Advances in Regional Anesthesia

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Disclosures

• None
Overview

• Upper Extremity Blocks
• Truncal Blocks
• Lower extremity Blocks
• Multimodal pain strategies
• “New” Block Alerts
Upper Extremity
Brachial Plexus

Cords
- Dorsal scapular nerve
- Suprascapular nerve

Divisions
- Nerve to subclavius
- Lateral pectoral nerve
- Musculocutaneous nerve
- Axillary nerve
- Median nerve
- Ulnar nerve
- Medial cutaneous nerve of the arm

Trunks
- C5
- C6
- C7
- C8
- T1

Roots
- Long thoracic nerve

https://en.wikipedia.org/wiki/Brachial_plexus
Interscalene
Interscalene

• Indications: Shoulder/upper arm surgery
• Goal: Local anesthetic spread around superior and middle trunks
• Typical local anesthetic amount: 15-30cc
• Location: Between middle and anterior scalene muscles
Distribution
Interscalene
Distribution
Supraclavicular

• Indications: Arm, elbow, forearm, and hand surgery
• Goal: Local anesthetic spread around divisions at level of subclavian artery
• Typical local anesthetic amount: 15-30cc
Infraclavicular

Cords
- Lateral pectoral nerve
- Musculocutaneous nerve
- Axillary nerve
- Median nerve
- Ulnar nerve
- Medial cutaneous nerve of the arm
- Medial cutaneous nerve of the forearm

Divisions
- Dorsal scapular nerve
- Suprascapular nerve
- Nerve to subclavius
- Lateral cord
- Posterior cord
- Medial cord

Trunks
- Upper subscapular nerve
- Medial pectoral nerve
- Thoraco dorsal nerve
- Lower subscapular nerve
- Radial nerve

Roots
- C5
- C6
- C7
- C8
- T1

Long thoracic nerve
Distribution
Infraclavicular

• Indications: Arm, elbow, forearm, and hand surgery
• Goal: Local anesthetic spread around cords at level of axillary artery
• Typical local anesthetic amount: 15-30cc
Axillary
Distribution

Source: Atchabahian A, Gupta R: *The Anesthesia Guide*
www.accessanesthesiology.com
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Axillary

• Indications: Forearm and hand surgery
• Goal: Local anesthetic spread around medial, radial, ulnar, and musculocutaneous nerves at level of axillary artery
• Typical local anesthetic amount: 25-30cc
Questions at This Point?
Truncal Blocks
Paravertebral
Indications

• First described in 1900s as labor analgesia (lumbar)

Current Uses:

• Breast surgery (eg. Mastectomy)
  – T1—T6

• Inguinal hernia repair
  – T10—L1, although this can often be performed with a TAP block

• Thoracic procedures, ie thoracotomy or VATS

• Adjuvant anesthesia for rib fractures
Paravertebral anatomy

Paravertebral space boundaries:
- Posteriorly—costotransverse ligament
- Anterolaterally: Parietal pleura
- Medially—Vertebrae, intervertebral foramen
- Superiorly—Heads of ribs
Mark the spines
Mark 2.5 cm to the appropriate side
This is the insertion point which overlies the transverse process

C7 most prominent spine
T7 lower border of scapula
Outcome studies of Thoracic Paravertebral Blocks

- Fewer side effects when compared with thoracic epidural
- Reduction in chronic pain following breast surgery
- Possible reduced recurrence rate in breast cancer surgery??
PVB vs Epidural

A comparison of the analgesic efficacy and side-effects of paravertebral vs epidural blockade for thoracotomy—a systematic review and meta-analysis of randomized trials

