

Damage Control Orthopedics

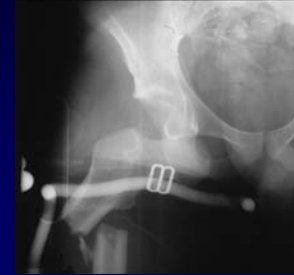


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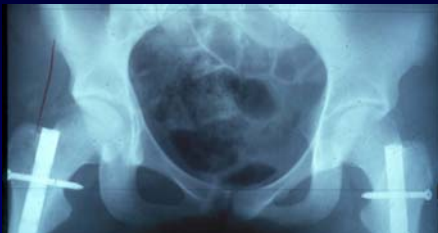


Femur Fracture Case

- 16 yo male, MVA
- Pulmonary Contusions
- Stable TBI
- Bilateral Femoral Fractures
- Hip Dislocation



Femur Fracture



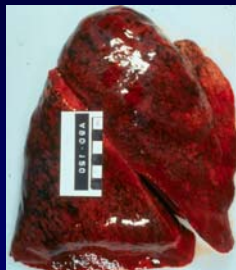
Femur Fractures

- 16 yo florid ARDS 96 hours after acute femoral nails in presence of mild head injury and pulmonary contusions

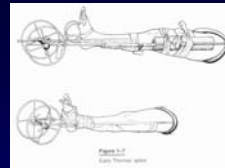


Femur Fractures

- Outcome at 1 week: **AUTOPSY**
- **Is this Inevitable? Or Preventable?**



Evolution of Controversy Traction Splinting



	1916
Femur fractures	80% Mortality
	1918
Femur fractures	20% Mortality



World War II

- Gerhard Kuntscher
- Introduced Concept & Cloverleaf Nail In 1939
- Closed IM Nailing
– No Reaming



Recognition of The Systemic Effect of Nailing



“Cardiorespiratory changes are the result of releasing bone marrow into general circulation”.

G. Kuntscher

Minimizing The Systemic Effects Of Nailing

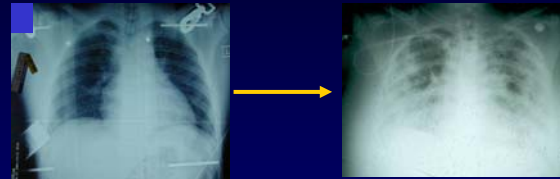
“Suggestions of the Time”

“Drive the nail slowly. Pause after a number of blows to give the marrow time to drain.”

“When nailing a femur, enlarge the opening through which the nail is inserted to enable the marrow to drain.”

G. Kuntscher. *Die Marnagelung* Berlin: Dr. Werner Saenger Verlag, 1950: 77- 95

Clinical Issues Related to Trauma In Patients with Femur Fractures



Acute Respiratory Distress Syndrome
ARDS
Fatty Embolus Syndrome
FES

Evolution of Controversy

- Traction vs IM Nail
 - Which is safer?
 - Debate of 50's, 60's, 70's
- Traction vs IM nail (5-10d)
 - Wait until risk of FES passes
 - Debate of 70's, mid 80's



Evolution of Controversy

- Delayed vs Early Nail
 - They will only get sicker
 - Nail ASAP
 - Debate of mid 80's, 90's




Reduces Morbidity and Mortality by Minimizing

- Decubiti
- Sepsis
- Pneumonia
- DVT & PE
- Systemic complications!

- **Early Stabilization in the first 24 hours**
 - Lawrence B. Bone, M.D.
 - Kenneth Johnson, M.D.

Early Total Care (ETC)


- Fix long bones within 24 hours
- Resuscitate aggressively
- Early Definitive surgery to decrease late complications




Immediate IM Nailing (< 24 hours) vs Stratify, Delay & Special Techniques

Debate of early '90's to present:

- Some are too sick
- Chest, brain trauma
- Reamed vs Unreamed nail vs External Fixation



Decisions are tough.



- Life as a trauma surgeon would be easy if all we had to deal with was the fracture.

Complicating factors.



