Trauma Orthopedics and Anesthetic Considerations

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Objectives

- Discuss timing fixation of long bone fx’s
- Discuss and define Early Total Care (ETC)
- Discuss and define Damage Control Orthopedics (DCO)
- Discuss anesthetic considerations for long bone fractures and pelvic ring fractures
Surgeries at the Trauma Center

- Nearly half of the surgeries performed at Shock Trauma are ortho related
How do broken bones occur?

- MVC
- MCC
- Ped struck
- Falls/jumps
- Gsw’s
- Intoxication
- Sometimes just by attempting to stand?!
Optimal Timing for Fracture Fixation

- Many changes throughout the decades
- With many mores changes to come
- No rules set in stone!!!
- But always do what is best for pt
Early Thoughts

- “Pt too sick to operate on”
- Pt placed in skeletal traction for long periods of time
  - Fear operative manipulation would release fat emboli/IM contents into circulation
  - Pts suffered resp compromise sitting on wards
- In 70’s early fixation showed vs usual care
  - descended pulmonary complications
  - Earlier pt mobilization
  - Earlier discharge from hospital
Fat Embolism Syndrome (FES)

- Characterized by release of fat droplets into systemic circulation after a traumatic event

Presentation
- pulmonary distress
- MS changes
- petechial rash 24 to 48 hrs post pelvic or long-bone fracture

- Incidence increases with the number of fractures

Clinical diagnosis is essential
- laboratory and radiographic findings are nonspecific

- Early supportive care and resuscitation may halt progression and prevent clinical deterioration

- If recognized and treated early, outcome is usually good
Changing 80’s

- Thought shift
- “Pt too sick not to operate”
- Bone et al demonstrated early fixation/stabilization
  - ↓ LOS/mortality/pulm complications
- Attempted to fix all fractures in one trip

Changing 80’s Cont.

- Seibel et al. compared immediate vs 10 days vs 30 days
- Mult OR teams ↓ OR time need for further operations
- ↓ time in hospital and out of work
- Reduced fracture complications
- Early total care (ETC) was born
Early versus Delayed Stabilization of Femoral Fractures

A PROSPECTIVE RANDOMIZED STUDY*†

BY LAWRENCE B. BONE, M.D.‡, KENNETH D. JOHNSON, M.D.§, JOHN WEIGELT, M.D.#, AND ROBERT SCHEINBERG, M.D.¶, DALLAS, TEXAS

From the Division of Orthopaedic Surgery, University of Texas Southwestern Medical Center at Dallas and Parkland Memorial Hospital, Dallas

- 178 patients
- Age 16-65
- Early fixation <24 hrs
- Late fixation >48 hrs

<table>
<thead>
<tr>
<th>Pulmonary Complications</th>
<th>Early isolated femur (n=42)</th>
<th>Late isolated femur (n=53)</th>
<th>Early multi injuries (n=46)</th>
<th>Late multi injuries (n=37)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>14</td>
<td>16</td>
<td>50</td>
</tr>
</tbody>
</table>

Early Total Care (ETC) of Fractures

- The good
  - No need for a second operation
  - Decreased infections
  - Easier mobilization for tests and other treatments
  - Decreased hemorrhage
  - Decreased inflammatory activation
Early Total Care of Fractures

- **The bad**
  - Longer OR times,
  - ↑ fluid/transfusions
  - ↑ hypoxia
  - ↑ hypotension
  - Worse outcome for TBIs
  - Thoracic injuries
  - ↑ ARDS
90’s Ortho Care

- ETC possibly harmful esp pt’s where IM reaming performed
  - Reaming causes mobilization of fat
  - Fat is broken down into free fatty acids leading to pulmonary injury
  - Cardiac instability

- Worse pulmonary complications in young pt’s w/ early reaming despite no thoracic injuries

- ETC increased ARDS leading to MOF
  - Thoracic injuries with cardiac instability
  - Head injuries
PRIMARLY INTRAMEDULLARY FEMUR FIXATION IN MULTIPLE TRAUMA PATIENTS WITH ASSOCIATED LUNG CONTUSION—A CAUSE OF POSTTRAUMATIC ARDS?