R. G. Davies, P. S. Myles and J. M. Graham

British Journal of Anaesthesia 2006 96(4):418-426

Ten studies published between 1989 and 2005 which included 520 adult patients

No difference in pain scores

<table>
<thead>
<tr>
<th>Study or sub-category</th>
<th>PVB mean (sd) N</th>
<th>Epidural mean (sd) N</th>
<th>WMD (random) 95% CI</th>
<th>Weight %</th>
<th>WMD (random) 95% CI</th>
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</thead>
<tbody>
<tr>
<td>DeCosmo et al.</td>
<td>3.70 (0.80) 25</td>
<td>2.20 (2.10) 25</td>
<td>-1.50 (1.92, 2.38)</td>
<td>19.20</td>
<td>-1.50 (1.92, 2.38)</td>
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<tr>
<td>Matthews et al.</td>
<td>1.30 (1.90) 10</td>
<td>1.30 (1.90) 9</td>
<td>0.00 (1.04, 1.04)</td>
<td>17.67</td>
<td>0.00 (1.04, 1.04)</td>
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<tr>
<td>Pernot et al.</td>
<td>7.10 (2.10) 15</td>
<td>8.20 (2.10) 15</td>
<td>-1.10 (-2.53, 0.33)</td>
<td>14.08</td>
<td>-1.10 (-2.53, 0.33)</td>
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<tr>
<td>Ramsay et al.</td>
<td>2.90 (1.20) 30</td>
<td>2.60 (1.20) 20</td>
<td>0.20 (0.72, 1.20)</td>
<td>21.10</td>
<td>0.20 (0.72, 1.20)</td>
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<td>Richardson et al.</td>
<td>1.62 (3.60) 46</td>
<td>2.35 (4.75) 49</td>
<td>-0.70 (-3.04, 1.80)</td>
<td>7.64</td>
<td>-0.70 (-3.04, 1.80)</td>
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<tr>
<td>Dziele et al.</td>
<td>4.50 (2.19) 20</td>
<td>4.20 (2.50) 20</td>
<td>0.30 (-1.60, 0.24)</td>
<td>8.93</td>
<td>0.30 (-1.60, 0.24)</td>
</tr>
<tr>
<td>Leaver et al.</td>
<td>3.04 (2.76) 14</td>
<td>3.85 (2.17) 15</td>
<td>-0.82 (-3.14, 0.50)</td>
<td>11.16</td>
<td>-0.82 (-3.14, 0.50)</td>
</tr>
</tbody>
</table>

Total (95% CI): 153
Test for heterogeneity: $\chi^2 = 17.42$, df=6 ($P=0.008$), $I^2=65.6$
Test for overall effect: Z=0.69 ($P=0.38$)
PVB vs Epidural

A comparison of the analgesic efficacy and side-effects of paravertebral vs epidural blockade for thoracotomy—a systematic review and meta-analysis of randomized trials

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**Fewer complications**
“This systematic review found no difference in analgesia with PVB techniques when compared with epidural regimens. PVB was associated with improvements in respiratory function and a reduction in complications. It appears that PVB is advantageous and can be recommended for major thoracic and upper abdominal surgery.”
Preincisional Paravertebral Block Reduces the Prevalence of Chronic Pain After Breast Surgery

Pekka M. Kairaluoma, MD, Martina S. Bachmann, MD, PhD, Per H. Rosenberg, MD, PhD, and Pertti J. Pere, MD, PhD
Anesth Analg 2006;103:703-708

Prospective, randomized, placebo-controlled, and single-blind outcome study in 60 patients who underwent breast surgery for cancer

30 patients were given a PVB 0.5% bupivacaine 1.5 mg/kg at T3
30 patients received a sham block saline subcutaneously at T3
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The prevalence of significant postoperative pain Visual Analog Scale >3 (VAS; 0–10) in the 14-day pain diary or Numeric Rating Scale >3 (0–10) in the 1-, 6-, and 12-mo telephone interviews during the follow-up.

- PVB = paravertebral block with bupivacaine;
- SHAM = sham block with saline.

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Can Anesthetic Technique for Primary Breast Cancer Surgery Affect Recurrence or Metastasis?

Aristomenis K. Exadaktylos, M.D.
Denis C. Moriarty, F.C.A.R.C.S.I.
Edward Mascha, Ph.D.
Daniel I. Sessler, M.D., Ph.D.

Anesthesiology 2006; 105:660–664

Retrospective study with 129 consecutive patients undergoing mastectomy and axillary clearance for breast cancer between September 2001 and December 2002.

<table>
<thead>
<tr>
<th></th>
<th>Paravertebral (n = 50)</th>
<th>General Anesthesia (n = 79)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude recurrence</td>
<td>3 (6)</td>
<td>19 (24)</td>
</tr>
<tr>
<td>Percent of patients recurrence-free at 24 months (95% CI)</td>
<td>94 (87–100)</td>
<td>82 (74–91) * ( P = 0.038 )</td>
</tr>
<tr>
<td>Percent of patients recurrence-free at 36 months (95% CI)</td>
<td>94 (87–100)</td>
<td>77 (68–87) * ( P = 0.007 )</td>
</tr>
<tr>
<td>Recurrence location</td>
<td></td>
<td></td>
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<tr>
<td>Local or axillary nodes</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Liver metastasis</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Bone metastasis</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Lung metastasis</td>
<td>0</td>
<td>2</td>
</tr>
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“We observed a substantial reduction in tumor recurrence and metastases when breast cancer surgery was performed with paravertebral anesthesia and analgesia.”

