Peripheral Nerve Blocks vs. Central Blocks

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Objectives

- Review the history of neuraxial anesthesia in children
- Review benefits of neuraxial anesthesia in peri-operative management
- Discuss contraindications to and potential complications of neuraxial anesthesia in children
1. Neuraxial anesthesia has been around for a long time . . .

- 1885 - Corning injected cocaine between the spinous processes of the lumbar vertebrae first in a dog and then in a man. He thought he had performed a spinal block, but it is more likely that he injected into the epidural space:
  - did not observe cerebrospinal fluid flow
  - cocaine dose was 8 x higher than dose subsequently used by Bier to produce spinal anesthesia
  - onset of analgesia was slower and dermatomal level lower

- 1921 - Pagés described a technique of injecting anesthetics between the 4th and 5th lumbar vertebrae, leaving the spinal canal untouched

- 1930’s - Dogliotti described a "loss-of-resistance" technique to identify the epidural space

including continuous epidural techniques

- 1941 - Hingson, Edwards and Southworth developed the technique of continuous caudal anesthesia for surgical procedures and childbirth
  - instead of removing the caudal needle after the injection, a continuous infusion was administered

- 1947 - Martínez Curbelo described the first placement of a lumbar epidural catheter
  - a 16-gauge Tuohy needle was introduced into the epidural space through which a 3.5 French ureteral catheter made of elastic silk was threaded into the lumbar epidural space
  - the needle was then removed leaving the catheter in place

Single shot neuraxial anesthesia has a long history in pediatric anesthesia as well . . .

- 1900 - Bainbridge publishes a report on the use of spinal anesthesia in an a 3-month old infant undergoing the repair of a strangulated hernia

- 1933 - Campbell mentions caudal blocks in children

- 1954 - Ruston reports on the use of single-shot thoracolumbar epidural anesthesia in > 40 infants and children undergoing abdominal or orthopedic surgery

The position of the child and the epidural anesthesia “kit” circa 1954
though catheter-based techniques are more recent

- 1983 – Meignier, et. al., placed epidural catheters at the end of surgery in 7 children (4-15 kg) with respiratory insufficiency undergoing abdominal surgery
  - facilitated post-op pain management and pulmonary toilet

- 1986 – Ecoffey, et. al., placed high lumbar or low thoracic catheters following induction of general anesthesia in 20 infants (age 3-36 months) for urologic or upper abdominal surgery
  - dosed intra- and post-op
  - good hemodynamic stability intra-op and analgesia intra- and post-op

1988 - Bosenburg et. al. studied the feasibility of passing an epidural catheter from the caudal to the thoracic epidural space in infants

- Phase 1 – studied in pediatric cadavers
- Phase 2 – attempted in piglets
- Phase 3 – placed catheters in 20 neonates and infants undergoing biliary tract surgery under general anesthesia
  - catheter placed within one vertebra in 19/20
  - anesthesia “successful” in all patients

But being around for a long time isn’t enough
2. Neuraxial techniques provide good analgesia
3. Neuraxial analgesia decreases the stress response

**Methods:** Plasma adrenaline and noradrenaline concentrations were measured in 40 infants receiving analgesia with systemic opioids or extradural bupivacaine during abdominal surgery.

**Results:** Perioperative adrenaline and noradrenaline levels were significantly higher in control group vs. epidural group.

Methods: Peri-operative plasma cortisol levels in 13 children undergoing surgery with general anesthesia and non-opioid analgesia post-op (Control) or general/epidural anesthesia with epidural analgesia post-op (Lumbar Epidural)

Results:
- Cortisol levels increased with incision and surgery in Control Group
- Cortisol levels decreased with incision in Lumbar Epidural group

4. Epidural analgesia may decrease need for post-op ventilation

35 patients undergoing repair of oesophageal atresia (light GETA + caudo-thoracic epidural) vs. 32 historical controls (GETA + opioid)

<table>
<thead>
<tr>
<th></th>
<th>GA Group (n = 36)</th>
<th>Epidural Group (n = 35)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (range)</td>
<td>3.05 days (1-10)</td>
<td>2.9 days (1-14)</td>
</tr>
<tr>
<td>Mean weight (range)</td>
<td>2.55 kg (1.2-4.3)</td>
<td>2.54 kg (1.45-4.8)</td>
</tr>
<tr>
<td>Post-op ventilation</td>
<td>19/36</td>
<td>5/32*</td>
</tr>
</tbody>
</table>

* 3 patients ventilated preoperatively

5. In some cases, neuraxial anesthesia is (almost) all you need

- LP success rate: 97.4% (residents: 83%)
- Surgical anesthesia: 95.4%
- Additional IV sedation: 24.1%
- Conversion to GA: 1.2%
- 5 patients required tracheal intubation - 4/5 extubated at end of case.

