How to Describe an Injury

While this may sound obvious, it is very important to be able to communicate as precise a description of the injury as possible.

Soft Tissue

The soft tissue envelope is extraordinarily important. Description of the extent of the wound is vital to plan management. We generally use a classification system described by Gustilo and Anderson (JBJS 58A: 453-458, 1976.)

Grade I - Low energy wound less than 1 cm. Often an "Inside to Outside" injury.

Grade II - Moderate energy wound greater than 1 cm and less than 10 cm.

Grade III - High energy or highly contaminated wound, larger than Grade II.
BEWARE: Crushing, significant abrasions,or burns increase the grade/ even if the opening is small.

IIIA - Limited periosteal stripping, adequate tissue for coverage
IIIB - Extensive periosteal and soft tissue stripping (degloving) without adequate tissue for coverage
IIIC - Associated neurovascular injury

Fractures

An easy seven point method of description will give nearly all the information required to make treatment decisions

1) Which bone is fractured?
2) Where in the bone is the fracture?
   Proximal or distal
   Metaphysis or diaphysis
3) What is the fracture pattern? transverse, oblique, comminuted
4) What is the degree of comminution, angulation or displacement?
5) How bad is the overlying soft tissue injury?
6) Is it an OPEN or CLOSED fracture?
7) Is there an associated neurological or vascular injury or compartment syndrome?

An Example: "The injury is a Grade II open, comminuted fracture of the left femoral

shaft; he is neurovascularly intact distally, and the compartments are soft."

Joint Aspiration

Occasionally you will be called upon to aspirate a joint. This procedure is used to rule out septic arthritis, gout, or to determine whether a traumatic arthrotomy has occurred. **IT IS VITAL THAT ANY JOINT ASPIRATION BE PERFORMED UNDER THE STRICTEST OF ASEPTIC TECHNIQUE.** A wheal of 1% lidocaine at the site of aspiration makes this procedure much less painful.

The fluid should be sent for CULTURE, GRAM STAIN, CELL COUNT & CRYSTALS. Fluid exam specimen goes in a PURPLE TOP TUBE.

ANKLE

LANDMARKS: 1-1.5 cm above the lines joining the tips of the malleoli.

After routine sterile prep, using sterile technique, palpate the medial and lateral maleolli. Palpate the dosalis pedis pulse, and choose an injection site into the anterior ankle away from the artery. Enter the joint parallel to the articular surface.

ELBOW

LANDMARKS: The triangle formed by the lateral epicondyle, the radial head and the tip of the olecranon with the elbow flexed 90 degrees.

Prep and drape the elbow in a sterile manner. Insert the needle at the point where a vertical line from the lateral epicondyle bisects the line formed from the radial head and olecranon.

KNEE

LANDMARKS: The lateral edge of the patella, and the patellofemoral joint.

The patient should be supine. Prep and drape the knee in a sterile manner. With the non-dominant gloved hand, translate the patella laterally and palpate the patellofemoral joint with that thumb. In a horizontal direction pass the needle posterior to the patella, parallel to the articular surface. If resistance is met, redirect slightly posteriorly. A medial approach is satisfactory. If there is excess fluid, insert the needle just above the patella into the suprapatellar bursa.

HIP

This is the most complex joint to aspirate. You need FLUOROSCOPY, an 18 gauge spinal needle, a three-way stopcock, an empty 20cc syringe, and a 12cc syringe with dilute omnipaque contrast for your arthrogram. Assemble your setup as follows:

Spinal needle on stopcock on 20cc syringe. Attach 12cc syringe with contrast to side port of stopcock and start with flow to larger syringe.

Locate the hip joint on spot fluoro scans, estimating the general direction to the hip joint. Because most of the femoral neck is intraarticular, it is usually easier to aim to the base of the femoral head rather than the joint line itself. A POST-PROCEDURE ARTHROGRAM (HARDCOPY) IS VITAL TO DOCUMENT INTRAARTICULAR ASPIRATION OF FLUID.

Anterior Approach

LANDMARKS: 2 cm below ASIS and 3 cm lateral to femoral pulse.

With the hip externally rotated and abducted slightly, prep and drape in a sterile manner. Locate the femoral pulse and insert the needle directed 60 degrees posteriorly and medially toward the base of the femoral head. Walk the needle up the neck, aspirating as you view on fluoro. Once fluid is obtained, inject a SMALL amount of contrast as a confirmatory arthrogram.

Medial Approach

LANDMARKS: Posterior to the adductor group of the medial proximal thigh.

With the hip externally rotated, flexed, and abducted slightly, prep and drape in a sterile manner. Using fluoro, palpate the femoral pulse, and direct the needle toward the ipsilateral shoulder starting posterior to the adductor mass. Once fluid is obtained, perform an arthrogram as described above.

Analgesia & Sedation

You will be called on numerous times to perform procedures in the ER which would be painful to the patient if not properly anesthetized or sedated. Below are guidelines for using a variety of agents and techniques. BE VERY CAREFUL TO DOCUMENT ANY PRIOR ALLERGIC REACTIONS AND THE SPECIFIC MODALITY USED.

Analgesia

Used in such circumstances as closed reduction of dislocations where pain relief and muscle relaxation is needed.

NARCOTICS ARE REVERSED WITH NARCAN - 10ug/kg IV

1) Fentanyl - 2-10 mcg/kg IV, titrate to effect q5 min
    - Short half life
    - Effect noted when patient rubs nose
2) Morphine/Demerol + Versed IV - titrate to effect
3) Ketamine - 0.5-2 mg/kg IV, 4 mg/kg IM, 10 mg/kg PO
    - May cause increased ICP, heart rate & secretions

Sedation

To quiet patients for studies or minor procedures where local/regional anesthesia will be used. These are generally NOT analgesics.

VERSED IS REVERSED WITH FLUMAZENIL - 0.2 mg IV

Children

1) Chloral Hydrate - 75mg/kg PR or PO
2) "DPT" - **D**emerol 2mg/kg
   Phenergan 1mg/kg IM
   Thorazine 1mg/kg
3) Versed - 0.7-1.0 mg/kg PO

Adults

1) Versed - 0.1-0.2 mg/kg IV

REGIONAL ANESTHESIA

Used for pain free outpatient procedures. May be combined with sedation if desired. Patience (i.e. TIME) is needed to allow the block to work.

Digital Block

Ideal for finger/toe lacerations, nailbed injuries, reduction of phalangeal fractures or dislocations, or testing of ligamentous stability of the digits.

What you will need ...
- 22 gauge needle
- 5-10cc 1% Lidocaine WITHOUT epinephrine

Procedure
1) Clean area to be blocked with betadine
2) Inject 2-3 cc at the radial and ulnar base of proximal phalanx between the metacarpal\metatarsal heads from a dorsal approach. Always aspirate to assure extra-vascular location.

Hematoma Block

Useful for simple closed reduction of distal forearm or phalanx fractures.

What you will need ...
- 22 gauge needle
- 5-10cc 1% Lidocaine WITHOUT epinephrine

Procedure
1) Clean area to be injected with betadine
2) Palpate the fracture site, and SLOWLY inject into the fracture hematoma from the dorsal or volar side. BEWARE the median nerve.

Wrist Block

Useful for more involved hand and finger injuries. Nice for pain relief when waiting to go to the O.R. for formal debridement/reconstruction.

What you will need ...
- 22 gauge needle (1.5" or longer)
- 5-10 cc 1% Lidocaine WITHOUT epinephrine

Procedure
1) Prep the volar and dorsal wrist with betadine
2) Block the **Median nerve**:
    - At the distal wrist crease, direct the needle distally, entering just ulnar to the palmaris longus (In line with the radial border of the ring finger) Inject 2-5cc.
3) Block the **Ulnar nerve**:
    - Palpate the ECU tendon and the ulnar pulse. Direct the needle distally from the proximal wrist crease and inject 1-3 cc.
4) Block the **superficial Radial nerve**:
    - Subcutaneously, directed radial to ulnar in the dorsum of the wrist, inject 2-5 cc, creating a "bracelet" of infiltration.

Ankle Block

Very useful for injuries and procedures to the foot. Complex, however since you must block 5 nerves.

What you will need ...
- 22 gauge needle (1.5" or longer)
- 10-30 cc 1% Lidocaine WITHOUT epinephrine

Procedure
1) Prep the entire foot and ankle with betadine
2) Block the **Posterior Tibial nerve**:
    - Palpate the posterior tibial pulse and direct the needle just posterior. Inject 5-10 cc.
3) Block the **Superficial Peroneal nerve**:

0) Direct the needle subcutaneously starting 2 fingerbredths superior to the tip of thelateral malleolus, across the anterior fibula & tibia. Inject 3-5 cc.

