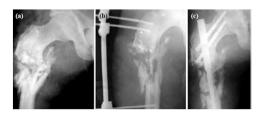
# Role and Technique for Spanning External Fixation

Jeff Anglen, MD

# WHEN TO DELAY FIXATION with spanning external fixation

- ➤ Severe Soft tissue injury
  - > swelling
  - blisters
  - > open wounds
  - > compartment syndrome
- ➤ Shock and multi-system trauma
  - ➤ "Damage Control"
- ≻Other
  - ➤ ? Most pilons
  - ➤ Knee dislocaton
  - > Severe elbow trauma



High velocity GSW to femur treated initially with ex fix, followed by delayed nailing Dar GN, Turkish journal of trauma 15(6): 553-60, 2009









# Damage Control

- Applied early during resuscitation
- Most studies involve femur fracture
- Risk-adapted approach
- What criteria?

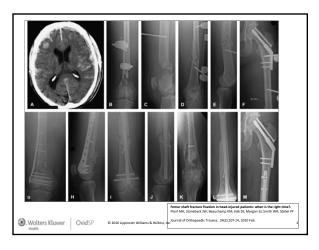
Reference	Suggested Dependent Variable	Recommended Threshold	
Trentz*4 (1978)	Systolic blood pressure	< 120 mm Hg	
	Heart rate	> 100 min <sup>-1</sup>	
	Central venous pressure	< 5 cmHLO	
	Cardiac index	< 3.0 l/min*m*	Evaluation of criteria for temporary external fixat
	Pulmonary arterial pressure	> 30 mm Hg	
	Pulmonary capillary pressure	> 24 mm Hg	risk-adapted damage control orthopedic surgery of
	PaO, (FiO, =0.21)	< 70 mm Ha	femur shaft fractures in multiple trauma patients:
	PaO <sub>4</sub> (FiO <sub>4</sub> =0.21)	< 300 mm Ho	"evidence-based medicine" versus "reality" in the
	SvO.	< 65%	trauma registry of the German Trauma Society.
	Planers	< 100,000/mm²	
	Fibringgen	< 100 mg/h	Rixen D; Grass G; Sauerland S; Lefering R; Raum MF
	Factor II	< 50%	Yucel N: Bouillon B: Neugebauer EA: Polytrauma Stu
	Factor V	< 50% < 50%	Group of the German Trauma Society
	Thrombin time	< 50% > 25 s	Group of the German Trauma Society
	Base excess	< - 6 mail	Journal of Trauma-Injury Infection & Critical Care.
	Ph	< 7.3	59(6):1375-94: discussion 1394-5, 2005 Dec.
Sturm <sup>30</sup> (1964)	Thorax trauma	Not reported	39(0):1373-94; Uncussion 1394-3, 2003 Dec.
Seibel <sup>15</sup> (1985)	Operation	Not done correctly	
	Oxygen transport	Not good	
	Blood clotting	Not good	
Burchardi <sup>39</sup> (1990)	Circulation	In shock	(A)
	Blood clotting	Severe dysfunction	<ul> <li>Wolters Kluwer Ovid</li> </ul>
v. Os <sup>45</sup> (1994)	Cardiovascular condition	Does not allow	
Reynolds <sup>68</sup> (1995)	Resuscitation	Prolonged	Health
		Poor with lingering base excess factate), hypothermia, coagulopathy	
	Lung	Significant intrapulmonary shunting	
	Additional injuries	Closed head injury with GCS <8	© 2005 Lippincott Williams & Wilkins, Inc.
		Chest injury is.g., pulmonary contusion)	
		Pelvic fracture	
		Prolonged CR period for repair of other injuries	
	Delay, inflammation	If OR cannot be done within 18 hours	
Fried*** (1996)	Injury Seventy Score	> 40	
Scales* (2000)	Physiciony	In shock Arretable	
	Thorax/abdomen injury	Requiring emergent treatment	
	Head injury	Significant	
Page <sup>27</sup> (2001)	Patient	In extremis	
, apr (0.00-)	7 800-1	Clinically unstable	
		In uncertain clinical condition (borderline patient)	
		Definition of borderline patient: # > 2 criteria are fulfilled:	
		Multiple trauma + ISS > 20 and thorax trauma (AIS > 2)	
		Multiple trauma with abdominal belivic trauma (Moore grade 3) and	
		hemorragic shock (mital systolic blood pressure < 90 mm Hg)	
		ISS:-40 in abscence of additional thoracic injury	
		Radiography (conventional or CT): bilateral lung contusion	
		Initial mean pulmonary arterial pressure > 24 mm Hg	
		Pulmonary arterial pressure increasing during intramedullary nalling	
		> 6 mm Hg	
		PaO <sub>y</sub> FiO <sub>2</sub> < 200 at admission	
		Platelet count < 95 (*1.000/µL)	
		Admission temperature = 32°C	
		IL-6 levels > 600 pg/ml	
Kutscha-Lissberg <sup>12</sup> (2001)	Circulation	Catecholamine treatment	
	Volume loss	Not corrected (verified by systemic arterial blood pressure, heart rate	
		and urinary volume (< 1 mL/kg body mass per hi)	
	Coagulation	Abnormalities (DIC, dilation coagulopathy, thrombocytopenia <	
		100,000 platelets per µ0	
Brundage <sup>53</sup> (2002)	Preoperative resuscitation	No normalization	
	Hemodynamics	No normalization	

