Epidural Analgesia

When bad catheters happen to good anesthetists.

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Wake Forest School of Medicine

History of Epidural Catheters

- 1901 First epidural injection
- 1931 Aburel- silk ureteral catheter for OB
- 1930 – 1950: random materials available to individual practitioner
- 1950-1960: 1mm PVC cut from industrial roll and sterilized.
- 1962: Lee’s catheter-smooth tip, side hole @ 1cm

Safer than general (?)… but not without risk

- 145,580 epidurals administered
  - intravascular injection = 1 in 5,000 (0.02%)
  - intrathecal injection = 1 in 2,900 (0.035%)
  - subdural injection = 1 in 4,200 (0.024%)
  - high or total spinal block = 1 in 16,200 (0.006%)


Safer than general (?)… but not without risk

- 19,259 deliveries; neuraxial labor analgesia rate was 75%; overall failure rate was 12%
  - After adequate initial placement, 6.8% required replacement. (1.5% had multiple replacements)
  - Intravenous placement - 6% (40% were made functional)
  - Wet tap-1.2%
  - The incidences of overall failure, intravenous catheter, wet tap, inadequate analgesia and catheter replacement were lower in patients receiving combined spinal-epidural analgesia.
  - For cesarean section, 7.1% of pre-existing labor epidural catheters failed and 4.3% of patients required conversion to general anesthesia. Spinal anesthesia for cesarean section had a lower failure rate of 2.7%, with 1.2% of the patients requiring general anesthesia.


Our goals:

- Pick a winner
- Get it in
- Keep it in
- Make it work
- Respond when it goes in the wrong place
- Pull it out
Types of Catheters

- **Material**
  - Polyamide Nylon (Braun, Portex)
  - Spring wound polyurethane polymer (Arrow)
  - Hybrid (Braun Soft-tip)

- **Orifices**
  - Single end hole
  - Multiple side holes

Nylon catheters

- Greater tensile strength
- More often associated with multiple side orifices
- Stiff
- Greater incidence of venous cannulations, paresthesias

Soft catheters

- Greater ease of threading
- Resistant to kinking
- Less paresthesias and vein cannulations
- Some require stylet
- Usually with single orifice
- More likely to curl
- Weaker; prone to becoming lodged, separated, and possibly broken upon withdrawal

**Arrow Flex-Tip Cath**

**Catheter comparison**

<table>
<thead>
<tr>
<th></th>
<th>Portex</th>
<th>Arrow (Soft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paresthesia</td>
<td>39</td>
<td>3</td>
</tr>
<tr>
<td>Vein Cannulation</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>Inability to insert</td>
<td>5 (*ns)</td>
<td>0</td>
</tr>
</tbody>
</table>
Catheter Strength

Anesth Analg 2001; 92: 246–8

Manufacturer | Reported malfunctions
--- | ---
Arrow | 248
Braun | 114
Abbott | 75
Baxter | 31
Smith | 25
Portex | 20
Epimed | 17
Becton Dickson | 2


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Multi-orifice catheters

- Better spread
- Potential for Multi-compartmental or partial block
- Unilateral block half as frequent than with single-orifice catheters (8% vs. 16%)


- Significantly less unilateral block or unblocked segments

To work well, a continuous infusion pump has to act like a bolus infusion device.


**Single-orifice catheters**

- Better spread to sacrum
- “...epidural catheter design does affect the distribution of solutions in the epidural space. Single orifice epidural catheters compared favourably with multi-orifice catheters, resulting in more even distribution and sacral extension of dye.”


**Our goals:**

- Pick a winner
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**Does position matter?**

- ~100 patients each sitting or lateral
- Vein cannulation 16% in sitting vs. 4% in lateral position


**Are all spaces created equally?**
Where do catheters go?

- Deviation from midline is more likely vein cannulation or paresthesia.
- 20% of catheter tips lay outside the lateral margins of the vertebral bodies.
- Lateral foramen: catheter deviation relative to distance inserted.

