Anesthesia for Robotic Surgery: *Is it a Different Ball Game?*

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Access to, and monitoring the patient

Combined Pneumoperitoneum and Trendelenburg
- Type and amount of inflation gas
- Pulmonary impairments
- Hydrostatic gradients
- Cardiovascular derangements
- Circulation to the lower limb
- Confounding obesity

Anesthetic adjuncts and outcomes
- Routine general anesthesia
- General and regional?
- Multimodal, narcotic-sparing, “ideal” anesthetic

At the end of this lecture, the learner will explain or understand:

- the physiological derangements associated with combined pneumoperitoneum and Trendelenburg posture
- the relationships between, and significance of hydrostatic pressure, blood pressure measurement and the risks of organ hypo/hyper-perfusion
- the reasons for choosing specific anesthetic management techniques and drugs.

No disclosures.
What you should know about your own surgical outcomes:

- operative time
- blood loss
- morbidity types and rates
- length of stay and criteria for discharge
- mortality (if any and its cause)
- postoperative pain and analgesic regimens
- nausea and vomiting rates
- use of intermittent pneumatic serial compression (IPSC)
- desired extremes of TP
- desired intra-abdominal inflation pressures (IAP)
- and, type of inflation gas
Pre-Anesthetic Assessment

- Airway (edema)
- Glaucoma
- Brachial plexus
- Common peroneal n.
- Calf pain
- Claudication
- Radiculopathy
- Back pain
- Murmurs-valvular disease
- OSA-COPD
- Renal function
- Volume status
- Intracranial pathology
Limited Access and Monitoring

- Vascular access:
  - Infiltration, hemorrhage, blood withdrawal
  - Use a short EJ catheter
  - Arterial line only for severe cardiovascular disease

- Non-invasive blood pressure

- Breath sounds: mainstem or pneumothorax?

- Nerve injury: pre-existing risk and padding

- More details regarding:
  - Neuromuscular monitoring
  - Pulse oximetry
Residual Neuromuscular Blockade

Joshi, G. New Concepts in Neuromuscular Blockade. CRASH 2010

- TOF > 0.9 is required for adequate reversal
- Critical respiratory events in PACU
  - Incidence of residual paresis 47%
  - Monitoring used in only 12%
  - Reversal in just 25%

Avoid or Minimize NMB

- Good/Excellent conditions in 66% RRP without NMB (King M, et.al. Anesthesiology 2000;93:1392-7)

- TIVA alone for laparoscopic surgery; NMB did not improve compliance, +/- PEEP

- No change in PIP or IAP or ventilatory plateau pressure
Monitor NMB Accurately
Mimetic or Mastication?

CNVI I - Facial

http://emedicine.medscape.com/article/883778-print
http://en.wikipedia.org/wiki/Muscles_of_mastication

CNV-3: Mandibular
Don’t Overdose Neostigmine

Joshi, G. New Concepts in Neuromuscular Blockade. CRASH 2010

- Excess neo. will *exacerbate* NMB
  (Caldwell Anesth Analg 1995;80:1168-74)

- Match the dose to the degree of NMB:
  - Rec: 10-30 mcg/kg, NOT 70 mcg/kg, for TOF 0.4-0.6

- PONV is NOT increased by neostigmine
Pulse Oximetry

- Tempting to use a forehead sensor
- OxiMax MAX FAST®, Nellcor/Tyco
- Contraindicated in Trendelenburg
- Readings lower than actual values
- Greater variability
- Pressure band inadequate solution

Carbon Dioxide Pneumoperitoneum

- **Favorable effects:**
  - Non-flammable, inexpensive
  - Readily soluble, diffusable and excreted
  - Isothermic (37°) improves PFT’s (Uzunkoy 2006)
  - Hypercarbia onset in 8 min, plateau after 20 min
  - Least reduction in hepatic blood flow

- **Unfavorable effects:**
  - Retroperitoneal insufflation: prolonged excretion
  - May cause extreme acidosis in compromised patients
  - Contributes to high sympathetic tone
  - Cardiac depression, ↑ICP
  - Abdominal /shoulder pain from carbonic acid
  - Inhibits TNF-alpha (leading to port-site mets?)