4) Block the **Deep Peroneal nerve**:
    - Palpate the tibialis anterior and extensor hallucis longus tendons, and direct the needle perpendicular to the bone between the tendons. Inject 5-7 cc.

5) Block the **Sural nerve**:
    - Direct the needle subcutaneously, starting 1 cm posterior to the peroneal tendons at the lateral malleolus, and inject 3-5 cc.
6) Block the **Saphenous nerve**:
    - Direct the needle subcutaneously, 1 fingerbreadth superior to the tip of the medial malleolus, injecting 3-5 cc anterior to the tibia.

Axillary Block

Useful for extended procedures or complex reductions in the arm below the elbow. This is a rather complex procedure with moderate risk. Perform only if you are comfortable with the procedure, and have sufficient monitoring available.

What you will need ..
- 35cc syringe
- 23 gauge butterfly
- 1-2% Lidocaine WITHOUT epinephrine (0.5cc/kg)

Procedure
1) Position the patient supine with the shoulder fully externally rotated and abducted to 90 degrees
2) Thoroughly clean the axilla with betadine
3) Palpate the axillary artery pulse and direct the butterfly needle TRANS-ARTERIALLY until you detect a flash of arterial blood
4) Direct the needle through the artery until you just lose the flash
5) Slowly inject the appropriate amount of anesthetic, checking occasionally assuringextravascular infiltration
6) Withdraw needle and hold pressure for 5 minutes, and let set up for 15 minutes

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YOU MUST ASSURE EXTRA-VASCULAR INFILTRATION
Intravascular injection of lidocaine may precipitate seizures, arrhythmias, or
DEATH

IV Regional Block (Bier Block)

Very useful type of anesthesia for extensive outpatient procedures or reductions.
It does require care and several pieces of equipment

What you will need ...
- EKG & SaO_2 monitors
- Peripheral IV (at least 18 gauge)
- 20 gauge Heparin lock
- Dual cuff tourniquet
- 1/2% Lidocaine w/o epinephrine - 3mg/kg

Procedure
1) Test both tourniquet cuffs to 300mm Hg
2) Place heparin lock distally in affected side
3) Exsanguinate arm with elevation or esmarch
4) Inflate DISTAL cuff, the PROXIMAL cuff to 100mm Hg above systolic
5) Deflate DISTAL cuff
6) Inject lidocaine into heplock - note mottled appearance of skin
7) Complete the reduction/procedure
8) If the patient experiences pain at the tourniquet (usually about 30 minutes), inflate the DISTAL cuff, then deflate the PROXIMAL cuff. ALWAYS INFLATE ONE OF THE CUFFS PRIOR TO DEFLATING THE OTHER.
9) At the completion, deflate the tourniquet by releasing the pressure for 2 seconds, then reinflating for 20 seconds. Repeat this cycle for 5 minutes to assure that there is not a bolus of lidocaine released into the system.

The toxic dose of Lidocaine is 7 mg/kg
The toxic dose of Marcaine is unknown

Commonly Used Medications

Antibiotics

	Adult Dose	Pediatric Dose
Ampicillin	50-100 mg/kg/day q6 IV/IM	75-200 mg/kg/day q6 IV/IM
Ancef	1.5-12 g/day q8 IV	50-100 mg/kg/day q8 IV
Augmentin	250-500 mg q8 PO	..
Cefotan	0.5-4 g/day q12 IV	..
Cefotaxime	2-12 g q8 IV	100-200 mg/kg/day q8 IV
Ciprofloxacin	250-750 mg q12 PO	..
Clindamycin	300-600 mg q6 IV	15-40 mg/kg/day q8 IV/IM
Gentamycin	1.5-2 mg/kg IV Loading Dose, 80% q12 IV OR 4 mg/kg/day IV	
Keflex	1-4 g/day q8 PO	25-50 mg/kg/day q8 PO
Nafcillin	4-18 g/day q6 IV	50-200 mg/kg/day q6 IV
Oxacillin	4-12 g/day q6 IV	50-200 mg/kg/day q6 IV
Vancomycin	1 g q12 IV	10-40 mg/kg/day q6 IV

Anti-Emetics

Compazine	5-10 mg q6-8 PO/PR	0.4 mg/kg/day q6-8 PO
Phenergan	12.5-50 mg q6-q12 PO/PR/IM	0.25-0.5 mg/kg q4-6 PR/IM
Reglan	1-2 mg/kg q4-6 IV	1-2 mg/kg q4-6 IV
Tigan	200 mg q4-6 PR	..

H_2 Blockers

Pepcid	20 mg q12 PO/IV	..
Tagamet	300 mg q6-8 PO/IV	20-40 mg/kg/day q6 PO/IV
Zantac	50 mg q8 IV	1-2 mg/kg/day q8 IV

Muscle Relaxants

Baclofen	5-25 mg q8 PO	..
Flexeril	10 mg q8 PO	..
Robaxin	750 mg q8 PO	..
Valium	2-10 mg q6-8 PO/IM	0.12-0.8 mg/kg/day q6-8 PO/IM

Narcotics

Codeine	15-60 mg q6 PO/IM	0.5-1 mg/kg q4-6 PO/IM
Demerol	50-100 mg q3-4 PO/IV/IM	1-1.5 mg/kg q3-4 PO/IM
Dilaudid	2-4 mg q4-6 PO/IV/IM	..
Fentanyl	2-50 mcg/kg IV	2-10 mcg/kg IV
Ketamine	0.5-2 mg/kg IV or 4 mg/kg IM or 10 mg/kg PO	
Morphine	4-15 mg q2-4 IV/IM	0.1-0.2 mg/kg q2-4 IV/IM
Stadol	1-2 mg q3-4 IV/IM	..

NSAIDS

	Adult Dose	Pediatric Dose
Clinoril	15 mg q12 PO	..
Daypro	1200 mg qDay PO	..
Dolobid	150-500 mg q8 PO	..
Feldene	10-20 mg qDay PO	..
Ibuprofen	1200-3200 mg/day q8 PO	30-70 mg/kg/day q8 PO
Indocin	25-75 mg q8-12 PO	..
Lodine	200-300 mg q12 PO	..
Naprosyn	250-500 mg q8-12 PO	..
Oruvail	200 mg qDay PO	..
Relafen	500 mg q8-12 PO	..
Tolectin	200-600 mg q8 PO	..
Voltaren	100-200 mg q8-12 PO	..
Celebrex	100 bid or 200mg qd	none
Vioxx	12.5 or 25 qd	none

Sedation

Ativan	2-3 mg q8-12 PO/IV/IM	..
Chloral Hydrate	5-15 mg/kg q8 PO/PR	5-15 mg/kg q8 PO/PR
Haldol	0.5-2 mg q8-12 PO/IM	..
Librium	25-100 mg q6-8 IV/IM	0.5 mg/kg/day q6-8 PO/IM
Valium	2-10 mg q6-8 PO/IV/IM	0.02-0.04 mg/kg/day q2-4IV/IM
Versed	0.1-0.2 mg/kg q6-8 IV	0.1-0.2 mg/kg q6-8 IV

Miscellaneous

Carafate	1 g qAC + qHS PO	..
Folate	0.10 mg qDay PO	0.04-0.4 mg qDay PO
Flumazenil	0.2 mg IV	0.2 mg IV
Narcan	0.4-2 mg IV	0.01-0.1 mg/kg IV
Thiamine	100 mg qDay IV	..
Tylenol	650-1000 mg q4-6 PO/PR	10 mg/kg q4-6 PO/PR
Vitamin K	10-50 mg qDay IV	5-10 mg qDay IV

X-Ray Pearls

The majority of your diagnoses will come from a good history and physical, along with appropriate x-rays. In the ER you can obtain plain films, CT scans, ultrasound, arteriography, and MRI if needed. MAKE SURE YOU HAVE ADEQUATE X-RAYS OF THE AFFECTED AREAS.