Hans-Christoph Pape, MD, Michael Auf’m’Kolk, MD, Thomas Paffrath, MD, Gerd Regel, MD, Johannes A. Sturm, MD, and Harald Tscherner, MD

- Retrospective study
- 106 severely injury patients
- ARDS
  - Vent support > 5 days
  - FIO2 ≥ 0.6 5 days
  - PEEP > 6 cm H2O > 5 days
  - Bil diffuse infiltrates on xray
    - No pneumonia
  - No cardiogenic pulmonary edema

![Severe chest injury vs ARDS and mortality](chart.png)
Adverse Outcomes Post ETC

- Borderline pts
- Coagulopathy (plt < 90K)
- Hypothermia (< 32 degrees)
- Massive transfusion
- Pulm contusion in initial X-ray
- Mult long bone/torso injuries
- OR > 6hrs
- Arterial injury/SBP < 90mmHg
- Exaggerated inflammatory response (IL-6 > 800pg/ml)
  - Pape et al.
90’s Ortho Care

- Townsend et al. showed early fix w/ brain injuries was dangerous b/c risk for decreases in CPP lasted >24hrs
- Thought change again!!
  - ETC was good for most but not all- esp head/ chest injuries
  - Timing may be an important factor
  - Goals CPP >70 and ICP <20
Two-Hit Theory

● First hit is inflammatory response to initial trauma
  ● Most recover
  ● If severe ARDS/MOF
  ● R/t increased pulm capillary permeability esp within first 6 hrs of initial trauma
  ● + correlation number of injuries with inflammatory response

● Second hit
  ● Additional inflammatory insult r/t surgery
  ● Increases ARDS/MOF substantially
  ● IL-6 best measure of magnitude of inflammatory response/outcome
Two-hit Theory

First hit

Reaction

Resolution

Severe response

Second hit

Surgical procedure

? nature

MOF/ARDS

MOF/ARDS
2000 And Beyond

- What have we learned so far?
  - Early fixation better than late in most pts but not all, esp head/chest injuries
  - Inflammatory response has an important role in the pt’s outcome- avoid or limit “Second Hit”
  - Timing is important but so is stabilization

- Damage Control Orthopedics (DCO)
Damage Control Surgery/Orthopedics

Damage control surgery

- Quickly explore and attempt to stop life threatening bleeding
- Pack liver/abdomen
- Leave abd open
- Re-explore when more stable
- Close when appropriate

Damage control orthopedics

- Multiple injured patient
- Unstable or extremis
  1. Temporary fixation
     - Ex fix
     - Ex lap
     - Decompressive crani
  2. ICU management and resuscitation
  3. Definitive fixation

DCO

- Term coined at Shock Trauma by Dr. Scalea and Dr. Pollak in 1999
- Temporary external fixation to delay definitive fixation
- Pts “Too sick” for definitive treatment
Damage Control Orthopedics

- ↓ time in the OR
- ↓ blood loss in the acute phase of resuscitation
- Avoid/limit the vicious cycle of hypothermia, coagulopathy and acidosis
- Limit fx hematoma
- Removal non viable tissue
- Prevents teams from “operating on the patient to death!” Dr. Dutton
- Allows pts to mobilized OOB decreasing pulm complications
Damage Control Orthopedics

- Scalea et al.
  - Ex fix took an average of 35 mins
  - Later definitive conversion of same pts resulted in 4x longer OR time/blood loss
### ETC vs DCO

<table>
<thead>
<tr>
<th>Femur Fxs</th>
<th>ETC (n=42)</th>
<th>DCO (n=55)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OR Time</td>
<td>125 min</td>
<td>22 min</td>
</tr>
<tr>
<td>EBL</td>
<td>330 ml</td>
<td>37 ml</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>hETC (n=57)</th>
<th>DCO (n=75)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OR Time</td>
<td>233±19 min</td>
<td>62±30 min</td>
</tr>
<tr>
<td>EBL</td>
<td>472 ml</td>
<td>&lt;50 ml</td>
</tr>
</tbody>
</table>