Helium as a Viable Alternative

- **Helium:**
  - No respiratory acidosis; easily maintained EtCO$_2$
  - Also reduces contractility
  - Behaves and diffuses like CO$_2$
  - Less inhibition of TNF?
  - May also cause metabolic acidosis indirectly

- **Argon:** greatest decrease in hepatic blood flow

- **N$_2$O** supports combustion, but clinical risk??

### Adverse Effects of Higher Intra-Abdominal Pressure (12-15 mmHg vs. 5-7 mmHg)

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<td>Intracranial pressure</td>
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- **EAES 2002 recs:** “use the lowest” (12-15 normal)
- **Consider AWL advantages in TP?**
  - Gurusamy 2008 Cochrane review

Pulmonary Effects

- Reduced lung compliance (44%)
- Increased airway resistance (29%)
- Cephalad shift of diaphragm (atelectasis)
- FRC decreased below closing capacity
- Compliance severely worsened, but improved by PEEP (and recruitment):

Specificity of Ventilation and Optimal PEEP

- Is PCV better?
  - More efficient
  - Better gas distribution
  - Req: vigilance and alarms

- VCV guarantees $V_E$
  - $P_{IP}$, $T_{INS}$, $P_{PLAT}$ matter

- Objective:
  - to reduce shunt, and improve compliance

- Either one best managed with spirometry and flow loops: optimal PEEP
Spirometry Facilitates Achievement of Maximal Lung Compliance

- PEEP
- VCV vs. PCV ??
- VT
- T_{IP}
- P_{INSPIRATORY}
- I:E
- T_{INSPIRATORY}

Also: Adaptive Support Ventilation with the Galileo ventilator (Lloréns, et al. 2009)
Hypercarbia Likely in Abnormal States

**Increased Production**
- Fever
- Sepsis
- Hyperalimentation
- Malignant hyperthermia

**Complications**
- Capnothorax
- Capnomediastinum
- Sub-cutaneous CO$_2$
- Fatal capnoembolism (Lantz 1994)

**Decreased Excretion**
- Retroperitoneal
- Low cardiac output
- Hypovolemia
- Metabolic acidemia

Post-op dysfunction less likely after *lower* abdominal surgery (Joris 1997)
Renal Issues

Renal dysfunction

- Reduced RBF, ?GFR, UOP
- Duration/degree of IAP
- Increased
  - Endothelin
  - Aldosterone
  - Renin/angiotensin
  - Vasopressin

Attenuation

- Nitroglycerine
- Dexmedetomidine
- Dopamine
- Esmolol
- Epidural analgesia

You Must Understand....

Hydrostatic gradients
54 y/o healthy female for shoulder replacement
BP cuff placed *on the calf*
*Deliberate* hypotension with labetalol
Systolic BP’s for two hours: 85-70-90
EtCO₂ in the ‘high twenties’
Delayed emergence, apnea, mydriasis: *Brain Death*
What was the perfusion pressure in her *BRAIN* when the calf read 70/50?

Cerebral ischemia during shoulder surgery in the upright position: a case series.
- At least 15 known cases of neuro-injury
- Induced hypotension OK if supine, \(^{\text{^CO}}\)
- Keep BP normal at the heart level
  - Siphon versus Waterfall effects
- Doppler flow velocity or NIRS best for ischemia
  - Multiple regions need to be monitored
- Lower limit of autoregulation 70, not 50
- Physical impairment to CBF from rotation
Potentially Catastrophic BIS Decrease

- Assess for new pharmacologic changes
- Assess current level of surgical stimulation
- Assess for other potential physiologic changes
- Assess raw EEG for large delta waves (paradoxical delta)
Let’s visualize the problem:

1. Here is Dr. Olympio’s blood pressure:
2. Or, is this Dr. Olympio’s pressure?
3. Or, maybe this is Dr. Olympio’s blood pressure:
4. Whoa!, what the heck is *this* blood pressure?
5. Now what pressure do we have in the “Beach Chair” position?

