Principles of External Fixation

AOTrauma Course
Basic Principles of Fracture Management for ORP

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Overview

• Basic knowledge about external fixator
  • Principles
  • Indications
  • Advantages/disadvantages
• Mechanics
• Complications
• Case examples
External Fixation

• Is a method of bony fixation outside the skin
• Is another method of “Relative stability”
• Bone and Soft tissue are stabilized at a distance
Indirect Bone Healing

Principle of External Fixation

Extramedullary Splinting

Relative stability

Indirect Bone Healing Callus
Pins = Screws
Clamps = Locking head
Rod = Plate
Indications

- Fractures & soft tissue care
  - Open fractures
  - Peri-articular fractures
  - Pediatric fractures
  - Definite treatment
- Multi-trauma
  - Damage control
    - Pelvic ring injury
    - Long bone fracture temporization
- Deformity Correction
  - Malunion/nonunion
  - Arthrodesis
  - Limb length
- Infection
  - Osteomyelitis
Advantages

- Minimally invasive
- Flexibility (build to fit)
- Quick application
- Useful both as a temporizing or definitive stabilization device
- Reconstructive and salvage applications
Disadvantages

- Mechanical
  - Inadequate immobilization
  - Pin-bone interface failure
  - Deformity
  - Patient compliance
- Biologic
  - Infection (pin track)
  - Neurovascular injury
  - Soft tissue contracture
Components of the Ex-fix

- Pins
- Clamps
- Connecting rods/ring
Pins

- Diameter?
- Threaded?
  - Length
  - Design
  - Radial preload
  - Self drilling
- Stress riser
Pins

- Principle: The pin is the critical link between the bone and the frame
  - Pin diameter
    - 3-5mm
  - Pin thread design
    - Pre-drilled vs self-drilling
    - Straight vs conical
  - Material
    - Stainless Steel
    - Titanium

< 1/3 dia
Clamps

• Two general varieties:
  • Pin to bar clamps
  • Bar to bar clamps

• Principles
  • Must securely hold the frame to the pin
  • Clamps placed closer to bone increases the rigidity of the entire fixator
Connecting rods and/or Frames

- Principle: increased diameter = increased rigidity and strength
Frame types

- Uniplanar
- Biplanar
- Circular (Ring Fixator)
  - Half-pins vs. transfixion wires
- Hybrid
Ring Fixators

• Principles:
  • Excellent bending and torsion stiffness
  • Multiple tensioned thin wires (90-130 kg)
  • Place wires as close to 90° to each other
  • Use full rings (more difficult to deform)

• Can maintain purchase in metaphyseal bone
• Allows dynamic loading
• May allow joint motion
Hybrid fixators

• Combine the advantages of ring fixators in periarticular areas with that of half pin fixators in diaphyseal bone
Fixator Mechanics: Pin Factors

- Larger pin diameter
- Increased pin spread
  - on the same side of the fracture
- Increased number of pins (both in and out of plane of construct)
Fixator Mechanics: Rod Factors

- Frames placed in the same plane as the applied load
- Decreased distance from bars to bone
- Double-stacking of bars
Frame Mechanics: Biplanar Construct

- Linkage between frames in perpendicular planes (DELTA)
Fixator Mechanics: Optimal frame construction

- a) Pins are placed widely separated in each main fracture fragment.
- b) Pins are preloaded.
- c) Tubes are connected to the pins close to the bone.
- d) Two tubes are utilized. However for purpose of this spanning external fixator this is rarely needed.
Safe Zone for pin placements

- Avoid
  - Nerves
  - Vessels
  - Joint capsules

- Minimize
  - Muscle transfixion
Complications

- Pin-track infection/loosening
- Frame or Pin/Wire Failure
- Malunion
- Non-union
- Soft-tissue impalement
Pin-track infection

• Most common complication
• 0 – 14.2% incidence
• 4 stages:
  • Stage I: Seropurulent Drainage
  • Stage II: Superficial Cellulitis
  • Stage III: Deep Infection
  • Stage IV: Osteomyelitis
Pin-track infection

- Proper pin/wire insertion technique:
  - Subcutaneous bone borders
  - Away from zone of injury
  - Adequate skin incision
  - Prevent soft tissue injury during insertion use “sleeve!”
  - Sharp drill bits and irrigation to prevent thermal necrosis
  - Manual pin insertion
CASE EXAMPLES
Case 25 year-old male, MCA
Debridement & external fixation
Female 83 years, Hit by car fracture pelvis with shock
As a tool for Indirect reduction
Indirect reduction
Summary

- External fixation provides relative stability with little damage to soft tissues or disturbance to blood supply to bone
- Simple, easy, and minimally invasive stabilization
- Understanding instruments, mechanics and frame construct is important
- Clinical applications
  - Damage control
  - Care for soft tissue injury, open fractures
  - Infections
  - Deformity correction, bone lengthening

When all else fails think of external fixator!!!