE). The goals of the surgery are to stabilize the hip joint to minimize early osteoarthritis.

2. Treatment of infants younger than 6 months is usually done with bracing in a Pavlik harness. Closed reduction is considered after 6 months of age in children with hip dislocation, and open reduction is usually done after 2 years of age because of the risk of avascular necrosis and the increased failure of closed reduction. At this point, open reduction with a pelvic osteotomy, usually through an anterolateral approach, is used.

3. Because there are no associated syndromes or comorbidities, it is reasonable to proceed without preoperative lab work. A baseline hematocrit can be obtained at the time the IV is placed, and if needed, a type and screen or crossmatch can be set up at that time.

Intraoperative Course

Questions

1. Your anesthetic plan for induction? Does the patient need premedication?

2. What kind of access do you plan? Any special considerations with regard to patient positioning? Is an arterial line necessary? A central venous line?

3. What is your strategy for blood conservation? Controlled hypotension? Hemodilution? Cell Saver?

4. What is your approach for a regional anesthetic for this patient? Is it necessary to avoid neuromuscular blockers for the block?

Answers

1. The preoperative conversation with the family will determine the need for premedication. This is usually an easy age group to work with, and if the child is conversational with strangers, having been in school for a few years, it is often easy to find some common ground to talk about. A parent-present induction without premedication would probably work out well, for this patient.

2. While it is extremely unlikely to require a transfusion, there is nevertheless a steady amount of bleeding during the osteotomies which may be underappreciated unless the surgical field is carefully watched. I would place two relatively large IVs after induction. I would not anticipate any sudden blood loss nor massive blood loss, and in a healthy child, the need for an arterial line or a central venous line to monitor gas exchange or metabolic status would probably not be necessary. It is important to consider this question because of the restricted extremity access for this procedure, so you need to be relatively sure from the beginning. Another factor is the age/size of the patient – the smaller the patient, the more likely that an arterial line would be an added safety benefit.

3. Blood conservation strategies should include the use of a Cell Saver and tranexamic acid. Intraoperative cell salvage can reduce allogenic blood transfusion by 50% in adults; however, the smaller the patient, the less likely this will make an impact on this statistic because the red cell mass that is salvaged is simply very small – unless there is massive blood loss [1, 2]. Nevertheless, blood transfusion was significantly reduced in volume and frequency when used in craniofacial, major orthopedic surgery (acetabuloplasty), scoliosis correction, and complex cardiac surgery [3]. Continuous systems are faster and require only small volumes of salvaged blood for processing and produce blood with high hematocrit, making them more suitable for pediatric cases. Tranexamic acid is a very useful strategy for decreasing blood loss and should be routinely used [4]. Controlled hypotension and hemodilution are techniques that have largely been replaced.

4. A regional anesthetic as a component of perioperative care is very useful. Lumbar plexus blocks as an adjunct to light general anesthesia for the procedure as well as postoperative analgesia are rapidly replacing epidural blocks in some centers. Some advantages of the more specific nerve block include a shorter duration of urinary catheterization and earlier ambulation. The majority of these blocks are now done with ultrasound guidance, but rarely, they need to be confirmed with the use of a nerve stimulator; therefore, it is good to avoid neuromuscular blockade until after the block is in. We typically use a continuous catheter technique as a way to provide perioperative continuous infusion.

5. How do you plan to keep this patient warm?

Postoperative Course

Questions

1. The patient is crying and in obvious pain in the PACU following the procedure. Should the lumbar plexus block be providing total anesthesia for this procedure? What areas does it not cover? The surgeon comes by and wants to give the patient diazepam – is this a rational suggestion?

2. Despite your best intraoperative efforts, the patient arrived in the PACU with a temperature of 34.8 °C and is shivering so badly that his teeth are chattering and there is no tracing on the ECG. Is this temperature dangerous? Would meperidine help? Why? Is it likely that an equianalgesic dose of fentanyl or morphine would work just as well?

5. Heat loss is a major consideration – there is much surgical exposure, the rooms are typically cold in order to keep personnel comfortable because they are covered in many layers including lead aprons, and because of patient size, there is not much surface area to heat. The wide prep involves the legs up to the nipple line. The forced hot air warmer is typically utilized as well as the use of low fresh gas flows or a closed-circuit anesthetic technique, reducing fresh gas flows to the minimum amount to meet metabolic needs. The most important aspect of keeping the patient warm is to not lose the heat in the first place, so these strategies should begin after induction, and not wait until the patient is prepped and draped and the surgeon is ready to begin – that can often be an hour after induction!

Answers

1. A lumbar plexus block provides analgesia to the three major nerves of the lumbar plexus, blocking sensation to the upper anterior leg and the lateral femoral cutaneous nerve. This block also anesthetizes the distal branches of the lumbar plexus, including the iliohypogastric, ilioinguinal, and genitofemoral nerves that innervate the groin area. The gluteal area and the posterior thigh are not blocked by a lumbar plexus block but rather a sciatic block, which is not routinely done in these patients, so there may very well be some spasm in the muscles of the posterior thigh. Diazepam is a very rational approach to treat spasm in this area (which may remain undetectable by physical diagnosis) and can be given in incremental intravenous amounts in the PACU until an effect is obtained.

