Ask the Expert: Practical Advises for the Use of Regional Anesthesia

José A. Aguirre, MD, MSc

2nd SARA Annual Meeting
29th June 2013

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Agenda

• General complications of regional anesthesia

• Regional anesthesia in patients at risk for compartment syndrome

• Adjuvants in peripheral regional anesthesia

• Regional anesthesia in patients with preexisting neurological diseases
## Infectious Risk of Continuous Peripheral Nerve Blocks

Xavier Capdevila, M.D., Ph.D.,* Sophie Bringuier, Pharm.D., M.Sc.,† Alain Borgeat, M.D., Ph.D.‡

<table>
<thead>
<tr>
<th>Study</th>
<th>Number of CA</th>
<th>CA Location</th>
<th>Overall CA Colonization (%)</th>
<th>Local inflammation (%)</th>
<th>Local Infection (%)</th>
<th>Abscesses (%)</th>
<th>Surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bergman et al.⁵</td>
<td>405</td>
<td>Axillary</td>
<td>NR</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>No</td>
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<tr>
<td>Cuvillon et al.⁵</td>
<td>208</td>
<td>Femoral</td>
<td>57</td>
<td>4.3</td>
<td>0</td>
<td>0</td>
<td>No</td>
</tr>
<tr>
<td>Borgeat et al.⁶</td>
<td>700</td>
<td>Interscal</td>
<td>NR</td>
<td>0.7</td>
<td>0.1</td>
<td>0.1</td>
<td>Yes</td>
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<tr>
<td>Borgeat et al.¹⁷</td>
<td>1,001</td>
<td>Popliteal</td>
<td>NR</td>
<td>0.2</td>
<td>0</td>
<td>0</td>
<td>No</td>
</tr>
<tr>
<td>Capdevila et al.¹</td>
<td>1,416</td>
<td>Different</td>
<td>28.7</td>
<td>3</td>
<td>0.1</td>
<td>0.1</td>
<td>No</td>
</tr>
<tr>
<td>Neuburger et al.²</td>
<td>2,285</td>
<td>Different</td>
<td>NR</td>
<td>4.2</td>
<td>3.2</td>
<td>0.9</td>
<td>Yes</td>
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<tr>
<td>Neuburger et al.⁷</td>
<td>3,491</td>
<td>Different</td>
<td>NR</td>
<td>4.2</td>
<td>2.4</td>
<td>0.8</td>
<td>Yes</td>
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<tr>
<td>Stojadinovic et al.⁷</td>
<td>361</td>
<td>Different</td>
<td>NR</td>
<td>NR</td>
<td>1.9</td>
<td>0</td>
<td>No</td>
</tr>
<tr>
<td>Morin et al.⁴</td>
<td>102</td>
<td>Different</td>
<td>23.7</td>
<td>13.7</td>
<td>1.9</td>
<td>0</td>
<td>No</td>
</tr>
<tr>
<td>Swenson et al.¹⁰</td>
<td>620</td>
<td>Different</td>
<td>NR</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>No</td>
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<tr>
<td>Wiegel et al.²⁶</td>
<td>1,398</td>
<td>Different</td>
<td>NR</td>
<td>0.6</td>
<td>0.2</td>
<td>0</td>
<td>No</td>
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<tr>
<td>Meier et al.⁸</td>
<td>91</td>
<td>Interscal</td>
<td>NR</td>
<td>8.7</td>
<td>2.1</td>
<td>0</td>
<td>No</td>
</tr>
</tbody>
</table>

The reported incidences of catheter colonizations in the literature extended from 23.7% to 57%. Those for skin inflammation and local infection extended, respectively, from 0% to 13.7% and from 0% to 3.2%. The percentage of proven systemic infection extended from 0% to 0.9%.

CA = catheter; Interscal = interscalene continuous block; NR = not reported.
Regional anesthesia and complications

• Neurological complications of pain catheters

  • central catheters: 0.01% / 2 - 4.2: 100’000
    Pöpping DM et al. BJM 2008; 101:832-840 (14'223 patients)

  • peripheral catheters: 0.4 – 2%
    Barrington MJ et al. RAPM 200); 34:534-541 (7’000 patients)
    Capdevila X et al. Anesthesiology 2005; 103:135-45 (1’416 patients)
    Auroy Y et al. Anesthesiology 2002; 97:1274-80 (43’946 patients)

• Peroneal palsy as complication of TKA: 0.3 -10%
• Neurologic complications after THA: 0.08 – 7.6%

  Indusuyi OB et al. JBJS Am 1996; 78:177-84
The Association Between Lower Extremity Continuous Peripheral Nerve Blocks and Patient Falls After Knee and Hip Arthroplasty