WHY?

-Cancer surgery releases tumor cells into surrounding healthy tissue and into the circulation.

-Authors speculate that whether these cells become established as recurrent cancer or metastases is likely to depend on immune competence in the immediate perioperative period.

-New research into the immune-dampening effects of volatile anesthetics and opiates

“Regional anesthesia and analgesia may help to preserve immune function by attenuating the surgical stress response and diminishing the need for opioids.”
Can Anesthetic Technique for Primary Breast Cancer Surgery Affect Recurrence or Metastasis?

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Major limitations in this study
retrospective
treatment was not standardized
patients were not randomized
tumor size was slightly larger and margins smaller in GA group
Thoracic Paravertebral complications

• Infection
• Bleeding
• hypotension (Sympathetic Chain!!)
• Epidural spread
• Pneumothorax (1.1%)—Increased 8 fold when bilateral!
• Failed block (6-10%)—Most common!
IS THERE ANOTHER WAY??

NEW BLOCK ALERT
PECS Block

Chest Wall Innervation is Three Groups:

- Lateral (C5-7) & medial (C8-T1) pectoral nerve (C5-7)
- Spinal nerves (T2-6)
- Long thoracic nerve (C5-7) and thoracodorsal nerve (C6-8) supplying serratus anterior & latissimus dorsi
PECS 1 and 2

- Goal: Block the lateral and medial pectoral nerves between pectoralis major and minor muscles
  - Vascular landmark: the pectoral branch of the thoraco-acromial artery
- Paravertebral does not block medial or lateral pectoral, long thoracic or thoracodorsal nerves.
- Indications: Breast, chest wall surgeries (ie pacemaker, ICD, mediports)
- PECS 1=Pectoralis major muscle work, such as breast expander/prosthesis
- PECS 2= axillary clearance (since it gets long thoracic and thoracodorsal)
A two steps infiltration aiming towards the 4th rib

1 (between muscles): 10 ml between Pec M & Pec m
Injection for the pectoral nerves

2 (entering the axilla): 20 ml under Pec m & around serratus m
Intercostals plus the long thoracic nerve

Indications:
Tumorectomies, wide excisions, mastectomies, axillary clearances
sentinel nodes, subpectoral prosthesis and multiple chest trauma
Thoracic paravertebral block versus pectoral nerve block for analgesia after breast surgery
Wahba, et.al, 2014, Egyptian Journal of Anaesthesia

- 60 patients undergoing elective MRM allocated into either PVB or Pecs
- Primary outcome measure was morphine consumption in the first 24 h
- Postoperative morphine consumed at 24 h was significantly lower in Pecs group
- Time for first request of morphine was longer in Pecs group
- Numerical rating score (NRS) at rest was lower in Pecs group at 1 h, 6 h and 12 h but at 18 h and 24 h it was lower in PVB group
- PONV was comparable between the groups
Transversus Abdominis Plane Block
Anatomy

- The abdominal wall is composed of 5 paired muscles
  - 2 vertical muscles (the rectus abdominis and the pyramidalis)
  - 3 layered, flat muscles (external oblique, internal oblique, and transversus abdominis)
- Between the transversus abdominis and internal oblique muscles lie the anterior rami of T7-L1.
- Injection here can provide unilateral analgesia to the skin, muscles, and parietal (NOT VISCERAL) peritoneum of the anterior abdominal wall from T7-L1
Indications

• Postoperative analgesia for laparotomy, appendectomy, laparoscopic surgery, abdominoplasty, hysterectomy, abdominal/inguinal hernia repair, cesarean delivery in the T7—L1 distribution
• Alternative to epidural anesthesia for operations on the abdominal wall
• Goal: Local anesthetic spread between the transversus abdominis and internal oblique muscle planes
• Local anesthetic: 20-30mL of 0.2% ropivicaine per side
• Variable length of analgesia, anywhere from 8-24 hours.
• Eliminates somatic abdominal incision
  – visceral pain will not be affected
Limitations

• Degree of anesthesia and analgesia is variable, likely dependent on:
  – Technique
  – Place of needle insertion (lateral → medial)
  – Volume of local anesthetic injected
  – Individual patient’s anatomic variability

• Early studies showed a T7 to L1 spread with a single injection making the block suitable for midline abdominal incisions

• Others failed to demonstrate a spread cephalad to T10 making it more suited for lower abdominal surgery

• In a small cadaveric study, T11, T12 and L1 were most consistently present in the transversus abdominis plane, while T10 was present in 50% of the cases.
Compare TAP to neuraxial?