- The fracture always has a patient attached to it.
- This forces us to consider more than just the bones.

Gray Areas

- Little research to guide us.
- The "art" of medicine.
- However, two rules exist which remove some uncertainty.



Two Fundamental Guidelines



Guideline No. 1

- Never operate on a trauma patient who is already dead.
- Sometimes it is hard to tell for sure.
- Do your best.



Guideline No. 2

- Never, ever operate on somebody who comes to your clinic wearing gold slippers.
- 100% correlation with poor outcome.



- Beyond these 2 iron-clad guidelines, I have few "rules" to offer.
- Decisions require deep thought and reflection...



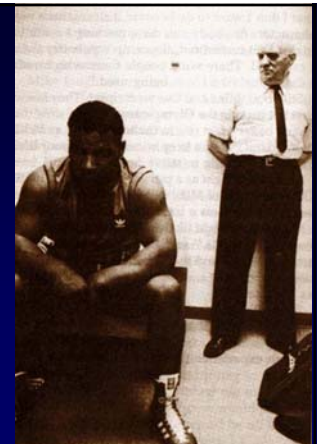
Three Broad Categories of Decisions

- Emergency surgery on patients at risk for death.
- Urgent surgery on recent trauma patients.
- Elective surgery on cold trauma.
 - easiest



Cold Trauma

- Take it or leave it.
- Usually you know the patient from the acute injury.
 - Remember the Gold Slippers !
- Often taking steps to make something BETTER.
- Luxury of time.
- Potential for disaster lessened.
 - Elective surgery
 - Prepared patient



Emergency Surgery

- Trauma is a surgical disease.
- This patient will not be helped by pills.
- It is clear that somebody has to do something with their hands.
- Question is not IF, but HOW? Or maybe HOW MUCH?



The Term "Damage Control"

- Rooted in naval warfare.
- An example - USS Yorktown, 1942



Battle of the Coral Sea, 7-8 May 1942

- Battle off the Solomon Islands
- The USS Lexington was badly damaged and abandoned.



USS Yorktown

- Badly damaged.
- Still afloat.



Damage Control

- Pearl Harbor.
- Holes plugged.
- Damaged bulkheads reinforced.



Live to Fight Another Day

- Battle of Midway, 4-7 June 1942
- Yorktown was there.

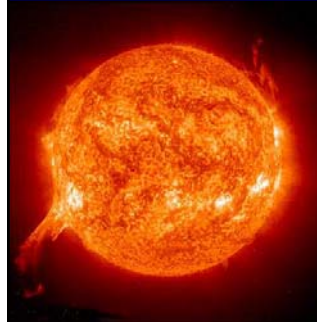


USS Yorktown

- Repair crews still on board when Yorktown left Pearl Harbor.
- US victory at Midway turned the tide of the war in the Pacific.



5 Tenets of Damage Control



- 1. Recognize who needs damage control.
- 2. Salvage operations.
- 3. Keep the patient alive.
- 4. Accept morbidity of the salvage procedures.
- 5. Definitive repair later.

Other Disciplines?

- Tenets the same.
- Example
 - General surgery
- Schwab CW. Introduction: Damage control at the start of 21st century. INJURY 2004; 35:639-41.



What Are We Doing?



- We're limiting the 2nd hit.

Trauma Mortality



- Bimodal
- Early death
 - Blood loss
 - Brain injury
- Late death
 - Secondary brain injury
 - Host defense failure - sepsis

“Hits” Induce a Host Immune Response



- First Hit
 - Hypoxia
 - Hypotension
 - organ & soft tissue injury
 - fractures
- Second Hit
 - ischemia/reperfusion injury
 - compartment syndrome
 - operative intervention
 - infection

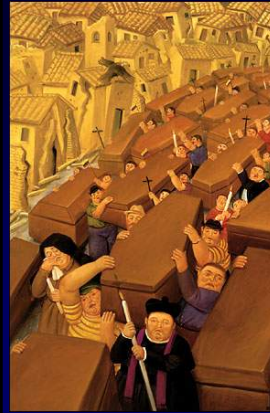
Keel M, Trentz O. Pathophysiology of polytrauma. INJURY 2005