Where do catheters go?

- Catheters track more straight into space if inserted at 50° vs. 90°.

Where do catheters go?


**Insertion vs. coiling**

- Fluoroscopy, paramedian approach
- Started at T9 reached to either T6-7 (obtuse 60%) or T7-8 (acute 40%).

<table>
<thead>
<tr>
<th>Coiling Length</th>
<th>Acute</th>
<th>Obtuse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>4.9</td>
<td>7.4</td>
</tr>
<tr>
<td>Min-Max 95% CI</td>
<td>3.8-6</td>
<td>6-8.7</td>
</tr>
</tbody>
</table>

Out of sight... out of epidural space?

Lateral catheter = unilateral block

Double, double, \textit{Coil} and trouble

- Coil / knot
- Arrow:
  - 7 cephalad
  - 3 caudad
  - 1 same space
- Portex
  - 3 cephalad
  - 3 same
  - 1 caudad

Double, double, \textit{Coil} and trouble

- 19ga Arrow Flex-Tip in 45 patients
- median coiling length- 2.8 cm (1.0–8.0 cm)
- Only 6 (13\%) threaded >4 cm without coiling
Double, Double, Coil and Trouble

- Pain & sensory loss in thigh
- Catheter coiled around L3 nerve root
- Stretched and broke on withdrawal

Double, Double, Coil and Trouble

- Catheter inserted 9 cm.
- Resistance on withdrawal. Steady pressure finally removed catheter (somewhat painfully)


Double, Double, Coil and Trouble

- Catheter inserted 8 cm.
- Attempt to pull back to 5 cm met with resistance.
- Knot and loop found at 7.5 cm

Huang, J. Another case of knotting of an epidural catheter. AANA J. 2010;78(2):93-94.

Where do catheters go, Up or down?

- Direction of insertion does not make much of a difference.
- 45 patients. Surgery affecting sacral nerves
- Catheters: half up; half down.
- No difference in onset time, duration, anesthetic level, and analgesic effect


Catheter shearing

- Don’t withdraw through needle
- Patient movement may cause shearing
Improving technique

- Ultrasound guidance to find ES in pediatric patients.
- US correlated 0.88 with conventional LOR
- Ultrasound estimation of depth significantly improved placement rate

Our goals:

- Pick a winner
- Get it in
- **Keep it in**
- Make it work
- Respond when it goes in the wrong place
- Pull it out

Disconnection

- Variety of connectors available.
- Careful with caustic antiseptics
- If meniscus moves/moved- whole cath may be contaminated
- 2% would reconnect
- 15% clean the outside and reconnect
- 4% would cut and reconnect
- 44% would clean, cut, and reconnect
- 35% would remove the catheter.
Disconnection

- Lockit device holds catheter securely at skin.
- Reduces, but does not prevent movement-related failure

**Epidural failure**

- 125 patients with surgical epidurals
- 25% failed.
- 45% of failed due to dislodgement

<table>
<thead>
<tr>
<th>CT scan region</th>
<th>Success</th>
<th>Failure</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin to epidural space</td>
<td>40</td>
<td>97</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Skin to peritoneal cavity</td>
<td>51</td>
<td>80</td>
<td>0.008</td>
</tr>
<tr>
<td>Anterior-posterior distance of catheter to skin</td>
<td>30</td>
<td>31</td>
<td>0.82</td>
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Where do catheters go?

- Pull out-
- Skin to epidural space distance increases when sitting lateral.
- Most pronounced in obese.

Our goals:

- Pick a winner
- Get it in
- Keep it in
- Make it work
- Respond when it goes in the wrong place
- Pull it out

Secured to skin or epidural space?

- Lockit device holds catheter securely at skin.
- Reduces, but does not prevent movement-related failure
Why do they stop working?

- Air or saline for LOR?
- A 31-year-old primip with L3-L4 labor epidural. 4 hours after catheter placement - constant, severe, sharp, bilateral subscapular back pain with radiation to left shoulder and arm that started acutely after pressing the PCEA button.