Brian M. Ilfeld, MD, MS,* Kimberly B. Duke, MS,† and Michael C. Donohue, PhD†

Table 1. Details on the Individual Patient Falls

<table>
<thead>
<tr>
<th>Fall</th>
<th>Joint replaced</th>
<th>Catheter location</th>
<th>Postoperative day, time</th>
<th>Ropivacaine infusion rate</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>Knee</td>
<td>Femoral</td>
<td>4, 11:00</td>
<td>5 mL/h</td>
<td>Tripped walking through front door of home after successfully ambulating for 4 days—quadriceps weakness denied. Readmission, no injury.</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
<td>Hip</td>
<td>Posterior lumbar plexus</td>
<td>1, 21:00</td>
<td>8 mL/h</td>
<td>Walking from hospital bed to bathroom after successfully ambulating twice earlier that day—possible quadriceps weakness. No injury.</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt;</td>
<td>Hip</td>
<td>Posterior lumbar plexus</td>
<td>3, 20:00</td>
<td>5 mL/h</td>
<td>Standing at sink at home and fell backward—quadriceps weakness contribution unclear. Readmission, no injury.</td>
</tr>
<tr>
<td>4&lt;sup&gt;th&lt;/sup&gt;</td>
<td>Hip</td>
<td>Posterior lumbar plexus</td>
<td>3, 22:00</td>
<td>5 mL/h</td>
<td>Walking from hospital bed to bathroom after successfully ambulating for 3 days—quadriceps weakness denied. Concurrent anemia and dizziness. No injury.</td>
</tr>
<tr>
<td>5&lt;sup&gt;th&lt;/sup&gt;</td>
<td>Knee</td>
<td>Femoral</td>
<td>2, 16:00</td>
<td>6 mL/h</td>
<td>Standing at hospital bedside after successfully ambulating for 2 days—quadriceps weakness contribution unclear. No injury.</td>
</tr>
<tr>
<td>6&lt;sup&gt;th&lt;/sup&gt;</td>
<td>Knee</td>
<td>Femoral</td>
<td>3, 12:00</td>
<td>5 mL/h</td>
<td>Exiting vehicle upon returning home after ambulating successfully for 3 days—quadriceps weakness denied. No injury.</td>
</tr>
<tr>
<td>7&lt;sup&gt;th&lt;/sup&gt;</td>
<td>Knee</td>
<td>Femoral</td>
<td>4, 11:00</td>
<td>5 mL/h</td>
<td>Same subject as fall 6. Fell backward “slowly” while walking her dog at home—quadriceps weakness denied. No injury.</td>
</tr>
</tbody>
</table>
Case report: Unusual complication during outpatient continuous regional popliteal analgesia

Étude de cas: Complication inhabituelle pendant un bloc régional poplité continu chez un patient ambulatoire

Andrea Saporito, MD · Evelina Sturini, MD · John Petri, MD · Alain Borgeat, MD · José A. Aguirre, MD
Peripheral catheters: the advantages

• Problems of ambulatory surgery
  – Unplanned hospital visits due to pain and PONV
  – Readmission rate after general anesthesia: 7-27%
  – Readmission rate after regional anesthesia: 4-13%

PONV: post anesthesia nausea and vomiting

Williams BA et al. Anesthesiology 2004; 100:697-706
CASE

• 18y, m, ASA 1
• Elective shoulder arthroscopy with rotator cuff repair right shoulder
• Beach chair position
• Patient wishes no pain after surgery and to sleep during the procedure
Catastrophic complication of an interscalene catheter for continuous peripheral nerve block analgesia

B. Yanovski, L. Gaitini, D. Volodarski and B. Ben-David

Anaesthesia 2012, 67, 1166-1169

- RA in anesthetized patient
- Winnie technique
- Bolus prior to catheter insertion
- 5cm catheter over needle tip
- Bolus injection on the ward without test
- First nurse control 6h after bolus
Regional anesthesia in patients at risk of compartment syndrome - the evidence
CASE

- 18y, m, ASA 1
- Trimalleolar fracture right ankle
- Uneventful general anesthesia and spinal anesthesia in the past for hernia repair and knee arthroscopy
- Patient wishes no pain after surgery
Compartment syndrome: Definition
Compartment syndrome: Definition

Ischemia – Reperfusion – Edema

→ compartment p > capillary pressure

→ arterial inflow & venous outflow

→ further compartment pressure

→ metabolic tissue demand > supply

→ rhabdomyolysis and necrosis
Acute compartment syndrome

- 200,000 diagnoses / year in the USA
- Majority from traumatic fractures
  - 40% tibial shaft fractures
  - 23% soft tibial trauma
  - 18% forearm fractures

- Incidence of ACS:
  - 4.3% after tibial shaft, 3.1% after diaphesal forearm, 0.25% after distal radial fractures

ACS: acute compartment syndrome

Compartment pressure

• Most common used objective method in clinical practice: “Golden Standard”
• Difficult to use in practice beyond 24h