What would the **Calf** pressure read if the bed were placed in steep Trendelenburg??
Are these differences explained by vertical hydrostatic gradients?

(Yes!)
Converting the Height of a Blood Column to a Blood Pressure

- Density of Hg:H₂O = 13.6:1
- So, 1 mmHg = 1.36 cmH₂O
- Or, 1.0 cmH₂O = 0.74 mmHg
- Therefore, ratio of cmH₂O:mmHg = 4:3
- Remember that 1” = 2.54 cm
- Example: 12” = 30cm = 23 mmHg
  
  1” ~ 2 mmHg
What about the arterial line? First, we’ll “zero” a transducer:

What is the significance of the tip being here?
Next, let’s do some measurements.

- The tip is outside the jug of water, at 13.6cm
- 13.6cmH₂O = 10mmHg
- What will the pressure on the transducer read?
That was easy.
A. Suppose the tip is just below the surface, inside the jug of water?

Write down your answer now.

A=?
B. Suppose the tip is half-way down inside the jug of water?

Write down your answer now.

B=?
C. Suppose the tip is all the way down to the bottom of the jug?

Write down your answer now.

\[ C = ? \]
And the answer is:
THE FORCE EXERTED BY A BODY OF WATER, RELATIVE TO A VERTICAL DISTANCE, IS MEASURED EQUALLY THOUGHOUT THE WATER.

The water in the tubing “becomes” a part of the water in the flask.
This is why the arm can be moved anywhere, after it is connected to the arterial line transducer, as long as the transducer, relative to the heart, is not changed.
Putting this all together:

38" = 99 cm H\_2O = 75 mm Hg

23" = 60 cm H\_2O = 45 mm Hg

- 93 mm Hg SBP
- 123 mm Hg SBP
- 168 mm Hg SBP
And, what does this have to do with Robotic Urologic Surgery?
Hypotension may have profound effects upon calf tissue oxygenation in T-burg
Impaired LE Circulation

In reverse Trendelenburg (r-TP) position:
- Venous stasis and high resistance
- Stress markers elevated
- IPSC improves LE flow, CO, and cerebral O₂
- Pressure equilibration improves LE flow, CO and SVR
- Perioperative LMWH advocated

In Trendelenburg position:
- Lower stress markers
- Presumed to be less impairment
- But, fatal PE reported
Calf Circulation in RALRP Could Be an Impending Disaster!

- 53 y/o cystoprostatectomy, HTN and dyslipidemia; 6-hr lithotomy
- Rhabdomyolysis with ARF, followed by
- 3-limb compartment syndrome
- Previously reported by several authors
- Risk factors: hypotension, vasoactive drugs, obesity, muscle hypertrophy, fibrate Rx, duration, compression


Ischemia stress markers not seen in Trendelenburg vs. r-TP
The Influence of Perfusion Interventions on Calf Muscle Oxygenation in Different Positions During Laparoscopic Surgery

- Near-infrared spectroscopy for StO₂
  - Tissue oxy-hemoglobin saturation
- Perfusion-related interventions:
  - Inflation and IAP
  - Hydrostatic effect of Trendelenburg
  - Perfusion pressure effect of MAP
  - Time effect

Tong, Olympio, et al. Wake Forest University Health Sciences, Institutional Review Board #00011281 (approved 1-18-10)
Elevated Intracranial Pressure