### The Borderline Patient

- (ISS) >20 with additional thoracic trauma AIS >2.
- abd/pelvic trauma and haemorrhagic shock (initial systolic BP <90 mmHg).</li>
- ISS >40
- CXR or CT evidence of bilateral pulmonary contusion.
- Initial mean pulmonary arterial pressure >24 mmHg.
- Pulmonary artery pressure ↑ during IM nailing >6 mmHg.

# **Damage Control**

- ? Chest trauma: pulmonary contusion
- ?Moderate or Severe TBI: GCS 3-13
  - Flierl MA et al. JOT 24(2):107-114



# Ex fix in Damage control Controversial Inconclusive evidence

# EXTERNAL FIXATION – Orthopaedic Advantages

- Maintains length and alignment
- Partial reduction of fracture via ligamentotaxis
- Stabilizes soft tissues and allows wound access



### **EXTERNAL FIXATION**

Can be applied quickly

- Minimal blood loss
- ED application possible
- Flouro not necesary

**Preserves Fixation Options** 



### **EXTERNAL FIXATION**

- Femoral fractures stabilized 5-7 days
- Conversion to IM nail
- Minimal orthopaedic complications Scalea J Trauma 2000



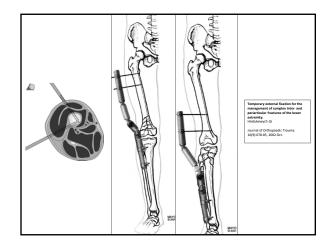


### **Principles**

- Place pins as far from injury as possible
- Consider incision locations for definitive fixation
- Restore length and alignment
- Minimize pin number don't cluster
  - Goal is not to maximize stability
- Place clamps away from necessary Xrays
- CT and planning films after ex fix

### Spanning the knee

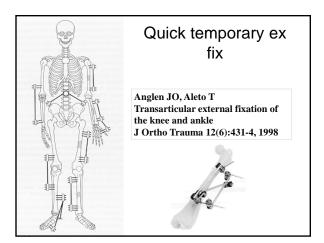
- Anterior pins allow sitting and wheelchair mobility
- Use drill guides and careful soft tissue technique through Quadriceps
- Gentle traction over a knee bump avoids hyperextension
- Make sure connection clamp is not over fracture site







# Temporizing External Fixation of the Lower Extremity: A Survey of the Orthopaedic Trauma Association Membership Cory Collinge, MD; Jason Kennedv. MD: Andrew Schmidt. MD Orthopaedics April 2010 - Volume 33 - Is OCT Survey Items With a High Rate of Agreement Among Orthopaedic Trauma Association Members Orthopaedic Trauma Association Members Survey Items With a High Rate of Agreement Among Acrage A CT scan of complex periarticular injuries should be obtained for preoperative planning A CT scan should be obtained after external closed reduction and fixator application Soft tissue protection should be used when drilling and applying pins 4.4 It is important to restore length with closed reduction 4.3 Femoral pins should be placed proximally for distal femur fractures and distally for proximal tibia fractures Tibia pins should be placed proximally for distal femur fractures and distally for proximal tibia fractures Avoid placing pin sites where they will later overlap plate placement 4.3 Adelsa frame configuration is preferred for tibial platond and anable fractures Abbreviations: CT, computed tomography.