Harris IA et al. J Trauma 2006; 60:1330-35
<table>
<thead>
<tr>
<th>Primary author</th>
<th>Year</th>
<th>Reference</th>
<th>Number of patients or limbs</th>
<th>Pathology</th>
<th>Threshold value used</th>
<th>Positive tests (%)</th>
<th>Fasciotomies (n)</th>
<th>Sequelae of CS (n)</th>
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<tbody>
<tr>
<td>Trifft et al.</td>
<td>1992</td>
<td>[54]</td>
<td>20</td>
<td>Closed tibial fractures</td>
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<td>70</td>
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<td>Trifft et al.</td>
<td>1992</td>
<td>[54]</td>
<td>20</td>
<td>Closed tibial fractures</td>
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<td>Heckman et al.</td>
<td>1994</td>
<td>[55]</td>
<td>25</td>
<td>Closed tibial fractures</td>
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<td>20</td>
<td>5</td>
<td>0</td>
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<td>Moehring et al.</td>
<td>1995</td>
<td>[56]</td>
<td>26</td>
<td>Nailed tibial fractures</td>
<td>ICP &gt; 40 mmHg</td>
<td>35</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Skjeldag et al.</td>
<td>1995</td>
<td>[57]</td>
<td>60</td>
<td>Nailed tibial fractures</td>
<td>ICP &gt; 30 mmHg for 30 min</td>
<td>18</td>
<td>11</td>
<td>0</td>
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<tr>
<td>Mc Queen et al.</td>
<td>1996</td>
<td>[58]</td>
<td>116</td>
<td>Tibial fractures</td>
<td>ICP &gt; 30 mmHg</td>
<td>43</td>
<td>3</td>
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<tr>
<td>Mc Queen et al.</td>
<td>1996</td>
<td>[58]</td>
<td>116</td>
<td>Tibial fractures</td>
<td>DCP-ICP &lt; 30 mmHg (12-h means)</td>
<td>2.5</td>
<td>3</td>
<td>0</td>
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<tr>
<td>Ovre et al.</td>
<td>1998</td>
<td>[59]</td>
<td>63</td>
<td>Nailed tibial fractures</td>
<td></td>
<td>29</td>
<td>18</td>
<td>3</td>
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<td>Mars et al.</td>
<td>1998</td>
<td>[60]</td>
<td>30</td>
<td>Children with clinical suspicion of raised intracompartmental pressure following snakebite (27) or lower limb fracture (3)</td>
<td></td>
<td>30</td>
<td>9</td>
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<td>Janzing et al.</td>
<td>2001</td>
<td>[61]</td>
<td>97</td>
<td>Tibial fractures</td>
<td>ICP &gt; 30 mmHg</td>
<td>63</td>
<td>14</td>
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<tr>
<td>Janzing et al.</td>
<td>2001</td>
<td>[61]</td>
<td>97</td>
<td>Tibial fractures</td>
<td>DBP-ICP &lt; 30 mmHg</td>
<td>45</td>
<td>14</td>
<td>15</td>
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<tr>
<td>Janzing et al.</td>
<td>2001</td>
<td>[61]</td>
<td>97</td>
<td>Tibial fractures</td>
<td>MAP-ICP &lt; 30 mmHg</td>
<td>13</td>
<td>14</td>
<td>15</td>
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<tr>
<td>Ozkayin et al.</td>
<td>2005</td>
<td>[62]</td>
<td>42</td>
<td>Polytrauma with lower extremity fracture</td>
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<td>7</td>
<td>3</td>
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<td>Prayson et al.</td>
<td>2006</td>
<td>[63]</td>
<td>19</td>
<td>Isolated lower extremity fractures</td>
<td>ICP &gt; 30 mmHg</td>
<td>95</td>
<td>0</td>
<td>0</td>
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<td>Prayson et al.</td>
<td>2006</td>
<td>[63]</td>
<td>19</td>
<td>Isolated lower extremity fractures</td>
<td>DBP-ICP &lt; 30 mmHg</td>
<td>84</td>
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<tr>
<td>Prayson et al.</td>
<td>2006</td>
<td>[63]</td>
<td>19</td>
<td>Isolated lower extremity fractures</td>
<td></td>
<td>42</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Harris et al.</td>
<td>2006</td>
<td>[64]</td>
<td>100</td>
<td>Tibial fractures</td>
<td></td>
<td>18</td>
<td>0</td>
<td>0</td>
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<td>Kosir et al.</td>
<td>2007</td>
<td>[65]</td>
<td>45</td>
<td>High risk intensive care patients</td>
<td></td>
<td>20</td>
<td>9</td>
<td>0</td>
</tr>
</tbody>
</table>
Compartment pressure

• Normal leg values
  – Caucasians 0-15mmHg
  – Nigerians 3-18mmHg (anterior comp.) / 3-14mmHg (deep comp.)

• Fasciotomy if
  – Absolute pressure ≥ 30mmHg (- 45mmHg)
  – DBP-CP = 10 - 20mmHg (≤ 30mmHg)
  – Δ-P: MAP – CP ≤ 40mmHg

CP: compartment pressure
DBP: diastolic blood pressure
MAP: mean arterial blood pressure

Ogunlusi JD et al. 2005; 25:200-02
Mubarak SJ et al. Philadelphia: WB Saunders; 1981:113
Compartment syndrome: Assessment

Clinical symptoms

- pain (on muscle stretching)
- paresthesia, hypoesthesia
- paralysis
- pulselessness
- pallor
- reduced tenderness on palpation

Kosir R et al. J Trauma 2007; 63:268-75
Compartment syndrome and pain

Pain:
- an unreliable symptom: subjective / variable
- obviously, it does not avoid compartment syndrome
- increasing analgesia demand precedes neurovascular changes by 7.3h
- confounding factors: extremes of age, pain thresholds, head injury/drugs, language barriers
- Pain not always present in ACS!