- IAP and TP may increase ICP 150% (Rosenthal 1997)
  - In those with abnormal cerebral compliance
  - Effects occur early, before hypercarbia (and with helium)
  - Increased CVP, IVC compression; impaired CSF resorption
  - Even occurs in r-TP, from IAP
  - Not reduced by pre-emptive hyperventilation
  - CPP generally maintained (trumps ICP)
  - More HA, N&V in lap vs open = ICP (Cooke 2001)
  - Reduction in regional cerebral oxygenation (Lee 2006, Casati 2007)

- Latest data: Kalmar et al. BJA 2010; 104:433-9
  - CPP super-ceded ICP elevation
    - (Both cvp/art transducers at brain level, below heart level)
    - MAP increased more than CVP
  - Cerebral Sct_{O2} increased from hyperperfusion (NIRS)
  - Et CO₂ to PaCO₂ gradient widens in TP
Intraocular and Pharyngeal Pressures

- Higher IOP: glaucoma may contraindicate LAP
  - Tight correlation with CVP
  - Related to choroidal vasodilation from hypercarbia?
  - Surgical duration of T-burg and ETCO₂ predicted IOP
    - 13 mmHg higher (Awad. Anesth Analg 2009;109:473-8)
  - BLINDNESS REPORTED:
    - Molloy B. AANA Journal Sept. 2007; Anesthesiology 2006; 105: A1693
    - Weber ED. J Neuroophthalmol 2007;27:285-7 (6.5 and 9 hours!)

- Can we predict post-op airway edema?
  - >15% leak in Vt predicts no-reintubation
    - (96% PPV: DeBast 2002)
Morbid Obesity and RALUS

- Obviously used in bariatric surgery (r-TP)
- Only two references for TP position
  - Sprung 2002, Nguyen 2005
- It’s possible (personal record: 450 pounds)
- But everything is extremely difficult with inadequate evidence for worse outcomes
Hemodynamic Effects of Pneumoperitoneum
(are NOT insignificant; we might be lucky!)

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Summary on next slide
Hemodynamics Summarized

- SVR is increased, but not as much as rTP
- Tri-phasic venous return (↑ then ↓ then ↑)
- MAP and PAP are therefore increased
- HR tends to remain stable
- CO tends to remain stable or declines
- Vasopressin, epi, and nor-epi temporal effects
- These changes may be likened to “CHF”
  - In those with impaired hearts
  - Pulmonary back pressure and edema
  - Cardiac valvular incompetence
  - EF and CO fall in those with a compromised heart
Potential Cardiac Decompensation

- SVR increased 65%; PVR 90%
- Decreased E/A ratio
- Increased myocardial wall stress and oxygen consumption
- Vagal responses with brady or AV-block
- Deleterious effects of beta-blockers, vapor
- Alpha-2 agonists may help (Joris 1998; Aho 1992)
Cardiac Decompensation

Recommendations for fluid management

- Optimize blood volume
- Maintain adequate circulation
- Abolish preoperative volume loading
- Abolish routine replacement of third-space losses
- Replace UOP with isotonic crystalloid
- Replace blood loss with iso-oncotic colloid
- Replace “as needed”
- Not restrictive therapy

- We do restrict, then replace IVF for RALRP
- Transient post-operative creatinine elevations

“Anesthesia for” RALUS...

- Nishanian 2005: surgical equipment and surg/anesthesia procedures
- Malhotra 2005: regional alone inappropriate
- Costello 2006: GA with remi, LEA, and oral clonidine; renal concerns with NSAIDS; >2L; morphine
- Conacher 2004: volume + mannitol; remi; morphine PCA; renal caution with NSAIDS
- Phong 2007: complications of stridor, brachial plexus injury
- Gerges 2006: MMA with NSAIDS, acetaminophen, NMDA, alpha-2, remi or tramadol; rectus sheath blocks
- Danic 2007: review of 1500 case experience: no mention of type of anesthesia; MAP decreased? 17%
Clinical Anesthesia Pearls