Inflammatory Host Response



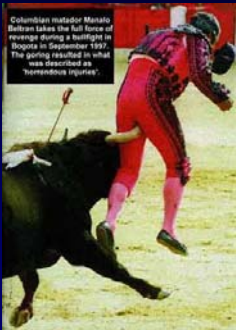
- Local and systemic release of:
 - pro-inflammatory cytokines
 - arachidonic acid metabolites
 - proteins of the coagulation system
 - complement factors
 - acute phase proteins
 - hormonal mediators
 - Too much? Systemic inflammatory response syndrome (SIRS)

SIRS



- Endothelial cell damage
- Accumulation of leukocytes
- Disseminated intravascular coagulation
- Apoptosis / necrosis of parenchymal cells
- Multiple organ dysfunction syndrome (MODS)
- Multiple organ failure (MOF)

Anti-Inflammatory Host Response



- Local and systemically, TH2-cells and monocytes/macrophages release:
 - IL-4
 - IL-10
 - IL-13
 - transforming growth factor- β (TGF- β)

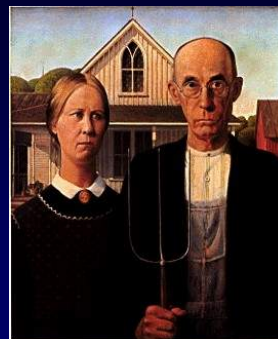
It's a Feedback Loop



- Anti-inflammatory mediators
 - Depress the activity of intracellular transcription factors
 - Depress synthesis of pro-inflammatory cytokines.
- Too much negative feedback?
 - Compensatory anti-inflammatory response syndrome (CARS)
 - Increased susceptibility to infection.

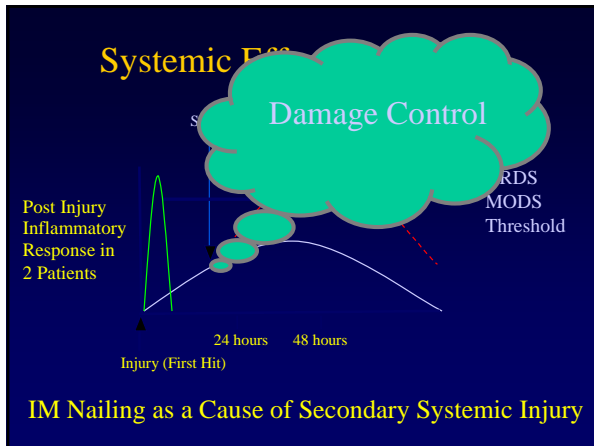


- Host defense response: Balance between SIRS and CARS
 - induce reparative mechanisms
 - limit entry or overload of microorganisms
 - avoid auto-aggressive inflammation, with secondary tissue damage
 - Avoid susceptibility to infection



Holy Smokes

- Confusing, huh?



When Should **Definitive** Early Stabilization be Delayed?

- Hypotension
- Coagulopathy
- Hypothermia
- Traumatic Brain Injury
- Vascular Injury
- Contaminated limb salvage

DCO: Principles

- Ortho team must be resuscitators and stabilizers: not “fixers”

What Should Be Stabilized?

- Will stabilizing this fracture:
 - Limit bleeding?
 - Lessen fat embolization?
 - Make patient transport easier?

Damage Control: Advantages

- Minimal systemic insult
- Help resuscitation
- Less work at night
- Allow better operative plan
- Less arguments with colleagues
- “Prudently aggressive”

DCO: Principles

- Do reconstruction under best circumstances
- More time for planning is usually better
- Best team possible for difficult work

Case Example

- 19 yo male
- Snowmobile accident
- TBI
- Liver lac-grade 3
- Open intraarticular distal femur
- Closed Femoral Shaft Fracture

These are difficult fractures in a sick patient!

These are difficult fractures in a well patient!