ALL TRAUMA PATIENTS MUST HAVE A CXR, AP PELVIS & LAT C-SPINE XRAY

✞ With multi-trauma patients, ask the techs to shoot portable films of obvious extremity fractures while they shoot the mandatory pelvis and chest views. This will save lots of grief should there be a delay in obtaining all plain films

✞ With comminuted femur & tibia fractures obtain a SCAN-O-GRAM view of the opposite unfractured bone for length measurements for pre-op planning

✞ With displaced femoral neck fractures, obtain a TEMPLATED AP pelvis and lateral of the affected side for possible endoprosthesis planning (especially in those patients over 60 years old)

✞ With acetabular fractures obtain JUDET views (aka 45 degree obliques/iliac & obturator obliques) to assess the three dimensional character of the fracture

✞ With pelvic ring fractures, obtain INLET & OUTLET views - the inlet allows assessment of lateral instability/deformity, and the outlet allows assessment of vertical instability/deformity

✞ With pelvic ring fractures, look hard if only one fracture is obvious - it is rare to have only a single fracture in the ring (NB: Look at the SACRUM)

✞ With acetabular fractures, traumatic hip dislocations or pelvic fractures obtain a CT SCAN with 3 mm CUTS to ascertain reduction, determine if fragments of bone are trapped between the joint surfaces, and to clarify the fracture pattern

✞ Always visualize the joint above and below a fracture

✞ NEVER obtain cervical flexion/extension views acutely

✞ In children, obtain views of the opposite side for comparison if there is a question (Especially with fractures/dislocations about the elbow)

✞ When evaluating fractures and/or dislocations about the shoulder, obtain a "Y" or axillary view to assess sagittal displacement (anterior to posterior)

✞ Always obtain another set of x-rays after reduction

✞ You MUST see the C7-T1 level before calling the views adequate - obtain a SWIMMER'S VIEW, or if that is inadequate a CT scan

✞ With EVERY spine fracture, obtain a CT scan from the level above to the level below the fracture to assess neural canal compromise, and associated pathology

✞ Lower extremity or pelvis fractures are often associated with spinal trauma, especially in high speed/energy accidents, or falls

✞ With femur fractures, look carefully for a femoral neck fracture

✞ If a patient goes to the OR, collect all of the films in a labeled jacket, bring to the OR, and leave a note for the radiologist that the films went to the OR. MAKE SURE THE XRAY JACKET IS RETURNED TO THE FILE ROOM WHEN DONE.

✞ Use all of your resources wisely - the trauma resident, the radiology resident, and the ER attending may miss or pick up things that are important

Spine Trauma

There are a large number of spinal injuries seen here. Always be suspicious, particularly of latent injuries in patients with frontal head trauma or loss of consciousness. A protocol for the care of spinal injuries has been developed here.

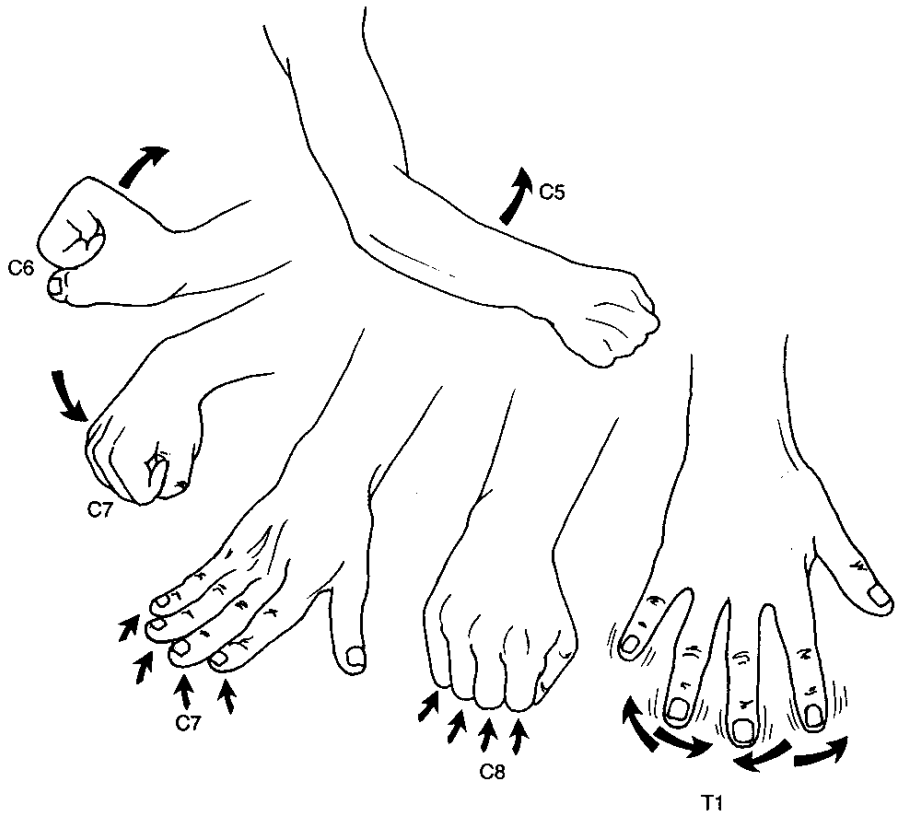
With EVERY spine injury

- Document a complete neuro exam including:
- Fill out the SPINE INJURY FORM

1) MOTOR STRENGTH	5/5 normal
	4/5 slightly diminished
	3/5 anti-gravity only
	2/5 unable against gravity
	1/5 muscle twitch
	0/5 absent motor
2) SENSORY	
3) REFLEXES	3+ hyperreflexic
	2+ normal
	1+ diminished
	0+ absent
4) RECTAL TONE	
5) BULBOCAVERNOSUS REFLEX	
6) LONG TRACT SIGNS	Hyperreflexia/Babinski/Clonus

PEARLS

- ✞ ALWAYS DATE AND TIME YOUR NEURO EXAM
- ✞ Obtain a CT scan "one level above to one level below" any fracture
- ✞ ALWAYS BE THINKING OF FRACTURES AT OTHER LEVELS
- ✞ If the patient is to be left in a C-collar, change them to a Philly collar - the trauma extrication collars can cause necrosis of the scalp if left on for long periods of time
- ✞ Don't hesitate to call your upper-level resident to help with a diagnosis or when putting on a halo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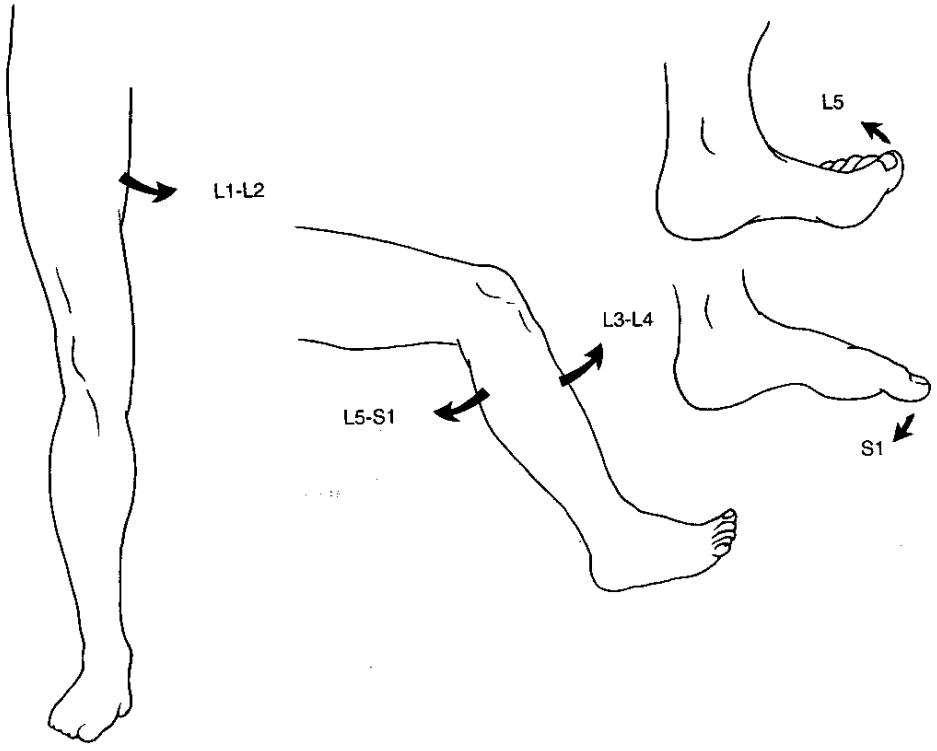
L1-L2
L5
L3-L4
L5-S1
S1

The Halo

The Halo-Vest is the most common method we use for immobilization of the cervical spine. It allows fairly rigid fixation, particularly in the upper cervical spine. Its application is complex and often requires two or more people. You should always contact your backup before application of the halo for assistance and/or indication for application. Ultimately it is up to the attending whether a halo is required.

Some indications for application may include:

- "Hangman's fractures" (Fractures of the posterior elements of C2)
- Unilateral/bilateral facet dislocations with or without fracture
- Unstable (2 or 3 column) burst fractures
- Types 2 or 3 odontoid fractures

The method of application of the halo ring is rigorous and fairly complex. The details are too lengthy for this manual, but the following guidelines should help your learning curve:

♈ Measure for the appropriate size ring and vest as per manufacturer guidelines

♈ The patient should be supine, <u>in a C-collar</u>. A 2-3 inch bump of towels behind the occiput will greatly assist in getting the ring back far enough. (Or you can use the aluminum "spoon" available in the ER to rest the patients head off the head of the table.)