**Vermont Infant Spinal Registry 1978-2005**

**Table 1. Types and Number of Surgical Procedures Performed Under Spinal Anesthesia**

<table>
<thead>
<tr>
<th>Surgical procedure</th>
<th>Number of procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anoplasty</td>
<td>19</td>
</tr>
<tr>
<td>Circumcision</td>
<td>65</td>
</tr>
<tr>
<td>Colostomy</td>
<td>41</td>
</tr>
<tr>
<td>Cystoscopy</td>
<td>24</td>
</tr>
<tr>
<td>Exploratory laparotomy</td>
<td>55</td>
</tr>
<tr>
<td>Gastrochisis</td>
<td>31</td>
</tr>
<tr>
<td>Inguinal hernia repair</td>
<td>855</td>
</tr>
<tr>
<td>Meningomyelocele repair</td>
<td>25</td>
</tr>
<tr>
<td>Omphalocele</td>
<td>5</td>
</tr>
<tr>
<td>Orthopedic lower extremity procedures</td>
<td>22</td>
</tr>
<tr>
<td>Patent ductus arteriosus ligation</td>
<td>20</td>
</tr>
<tr>
<td>Pyloromyotomy</td>
<td>136</td>
</tr>
<tr>
<td>Total</td>
<td>1554</td>
</tr>
</tbody>
</table>

6. Neuraxial Anesthesia is Versatile

The epidural space can be entered at multiple locations to deliver analgesics.
The Swiss Army Knife of Regional Anesthesia

- TAP block vs. Epidural
- Penile block vs. Epidural
- Femoral nerve block vs. Epidural
8. Sometimes an epidural is just better

**Methods:** 58 adult patients undergoing hepatobiliary or renal surgery under GETA/epidural were randomized to receive subcostal TAP catheters or epidural analgesia for post-op pain management

**Authors’ Conclusion:** TAP catheters may be an effective alternative to epidural infusion for post-op analgesia

<table>
<thead>
<tr>
<th></th>
<th>Epidural (n=31)</th>
<th>TAP catheter (n = 27)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Success (%)</td>
<td>24 (78%)</td>
<td>17 (63%)</td>
</tr>
<tr>
<td>Satisfaction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good or Excellent</td>
<td>24 (78%)</td>
<td>20 (74%)</td>
</tr>
<tr>
<td>Total tramadol (mg) median (IQR)</td>
<td>200 (100-350)</td>
<td>400 (300-500)*</td>
</tr>
<tr>
<td>24 h VAS score (coughing) median (IQR)</td>
<td>4.0 (1.8-4.6)</td>
<td>3.5 (1.8-5.5)</td>
</tr>
</tbody>
</table>

*p < 0.001

8. Neuraxial analgesia is “simple”

Keep It Simple Stupid
Typical Peripheral Nerve Block

> 80% of upper extremity and > 60% of lower extremity blocks in PRAN database were placed under ultrasound guidance.
You can use ultrasound guidance to place a caudal in an infant...
or epidural nerve root stimulation

Epidural Positioning System using Tsui test, Arrow International, Inc. USA

but you don’t have to – and probably won’t

84% of continuous neuraxial blocks in the PRAN database were placed without the use of localizing techniques.
9. While in most instances you can’t go home with one, neuraxial catheters can remain in for a protracted period to provide peri-operative analgesia.
Placement of a tunneled caudal epidural

10. Neuraxial analgesia is generally safe
Disclaimer: There ARE times when it may be a bad idea to use neuraxial anesthesia

- Spinal cord abnormalities
  - spina bifida, scoliosis, previous spinal surgery

- Cardiovascular contra-indications
  - uncorrected hypovolemic or aortic stenosis