Benevides ML et al. Rev Bras Anestesiol 2006; 56:408-12
Hailer NP et al. Acta Orthop 2007; 78:293-95
4 cases of compartment syndrome without any significant pain:

- CS in the well leg after surgery for femoral shaft fracture on the other side
- CS post-operatively following a tibial nailing for tibial fracture
- CS following tibial plateau fracture
- CS after closed, extraarticular multifragmentary fracture of the right prox. Tibia and fibula
Compartment syndrome and pain

- Clinical signs:
  - Probability of compartment syndrome with 1 clinical sign: 25%
  - Probability of compartment syndrome with 3 clinical signs: 93%

References:
- Benevides ML et al. Rev Bras Anestesiol 2006; 56:408-12
- Ulmer T. J Orthop Trauma 2002; 8:572-77
Compartment syndrome and regional anesthesia?

Clinical symptoms

- pain (on muscle stretching)
- paresthesia, hypoesthesia
- paralysis
- pulselessness (late sign!)
- pallor
- reduced tenderness on palpation

RA: regional anesthesia
General anesthesia and compartment syndrome

- As pressure in the compartment approaches 10mmHg of diastolic BP, blood flow will cease.
- Probably this may occur within 20mmHg of diastolic BP in injured muscle tissue.

Potential concerns with hypotensive anesthesia techniques.

Several cases of orthognathic surgery using hypotensive anesthesia techniques with compartment syndrome of the lower extremity have been described:

- Bilateral anterior ACS after short fascial plastic surgery under general anesthesia → bilateral peroneal nerve palsyns
  Godeiro-Junior CO et al. Arq Neuropsiquiatr 2007; 65:826

- Two cases of orthognathic surgery in general anesthesia with unilateral ACS of the lower extremities → ankle-foot orthosis

- One case of ACS of the lower extremity after Le Fort osteotomy in general anesthesia → ankle-foot orthosis

ACS: acute compartment syndrome
Compartment syndrome and regional anesthesia

- No randomized-controlled trial comparing outcomes in patients at risk of ACS with regional anesthesia vs general anesthesia.
- Therefore, clinical practice is only based on case reports and retrospective case series.
- -> no national or international guidelines for best practice
- Practice: regional anesthesia leads to decrease in postoperative pain and to sensory blockade masking ACS…
Compartment syndrome and regional anesthesia

• Central nerve blocks
  – have never been implicated in delaying diagnosis of abdominal compartment syndrome. Increase in perfusion pressure and decrease in intraabdominal pressure
  – EDA has been implicated in ACS of lower limbs
  – no report of single shot SPA or EDA implicated in ACS
  – intraoperative $\Delta$-P only reduced in GA (DBP ↓) but not during unilateral SPA

EDA: epidural anesthesia
SPA: spinal anesthesia
ACS: acute compartment syndrome
GA: general anesthesia

Compartment syndrome and regional anesthesia

- Upper extremity blocks
  - No published case of ACS after upper limb regional anesthesia
  - One published case of ACS diagnose thanks to upper limb regional anesthesia: breakthrough pain as main indicator

ACS: acute compartment syndrome

Mar GJ et al. BJA 2009; 102:3-11
Aguirre J et al. Anesthesiology 2013; 118:1198-205
Compartment syndrome and regional anesthesia

• Lower extremity blocks
  – One case of an ACS during continuous ambulant popliteal sciatic nerve block
    • Increasing pain over 2 days
    • Pain relieved after splitting the patient’s cast
    • Catheter remained in place until POD4
    • Four weeks after cast removal, evidence of prior full-thickness skin ulceration on the anterior aspect of the ankle
      – ACS or tight cast injury?
Compartment syndrome and regional anesthesia

• Lower extremity blocks
  – Three published cases of ACS after single shot lower limb regional anesthesia
    • femoral nerve block delayed ACS diagnosis after intramedullar tibia nailing despite pain being a significant symptom
    • femoral nerve block delayed ACS diagnosis after intramedullar femoral nailing
    • ankle block delayed ACS diagnosis after forefoot arthroplasty despite pain being a significant symptom

ACS: acute compartment syndrome

Compartment syndrome and regional anesthesia

• Lower extremity blocks
  – One published case of ACS after continuous femoral and sciatic nerve block:
    • Distal femur and proximal tibia osteotomy with external fixation of the right leg.
    • General anesthesia
    • Continuous femoral nerve block and continuous sciatic nerve block with 0.2% ropivacaine, 10ml/h

Case Scenario: Compartment Syndrome of the Forearm in Patient with an Infraclavicular Catheter