♓ The ring should be positioned just above the level of the eyebrows, and approximately 1cm superior to the ears. Clearance to the skull should be even all the way around.

♈ During placement, have the patient close their eyes firmly, but not tightly. This avoids trapping the frontalis muscle, making it difficult to close one's eyes.

♈ The anterior pins should be at the "corner of the skull". This means, avoid lateral placement in the temporal bone, or anterior placement which could damage the superior orbital nerve.

♈ The posterior pins should rest just inferior to the equator of the skull, aiming slightly anterior, avoiding the mastoid area. (Usually the last or second to last hole in the ring is appropriate.)

♈ Tighten opposing screw pairs together, watching for any shift in ring clearance with the skull. Usually switching back and forth between pairs is easiest.

♓ TIGHTEN TO 8-10 ft. lbs.

♈ You can usually place the vest either by log-rolling the patient, or by sitting him/her

up. You should have assistance for this procedure.

♈ When secured, the patient should feel like he/she is looking straight ahead, the shoulders of the vest should NOT be riding up (Make sure they clear they clear the earlobes), and the vest should be snug but not constrictive. Only then can you remove the C-collar safely.

♓ Always obtain a post-placement lateral C-spine x-ray to document position.

Halo Traction

Commonly used to aid in reduction of cervical dislocations. Apply the halo ring as described above. Attach the halo-ring blocks on each side, and attach the halo traction bail to the posterior most bolt you used for the block attachment. For halo traction you will need a traction cart with a simple single pulley set-up at the head of the bed. Make sure you can adjust the pulley to allow traction to be applied from an angle. It is usually very helpful to add a snap-swivel to the rope to allow easy connect/disconnect of the weight from the traction bail assembly.

Guidelines for halo traction:

♓ Allow 10 lbs for the head and a MAXIMUM of 5 lbs for each level above the affected level. (i.e. A C5/6 bilateral jumped facet should be treated with a maximum of 10 lbs + 5 lbs x 5 levels = 35 lbs)

♈ Always start with a small amount of weight, adding slowly, and checking a portable lateral C-spine film before adding more weight. Allow about 20-30 minutes between each weight change.

♓ Always document a neuro exam when adding weight, or changing position.

♈ Many times, an angle of about 30 degrees of pull (slight flexion) may help in the reduction of the injury.

♈ THE ATTENDING WILL TELL YOU THE MAXIMUM AMOUNT OF WEIGHT THAT SHOULD BE USED, AND ANY OTHER MANEUVERS ETC.

DON T BE A PIONEER

Orthopaedic Emergencies

There are few true orthopaedic emergencies, but those few must be addressed as quickly as possible to avoid serious sequelae.

Pelvic Fractures complicated by Impending Exsanguination

- **EVALUATE IMMEDIATELY**

1) Input & Output
2) VSS over time
3) Gently check pelvic stability
4) START CALLING BACK-UP & ATTENDING

Compartment Syndromes

- ✞ History & Clinical Exam
- ✞ Measure and record compartment pressures

Dislocations of Major Joints

- ✞ Assess neurovascular status
- ✞ GENTLY reduce dislocation & immobilize
- ✞ Recheck neurovascular status
- ✞ Consider an arteriogram with a knee dislocation

Septic Joints

- ✞ In depth history & clinical exam
  - * Recent febrile illness
  - * Recent antibiotics
  - * Chronology of presentation
  - * Medical problems such as sickle cell, prior osteomyelitis, arthritis etc.
- ✞ Clinical Exam & Labs
  - * WBC, ESR
  - * Joint mobility, bony tenderness, erythema, swelling
- ✞ Joint Aspiration
  - * Culture, Gram Stain, Cell Count, Crystals

Spine Injuries Associated With Neurological Progression

- ✞ Always document the exam (Date & Time!!)

Open Fractures

- ✞ Record extent of soft-tissue injury
- ✞ Record time of injury and delay until treatment
- ✞ Record any antibiotics given and when. Consider antibiotic coverage
- ✞ Note any contamination present and type (i.e. barnyard, marine, lake/river)

Compartment Syndromes

The clinical entity of increased pressure within a myofascial compartment leading to ischemia, and possible necrosis of the elements within the compartment. THIS IS A SURGICAL EMERGENCY which will usually require release of the compartments by fasciotomy.

Have a high suspicion with:

- Blunt trauma, with or without fractures, particularly "bumper" injuries to the tibia
- Circumfrential burns
- Injection/infiltration injuries
- Revascularization after arterial reanastomosis
- An unconscious patient with a compressed limb

Diagnosis: Clinical observation (The five "P's"):

- Pain with passive stretch of the muscle groups contained within that compartment
- Pain out of proportion of the injury
- Pallor/Poor capillary refill
- Paresthesias/Paralysis, particularly in the distribution of the nerves within the compartment
- Pulselessness distally

And courtesy of an old trauma fellow, Jim Pape, the Iowa pig farmer:

- Porkiness - swelling of the compartment

Objective findings:

- Increased compartmental pressures as measured by a pressure monitor

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diastolic pressure minus compartment pressure **< 30mm hg - Fasciotomy**

PEARLS

- ✞ Pain with passive stretch is the most reliable clinical finding
- ✞ The highest pressure will be found at the level of the fracture (and DEEP)
- ✞ An open fracture DOES NOT mean that the compartment has been released
- ✞ Pulselessness is a poor indicator - a compartment syndrome can exist with a strong distal pulse
- ✞ Paresthesias may be first and only finding

Using the Stryker Pressure Monitor

Where to find it ...

- The supply room in the ER
- Surgical services on 10N

How to use it ...

Assembly

Obtain the transducer kits from the charge nurse in the ER
or the Unicell in Trauma Unit

1) Screw plunger into vial
2) Screw vial into transducer module
3) Attach needle to other end of transducer
4) Snap transducer into monitor
5) Purge air bubbles from vial/transducer/needle

Zeroing the monitor

1) Turn the switch to ON and make sure readout works
2) With the needle at the point of skin insertion, press the zero button once - you should see '00 on the readout. If you don't after several tries you must subtract the readout value from the ultimate reading.

Measuring the pressure

1) Prepare the skin with Betadine prep
2) Zero the monitor
3) Insert the needle into the desired compartment and inject 0.1cc saline
4) Wait for pressure reading to stabilize and record
5) Repeat in the same compartment at different locations

PEARLS

✞ Make sure the connections are tight

✞ ALWAYS RETURN THE MONITOR TO THE PLACE FROM WHERE YOU OBTAINED IT!!!

Creating Your Own Pressure Monitor

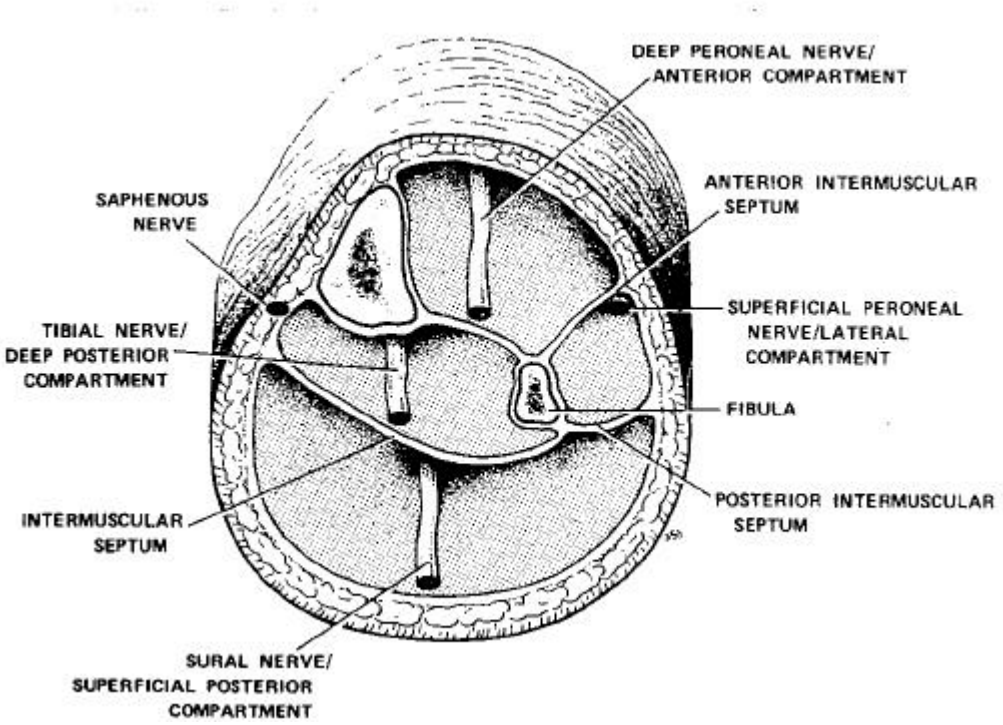
Should you find yourself in a position where the Stryker monitor is unavailable (the VA etc.) a simple monitor can be rigged up with few items.