2. Meperidine would likely help decrease the shivering. Although the mechanism is not totally understood, it is thought that the special antishivering efficacy of meperidine results at least in part from an uncharacteristically large reduction in the shivering threshold rather than from an exaggerated generalized thermoregulatory inhibition. This pattern differs from that produced by alfentanil, clonidine, propofol, and the volatile anesthetics, all of which reduce the vasoconstriction and shivering thresholds comparably [5, 6].

Additional Topics

Questions

1. A healthy 17-year-old high school football player wants to wake up with as little pain as possible following his ACL reconstruction and is particularly interested in regional anesthesia as an adjunct. He makes it clear he wants a general anesthetic as his primary anesthetic. What can you offer him as a plan?

2. What is a club foot? At what age do you typically encounter these patients? Any special considerations for their anesthetic? What are the advantages and disadvantages of offering a regional anesthetic as an adjunct?

Answers

1. There are several effective approaches to local anesthetic/regional techniques as adjuncts to perioperative analgesia. First, it is important to acknowledge that a regional block is not required for effective postoperative analgesia; much success has been achieved with multimodal pain approaches, particularly as they have been used to reduce opioid requirements. That said, the earliest consistent nerve blocking technique was the femoral nerve block, introduced about 20 years ago. A few years later, an adductor canal approach was introduced, in an effort to improve ambulation postoperatively. Recently, comparative studies have examined these two techniques, which appear to be equally effective in analgesia, with simple instillation of local anesthetic in the joint space. All three appear to be, at least statistically, without significant difference. It is likely that the optimal combination would include multimodal approaches along with nerve block or instillation [7–9].

2. Club foot (talipes equinovarus) occurs in 10:10,000 births with equal prevalence in males and females. There can be neurogenic causes (arthrogryposis, spina bifida, and tethered cord), connective tissue disorders (Larsen syndrome), and mechanical causes (oligohydramnios, intrauterine band disorders), or it can be an isolated idiopathic deformity. These associations should be carefully considered in the preoperative evaluation. These children are seen in infancy. Talipes equinovarus surgery involves lengthening some tendons and releasing tight ligaments in order to place bones and joints in normal position. Surgery is generally done during infancy, and the foot is placed in a cast to maintain the correct position while the tendons and ligaments heal. There is minimal blood loss during surgery because surgical tourniquets are used. Regional anesthesia can be considered, but only after weighing the benefits and risks. What has to be kept in mind is that pain control can be accomplished with narcotic analgesics and NSAIDs. Children who have talipes equinavara surgery are usually placed in bilateral short leg casts postoperatively and are at risk for postoperative swelling which can cause nerve, muscle, and skin damage. These children need to be monitored closely for this complication. A regional block can interfere with evolving signs of such complications in an infant. As long as this is continuously evaluated, then a caudal or lumbar plexus block would be reasonable choices. There are occasions and associated comorbidities when a regional anesthetic is preferred as the primary anesthetic, with supplemental sedation [10].

3. A 5-year-old with a right Sprengel deformity requires correction. What else would you like to know, as the anesthesiologist? How does this anomaly develop? Should you expect any associated disorders?

3. The Sprengel deformity is the most common congenital malformation of the shoulder girdle with a male to female ratio of 3:1. The condition is usually sporadic although it can be familial with an autosomal dominant pattern of inheritance. Embryologically, the scapula begins as a cervical appendage that differentiates opposite the fourth, fifth, and sixth cervical vertebral bodies at approximately 5 weeks of gestation. Normally it descends into the appropriate position approximately 90 days later. Any obstruction to this migration will result in a hypoplastic, elevated scapula. There may be some limitation of motion due to an omovertebral connection between the medial border of the scapula and the lower cervical spinous process. This rhomboid- or trapezoid-shaped cartilage or bone can be found in approximately one-third of these patients. Additionally, the prescapular muscles may be contracted and fibrotic. These deformities can vary in severity and have been classified by Cavendish:

   - Grade 1 Very mild. Shoulders almost level. Clothing masks deformity.
   - Grade 2 Mild. Shoulders almost level, but superomedial portion of high scapula is visible.
   - Grade 3 Moderate. Shoulder is elevated 2–5 cm higher on the affected side.
   - Grade 4 Severe. Scapula is very high with superomedial angle at occiput with neck webbing and brevicollis.

   The Sprengel deformity is usually associated with other malformations such as fused ribs, chest wall asymmetry, cervical ribs, congenital scoliosis, and cervical spina bifida. It can also be associated with a number of syndromes: Klippel-Feil sequence, Moebius sequence, Poland sequence, VACTERL, velocardiofacial syndrome (22q11 deletion), and Goldenhar syndrome [11].

References

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Annotated

McCann ME, Brustowicz RM, Holzman RS. Chap. 26 The mMusculoskeletal sSystem and Orthopedic sSurgery. In: Holzman R, Mancuso T, Polaner D, editors. A pPractical aApproach to Pediatric Anesthesia. 2nd ed. Philadelphia: Lippincott Williams and Wilkins; 2015.
A good general review of anesthesia for pediatric orthopedic surgery, with embryology of the various anomalies and their anesthetic implications.

Further Reading

Lonsdale H, Owen J. Anaesthesia for paediatric lower limb surgery. BJA Education. 2016;16(2):58–65.