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Intraosseous Needle Placement

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Overview

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For unstable patients requiring urgent administration of medications, fluids, or blood products, establishing vascular access quickly is essential. However, there are many factors that can complicate placement of a peripheral intravenous cannula (PIV), and it is extremely common for PIV attempts to fail. PIV placement may be technically challenging in small children, injection drug users, obese people, people with chronic illnesses necessitating frequent vascular access, and in those with burns and other skin conditions. Furthermore, for patients in shock, blood is shunted away from the periphery in order to compensate for impaired perfusion of vital organs, making peripheral vessels difficult to find and cannulate. In these situations, intraosseous (IO) needle placement is an extremely effective alternative to PIV placement, allowing rapid and technically straightforward access to the highly vascularized intramedullary space inside the long bones. From here, medications and fluids are readily absorbed into the bloodstream, permitting stabilization of critically ill patients.

Procedure

1. Choose a location for IO needle placement.

1. Location options include:
    1. Proximal tibia: on the medial (flat) side of the tibia at the level of the tibial tuberosity, 3 cm distal to the inferior border of the patella (1-2 cm in infants/children).
    2. Distal tibia: on the medial (flat) side of the tibia, 3 cm proximal to the medial malleolus (1-2 cm in infants/children).
    3. Proximal humerus: on the most prominent aspect of the greater tubercle, 1-2 cm proximal to the surgical neck.

2. Ensure that there are no contraindications to use of the chosen location:
    1. Acute or recent fracture of the target bone
    2. Previous significant orthopedic procedure at the target site
    3. Overlying skin/soft tissue infection at the target site
    4. Inability to appreciate anatomic landmarks by palpation
    5. Previous IO at the target site within the past 48 hours

3. There is no compelling evidence that one site is uniformly "better" than another in terms of efficacy or patient comfort. The proximal humerus is the preferred site in patients with abdominopelvic or lower extremity trauma. Otherwise, site selection is based on patient size, anatomy, indication for insertion, provider's ability to identify anatomic landmarks, provider's experience and comfort, and of course absence of contraindications to use of a specific site.

2. Position the patient properly.

1. For tibial insertions, put the patient in a "frog leg" position, with the knee slightly bent and abducted, allowing access to the medial aspect of the tibia
2. For humeral insertions, adduct the patient's elbow and rest the forearm across the abdomen - this internally rotates the humerus, moving the tubercle into an anterior position.

3. Palpate thoroughly to identify the insertion site. You will not be able to touch the site once it has been cleaned, so make sure you know exactly where you plan to place the needle.

4. Cleanse the insertion site with the antiseptic solution of your choice.

5. While the antiseptic solution is drying, prepare your equipment:

1. Intraosseous drill - test to make sure it is charged and functional
2. Intraosseous needle - select the appropriate length (all are 15 g):
    1. 15 mm: infants/small children
    2. 25 mm: larger children/adults
    3. 40 mm: unusually large adults
3. Attach needle to drill by simply clicking it into place
4. Connector set to flush and administer medications/fluids
5. Dressing to stabilize needle once inserted

6. Stabilize the extremity with your nondominant hand, taking care not to contaminate the insertion site.

7. Aim the needle at a 90° angle to the center of the bone. In children, you may angle slightly away from the growth plate, or toward the shaft of the bone.

8. Push the needle tip through the skin at the chosen insertion site, and let it rest against the bone.

9. The needle has black markings every 5 mm from the tip to the top of the shaft. Ensure that the first 5 mm mark is visible above the skin surface; if not, then you must use a LONGER needle to ensure adequate length to reach the medullary space.

10. Begin drilling, holding the needle steady and applying the gentlest possible pressure.

11. Watch and feel carefully: when the needle enters the medullary space, you will feel it "give way" as the high resistance of the mineralized cortex changes to the much lower resistance of the soft marrow. This sensation is much less prominent in young children, whose bones remain cartilaginous.

12. As soon as you feel or see the "give," STOP DRILLING. Continuing may cause the needle tip to lodge in the cortex of the bone on the other side of the medullary space.

13. Note the position of the needle and resume drilling, very carefully advancing the tip 1-2 cm into the medullary space. If you feel resistance, you may have reached the far cortex, and you should back up slightly.

14. Your goal is NOT to get the hub of the needle against the skin - this may result in excessively deep insertion. Your goal is to get 1-2 cm into the medullary space, which will usually (but not always) result in the hub ending up next to the skin, assuming proper needle length selection.

15. Hold the hub in place while gently pulling the driver straight off the needle.

16. Continue holding the hub in place while gently twisting the stylet off the hub (unscrew it counter-clockwise), then pull the stylet out of the hollow-bore needle and discard in a sharps container.

17. Verify that the needle feels firmly seated in the bone. If it moves easily, then it is in the subcutaneous tissue.

18. Assuming you are satisfied that the needle is firmly seated in the bone, then stabilize and protect the needle using gauze and tape, or a purpose-made stabilizer dressing.

19. Attach a primed connector set and 5-10 cc flush syringe to the needle hub.

20. Verify that the IO is properly positioned and functional by aspirating. You will usually (but not always) see pink marrow reflux into the tubing.

21. Further verify the functionality of the IO by flushing. You should never see leakage of fluid around the insertion site, and the skin should not become puffy. There may be some resistance to flushing, especially at first, but it should not be difficult to infuse the full syringe of fluid into the medullary space.

22. For pediatric patients and for adults who are unresponsive to pain, the IO is now ready to use.

1. Anything that can be infused into a central venous catheter can also be infused into an IO, including fluids, blood products, bolus medications, and continuously infused medications.
2. Infusions must be pressurized to flow effectively through an IO needle; fluid will not reliably run through an IO via gravity. This can be accomplished by using an infusion pump or a hand-pumped pressure bag. For smaller volumes of fluid (as in pediatrics), a syringe can be used to manually inject fluid into the IO as well.
3. The patient must be frequently assessed for signs of extravasation, malposition, or any other complications.

23. For adults who are responsive to pain, 2% intravenous (preservative-free) lidocaine may be used to anesthetize the medullary space.

1. Slowly infuse 40 mg lidocaine through the IO needle over two minutes
2. Allow the lidocaine to remain in the medullary space for one minute
3. Flush with 5-10 cc saline
4. Repeat doses of 20 mg (given over one minute) may be given as needed for ongoing control of pain associated with infusion through the IO needle
5. The threshold of lidocaine toxicity should be calculated for the patient, and care should be taken to ensure that this threshold is not exceeded by repeated administration. The minimum toxic dose of intravenous lidocaine is 6.4 mg/kg. Calculate toxicity threshold as follows:
   Patient weight (kg) × 6.4 = maximum lidocaine dose (mg)
6. Systemic analgesia or alternate access approaches should be considered for patients who require repeated doses of lidocaine.

Summary

The ability to quickly establish vascular access can mean the difference between life and death for critically ill patients. In cases where traditional intravenous access cannot be secured, IO access is a rapid, safe, and effective alternative. Fluids, blood products, and medications are readily bioavailable when infused into the intramedullary space inside of the long bones. The commercial availability of IO drills has made this traditional pediatric procedure feasible for patients of all ages. It is a technically simple procedure that can readily be mastered by healthcare workers, and used to save lives!