What you will need ...

- A bedside monitor capable of using an arterial line transducer
- An arterial line transducer and setup
- A three-way stopcock
- A 12cc syringe with sterile saline
- A 20 gauge needle

What to do ...

1) Set up the arterial line transducer and tubing as is normally done
2) Attach the stopcock to the tubing, and attach the needle and syringe to the stopcock
3) Flush the system with saline from the pressure bag
4) Zero the monitor
5) Insert the needle into the desired compartment. Using the stopcock inject 0.1cc saline from the syringe then change the stopcock to the monitor
6) Record the reading



Compartments & their Muscles & Nerves

Forearm

Flexor Compartment:

* FCR, FCU, FDS, FDP, FPL, PL
* ✞Median, Radial, Ulnar nerves

Extensor Compartment:

* ECU, EDC, EPL, EIP

Mobile Wad:

* ECRB, ECRL, BR
* ✞Superficial Radial nerve

Upper Arm

Anterior Compartment:

* Biceps

Lateral Compartment:

* Brachialis, BR

Posterior Compartment:

* Triceps
* ✞ Radial nerve

Thigh

Anterior Compartment:

* VL, VMO, VI

Medial Compartment:

* Adductors

Posterior Compartment:

* ST, SM, Gracilis

Leg

Anterior Compartment:

* TA
* ✞ Ant. Tibial nerve

Lateral Compartment:

* Peroneals
* ✞ Superficial peroneal nerve

Deep Posterior Compartment:

* PT, FHL
* ✞ Post. Tibial nerve, Common peroneal nerve

Superficial Posterior Compartment:

* Gastrocnemius, Soleus
* ✞ Sural nerve

Traction

We rarely use traction for long term care of fractures. Traction is mainly used for short-term immobilization while the patient awaits surgery, to restore or maintain length prior to surgery, or to allow control of the limb.

A myriad of set-ups are available. Below are some of the basic ones we have found effective. All can be set up by one person using material available on a traction cart.

Basic setups you should be familiar with:

- **Buck's traction**
- **Distal femoral pin traction**
- **Proximal tibial pin traction**
- **Calcaneal pin traction**
- **Balanced skeletal traction**
- **Bryant's traction**
- **90/90 Femoral traction**
- **Halo Traction (See section on spine trauma)**

Pin Care

In general, traction pins should be cared for just like external fixator pins. Keeping the pin sites clean will avoid the occasionally tragic pin tract infection. Pin sites should be cleansed with antibacterial soap and water bid and dressed with sterile gauze. Make sure you order daily pin site care.

PEARLS

- ✞ Order a traction and Steinman pin cart to the bedside as soon as you know you will need traction - it takes forever to get them
- ✞ Use the largest SMOOTH Steinman pin unless traction is planned for more than 1-2 days - then use a THREADED pin
- ✞ ALWAYS use a small SMOOTH pin in children
- ✞ DO NOT PUT CHILDREN IN PROXIMAL TIBIAL PIN TRACTION
- ✞ The periosteum hurts, a lot - make sure it is numb
- ✞ Always obtain an x-ray of the pin location prior to starting traction
- ✞ Beware the distal femoral physis in children
- ✞ Don't be offended if someone changes your setup
- ✞ Traction needs adjustment FREQUENTLY

(The following excerpts have been borrowed from "The Orthopaedic Traction Manual"; Brooker,AF & Schmeisser,G., Williams & Wilkins; Baltimore, 1980.)

Distal Femoral Traction

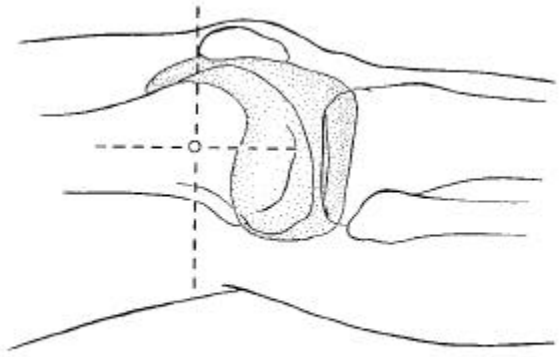
Indications. This traction system involves application of skeletal traction to the distal femur with alignment of the traction force in the longitudinal axis of the lower limb with the hip and knee minimally flexed. If forces of 10 lbs or less are desired with the limb in the same position, Buck's extension is preferable. If forces between 10 and 15 lbs are desired and if knee joint pathology is absent, proximal tibial skeletal traction in extension is preferable. Distal femoral traction in extension is the best choice when strong traction is desired. Examples are fractures of the pelvis or acetabulum with cephalad displacement which might be pulled into place by strong longitudinal traction on the lower limb. As mentioned previously, lateral femoral traction on an eyelet screw in the greater trochanter is more appropriate for medial or central acetabular fracture dislocation. Distal femoral skeletal traction in extension is useful following resection of the femoral head or removal of an endoprosthesis. Finally, it is a useful alternative to tibial skeletal traction for a femoral shaft fracture when co-existing knee pathology, ligament injury, or fracture of the proximal tibial metaphysis precludes tibial skeletal traction.

Application. The traction wire or pin must be inserted with particular care in view of the extent of the suprapatellar pouch anteriorly and proximally, the neurovascular structures behind the distal femur, and, in children, the presence of the distal femoral epiphyseal plate. In general, the pin should pass along or slightly posterior to the midcoronal plane of the femoral shaft (Fig. 36). It should also pass just proximal to the adductor tubercle in order to avoid engagement of the collateral ligaments. When swelling has obscured the landmark, it is helpful to remember that it lies almost at the level of the proximal pole of the patella in the relaxed and extended knee. During actual insertion of the wire, the knee should preferably be flexed in order to draw the periarticular soft tissues into the position they will occupy while the limb is in traction, thereby reducing pressure necrosis of the skin around the wire.

A Kirschner wire should be used only if it is of the largest size, i.e. 0.62 inch thick, not threaded or nicked, and securely fastened to a Kirschner wire tractor bow which is tightened forcefully. To prevent unintentional disengagement of the wire from the tractor bow, the two wire grippers or the ends of the bow arms should be firmly closed and the ends of the wire bent to lie along the outside of the bow arms thereby locking the grippers. In this position, the wires should be taped to the bow so that their sharp tips are not exposed and the grippers cannot be inadvertently released.

If a Steinmann pin is used in an adult, it should be at least 1/8 inch thick. Although a smaller sized pin may not break, bending becomes a problem. A Steinmann pin bow should be used with a Steinmann pin rather than a Kirschner wire bow. The tips of the Steinmann pin should be clipped close to the bow and capped. Kirschner wires are

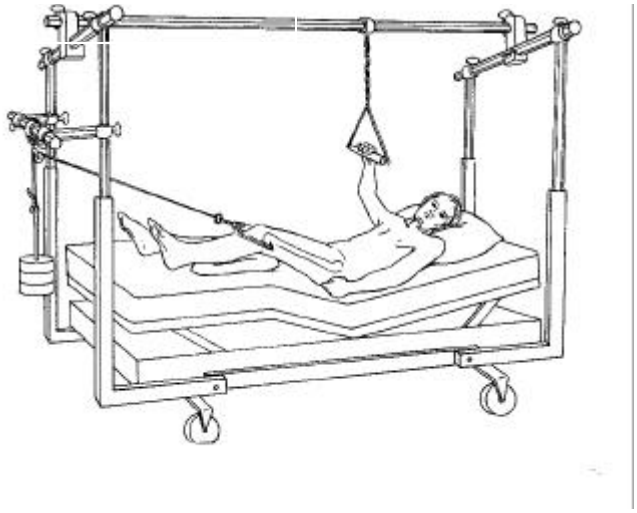
usually provided with a diamond shaped tip which facilitates penetration of bone when used in a drill. Larger Steinmann pins may have a trochar tip. Pins with this tip are more easily hammered than drilled across the bone. In either case, counter force provided by an assistant pressing against the limb from the opposite side is helpful.



Risks. Some degree of knee stiffness and hip flexion contracture are the most frequent problems with this form of traction. These problems are especially frequent with adult patients.

Malplacement of the skeletal traction pin resulting in contamination of the knee joint, injury to the distal femoral epiphyseal growth plate, or neurovascular injury are potentially serious problems and require immediate correction.

As with any percutaneous skeletal traction device, infection can occur. To avoid this complication, the condition of the skin about the traction pin should be carefully monitored and, if evidence of infection develops, the traction pin should be removed and appropriate treatment rendered.