- Coagulopathy due to bleeding disorder or anticoagulant medication

- Infection near the point of insertion site
Prospective multicenter study of regional anesthesia in children in France (2005-2006)

31,132 regional blocks including 1628 neuraxial catheters

41 complications overall (0.13%)
  31 in neuraxial blocks (0.295%)
  0.14% vs 0.13% catheter vs non-catheter

Adverse Events
- 3 high spinals/10 dural punctures
- 13 LA toxicity (none required active treatment)
- 3 transient nerve injuries
- 1 inflammation at epidural site
- 1 persistent back pain (x 1 yr)

No complication resulted in any long-term sequellae

Pediatric Regional Anesthesia Network (PRAN): A Multi-Institutional Study of the Use and Incidence of Complications of Pediatric Regional Anesthesia

Ongoing centralized database collecting prospective data on regional anesthetics performed at participating institutions (n = 14)

2007-2010 Data:

• 14,917 regional blocks performed on 13,725 patients, including
  • 6210 neuraxial blocks (single shot caudals most common)
  • 455 upper extremity blocks
  • 2307 lower extremity blocks

<table>
<thead>
<tr>
<th></th>
<th>Total procedures 2007-2010/( 2007-2104)</th>
<th>Total adverse events 2007-2010 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neuraxial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single shot</td>
<td>6210 (27558)</td>
<td>183 (3%)</td>
</tr>
<tr>
<td>Catheter</td>
<td>2946 (9814)</td>
<td>520 (18%)</td>
</tr>
<tr>
<td>Upper extremity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single shot</td>
<td>455 (4435)</td>
<td>8 (2%)</td>
</tr>
<tr>
<td>Catheter</td>
<td>26 (223)</td>
<td>6 (23%)</td>
</tr>
<tr>
<td>Lower extremity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single shot</td>
<td>2307 (13698)</td>
<td>33 (1%)</td>
</tr>
<tr>
<td>Catheter</td>
<td>544 (2416)</td>
<td>97 (18%)</td>
</tr>
<tr>
<td>Adverse Event/Complication</td>
<td>Single Shot (n = 6210)</td>
<td>Catheter Intra-op (n = 2946)</td>
</tr>
<tr>
<td>---------------------------------------------------------</td>
<td>------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>(++) Test dose or vascular puncture</td>
<td>56</td>
<td>46</td>
</tr>
<tr>
<td>Dural puncture</td>
<td>7</td>
<td>26</td>
</tr>
<tr>
<td>Abandoned or failed block</td>
<td>104</td>
<td>46</td>
</tr>
<tr>
<td>Catheter problem</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unilateral, prolonged or excessive motor block</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adverse drug reaction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Neurologic</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Hematoma</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other (includes infection)</td>
<td>15</td>
<td>19</td>
</tr>
</tbody>
</table>
Details of Adverse Events

Single Shot Blocks
• 0 complications reported in caudal group
• 1 report of hypotension from spinal
• 57% of complications were block failure

Continuous Neuraxial Blocks
• 4 PDPH required blood patch
• 4 Horner’s syndrome (all with thoracic epidural)
• 3 paresthesias – all resolved by discharge
• 5 episodes of respiratory depression – all resolved with change in infusate content or rate

No deaths or complications with sequellae lasting >3 months
Prospective audit of children in Great Britain and Ireland receiving epidural infusion analgesia (2001-2005)

56 incident reports in 10,633 data sets (0.53%)

Adverse Events

- 2 inadvertent spinals/6 PDPH
- 12 drug error/1 LA toxicity
- 6 transient peripheral nerve injury
- 2 epidural abscess/1 meningism/25 local infection
- 1 drug error resulting in cauda equina syndrome and persistent long-term sequellae

4 cases of long-term neurologic complications associated with epidural analgesia

- 23 month old female – flaccid paralysis after lumbar epidural catheter
- 12 year old female – flaccid paralysis after high lumbar epidural catheter
- 12 year old male with CRPS – bladder dysfunction after lumbar epidural (resolved after 8 months)
- 11 year old male – left lower extremity paresis after thoracic epidural
Aggregate estimated rates of occurrence and 95% confidence intervals for neurological complications after neuraxial blockade (A) and neuropathy after peripheral nerve blockade (B)

A

B