*Breakthrough Pain as Indicator*

José A. Aguirre, M.D., M.Sc.,* Daniela Gresch, M.D.,† Annemarie Popovici, B.Med.,‡ Jost Bernhard, M.D.,§ Alain Borgeat, M.D.||
<table>
<thead>
<tr>
<th>Anesthesia Techniques</th>
<th>Drugs to Be Used</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General anesthesia</strong></td>
<td>Propofol/gas</td>
<td>Avoid central blocks if there is no need to avoid general anesthesia and if surgery extends short-/medium-acting local anesthetics for neuraxial blocks. Combine GA with CPNB if possible for postoperative pain.</td>
</tr>
<tr>
<td></td>
<td>Low dose long-acting opioids (fentanyl); remifentanil target controlled infusion until CPNB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bupivacaine 0.5% hyperbaric/isobaric low dose (7.5 mg- max 10mg)</td>
<td>No case report correlated to ACS. Consider unilateral SSPA for shorter duration. Avoid combination with CEDA.</td>
</tr>
<tr>
<td></td>
<td>Mepivacaine 1% (30mg)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chlorocaine 1% 50 mg Prilocaine 2% hyper/isobaric 30–60 mg</td>
<td></td>
</tr>
<tr>
<td><strong>Continuous spinal</strong></td>
<td>Surgery: Bupivacaine hyperbaric 0.5% Analgesia: Bupivacaine isobaric 0.125–0.2% for 0.5–1 ml/h</td>
<td>No case report correlated to ACS. Start the analgesia with the lowest concentration and rise the sensory level just to cover the site of surgery. Close documented monitoring (every hour) during infusion.</td>
</tr>
<tr>
<td><strong>Single shot epidural</strong></td>
<td>Lidocaine 1.5%</td>
<td>No case report correlated to ACS. Avoid combination with CEDA.</td>
</tr>
<tr>
<td></td>
<td>Chloroprocaine 3%</td>
<td></td>
</tr>
<tr>
<td><strong>Continuous epidural</strong></td>
<td>Ropivacaine 0.1% (–0.2%)</td>
<td>Avoid EDA whenever possible. Many case reports also if only two with dense motor block associated with ACS. Close documented monitoring (every hour) during infusion. Consider wash out. No patient controlled epidural analgesia.</td>
</tr>
<tr>
<td><strong>Single shot PNB</strong></td>
<td>Lidocaine 1.5%</td>
<td>Case reports for the lower extremity (but ACS signs ignored). For a better postoperative pain control CPNB is the better choice, otherwise combine SPNB with multimodal systemic analgesia.</td>
</tr>
<tr>
<td></td>
<td>Mepivacaine 1%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chlorprocaine 3%</td>
<td></td>
</tr>
<tr>
<td><strong>Continuous PNB</strong></td>
<td>Ropivacaine: bolus with 10–20 ml of 0.1–0.2%PCRA; ropivacaine 0.1–0.2% (0.3%) 4–6 ml/h, bolus 3–4 ml, lock out 20–30 min</td>
<td>Case reports for the lower extremity (but ACS signs ignored). If possible avoid initial bolus, or perform it with the lowest concentration. PCRA or CPNB possible. 0.3% only if pain problem after exclusion of ACS. Avoid for top up of catheters high concentrations like 0.5% in patients at risk of ACS.</td>
</tr>
<tr>
<td></td>
<td>Ropivacaine 0.2–0.3%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bupivacaine 0.25%</td>
<td>For lower extremity not inferior to PNB, for upper extremity unclear data, PNB probably more effective.</td>
</tr>
</tbody>
</table>

ACS = acute compartment syndrome; CEDA = continuous epidural analgesia; CPNB = continuous perineural block; CSPA = continuous spinal anesthesia; EDA = epidural anesthesia; GA = general anesthesia; PCRA = patient-controlled regional anesthesia; PNB = perineural block; SPNB = Single shot perineural block; SSPA = single shot spinal anesthesia.
Adjuvants for peripheral regional anesthesia
CASE

- 48y, m, ASA 2
- Hallux valgus repair right foot
- Controlled arterial hypertension, increased alcohol intake, moderate peripheral neuropathy
- No prior anesthesia
- Patient wishes no pain after surgery
Why adjuvants for LA?

• Shorten the onset time of LA action
  – Only for central blocks?
• Limit the absorption of LA
  – Decrease of spinal cord blood flow?
  – Risk of peripheral neuropathy?
  – Nausea and vomiting?
• Improvement of block intensity/duration
  – Clinical evidence?

LA: local anesthetic

Limit the absorption of local anesthetic

Systemic resorption depends on local blood flow!

Artery

Vein

Nerve

97-98%

2-3%

-30%

Heavner JE. Curr Opin Anaesthesiol 2007; 20:336-42. Review
Improvement of block intensity: clonidine

Analgesic benefit from the addition of clonidine to local anesthetics? \textbf{YES}

Mechanisms of action?
- Centrally mediated analgesia?
- \(\alpha_2\)-mediated vasoconstriction in the periphery?
- Clear: not \(\alpha_2\)-mediated block prolongation but inhibition of hyperpolarization-action current. Effect more profound in C-fibers.

McCartney CJ et al. RAPM 2007; 32:330-338
Leem JW et al. RAPM 2000; 25:620-25
Improvement of block intensity: clonidine

Side effects:

- Hypotension
- Bradycardia
- Sedation

Less side effects compared to epidural/spinal administration. Related to the dose and to plasma levels.