- TAP blocks do not result in a sympathetic (no hypotension)
- Sensory blockade limited to the abdominal wall muscles
- No urinary retention, pruritus, nausea and vomiting, or sedation
- Ok for patients on anticoagulation
- Placement under general anesthesia is not considered unsafe because the target for local anesthetic infiltration is along a muscle plane and not a nerve root or outside the spinal cord
- Procedure may be performed with patient supine
More Anatomy!

- Patient positioned supine
- Iliac crest and costal margin are palpated, the space between them in the mid-axillary line is the initial transducer position
- Three muscle layers to the abdominal wall overlying peritoneum
  - External oblique
  - Internal oblique (thickest)
  - Transversus abdominis (thinnest)
- Can see peristalsis underneath
- Nerves not visualized
Inguinal Hernia Repair
Almost all cases of hernia, with the possible exception of those in young children, could undoubtedly be subjected to the radical operation under local anesthesia.

-Harvey Cushing, Annals of Surgery, 1900
• Postherniorrhaphy pain is moderate to severe
  • often poorly controlled with opioids as the single modal therapy
  • One technique to block the affected dermatome (L1) is a lumbar paravertebral block
    • Problem—Femoral nerve arises from L2-L3, very close!!!
Is there another way??

NEW BLOCK ALERT
Ilioinguinal/Iliohypogastric

- Ilioinguinal and iliohypogastric blocks have been shown to significantly reduce pain associated with herniorrhaphy, regardless of whether the blocks are used as the primary anesthetic or for pain control.
Anatomy

• Both iliohypogastric and ilioinguinal nerves emanate from the first lumbar spinal root.

• Superomedial to the anterior superior iliac spine, the iliohypogastric and ilioinguinal nerves pierce the transversus abdominus to lie between it and the internal oblique muscles
  • Their ventral rami pierce the internal oblique to lie between the internal and external oblique muscles

• The iliohypogastric nerve supplies the skin over the inguinal region.

• The ilioinguinal nerve runs anteroinferiorly to the superficial inguinal ring, skin on the superomedial aspect of the thigh
Surface landmarks. Needle insertion is marked 2 cm medial & 2 cm superior from the anterior superior iliac spine.

- Place local anesthetic between **BOTH** the TA and IO muscles **AS WELL AS** between the IO and EO muscles.
Indications

• Any somatic procedure involving the lower abdominal wall/inguinal region
  • inguinal herniorrhaphy
  • cesarean section
  • abdominal hysterectomy

• These blocks do not provide visceral anesthesia and thus cannot be used as the sole anesthetic
  • When used for inguinal herniorrhaphy, the sac (containing peritoneum) must be infiltrated with local anesthetic by the surgeon for complete anesthesia
Side Effects

• Even properly performed ilioinguinal/iliohypogastric blocks can result in transient femoral anesthesia with a reported incidence of 3.7–5%.
  • CONTRAST THIS TO LUMBAR PARAVERTEBRALS
  • Tracking of local anesthetic along the fascia iliaca
• Perforation of bowel
• Pelvic hematoma
Technique

- Transducer placed just superomedial to the ASIS, oriented on a line joining the ASIS with the umbilicus.
- The three muscle layers should be identified. The nerves should appear as hypoechoic ovals between the IOM and TAM muscles.
- Color Doppler may be used to attempt to visualize the deep circumflex iliac artery.
- Goal: local anesthetic spread between the TA---internal oblique muscle planes as well as IO-EO.
- Local anesthetic: 10-20 mL per side (adults); 0.15 mL/kg per side (children).
- Hydrodissection may be prudent.
• Several hypoechoic structures (arrowheads) may be located within the plane between internal oblique and transverse abdominis.
• Use Color Doppler to identify the branch of the deep circumflex iliac artery (red dot)
Lower Extremity Blocks
Femoral

• Indications: Anterior thigh, femur, and knee surgery
• Goal: Local anesthetic spread adjacent to the femoral nerve
• Typical local anesthetic amount: 15-30cc
• Location: transverse, in inguinal crease
Femoral
Femoral Nerve Block in Total Knee Replacements

- Improved pain scores, less narcotic use and associated side effects
- Decreased hospital length of stay
- Decreased healthcare expenditures
- Greater patient satisfaction
- However...
- Prolonged motor blockade from FNB is associated with a small (2%) but clinically important risk of fall
- Patients are falling! What can we do?
Is there another way??