What if it’s “iffy”?

- Important to calculate depth in epidural space.
- For patchy block, add bolus; if no relief, withdraw catheter 1 cm.
- Maintain at least 3 cm in space for multi; at least 2 cm for single orifice.

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Intravenous Placement

- Lateral situation?
- Collapsible - test passive aspiration
- Appropriate to withdraw, flush, salvage
- Expand space - 2% vs. 16% incidence of venous placement
- Pre-flushed catheter - takes 2x as long to identify IV placement
  - Bell, O'Connor & Leslie.. Anaesthesia & Intensive Care. 35(6):932-8, 2007

Unintentional IV Injection

- ↑HR 20-30 bpm (epinephrine)
- Patient complaints:
  - “ringing” in the ears
  - dizziness
  - tinnitus
  - circumoral numbness

*Initial study used non-pregnant patients
Speaking of Intravenous Placement… test dose

- Isoproterenol to avoid α-effect of epi
- HR response non-specific in labor
- Careful about multiple repeats
- With dilute solutions following CSE, test for IT placement only
- T-wave changes

Speaking of Intravenous Placement… test dose

- Meniscus test
- Inject air, then saline
- Hold catheter up
- Dropping meniscus = epidural placement
- Hold catheter down
- Continuing flow = subarachnoid or vein
- Return of bubbles + outflow that stops = epidural


Where do catheters go?

- Subdural- high, patchy block, horner's syndrome; multi-compartmental catheter

Subdural catheter- Railroad Tracks

Subdural catheter- Railroad Tracks

Characteristics of Subdural placement
Characteristics of Subdural placement

- Excessive spread of block with:
  - Slow onset > 20 min.
  - CV instability
  - Motor sparing with sensory block
  - Patchy/asymetrical block
  - Respiratory failure
  - Facial/head involvement


Where do catheters go?

- Through dura
- Contrary to intuition, CSE does not increase subdural placement.
- 100 patients; eposcan vs. conventional touhy. No dural puncture of catheter


Where do catheters go?

- Subarachnoid

<table>
<thead>
<tr>
<th></th>
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<th>Arrow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intact dura</td>
<td>0/300</td>
<td>0/300</td>
</tr>
<tr>
<td>Occult 17ga hole</td>
<td>6/33</td>
<td>1/14</td>
</tr>
<tr>
<td>Obvious 17ga hole</td>
<td>1/35</td>
<td>0/90</td>
</tr>
<tr>
<td>25ga CSE</td>
<td>0/90</td>
<td>0/90</td>
</tr>
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Subarachnoid catheter; What next?

- Survey in UK. 176 units. 144 of which have written guidelines
- 28% place catheter, 31% give option]
- Rationale: avoid potential for additional dural puncture and provide immediate analgesia
- 71%: EBP only after conservative measures fail for PDPH

Baraz R, Collis RE. The management of accidental dural puncture during labour epidural analgesia: a survey of UK practice. Anaesthesia. 60(7):673-9, 2005

Where do catheters go?

- Subarachnoid
- Decision tree- thread catheter

Where do catheters go?

- Subarachnoid Catheter vs. PDPH
- Efficacy increases with duration left in

<table>
<thead>
<tr>
<th>Strategy</th>
<th>PDPH Incidence</th>
</tr>
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<tbody>
<tr>
<td>Replace epidural</td>
<td>80%</td>
</tr>
<tr>
<td>IT catheter, removed @ delivery</td>
<td>30%</td>
</tr>
<tr>
<td>IT catheter, left for 24 hours</td>
<td>3%</td>
</tr>
</tbody>
</table>

Responding to Problems

- Intrathecal “epidural” catheter
- Intrathecal injection possibly 200 mg of lidocaine and 61 mg of bupivacaine
- Apnea and fixed dilated pupils

20ml cerebrospinal fluid was replaced with 10 mL of NS and 10 mL of LR
- Spontaneous respiration 5 min later, extubated in 30 min. No deficits or PDPH

Responding to Problems

- Inadvertent intrathecal drugs (bupivacaine, lido, chloroprocaine) all associated with cauda equina syndrome.