- Peripheral IV but use 18g EJ during the case
- NIBP but no routine arterial line
- No NG-tube, unless kidney surgery
- IPSC but not ace wraps for the legs
- Support neck if lateral
- Local anesthetic infiltration
- No shoulder braces?
- Tuck the arms awake
Routine (or thoughtless?) General Anesthesia

- Midazolam, fentanyl, isoflurane, rocuronium
  - Increasing doses of fentanyl and iso for HTN
  - Repetitive doses out of habit, emotion, or BIS

- Nitrous oxide
  - Undetectable bowel distention (Taylor 2002)
  - Continued use advocated (Mirski 2008)
  - No compelling evidence against its use

- TIVA
  - Many types reported, without vapor

- Morphine or hydromorphone for PACU
Multimodal Analgesic Strategies

Can we provide narcotic-free anesthesia to promote early discharge?

- Does a reduction (20-50%) in opioid eliminate opioid side effects?
- There may be a difference between percent and absolute reduction of narcotic
- Type of surgery determines the adverse profile
  - What is the current profile for RALRP?
  - Visceral, somatic, referred pain mechanisms
- Inadequate research on multi-modal therapy
  - Expectation that inhibition of multiple mechanisms may reduce or eliminate the opioid
Narcotic Side Effects

- Ventilatory depression
- Drowsiness and sedation
- Postoperative nausea and vomiting (PONV)
- Pruritus
- Urinary retention
- Post-op ileus, bloating, and constipation
  - The single most significant POD-1 issue
- Large intra-op doses can increase post-op pain
Are the risks of MMA worth it?

- Bleeding
- Renal impairment
- Stroke
- Coronary events

Multimodal Analgesics

- local anesthetics
- acetaminophen
- NSAIDs: ibuprofen, ketorolac
- Cox-II inhibitors: celecoxib
- NMDA receptor antagonists: ketamine, dextromethorphan
- alpha-2 agonists: dexmedetomidine, clonidine
- anticonvulsants: gabapentin, pre-gabalin
- Others: dexamethasone, tramadol, lidocaine
**Acetaminophen**

- Safest and most cost-effective of all the non-narcotics!
- **Concurrent** with an NSAID is superior for analgesia
- Requires high-enough dosage (2 gm reported, or at least 1 gm q 4 hours)
- Hepatotoxicity
- GI: upset
NSAIDS (po ibuprofen or iv ketorolac)

- Non-specific inhibitor of cyclo-oxygenase, reducing prostaglandin synthesis and the mediators of the acute inflammatory response.
- Acting peripherally or in the spinal cord.
- Caution:
  - Altered platelet function (equivocal evidence: Moiniche)
  - Gastric mucosal irritation, bleeding
  - May cause renal tubular dysfunction
  - Do not use if hepatic dysfunction
  - May cause bronchospasm
- Should be continued post-discharge to maintain beneficial effect
Cox-2 Inhibitors (Celebrex)

- To minimize platelet inhibition, GI irritation, and renal effects
  - NO effect on platelets (because no Cox-1 inhibition)
  - Less renal concern, but still exists
  - Not for those with hepatic dysfunction
- Do they really offer an advantage over NSAIDs?
- Concerns over increased cardiovascular toxicity:
  - MI, stroke, especially after CABG
  - Hypertension (new onset or exacerbation)
- Inhibition of bone healing, and bone growth
- Use the lowest dose for the shortest time period
NMDA antagonists (ketamine, dextromethorphan)

- Decades of use as primary anesthetic (burn victims)
- Higher dose side effect profile:
  - Diplopia and nystagmus
  - Dizziness, confusion, psychotomimetic reactions
  - Increased ICP, sympathomimetic effects
- Low-dose analgesic benefits without side-effects
  - 0.1-0.2 mg/kg adjunctive dosage
- Acts on dorsal horn neurons
- Dextromethorphan 90-150 mg po effective in lap-chole