Optimal dose: 150μg (adults).

Recommendations for the use of adjuvants

Epinephrine: no use (as test dose??)
Clonidine: up to 150μg for adults
Dexmedetomidine: wait for better data
Buprenorphine / Tramadol: little efficacy
Dexamethasone: CAVE: dose-response-related neurotoxicity
Midazolam: CAVE: dose-response-related neurotoxicity
Recommendations for the use of adjuvants

• Use the least toxic drug
  – Spinal anesthesia: bupivacaine, chloroprocaine, prilocaine.
  – Peripheral: ropivacaine / bupivacaine (?), mepivacaine, lidocaine.

• Avoid unnecessary risk with adjuvants
  – NO epinephrine & lidocaine for central nerve blocks.
  – NO tramadol / bicarbonate for peripheral nerve blocks.
  – NO midazolam for peripheral nerve blocks.
  – NO adjuvants to ropivacaine. Clonidine??

Lirk P et al. RAPM 2012; 37:601-606
Cuvillon P et al. BJA 2013; ahead of print
When to use continuous regional anesthesia

• Use perineural catheters for:
  – extremely painful surgery (rotator cuff repair, total knee arthroplasty): ≥ 48h
  – painful joint mobilisation (capsulotomy, synovectomy): ≥ 5d
  – chronic pain patients and expected moderate to severe postoperative pain: ≥ 48h
  – repetitive surgery (diabetic foot, wound controls): ≥ 5d

• Use perineural catheters only if:
  – you and your team can manage them!!!
Regional Anesthesia in the Patient with Neurological Disease
CASE

- 28y, m, ASA 2
- Hallux valgus repair right foot
- Controlled arterial hypertension, Type 1 diabetes mellitus with implanted insulin pump, weak peripheral neuropathy
- No prior anesthesia
- Patient wishes no pain after surgery and is sceptical against spinal anesthesia
The unanswered questions

• Do regional blocks worsen preexisting neurological pathologies?

• Are LA more neurotoxic in this context?

• Does the failure rate increase?

LA: Local anesthetics

Blumenthal S et al. Anesthesiology 2006; 105:1053-6
Naveen E et al. Anesthesiology 2007; 107:177-178
Double crush phenomenon

Axoplasmic flow

(a)

(b)

(c) $X_1$, $X_2$

(d) $X$

(e) $X$

Hebl JR et al. A&A 2006; 103:1294–1299
Double crush phenomenon

- Increased vulnerability of a distal lesion
- Impairment in axonal flow
- Chronic compression
- Segmental demyelination
- Nodal intussusception
- Bulbous myelin lesions
Double crush phenomenon
Double crush phenomenon
Differences in Quantitative Architecture of Sciatic Nerve May Explain Differences in Potential Vulnerability to Nerve Injury, Onset Time, and Minimum Effective Anesthetic Volume

Nizar Moayeri, M.D.,* Gerbrand J. Groen, M.D., Ph.D.†
# Infectious Risk of Continuous Peripheral Nerve Blocks

Xavier Capdevila, M.D., Ph.D., Sophie Bringuier, Pharm.D., M.Sc., Alain Borgeat, M.D., Ph.D.

<table>
<thead>
<tr>
<th>Study</th>
<th>Number of CA</th>
<th>CA Location</th>
<th>Overall CA Colonization (%)</th>
<th>Local inflammation (%)</th>
<th>Local Infection (%)</th>
<th>Abscesses (%)</th>
<th>Surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bergman et al.⁵</td>
<td>405</td>
<td>Axillary</td>
<td>NR</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>No</td>
</tr>
<tr>
<td>Cuvillon et al.²</td>
<td>208</td>
<td>Femoral</td>
<td>57</td>
<td>4.3</td>
<td>0</td>
<td>0</td>
<td>No</td>
</tr>
<tr>
<td>Borgeat et al.⁶</td>
<td>700</td>
<td>Interscal</td>
<td>NR</td>
<td>0.7</td>
<td>0.1</td>
<td>0.1</td>
<td>Yes</td>
</tr>
<tr>
<td>Borgeat et al.¹⁷</td>
<td>1,001</td>
<td>Popliteal</td>
<td>NR</td>
<td>0.2</td>
<td>0</td>
<td>0</td>
<td>No</td>
</tr>
<tr>
<td>Capdevila et al.¹</td>
<td>1,416</td>
<td>Different</td>
<td>28.7</td>
<td>3</td>
<td>0.1</td>
<td>0.1</td>
<td>No</td>
</tr>
<tr>
<td>Neuburger et al.²</td>
<td>2,285</td>
<td>Different</td>
<td>NR</td>
<td>4.2</td>
<td>3.2</td>
<td>0.9</td>
<td>Yes</td>
</tr>
<tr>
<td>Neuburger et al.⁹</td>
<td>3,491</td>
<td>Different</td>
<td>NR</td>
<td>4.2</td>
<td>2.4</td>
<td>0.8</td>
<td>Yes</td>
</tr>
<tr>
<td>Stojadinovic et al.⁷</td>
<td>361</td>
<td>Different</td>
<td>NR</td>
<td>NR</td>
<td>1.9</td>
<td>0</td>
<td>No</td>
</tr>
<tr>
<td>Morin et al.⁴</td>
<td>102</td>
<td>Different</td>
<td>23.7</td>
<td>13.7</td>
<td>1.9</td>
<td>0</td>
<td>No</td>
</tr>
<tr>
<td>Swenson et al.¹⁰</td>
<td>620</td>
<td>Different</td>
<td>NR</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>No</td>
</tr>
<tr>
<td>Wiegel et al.²⁶</td>
<td>1,398</td>
<td>Different</td>
<td>NR</td>
<td>0.6</td>
<td>0.2</td>
<td>0</td>
<td>No</td>
</tr>
<tr>
<td>Meier et al.⁸</td>
<td>91</td>
<td>Interscal</td>
<td>NR</td>
<td>8.7</td>
<td>2.1</td>
<td>0</td>
<td>No</td>
</tr>
</tbody>
</table>