- Immediate injection of 10ml PF saline will help to dilute and has been shown to decrease incidence of subsequent PDPH.

Inadvertent subarachnoid injection

- Tsui, Ban C. H. MD, MSc, FRCP(C)*; Malherbe, Stephan MB, ChB, MMed, FCA(SA)*; Koller, John MD, FRCP(C)*; Aronyk, Keith MD, FRCS(C)† Anesthesia & Analgesia (2004) 98(2) 434-43 Reversal of an Unintentional Spinal Anesthetic by Cerebrospinal Lavage


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What goes up must come down; what goes in...

- Removal complications
- Arrow catheter stretches significantly more and breaks at lower weight than nylon


- Soft catheters appear in numerous case reports lodged/unable to be removed
Reinforced wire catheter problems

- Catheter stuck.
- Patient placed into the left lateral decubitus position and the catheter was removed without difficulty.
- However, it was noted that the catheter reinforcing wire had become uncoiled at the distal end and remained inside the patient.
- The wire was successfully withdrawn with steady traction.

Bastien JL, McCarroll MG, Everett LL. Uncoiling of Arrow Flextip plus epidural catheter reinforcing wire during catheter removal: an unusual complication. Anesthesiology. 98(2):554-5, 2004

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What goes up must come down; what goes in...

- Inadvertent intrathecal placement, with inability to remove catheter immediately after placement.
- Epidural placement with immediate attempt to withdraw, but unable.
- Catheter left in place for 3 days, with daily attempts to remove, until finally removed.


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What goes up must come down; what goes in...

- Patient in lateral position for withdrawal. Resistance felt before catheter broke without any significant stretching.
- Allowed the patient to relax for 3 hours, placing the patient in the lateral decubitus position, and placing continuous tension on the catheter itself so as to let it "work its way out".

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What goes up must come down; what goes in...

- Catheter began to distort at 7cm
- Small incision, grasped at 6cm
- Had pt twist her hips


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What goes up must come down; what goes in...???

- Case reports:
  - Catheter placed intrathecally; inability to remove immediately
  - Catheter placed normally; inability to withdraw for depth immediately
  - Difficulty persisted for 3 days until finally removed
  - Catheter pulled with hemostat; broke at grip site

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Measures to remove entrapped catheter

- Don't force
- Gently tighten knot
- Lateral position or same as insertion
- Don’t use instruments
- Give “rest time” (hours or days)
- Steady, progressive traction
- Injection of saline to R/O knot
- GA with muscle relaxants

Summary

- In spite of safety with regional techniques, proper placement of epidural catheters can be challenging, even in cases of uneventful insertion.
- Avoid complications
  - Distend space with saline
  - Lateral position/soft up to reduce vein cannulation
  - CSF for placement verification
  - Limit insertion depth
- Secure to non-moveable anchor, but not before soft tissue shifts
- Recognize limitations of test doses/Every dose is a “test dose”
- Intrathecal placement now more commonly left in place instead of replaced

Arrow Flex-tip catheter

- In contradistinction to “Buenos Aires” catheters, the Arrow Flex-tip catheter has distinct properties.
- The Arrow Flex is a “pillow-top” technique that allows for greater flexibility and reduced pressure on the insertion site.
- It is designed to minimize the risk of vein damage and soft tissue trauma.
- Injection of saline is recommended to help dislodge the catheter from the vein.
- If necessary, gentle traction can be applied, but care must be taken to avoid excessive force.

Summary

- Soft catheters reduce intravascular placement and paresthesias, but are more likely to become lodged and subsequently break
- High index of suspicion for catheter failure
  - Break-through pain/spotty block
  - Lots of top-up doses
  - Large patient size
- Lodged catheters should be removed conservatively
  - Lateral position
  - Gentle, steady pressure
  - Position change
  - Saline injection