Damage Control Orthopedics

- Usually pt’s with ongoing resuscitation
- Decreases “second hit”
- Pape et al demonstrated DCO can be performed with little to no secondary inflammatory response
Timing to Definitive Conversion

Early Total Care versus Damage Control: Current Concepts in the Orthopedic Care of Polytrauma Patients

Review Article

Definition of the borderline patient

- Multiple injuries with an injury severity score (ISS) >20 with additional thoracic trauma
- Multiple injuries with abdominal/pelvic trauma
- Hemorrhagic shock (initial systolic BP <90 mmHg)
- ISS >40
- Radiographic (CXR or CT) evidence of bilateral pulmonary contusion
- Initial mean pulmonary arterial pressure >24 mmHg
- Pulmonary artery pressure increase during IM nailing >6 mmHg

Endpoints of resuscitation

- Stable hemodynamics
- Stable oxygenation
- Stable or improving lactate
- Stable coagulation
- Normothermia
- Adequate u/o
- ? Inotropic support
Resuscitation Before Stabilization of Femoral Fractures Limits Acute Respiratory Distress Syndrome in Patients With Multiple Traumatic Injuries Despite Low Use of Damage Control Orthopedics

Robert V. O’Toole, MD, Michael O’Brien, MD, Thomas M. Scalea, MD, Nader Habashi, MD, Andrew N. Pollak, MD, and Clifford H. Turen, MD

**TABLE 3.** Comparison of Patients With Femoral Shaft Fractures and Injury Severity Scores >17 by Treatment Group

<table>
<thead>
<tr>
<th>Initial Treatment</th>
<th>Patients, n (%)</th>
<th>Initial Lactate Value (mmol/L)</th>
<th>Lactate Value Before Surgery (mmol/L)</th>
<th>Best Lactate Value on the Day of Surgery (mmol/L)</th>
<th>Death Percentage of Patients</th>
<th>Intensive Care Unit (d)</th>
<th>ARDS Percentage of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nailing</td>
<td>199 (88)</td>
<td>3.8*</td>
<td>2.9*†</td>
<td>2.2*†</td>
<td>2.0*</td>
<td>7.1*</td>
<td>1.5</td>
</tr>
<tr>
<td>DCO</td>
<td>28 (12)</td>
<td>6.5</td>
<td>4.1†</td>
<td>2.7†</td>
<td>17.9</td>
<td>17.3</td>
<td>0.0</td>
</tr>
</tbody>
</table>

* p < 0.05 for all values comparing DCO with reamed nailing.
† p < 0.05 compared with presenting lactate.

**TABLE 4.** Comparison of Patients With Femoral Shaft Fractures and Injury Severity Scores >17 Plus Significant Lung Injury (Abbreviated Injury Scale Scores >2)

<table>
<thead>
<tr>
<th>Initial Treatment</th>
<th>Patients, n (%)</th>
<th>ISS</th>
<th>Initial Lactate Value (mmol/L)</th>
<th>Lactate Value Before Surgery (mmol/L)</th>
<th>Best Lactate Value on the Day of Surgery (mmol/L)</th>
<th>Death Percentage of Patients</th>
<th>Intensive Care Unit (d)</th>
<th>ARDS Percentage of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nailing</td>
<td>151 (86)</td>
<td>28.3*</td>
<td>3.8*</td>
<td>2.8*†</td>
<td>2.2*†</td>
<td>2.0*</td>
<td>7.6*</td>
<td>2.0</td>
</tr>
<tr>
<td>DCO</td>
<td>24 (14)</td>
<td>36.9</td>
<td>6.4</td>
<td>3.8†</td>
<td>2.7†</td>
<td>12.5</td>
<td>15.9</td>
<td>0.0</td>
</tr>
</tbody>
</table>

* p < 0.05 for all values comparing DCO with reamed nailing.
† p < 0.05 compared with presenting lactate.