## Spanning the ankle

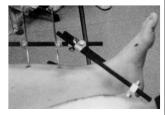
- Tibia calcaneus
- Articulated fixator with pins in talus/ calc
- Don't forget the forefoot!
  - Equinus in ankle, or in midfoot
  - Pins in metatarsals
  - Foot plate



"Transfixion" centrally threaded pin in the calcaneous

Two anterior-posterior tibial half pins

"A frame" or delta frame

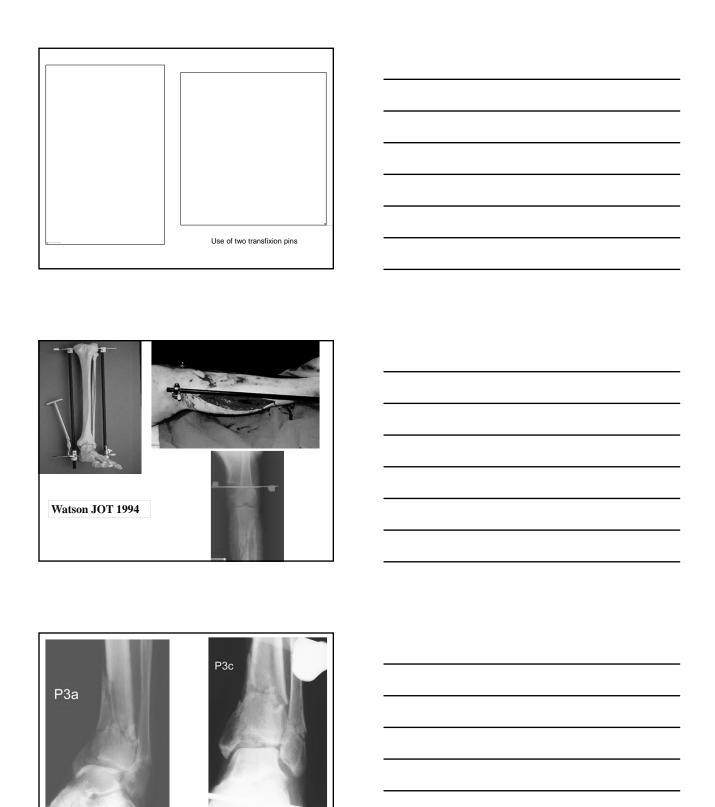




Elevation above the heart – Use of foot pumps

Pre-drill 3.5 mm
Use drill guides
Place centrally
threaded pin under
power





Reduction through ligamentotaxis

### Subsequent procedures

 Temporary fixators can be safely prepped into the field using Alcohol, Iodine prep scrub and lodine spray

Watson JT, Occhietti MJ, Moed BR, et al. Perioperative external fixator management during secondary surgical procedures. Presented at: 15th Annual Meeting of the Orthopedic Trauma Association; 1999; Charlotte, North Carolina.

Can External Fixators Be Sterilized for Surgery? (yes) A Prospective Cohort Study in Orthopaedic Trauma Patients David Hardeski, Greg Gaski, Richard Venezia, Jason Nascone, Marcus Sciadini, , Robert O'Toole Department of Orthopsedic Surgery, University of Maryland School of Medicine

OTA Poster 2012

### Conversion to internal fixation

• Overlap of plates with pin sites does not seem to increase risk of infection

Laible C, JOT 2012, 26:92-97

• Infection rate after conversion to IM nail, goes up if delayed >28 days

Bhandari M et al JOT 2005, 19:140-144

• If pin site infections, consider a "pin holiday" prior to nailing

### Compartment Syndrome

- Temporary ex fix for Medial tibial plateau fx dislocation may contribute to development of compartment syndrome
  - Monitor carefully
  - Leave foot out

Stark E et al. JOT 2009 23:502-506

• Transient elevation of pressures seen after application of ex fix and restoration of length

Egol KA et al. JOT 2008 22:680-685

 Protocol of early joint spanning ex fix and LMWH resulted in DVT rates similar to historical controls

Sems SA et al. J Trauma 2009 66(4):1164-9

# Thank You



I've had a wonderful evening.

Unfortunately, this wasn't it. Groucho