The reported incidences of catheter colonizations in the literature extended from 23.7% to 57%. Those for skin inflammation and local infection extended, respectively, from 0% to 13.7% and from 0% to 3.2%. The percentage of proven systemic infection extended from 0% to 0.9%.

CA = catheter; Interscal = interscalene continuous block; NR = not reported.
Impact on postoperative complications

- Infectious risk of pain catheters
  - local infection: 0 – 3.2%
  - proven systemic infection: 0 – 0.9%
  Capdevila X et al. Anesthesiology 2009; 110:182-88 (12'078 patients)

- SSI infections complicate 5% - 10% of all surgeries increasing hospital length of stay by 48% - 310% and increase costs by 34% - 226%.

- Prevention of vasoconstriction at operation site and increasing surgical-site tissue oxygen tension with RA may reduce the occurrence of SSIs.

SSI: surgical site infection
RA: regional anesthesia
RCT: randomized controlled trial

Sessler DI et al. Anesthesiology 2010; 113:265-67
Chang CC et al. Anesthesiology 2010; 113:279-84
Buggy DJ et al. Anesthesiology 2002; 97:952-58
Regional anesthesia and complications

- Neurological complications of pain catheters
  
  - **Central catheters:** *0.01% / 2 - 4.2: 100‘000*
    
    Pöpping DM et al. BJM 2008; 101:832-840 (14‘223 patients)
  
  - **Peripheral catheters:** *0.4 – 2%*
    
    Barrington MJ et al. RAPM 2000; 34:534-541 (7‘000 patients)
    Capdevila X et al. Anesthesiology 2005; 103:135-45 (1‘416 patients)
    Auroy Y et al. Anesthesiology 2002; 97:1274-80 (43‘946 patients)

- Peroneal palsy as complication of TKA: *0.3 -10%*
- Neurologic complications after THA: *0.08 – 7.6%*

Indusuyi OB et al. JBJS Am 1996; 78:177-84
Regional anesthesia and complications

• Peripheral nerve injuries due to regional anesthesia are often transient:
  ➢ mild paresthesias present in about 15% of patients after peripheral nerve blocks
  ➢ most symptoms resolve within days to weeks
  ➢ 99% complete resolving within 1 year

• Most neuraxial injuries are often permanent:
  ➢ 15% - 80 - 100% permanent injuries
  ➢ frequency highly dependent on the type of neural lesion

Liguori GA. J Neurosurg Anesthesiol 2004; 16:84-86
Neal JM et al. RAPM 2002; 27:402-28
Auroy Y et al. Anesthesiology 2002; 97:1274-80
Auroy Y et al. Anesthesiology 1997; 87:479-86
Lee LA et al Anesthesiology 2004; 101:143-52
Classification of neuromuscular diseases

- Neuromuscular diseases (NMD)
  - pre-junctional diseases (motoneurons and peripheral nerves)
    - ALS, MS, Guillan-Barré-Syndrome
  - junctional diseases (synaptic transmission)
    - myasthenia gravis
  - post-junctional diseases (muscular)
    - muscle dystrophies
    - myotonies

ALS: amyothrophic lateral sclerosis
MS: multiple sclerosis
Anesthetic risk factors of neuromuscular diseases

- Cardiopulmonary comorbidities.
- Dysphagia → danger of aspiration pneumonia.
- Possible pulmonary dysfunction.
- Muscle relaxants: unpredictable duration of action.
- Volatile anesthetics: negative inotrope effect.

Finsterer J et al. Cardiology 2000; 94:1–11
Regional anesthesia and neuromuscular diseases

• Advantages
  – avoidance of negative inotrope drugs and muscle relaxants
  – maintenance of spontaneous breathing
  – hemodynamic stability

• Concerns
  – double crush theory
  – case reports of adverse neurological outcome
  – no controlled, randomized studies
  – non-binding guidelines

Regional anesthesia and neuromuscular diseases

• Pro RA
  – Junctional and post-junctional diseases: no damage of neurons: no absolute contraindication for RA
  – Pre-junctional diseases: Hebl et al. found a low risk for central regional anesthesia techniques. No absolute contraindication for RA. Individual decision for patients with ALS, MS, GBS etc.