**TABLE 5.** Comparison of Patients With Femoral Shaft Fractures and Injury Severity Scores >28 Plus Significant Lung Injury (Abbreviated Injury Scale Scores >2)

<table>
<thead>
<tr>
<th>Initial Treatment</th>
<th>Patients, n (%)</th>
<th>ISS</th>
<th>Initial Lactate Value (mmol/L)</th>
<th>Lactate Value Before Surgery (mmol/L)</th>
<th>Best Lactate Value on the Day of Surgery (mmol/L)</th>
<th>Death Percentage of Patients</th>
<th>Intensive Care Unit (d)</th>
<th>ARDS Percentage of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nailing</td>
<td>60 (77)</td>
<td>36.6*</td>
<td>4.2*</td>
<td>2.6*†</td>
<td>2.2*†</td>
<td>1.7</td>
<td>13.4</td>
<td>3.3</td>
</tr>
<tr>
<td>DCO</td>
<td>18 (23)</td>
<td>41.4</td>
<td>6.3</td>
<td>3.9†</td>
<td>2.9†</td>
<td>11.1</td>
<td>17.2</td>
<td>0.0</td>
</tr>
</tbody>
</table>

* p < 0.05 for all values comparing DCO with reamed nailing.
† p < 0.05 compared with presenting lactate.

J Trauma. 2009;67: 1013–1021
Resuscitation Before Stabilization of Femoral Fractures Limits Acute Respiratory Distress Syndrome in Patients With Multiple Traumatic Injuries Despite Low Use of Damage Control Orthopedics

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“Resuscitation before stabilization”

<table>
<thead>
<tr>
<th>Study</th>
<th>Inclusion Criteria, (ISS)</th>
<th>DCO Rate (%)</th>
<th>No of Primary Nails</th>
<th>Average ISS With 1° Nail</th>
<th>ARDS Rate After 1° Nail (%)</th>
<th>Death Rate After 1° Nail (%)</th>
<th>MOF Rate After 1° Nail (%)</th>
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</thead>
<tbody>
<tr>
<td>Present study</td>
<td>&gt;17</td>
<td>12*</td>
<td>199</td>
<td>27.4</td>
<td>1.5†</td>
<td>2.0</td>
<td>NR</td>
</tr>
<tr>
<td>Pape et al.²⁷</td>
<td>&gt;17</td>
<td>36</td>
<td>110</td>
<td>35.8</td>
<td>26.4‡</td>
<td>NR</td>
<td>28</td>
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<tr>
<td>Brandage et al.⁵</td>
<td>&gt;15</td>
<td>NR</td>
<td>516⁵</td>
<td>25.5</td>
<td>10.1‡</td>
<td>4.1</td>
<td>NR</td>
</tr>
<tr>
<td>Bosse et al.³⁷</td>
<td>&gt;16</td>
<td>NR</td>
<td>235</td>
<td>28.0</td>
<td>3.0</td>
<td>2.6</td>
<td>2.1</td>
</tr>
<tr>
<td>Charras et al.⁶</td>
<td>&gt;17</td>
<td>NR</td>
<td>138⁴</td>
<td>26.5</td>
<td>3.6</td>
<td>5.1</td>
<td>NR</td>
</tr>
<tr>
<td>Bone et al.⁴</td>
<td>&gt;17**</td>
<td>NR</td>
<td>83⁴</td>
<td>30.6</td>
<td>8.4</td>
<td>3.6</td>
<td>NR</td>
</tr>
</tbody>
</table>

MOF, multisystem organ failure; NR, not reported.
* p < 0.001 by Student’s t test comparing DCO rate from present study with that from study by Pape et al.²⁷
† p < 0.005 by Student’s t test comparing ARDS rate from present study with that from study by Pape et al.²⁷
‡ Article reports 15.1% ARDS rate for primary nails in most recent cm. However, subsequent publication states that was excluding retrograde nails and that ARDS rate for both antegrade and retrograde nails was 26.4%³¹,²⁵ Either rate is still statistically different from our rate.
§ Article heading for patients with multiple injuries is ISS >15, but text of same paragraph states ISS ≥15.
¶ Article states approximately 95% were treated with reamed nails, 5% with plates or unreamed nails, no mention of DCO rate.
* Includes both early- and late-fixation groups.
* This is the ARDS value for all patients, calculated by combining the reported rates for early and late treatment groups.
** Article has conflicting ISS information: page 340 “more than 18 points” and page 338 “18 points or more.”
Anesthesia Considerations in ED