Himmelseher S, Durieux ME (2005) Anesthesiology 102:211-220
Alpha-2 agonists: (dexmedetomidine, clonidine)

- Action on brain stem, causing inhibition of sympatho-adrenal outflow, pain modulation, sedation, morphine sparing
- Decreased renal vascular resistance, SVR (at low dose!)
- Hypotension, bradycardia (or aystole), worsened by beta-blockers and alpha-agonists
- Caution:
  - hypertension from high infusion rate
  - with hepatic impairment
- Effective parenterally, neuraxially, peripherally
- Clonidine 0.3 mg IV may not reduce morphine requirement, but does reduce side effect profile
- Infusions may (need to) be run into the post-operative period
What robotic cases are appropriate for MMA?

- When is the greatest benefit obtained?
  - Mild to moderate pain
  - Not those already going home
  - Not those with severe pain or opioid tolerance
  - Those who are staying one or two nights

- Potential to effect an overnight discharge

- Examples:
  - RALRP
  - Ureteroscopic stone extraction
How to assess outcomes?

- Measure specific “opioid-related” adverse effects
  - Bowel sounds, defecation?
  - PONV, pruritis, sedation
  - Assume no respiratory depression

- Measure pain scores
  - Spontaneous vs. movement-evoked

- Health-related Quality of Recovery
  - Emotional state; social function
  - Comfort; sleep quality
  - Cognition; psychological support
  - Physical independence
## Possible MMA regimen for RALRP

<table>
<thead>
<tr>
<th></th>
<th>Anticon.</th>
<th>Acet.</th>
<th>NSAID</th>
<th>COX-2</th>
<th>NMDA</th>
<th>Alpha-2</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Premed:</strong></td>
<td>?pregabalin</td>
<td>Yes*</td>
<td>No, no benefit early, and may increase bleeding</td>
<td>Yes** celecoxib p.o.</td>
<td>No</td>
<td>clonidine?</td>
<td>lidocaine 1.5 mg/kg iv</td>
</tr>
<tr>
<td><strong>Intra-op</strong></td>
<td>No</td>
<td>No</td>
<td>Yes***, ketorolac during closure</td>
<td>No</td>
<td>Yes, ketamine low dose 0.1-0.5 mg/kg</td>
<td>Yes, dexam low dose 0.1-0.4 mcg/kg/hr</td>
<td>SAB with 10 mg tetracaine; Dexameth; lidocaine</td>
</tr>
<tr>
<td><strong>Post-op</strong></td>
<td>No</td>
<td>Yes, q4h?</td>
<td>Yes, unless gastric issues. Q6h?</td>
<td>Yes, as substitute for NSAID q6h?</td>
<td>No, but ?dextrometh orphan</td>
<td>No</td>
<td>fentanyl in pacu; tramadol on floor?</td>
</tr>
</tbody>
</table>

*If hepatic impairment, then omit.
**If cardiac impairment then use NSAID such as ibuprofen.
***If renal impairment, then omit and use p.o. COX-2

Anti-emetics include: ondansetron, ?dexamethasone, ?droperidol
Why consider neuraxial blockade?

- SAB, LEA, TEA, CSE, EREM
- Sympathectomy for hemodynamics?
- Reduce POI: (Gannon 2007, Jørgensen 2000)
- To minimize narcotic SE; avoid acute tolerance
- Minimize post-op pain
- Reduce stress response, catabolism, hyper-coagulability, immune suppression
- Minimize PONV
- Improved pulmonary dynamics (Hong 2009)
Neuraxial Anesthesia Alone for Laparoscopic Surgery!

