Intraosseous infusion technique for pediatric emergencies and anesthesia

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Intraosseous Infusion Technique

History

The circulation in the mammalian bone-marrow

Drinker CK- Am J Physiol 1922
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History

The circulation of the bone-marrow

Doan CE - Contrib Embryol 1922
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History

- **1940s**: Many studies demonstrated versatility and utility in children
- **1940**: Henning reports intraosseous blood transfusion
- **1944**: Meola reported 326 successful bone marrow infusions in 144 pediatric patients
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History

- **1947**: Heinild reports of the experience close to 1000 infusions in children between 2 days and 4 years
- **1950s and 1960s**: venous cut-down techniques and plastic catheter technology which could be left in veins for long periods improved and IO fell into disuse and subsequent obscurity
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History

- **1983**: Dead due to bleeding tonsils in a child without intravenous access for induction of anaesthesia -> Henry Turkel “Why is it being ignored?”
- The rejuvenation of the technique of intraosseous infusions began in 1983 with a letter to the editor of the *American Journal of Diseases of Children* by Henry Turkel.

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History

- **Since 1985** over 200 hundred studies, investigating intraosseous infusion technique has been performed and published.
- **1988**: Textbook of Advanced Pediatric Life Support (Chameides L) recommended the intra-osseous infusion technique for emergency vascular access in children under 6 yrs.
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**Signs of Successful Needle Insertion**

- Loss of resistance
- Needle stands firmly in the bone
- Bone marrow can be aspirated
- Fluid can be administered
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Monitoring of the IO Needle

- Swelling (anterior/posterior)
- Minor swelling around the needle can be occur
- Skin vasoconstriction of the leg after epinephrine can occur
- Pain on injection can occur
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Bone Marrow Sampling

- Testing for blood products
- Testing for hematology blood chemistry and glucose
- Testing for blood gas analysis and acid base state
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Complications

- Infection (osteomyelitis - 0.6 %)
- Fractures
- Injuries to inadequate needle position
- Compartment syndrom
- Damage of the epiphyseal plate / bone
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Complications

- Bone marrow and fat embolism to the lung
- The only deaths resulting directly from intraosseous infusion were associated with the sternal approach (mediastinitis, hydrothorax, and cardiac or great vessel injury)
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Medication

All fluids and drugs required for resuscitation can be given by the intraosseous route

(incl. antibiotics, colloids, blood products, hypertonic solutions, etc.)
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Drug Dosage

Intraosseous drug dosage and fluid amounts/rates are the same like with intravenous application
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Effectiveness

Onset and effectiveness of pharmacological action of intraosseous infusion is similar to central venous drug/fluid application and even faster and more effective than peripheral venous drug/fluid application.
# Intraosseous Infusion Technique

## Fluid Rates

<table>
<thead>
<tr>
<th></th>
<th>Dog Tibia</th>
<th>Bovine Tibia</th>
</tr>
</thead>
<tbody>
<tr>
<td>by gravity</td>
<td>300 mm/Hg</td>
<td></td>
</tr>
<tr>
<td>20-gauge</td>
<td>11 ml/min</td>
<td>10 ml/min</td>
</tr>
<tr>
<td>13-gauge</td>
<td>13 ml/min</td>
<td>13 ml/min</td>
</tr>
<tr>
<td>Bovine</td>
<td></td>
<td>41 ml/min</td>
</tr>
<tr>
<td>13-gauge</td>
<td>(600 ml/h)</td>
<td>(2400 ml/h)</td>
</tr>
</tbody>
</table>

- Dog Tibia by gravity: 300 mm/Hg
- 20-gauge: 11 ml/min, 24 ml/min
- 13-gauge: 13 ml/min, 29 ml/min
- Bovine Tibia 13-gauge: 10 ml/min, 41 ml/min
- Bovine Tibia 13-gauge: (600 ml/h), (2400 ml/h)
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Contraindications

In principal, there are very rare contraindications for insertion of an intraosseous needle, if a patient urgently requires vascular access.
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Absolute Contraindications

- **Local infection** at the site of needle insertion
- **Local fracture** at the site of needle insertion
- **Local needle hole** from prior unsuccessful intraosseous needle insertion
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Relative Contraindications

- Osteogenesis imperfecta
  - Osteopetrosis
  - Burned skin
- Pyogenic septicemia
Duration of Intraosseous Infusion

- As long as required for resuscitation of the patient
- maximum 12 h - 24 h
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Indications: Pediatric Emergency Care I

90 - 120 seconds after unsuccessful intravenous cannulation in the critically ill child urgently requiring drugs and fluids for resuscitation
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Indications: Pediatric Emergency Care II

Primary vascular access
in the child
with asystole cardiac arrest
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Indications: Pediatric Anesthesia I

- Acute bleeding (Tonsils)
- Laryngospasm
- Resuscitation
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Indications: Pediatric Anesthesia II

- For rapid induction if intravenous access cannot be established?
- Intraosseous infusion: elective use in pediatric anesthesia?

Stewart FC- Anesth Analg 1992
Conclusions

- **Simple, safe and effective technique** to establish an intravascular access
- **Rapid** technique (60 seconds)
- Possibility for blood testing
- **Low risk** of complications
- **All fluids and medications** can be applied
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Conclusions

- All doctors, nurses, paramedics caring for children must know and be skilled with intraosseous infusion technique
- In all locations, where children are treated, adequate equipment must be immediately available establishing an intraosseous infusion