- Why are we called to ED?
  - Provide sedation
  - Airway management
  - Pain control
  - Narcotics
  - Regional anesthesia
Anesthesia Considerations in ED

- All pt’s full stomach
- Suction
- RSI Adjust dosages
- MRSI vs true RSI
- VL vs DL
- Airway adjuncts available
- Know difficult airway algorithm in and out
Anesthesia Considerations in ED

- Provide sedation
  - Awake/paralyzed not good!
  - As long as pt can handle it
- Continue resuscitation
- If OR a possibility we become a bit more visible to “Help out”
## Anesthesia Considerations Ortho Trauma

### Early Fixation
- Pt is usually stable and has been cleared by Team
- Discuss anesthesia with patient or guardians
- NPO status
- General +/- regional PNB
- Discuss plan with surgical team
- Blood availability based on procedure
- Lines based on pt/procedure

### Late Fixation
- Surgeries sometimes delayed for various reasons
- If pt is stable, swelling may delay case
- Concerns about soft tissues and difficulty closing wound
- Waiting may eliminate need for further surgery/risk for infection
- Watch for changes in ventilation
Anesthesia Considerations DCO

- Airway usually established
- Blood product availability
- Adequate venous access
  - Central access preferred - allows for continued resuscitation
- A-line above diaphragm
- Communication
  - Keep surgeons aware of any changes in the patient’s condition
    - Hypotension
    - Difficulty with ventilation
- Goal is QUICK stabilization!!!
Anesthesia Considerations DCO

- Attempt to keep up with labs
  - ABGs, CBC, coags, lactate

- If pt hypotensive, the usually pt hypovolemic- most of the time

- Don’t forget the antibiotics!!

- Final disposition
Ortho vs Anesthesia

● “Does the patient has zero twitches?”

● Routine reversal – (1-4 twitches)
  ● 2 mg/kg

● Reversal of profound blockade – (1-2 post-tetanic counts)
  ● 4 mg/kg

● Immediate reversal of Rocuronium induced-blockade
  ● 16 mg/kg

<table>
<thead>
<tr>
<th></th>
<th>Sugammadex</th>
<th>Neostigmine / Glycopyrrolate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Routine Reversal</td>
<td>88.67</td>
<td>86.05</td>
</tr>
<tr>
<td>Reversal of Profound Blockade</td>
<td>162.41 (177.34)</td>
<td>86.05 + (time)</td>
</tr>
<tr>
<td>Immediate Reversal of Rocuronium</td>
<td>575.90</td>
<td></td>
</tr>
</tbody>
</table>
Pelvic Fracture

- High incidence hemorrhagic shock
- Anatomic proximities of veins/arteries
- Fractures + vascular injuries
- Mortality 50% in poly trauma w/ pelvic fxs
- 90% venous injury
- Hematomas in pelvis/retroperitoneum
Early Total Care versus Damage Control: Current Concepts in the Orthopedic Care of Polytrauma Patients

Initial management

- Brief primary/secondary survey
- Definitive airway management
- FAST
- CXR for chest injuries
- Appropriate venous/arterial access
- Type & cross
- Avoid hypothermia
Management of Pelvic Fractures

- Internal iliac disruption most common
  - Fracture reduction
  - Angiographic embolization
Conclusion

- ETC is best for most
- Caution in head/chest injuries
- Inflammatory response important
- Limit “second hit”
- DCO as bridge to definitive fixation
- All treatments should be individualized for that specific pt (depending on condition)
- Communicate openly with all involved in care
- Do what’s best for that pt at that time
References

- Scalea, T. Optimal timing of fracture fixation: have we learned anything in the past 20 years? J Trauma. 2008;65:253-260.


References