RA: regional anesthesia
ALS: amyothrophic lateral sclerosis
MS: multiple sclerosis
GBS: Guillan-Barré-Syndrome

Hebl JR et al. A&A 2006; 103:1294–1299
Hebl JR et al. A&A 2006; 103:223–228
Demyelinating CNS disease: Multiple sclerosis

- Most common demyelinating disease of the CNS. Motoneurons affected.
- Random, multiple sites of demyelination in the brain and spinal cord. Rare involvement of the peripheral nerve system, but described. Subtle nerve lesions without real demyelination.
- Subclinical peripheral neuropathy (?)

CNS: central nervous system

Gartzen K et al. Eur J Neurol 2011; 5:789-91
Multiple sclerosis & general anesthesia

• Autonomic dysfunction is frequent.
• Stress response may be associated with relapse
  – no difference in postoperative aggravation compared to regional anesthesia (spinal)
• General anesthesia recommended if
  – unclear disease progression
  – no possible cooperation with a neurologist

Multiple sclerosis & regional anesthesia

• No real worsening after peripheral nerve block
  – anesthetic plan influenced by case reports and personal experience

• Controversy concerning spinal and epidural block
  – effect of LA on demyelinated nerves
  – systemic application of LA leads to discovery of non-diagnosed demyelinated areas
  – typical symptoms are aggravated temporarily temporarily

LA: local anesthetic

Multiple sclerosis & regional anesthesia

• Central regional anesthesia
  – Epidural anesthesia might be considered. Use lowest LA dose possible. Avoid lidocaine. If adjuvants use clonidine / buprenorphine
  – Consider spinal anesthesia only in cases of real advantage (C-section)

• Peripheral regional anesthesia
  – May be considered whenever possible, inform patients about relapse possibility

LA: local anesthetic
Peripheral neuropathy

• Multiple mononeuropathy: polyarteritis nodosa, SLE, scleroderma, sarcoidosis, HIV, diabetes.

• Microorganisms (mononeuropathy): diphteria, Guillain-Barré.

• Toxic agents (polyneuropathy): sulfonamides, phenytoin, heavy metals, chemotherapy….

• Nutritional deficiency and metabolic disorders (polyneuropathy): alcoholism, pernicious anemia, diabetes…).

• Malignancy (polyneuropathy): multiple myeloma.
Diabetes: Concerns

• Oedema of the nerves may be directly related to hyperglycemia.

• Microangiopathy may further lead to ischemia of the oedematous nerve and decrease blood flow and drug uptake.

• Prolonged exposure to local anesthetics.
Strategies to minimize risk in PNB

Preoperative evaluation:

• Interdisciplinary approach for cardiopulmonary diseases
  – electrocardiography, X-Ray of the chest, lung function if needed
• RA in the case of severe co-morbidities is the first choice
  – epidural anesthesia for caesarean section in patients with GBS

PNB: peripheral nerve block
RA: regional anesthesia
GBS: Guillan-Barré-Syndrome

Strategies to minimize risk in PNB

Preoperative examination:

• Exact neurological examination
  – deficits must be documented

• Patients should be informed about
  – technical difficulties
  – possible relapses and/or progression associated with stress, surgery and anesthesia
Strategies to minimize risk in PNB

• Technique of RA
  – No superiority of US over NS described
  – Adapt stimulation setting (>0.3mA, 0.3ms, 2Hz)

• Choice / concentration of LA
  – All LA are neurotoxic. Neurotoxicity comparable at equipotent doses.
  – Diabetic nerves more sensitive. Reduce concentration, longer duration
Strategies to minimize risk in PNB

• Role of adjuvants
  – Epinephrine reduces blood flow in peripheral nerves → reduced wash out and prolonged LA exposure
  – Clonidine may prove to be useful adjuvants to prolong sensory block

LA: local anesthetic
Goal: to inform practitioners of regional anesthesia and pain medicine regarding the etiology, differential diagnosis, prevention, and treatment of neurologic complications.

Methods: extensive review of literature by specialists on the field.
• Ultrasound and neurostimulation equivalent.

• Reduction of dose, concentration, potency of local anesthetic and reduction (elimination) of concentration of vasoconstrictive additive are potential considerations (based on animal studies).
Patients with pre-existing peripheral neurologic disease
  – theoretic increase of the risk of new or progressive postoperative neurologic complications. No clinical data to confirm or refute this theory
  – individual risk/benefit assessment
• Patients with pre-existing central neurologic disease
  – lacking clinical evidence for increase of risk of new or progressive postoperative neurologic complications
  – individual risk/benefit assessment

• Spinal stenosis or mass lesions in spinal canal
  – individual risk/benefit assessment
  – high local anesthetic volume neuraxial technique (EDA) might have a higher risk of progressive mass effect compared with low volume technique (SPA)
Overall approach to patients with pre-existing neurologic deficits:

- these patients might be at increased risk of new or worsening injury regardless of the anesthetic technique
- if regional anesthesia is chosen, modifications of the technique (dose, volume, concentration, drugs) might minimize the risks
- limited human data neither confirm nor refute these modifications