NEW BLOCK ALERT
Adductor Canal
Adductor Canal
Adductor Canal Block versus Femoral Nerve Block for Total Knee Arthroplasty: A Prospective, Randomized, Controlled Trial

Kim, et.al. Anesthesiology 2014

• Prospective double-blinded, randomized controlled trial
• Hypothesis: ACB, compared with FNB, would exhibit less quadriceps weakness and demonstrate noninferior pain score and opioid consumption at 6 to 8 hours.
• 46 patients received ACB; 47 patients received FNB. At 6 to 8 h postanesthesia, ACB patients had significantly higher median dynamometer readings versus FNB patients but was not inferior to FNB with regard to Numeric Rating Scale pain scores or to opioid consumption
• At 24 and 48 h postanesthesia, there was no significant statistical difference in dynamometer results, pain scores, or opioid use between the two groups.
• Conclusion: At 6 to 8 h post anesthesia, the ACB, compared with the FNB, exhibited early relative sparing of quadriceps strength and was not inferior in both providing analgesia or opioid intake.

The adductor canal block results in less motor impairment after surgery, but provides a comparable level of pain relief.
NERVE SUPPLY OF KNEE JOINT

- Number: **ten nerves.**

1) **Femoral nerve:** gives twigs from the nerves to the three vasti.

2) **Tibial nerve:** gives:
   1) Superior medial genicular.
   2) Inferior medial genicular.
   3) Middle genicular nerve.

3) **Common peroneal nerve:** gives:
   1) Superior lateral genicular.
   2) Inferior lateral genicular.
   3) Recurrent genicular nerve.

4) **Obturator nerve:** gives the genicular branch from its posterior division.

Dr M Eladl
Sciatc-Popliteal

- Indications: Knee, tibia/fibula, foot and ankle surgery
- Goal: Local anesthetic spread surrounding the sciatic nerve
- Typical local anesthetic amount: 15-30cc
- Location: transverse in the popliteal fossa
- Composed of the tibial and common peroneal nerve
Separating the Sciatic into Tibial and Peroneal
Sciatic Nerve Block in TKA

• Posterior aspect of the knee, with some lateral/medial branches
• When combined with adductor canal, full below the knee numbness/weakness
• Fall risk greater
• Risk for covering nerve injury from surgery (common peroneal)
• Pain scores better, but patient satisfaction scores lower
  • Cannot ambulate, participate in physical therapy
Is there another way??

NEW BLOCK ALERT
iPACK Block

• Target: Posterior capsule of the knee, the geniculate (pure sensory) nerves
  • Surgeons attempt to do this in the operating room blindly
• Goal: Local anesthetic in the interspace between the popliteal artery and capsule of the knee (iPACK)
• 20cc 0.2% ropivacaine
• Pain scores somewhat better; hyperextension with physical therapy much better!
Advances in Pain Management Strategies

• Multimodal analgesia
• Continuous peripheral nerve block catheters
• Novel local anesthetic
Multimodal Analgesia

• Preoperative:
  • Acetaminophen
  • Gabapentin/pregabalin
  • Celecoxib
  • Oxycoxin

• Adductor Canal Block—catheter??
• Posterior Capsule Block
• Intraoperative
  • Ketamine
  • Dexamethasone

• Post-operative
  • All of the above, sans ketamine!
Continuous peripheral nerve block catheters

• Provide days of relief
• Easy to manage
• Safe
• Callback system absolutely essential
• Problems/complaints
  • Pain transition from initial block to catheter medication
  • Another tube/tape/dressing for the patient, vulnerable to dislodging
  • Leaking around insertion site
  • Adequate analgesia as a constant low infusion versus intermittent boluses
Is there another way??

NEW MEDICATION ALERT
Liposomal Bupivacaine

- Novel Formulation of local anesthetic (bupivacaine) encased in a slow release form
- Purported 72-96 hours of pain control
- End to catheters?
- Drawbacks?
- NOT APPROVED FOR PERIPHERAL NERVE BLOCKS
Let’s Review

• Advent of ultrasound has revolutionized regional anesthesia
  • Increased success rate, decreased placement time, increased utilization
  • ? Safer

• Upper Extremity Blocks

• Truncal Blocks
  • PECS, TAP, ilioinguinal/iliohypogastric

• Lower Extremity Blocks
  • Adductor Canal, Posterior Capsule (iPACK)

• Multimodal Pain Strategies
  • Continuous peripheral nerve catheters, Liposomal bupivacaine

More To Come in the Future!!!
Thank You!
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