Damage Control

- OR Urgently
- Continued resuscitation
- Bilateral Ex Fix
- Benefits
 - Fast
 - No Harm to Pt
 - Traction Radiographs
 - Improved Pre op Planning



Definitive Care

- Systemic stabilization achieved
- Reconstruction 3 days later
- Advantages
 - Minimized Systemic effect of Orthopedic trauma
 - Difficult ORIF Peromed with experienced OR Team



Not just for patients *in extremis*

- Also works for difficult fractures.
- Apply same sort of judgement to peri-articular fractures.
- Instead of saving the LIFE, you're trying to save the JOINT.
- Death isn't at risk - you're scared of wound breakdown and infection
- Do URGENT care later
 - Repair the joint definitively when the limb is ready



Isolated Damage Control



Poor Soft Tissues

Isolated DCO



Isolated DCO

- Definitive Fixation
- Good Soft Tissue Envelope



What Do I Need For DCO ?

- Fixator Set
– Options
- Drill
- Knife
- Radiolucent Table



Do I Need Fluoroscopy ?

No



Femur Fractures



Distal Femur Proximal Tibia Fractures



Distal Femur Proximal Tibia Fractures



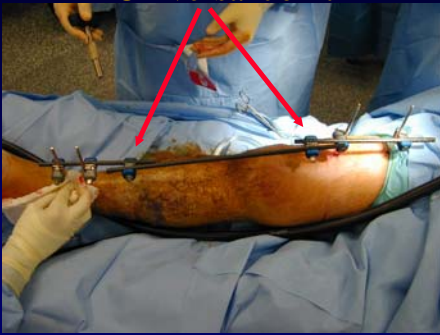
Pin Insertion



Pin Bar Clusters



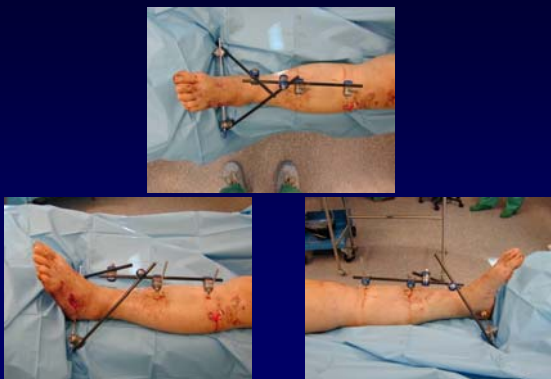
Universal Joint



Distal Tibia Fractures



A Frame



Versatility



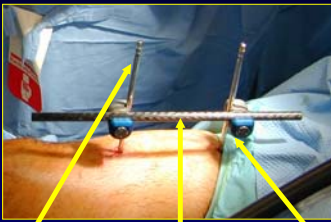
Cost Issues



Fixator Cost

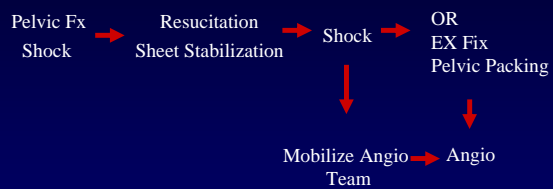


Fixator Cost



Occasionally More Than a Fixator !

Denver Protocol



Mechanical Stabilization



KISS

- Keep it simple
- Keep it quick
- Keep it from interfering

External Fixation

- Keep it Simple & Quick
- 2 Pin Fixator
- Ganz or C-Clamp
- Complications

Denver Technique

- Stabilize Pelvis
 - EX Fix
 - Clamp
- Mid line Incision
 - Split Rectus
 - Retro-peritoneal
 - Enter Space Reitzus

- Retract Bladder
 - Blunt Dissection
 - Follow Pelvic Brim
 - Posterior to Sacrum
 - 3 Sponges
 - Posterior – Anterior
 - Below pelvic Brim

Finished Result

Impediments to DC

- Lack of Understanding of the Problem
- Surgical EGO
- System problems
- The misconceptions of the past

Save the Patient First

- They have to be alive to complain.



Stick & Move

- Speed counts.
- Keep them resuscitated and warm.



Individual Cases Test Us These Can Be Challenging Eventually Get it Right



Thank You