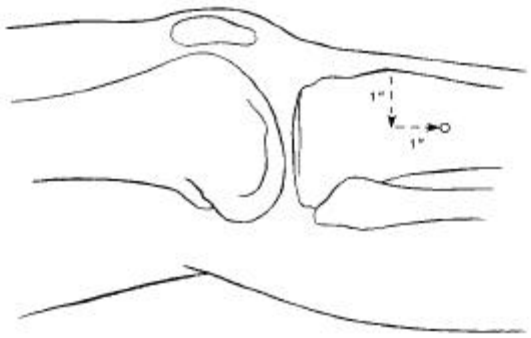
Proximal Tibial Traction

Indications. Proximal tibial traction is most frequently used in the treatment of fractures of the distal two-thirds of the shaft of the femur in children over 10 years and in adults. In these circumstances, skin traction is usually unsatisfactory due to its limited force tolerance. Distal femoral skeletal traction is unsatisfactory because the rotational moments about a femoral pin are unlikely to favor reduction of fractures in this portion of the femur.

Additional advantages of a proximal tibial traction pin site compared with a distal femoral pin site are the easier avoidance of the knee joint, the epiphyseal plate, and the soft tissues involved in knee joint motion.

Proximal tibial skeletal traction transmits traction forces across the knee joint. Therefore, it is contraindicated if the knee ligaments have been torn or relatively high force levels are used. For the latter reason it should not be used in a ninety-90 degrees position.

Application. Proximal tibial traction may be used in extension without any form of balanced suspension. Alternatively, it may be used with greater hip and knee flexion and in some form of balanced suspension. Three modes of suspension are currently in common use. These various options will be individually discussed. Details of pin insertion are the same.



The ideal point for pin insertion of the wire or pin in an adult is approximately 1 inch posterior and 1 inch distal to the tibial tubercle (Fig. 38). With the patient supine and the lower limb preferably supported on pillows, the proximal tibial area should be shaved and prepped as for any other surgical procedure. Following local infiltration, the Kirschner wire or Steinmann pin should be driven transversely through the proximal tibial metaphysis, not the diaphysis. In a child, the proximal epiphyseal plate cephalad and the epiphyseal plate of the tibial tubercle anteriorly should be avoided. The branches of the peroneal nerve posteriorly are easily avoided. Occasionally, during insertion, the tip of the wire may creep anteriorly until the pin traverses the limb through the thick periosteum just in front of the tibial crest and routine x-rays may fail to reveal its incorrect location.
The application of traction to a wire in this location will soon cause excessive and persisting pain. Within a couple of days, the wire will lift away from the bone and stretch the skin. In these circumstances, the location of the wire should be promptly corrected. Incorrect wire placement can usually be prevented by inserting the wire well posterior to the tibial crest and attempting to penetrate the bone with the wire perpendicular to its surface.

The largest size of Kirschner wire, i.e. 0.62 inch thick and without threads or nicks, or a Steinmann pin approximately 1/8 inch thick is usually satisfactory. Smaller Steinmann pins may not break, but bending becomes a problem. Kirschner wires are usually provided with a diamond-shaped tip which facilitates penetration of bone when used in a drill. Larger Steinmann pins may have a trochar tip. Pins with a trochar tip are more easily hammered than drilled across a bone. In either case, counterforce provided by an assistant pressing against the limb from the opposite side is helpful.

A Kirschner wire tractor bow should always be used with a Kirschner wire and firmly tightened to stretch the wire in its long axis. To prevent unintentional disengagement of the wire from the tractor bow, the two wire grippers on the ends of the bow arms should be firmly closed and the ends of the wire bent to lie along the outside of the bow arms, thereby locking the grippers. In this position, the wires should be taped to the bow arms so that their sharp tips are not exposed and the grippers cannot be inadvertently released.

The bed is adjusted and the traction equipment is arranged as for distal femoral traction in extension (Fig. 37). Adjustment for countertraction is necessary to prevent the patient from sliding to the foot of the bed and losing effective traction. The bed must

either be tilted or elevated on shock blocks to oppose the traction force. The knee support of the mattress frames should be elevated slightly. A pillow should be placed under the limb and positioned to prevent pressure on the heel and lift the knee enough to prevent contact between the tractor bow and the skin on the front of the leg. When this system is used for a fracture of the femur, a traction force of 10 to 25 lbs is used and the traction cord is aligned approximately in the long axis of the proximal fragment of the femur. If greater hip and knee flexion are desired, supporting the limb in a balanced suspension system may be preferable to supporting it on a pillow. Three appropriate balanced suspension systems are discussed later in this text. One of these involves a traction split and Pearson attachment. Another involves double slings. The third involves a cast brace.

Risks. Extension of infection into the proximal tibia from the soft tissues around the percutaneous traction wire or pin can occur. Rarely it may become a serious complication. To avoid this problem, the condition of the skin around the device should be carefully monitored. If evidence of infection develops, the wire or pin should be removed and appropriate treatment rendered. The development of troublesome infection is more likely if the wire or pin slips sideways. Sideways slip can be avoided by using a Steinmann pin with a short, threaded segment similar to the type used for the Hoffmann type external fixation apparatus. After insertion of the pin, the threaded segment should engage as much bone as possible and preferably not protrude through the skin. For this reason, fully threaded Steinmann pins are less satisfactory than partially threaded ones.

Contamination of the knee joint or injury to the epiphyseal plate or neurovascular structures is less likely when a proximal tibial wire or pin is used than a distal femoral one; however, anterior malposition of the wire or pin is more likely. This problem and its correction have been described earlier in this chapter.

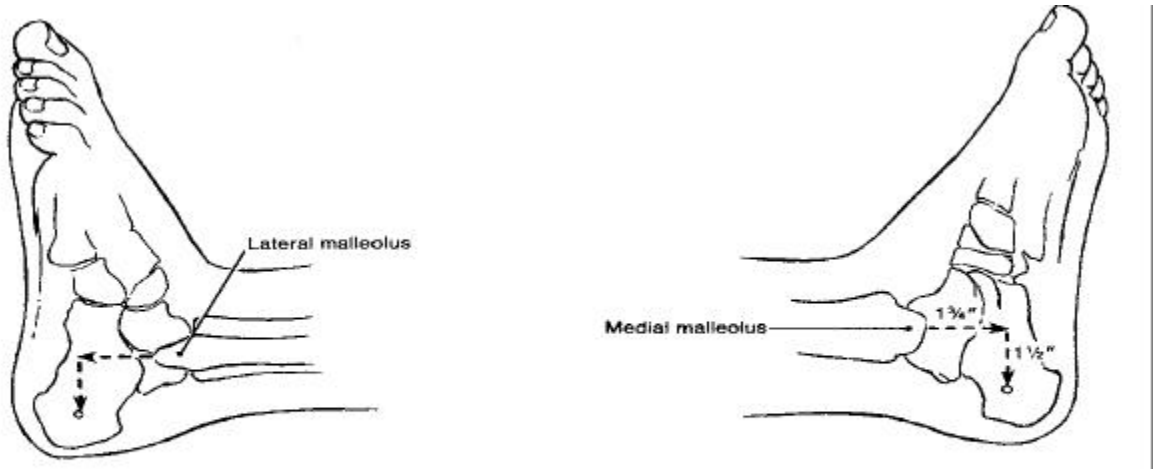
Calcaneal Traction

Indications. Although treatment of a fracture of the calcaneus by traction is uncoinnon, and presents the disadvantage of contamination of the fracture hematoma by a percutaneous pin, this form of treatment is occasionally useful with a marked loss of the tuber joint (Bohler's) angle.

Occasionally, this form of traction is also useful temporarily for tibial shaft fractures to recover or maintain length prior to definitive treatment by some other technique.

Application. The correct spot for insertion of the pin may be measured from the malleoli, these being landmarks which can usually be palpated even in swollen feet (Fig. 51). Ideally, the pin should be inserted as far posterior as possible while still engaging sound bone. The tendons and neurovascular bundle passing behind the malleoli and, of course, the talocalcaneal joint are to be avoided. The traction pin should never be placed through the soft tissue space between the talus, calcaneus, and tendo-Achilles; this technique may lead to disasterous slough and infection.

The lower limb should be elevated slightly with slight flexion in the knee and a pillow beneath the leg avoiding pressure on the heel or tendo-Achilles.



Risks. Pain and swelling are frequent problems with calcaneal fractures. Constrictive dressing must be released and any localized pressure relieved in order to avoid skin slough.

Buck's Traction

Indications. Used mainly for temporary immobilization for intertrochanteric hip fractures

awaiting fixation, or s/p closed reduction of hip dislocations.

Application. Apply skin traction with the foam Buck's boot attached to 5-10 lbs of weight taken off the foot of the bed.