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Ref #</th>
<th>Surgery</th>
<th>Tmax (min)</th>
<th>Type/Level</th>
<th># Pts</th>
<th>Reason</th>
<th>IAP/Pos</th>
<th>Sedation</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pursani</td>
<td>1998</td>
<td>235</td>
<td>Chole</td>
<td>60</td>
<td>TEA/T4</td>
<td>6</td>
<td>COPD: FEV₁/FVC=52%</td>
<td>10/RT</td>
<td>alfentanil</td>
<td>Most c/o brachioscapular pain, secondary to liver retraction or diaphragm stretch. No narcotics or respiratory depression. Non-CO₂ retainers. Low re-intra-op SpO₂ of 86-90% tolerated well.</td>
</tr>
<tr>
<td>Schmidt</td>
<td>2001</td>
<td>236</td>
<td>Ing hernia</td>
<td>27</td>
<td>LSA/T6</td>
<td>15</td>
<td>COPD:FEV₁/FVC=58%</td>
<td>10/S</td>
<td>midazolam remifentanil</td>
<td>SpO₂ &gt;90% was acceptable. No change postop vent. No shoulder pain. No analgesics required first day.</td>
</tr>
<tr>
<td>Stewart</td>
<td>2001</td>
<td>237</td>
<td>O/P Gyn</td>
<td>unk</td>
<td>LSA/unk</td>
<td>20</td>
<td>Compare to propofol GA</td>
<td>?:S</td>
<td>IT sufentanil midazolam fentanyl</td>
<td>10 mg selective spinal with 1% lidocaine. Randomized to general anesthesia. Improved recovery profile.</td>
</tr>
<tr>
<td>Vaghadia</td>
<td>2001</td>
<td>238</td>
<td>O/P Gyn</td>
<td>unk</td>
<td>LSA/T5</td>
<td>30</td>
<td>To determine minimal dose</td>
<td>?:T</td>
<td>midazolam alfentanil</td>
<td>Lowest dose 10 mg lidocaine with IT sufentanil provided selective analgesia without motor block. Well tolerated.</td>
</tr>
<tr>
<td>Grammatica</td>
<td>2002</td>
<td>239</td>
<td>Chole</td>
<td>120</td>
<td>TEA/unk</td>
<td>29</td>
<td>COPD, 34% were severe</td>
<td>10/?</td>
<td>midazolam fentanyl</td>
<td>None were obese. 48% shoulder pain. Immediate postop oral intake. No postop analgesics.</td>
</tr>
<tr>
<td>Lennox</td>
<td>2002</td>
<td>240</td>
<td>O/P Gyn</td>
<td>23</td>
<td>LSA/unk</td>
<td>10</td>
<td>Compare to desflurane GA</td>
<td>?:T</td>
<td>IT sufentanil midazolam fentanyl</td>
<td>10 mg selective spinal with 1% lidocaine. Randomized to general anesthesia. Improved recovery profile. 40% pruritus.</td>
</tr>
<tr>
<td>Hamad</td>
<td>2003</td>
<td>241</td>
<td>Chole</td>
<td>115</td>
<td>LSA/T5</td>
<td>10</td>
<td>First feasibility study</td>
<td>11/?</td>
<td>IT fentanyl</td>
<td>Successive patients. Nitrous insufflation gas. One conversion to GA for intolerable shoulder pain. One patient vomited intraop. 9/10 described it as satisfactory.</td>
</tr>
</tbody>
</table>

Don’t try to read this…..just so you believe it can be done!
Other Complications

- Corneal abrasion
- IV infiltration and compartment syndrome
- Peripheral n. injury: (peroneal, femoral, ulnar) avoid shoulder braces
- Gas embolism: $\text{ETCO}_2$ increases, may be fatal
- Sub-q emphysema: self-limited
- Pneumothorax (tension)
- Edema
- Hypoxemia
- Vagal bradycardia: during insufflation
- Pulmonary thromboembolism

Summary

- Anesthesia in robotic surgery *is* different
- Access and hydrostatic concerns
- Combined pneumoperitoneum and Trendelenburg are physiological insults
- Anesthesia that addresses this physiology may improve outcome satisfaction
- Multimodal techniques may eliminate narcotic side effects