Risks. Because this is skin traction, frequent skin checks are mandatory to avoid skin breakdown. Ten pounds weight maximum.

Bryant's Traction

Indications. Used, historically, for the treadment of DDH in the infant. It is also used with bladder extrophy repair.

Application. Adhesive moleskin strips are applied the the medial and lateral lower extremities, and reinforced with an elastic bandage. Traction rope runs overhead to the feet. Traction should maintain hip flexion of 90 degrees, and abduction of 30 degrees. The weight should just lift the buttocks from the bed.

Risks. Vascular compromise is very possible. Be vigilant. Absolutely contraindicated in children over 6 months of age.

90/90 Femoral Traction

Indications. Very useful in the treatment of subtrochanteric femur fractures, or displaced/open diaphyseal femur fractures in children.

Application. Insert a distal femoral traction pin as described. Suspend from overhead putting the hip at 90 degrees flexion. The lower leg is supported in a Buck's boot or splint from above, putting the knee at 90 degrees. Light axial traction on the foot, to the foot of the bed keeps the femur from rotating.

Risks. As with any distal femoral traction pin, accurate placement is a must. Watch also for vascular compromise as in Bryant's traction.

Most injuries may be splinted and dealt with at a later time. Splints should be applied aggressively, as immobilized injuries are less painful, allow the patient to be moved more readily, and may avoid further injury. Splinting techniques are widespread, but a few simple concepts will keep you out of trouble.

Splints should be:

- **Well padded**, especially at the ends and at bony prominences and potential pressure points. (i.e. the fibular head, the patella, the olecranon, the peroneal nerve) Usually 5-6 layers of NON-WRINKLED cast padding is sufficient.
- **Appropriately sized**. They should be long enough to capture the bones, but not impinge on bones/joints which do not need immobilization.
- **Appropriately Moulded.** The efficacy of a splint is directly related to how well it conforms to the limb. You must avoid finger or thumb impressions or uneven, undulating splints which might cause pressure points. Additionally, the splint must conform, otherwise it will be loose. Too much padding can hamper this.
- **Split** to allow some swelling. The padding, kling, and plaster must be split, and NOT circumfrential. This could lead to an external compression syndrome.
- Lower extremity splint must **avoid equinus** position of the ankle. Neutral dorsiflexion is generally the goal. A good **foot plate** is also important to protect the toes, and avoid a flexion contracture.
- Splints of the hand/wrist must not block desired MCP or phalangeal motion.

- You must remember the **position of safety** when splinting the hand and wrist. Imagine the position of holding a soda can (wrist extension, MCPs at 70-90, and thumb aabduction & flexion)
- Remember the **Thigh** is **rectangular** and the **Leg** is **triangular** in cross-section

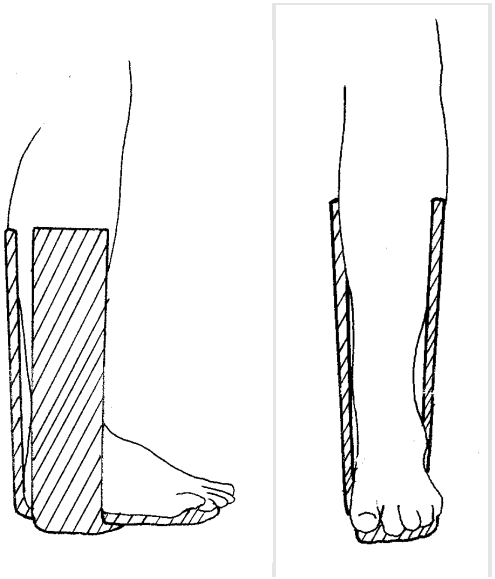
General materials needed:

- Warm (not hot) water
- Appropriate plaster material to make a splint 7-15 layers thick
- Appropriate cast padding to make 5-7 layers
- Kling roll to aide in conformity
- Elastic bandages to hold it together once split

Common Splints - Lower Extremity

Cadillac Splint

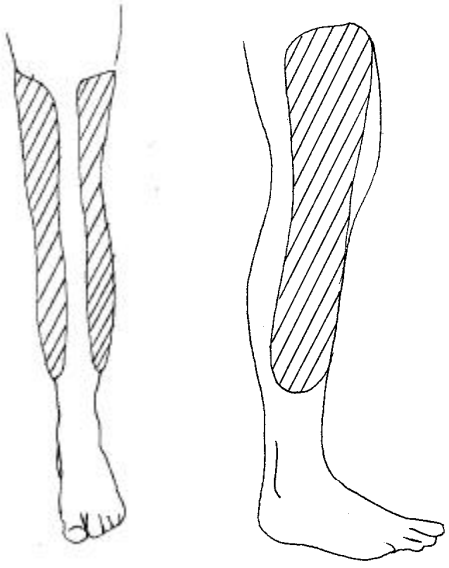
Indications. Used to immobilize injuries to the distal tibia, ankle and foot



Configuration. A posterior splint with a "U" from toes to proximal tibia.

Application. Easiest to apply with the patient prone and the affected limb toward the ceiling (If the patient can cooperate, and the injury will not be displaced.)
I. Apply padding to extremity
II. Apply posterior splint first from the toes to just distal to the popliteal fossa
III. Apply medial/lateral "U" centered over axis of tibia. Beware the peroneal nerve.
IV. Wrap with kling, hold ankle in neutral until hard, split kling anteriorly, and apply ace wrap

Medial-Lateral Splints



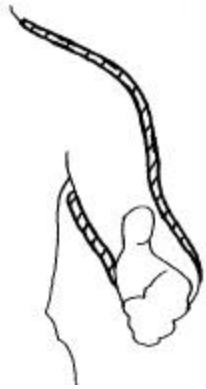
Indications. Temporary immobilization of the knee, distal femur or proximal tibia

Configuration. As the name implies, plaster slabs medial & lateral to the knee from the proximal thigh to the ankle.

Application. Usually applied supine. The knee should be fully extended or partially (approx. 20-30 degrees) flexed.
I. Apply padding
II. Apply medial & lateral plaster slabs, centered about the knee. You may create an "I" beam effect by creating a fold in the central third of each slab, thus increasing the stiffness.
III. Apply kling, mold on supracondylar area and tibial shaft, split kling anteriorly, and apply ace wrap

Common Splints - Upper Extremity

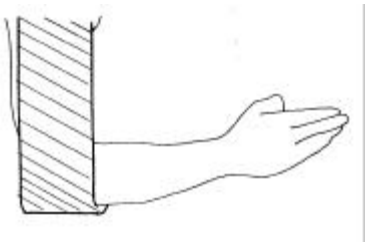
Coaptation Splint



Indications. Used to immobilize injuries to the proximal humerus/shoulder girdle, or diaphysis of the humerus.

Configuration. A "U" around the elbow extending from the axilla, up the arm and over the deltoid area.

Application. Easiest to apply if patient is sitting up. Usually need two people to apply.
I. Spray shoulder and neck with Benzoin to aid in postitioning
II. Apply cast padding from neck, over shoulder, around elbow to just distal to the axilla
III. While assistant holds reduction with elbow at 90 degrees, apply plaster slab from neck/shoulder to axilla, avoiding impinging upon the axilla
IV. Wrap with kling and mould, split kling anteriorly, and wrap with ace. Apply sling.



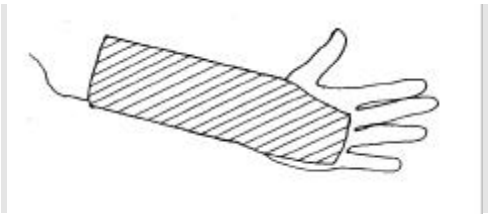
Thumb Spica Splint

Indications. Used to immobilize the base of the thumb or scaphoid.

Configuration. A moulded slab along the radial aspect of the wrist incorporating the thumb held in abduction.

Application.
I. Apply padding from proximal forearm to tip of thumb
II. Apply plaster and wrap with kling. Position thumb in abduction (45 degrees) and slight volar flexion. Hold in position with your opposite side hand as if "Thumb shaking" (palm to palm with thumbs intertwined). Split kling along ulnar border, and wrap with ace bandage.

Dorsal-Volar Splint

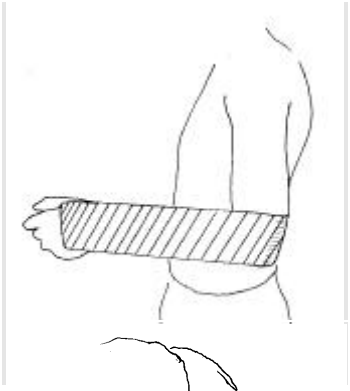


Indications. Utility splint for most injuries involving the metacarpals, carpus or hand.

Configuration. A sandwich of the hand with dorsal and volar slabs. Generally the hand and wrist are in the "safety position". (May also be made with just a volar component)

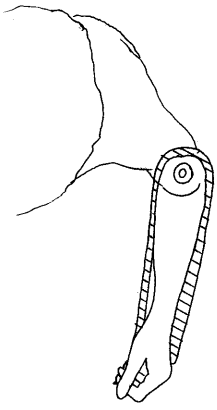
Application.
I. Prepare a dorsal and volar slab of padding from proximal forearm to the DISTAL PALMAR CREASE.
II. Prepare similar slabs of plaster. You must create a space for the thenar muscles.
III. Apply "sandwich" making sure it does not extend past the distal palmar crease, nor impinge upon the thenar emminence.
IV. Wrap with kling, hold in functional postion until hard,split kling along ulnar border, and wrap with ace bandage.

Sugar Tong Splint



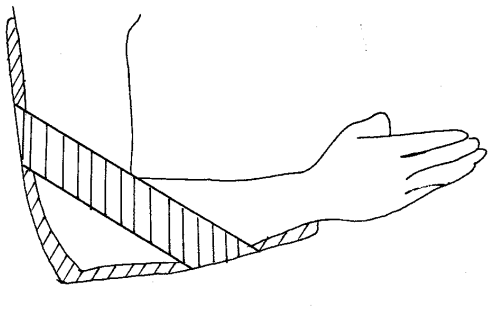
Indications. Used to immobilize the forearm and wrist.

Configuration. A "U" about the elbow from the distal palmar crease volarly to the MCPs dorsally.



Application. Often easier to apply with two persons.
I. Measure length from PIP volarly to PIP dorsally around the elbow
II. Create a slab of this length with 5-7 layers of cast padding. (4" for adults, 3" for kids)
III. Create a slab of plaster 7-10 layers thick in a similar manner. (Again 4" for adults, and 3" for children.)
IV. After dipping the plaster, lay it onto the padding and wrap around the flexed elbow. The patient or assistant can hold it in a pincer fashion at the end on the fingers.
V. Wrap with kling for conformity and mould splint. Splint should end at the MCPs dorsally and the distal palmar crease volarly. Split the kling completely along radial border, and overwrap with an ace bandage.

Posterior Elbow Splint



Indications. An excellent splint for injuries about the elbow.

Configuration. A posterior slab about the elbow from the axillary crease to the wrist. The oblique lateral A-frame adds significant strength.

Application.

I. Measure from the wrist to the axillary crease about a flexed elbow.

II. Create a slab of padding 5-7 layers thick, as well as a plaster slab of 7-10 layers.

III. Dip plaster and lay slab onto padding, and in turn place about elbow posteriorly with elbow flexed to 90 degrees. Overwrap with kling.

IV. If adding an A-Frame create a plaster/padding slab an lay obliquely across the elbow laterally, joining the brachial and antebrachial limbs.

V. Once hard, split kling completely anteriorly, and wrap in an ace bandage. Sling.

Buddy Taping

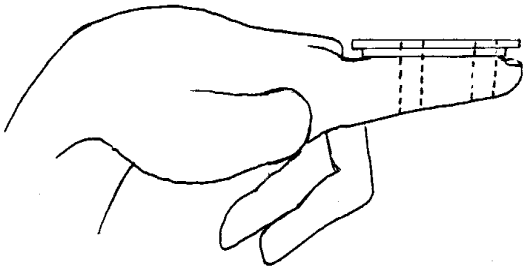
Indications. Useful to treat finger sprains, nondisplaced/acceptably displaced phalageal fractures, and interphalangeal dislocations after reduction.

Configuration. Injured finger buddy taped to neighboring finger.

Application.
I. Two or three layers of cast padding between fingers to prevent maceration.
II. Two strips of 1/4" tape (preferably cloth) proximal and distal to affected joint, snugly but not constrictive.
III. Give patient a supply of cast padding and tape to replace at home.

Dorsal Aluminum Splint

Indications. This is ideal for mallet finger injuries, traumatic boutinerre s, and to protect the interphalangeal joints while in extension. May be combined with buddy taping.



Configuration. A small piece of aluminafoam splint cut to the appropriate size, and 1/4 inch tape (preferably cloth)

Application.
I. Place the injured digit in extension.
II. Tape with the splint dorsally placed over the affected joint.
III. Give the patient extra tape.

Spine

Cervical Spine

The C-Spine series includes AP/Lat C-Spine, Oblique C-Spine and Open Mouth Odontoid View. The Swimmer's View may be included if others are inadequate. Remember you must see the C7-T1 interval to consider the films adequate. An MRI should be considered in any Quadriplegic or other neurological deficit.

FRACTURE	XRAYS NEEDED	IMMOBILIZATION
Jefferson's Fx (C1 fx, commonly burst)	C-Spine Series CT Scan	Halo Vest vs Collar
Hangman s Fx (Traumatic spondy. C2)	C-Spine Series CT Scan	Halo Vest
Odontoid	C-Spine Series CT Scan	Halo Vest for Type 2,3 Collar for Type 1
Compression Burst Teardrop	C-Spine Series CT Scan (Occ. need MRI)	Collar May need halo +/- O.R.
Facet Dislocation (unilateral or bilateral)	C-Spine Series CT Scan	Halo Traction vs Vest
Clay Shoveler's (Spinous process fx)	C-Spine Series	Collar

Thoracic & Lumbar Spine

Injuries to these areas are common, particularly with falls and axial loads. Be suspicious of lumbar fractures with calcaneal fractures etc. Examine the sternum with a thoracic spine fracture for fracture or sterno-manubrial dislocation.

FRACTURE	XRAYS NEEDED	IMMOBILIZATION
Compression/Burst	AP/Lat T or L-Spine Oblique View CT Scan	Spine Precautions
Facet Dislocation	AP/Lat T or L-Spine Oblique View CT Scan	Spine Precautions
Spinous/Transverse Process	AP/Lat T or L-Spine Oblique View CT Scan	Spine Precautions

Other Commonly Encountered Injuries

There are a myriad of other musculoskeletal injuries you will encounter in the emergency room. These include dislocations, soft tissue injuries, sprains, strains and contusions. All should have routine early follow up. To follow are guidelines for care of some of the more common injuries.

INJURY	MECHANISM	X-RAYS	TREATMENT
Nailbed Injury	Crush	AP/Lat Finger	1) Remove nail 2) I&D 3) Repair nailbed with 5-0 chromic 4) Replace nail or substitute to keep nail fold open (I use a piece of the suture package) 5) Splint with volar aluminum splint
Fingertip avulsion	Usually a door slammed onto finger	AP/Lat Finger	1) If a child and the tip is available, loosely suture. If an adult or the tip is lost, I&D and dress. 2) Nailbed repair if applicable. 3) Splint. 4) Antibiotics (Keflex)
Felon (Pulp infection)		n.a.	1) Incise & drain - Ulnar midlateral incision (except thumb, little). CULTURE. 2) Penrose drain 3) Splint 4) Antibiotics (Keflex)

INJURY	MECHANISM	X-RAYS	TREATMENT
Ingrown fingernail or toenail		n.a.	1) Incise & drain - Elevate edge of nail and trim off vs. pack 2) Antibiotics (Keflex)
EDC Avulsion (Mallet Finger)	Forced Flexion of DIP (Jammed or struck with a ball)	AP/Lat Finger	Stack splint or volar aluminafoam (Needs ORIF if subluxed/bony inj)
FDP Avulsion (Jersey Finger)	Forced Extension of DIP	AP/Lat Finger	Dorsal DIP splint (Needs repair)
Boutonniere	Central slip injury	AP/Lat Finger	Dorsal splint PIP in extension
Gamekeeper s Thumb	Ulnar colateral lig. Injury (Abduction)	AP/Lat Thumb	Thumb spica splint May need ORIF
DIP or PIP Dislocation		AP/Lat Finger	1) Clsd reduction 2) Dorsal splint in extension vs buddy tape
Nursemaid s Elbow (Radial head dislocation)	Usually picked child up by one arm	AP/Lat Elbow Comparison views can help	1) Clsd reduction: extend, supinate forearm, then flex elbow. 2) No splint.
Elbow Dislocation	Usually a fall onto an outstretched arm	AP/Lat Elbow Comparison views can help	1) Reduce: Usually need axial traction with guidance of olecranon med/lat. 2) Posterior splint. 3) Post reduction XRAY mandatory

INJURY	MECHANISM	X-RAYS	TREATMENT
Shoulder Dislocation	Anterior - Direct trauma Posterior - Seizure	AP/Axillary Lat of shoulder. Transscapular Y if unclear as to direction.	**If anterior** 1) Patient supine. 2) Axial traction, while bringing shoulder to full abduction. 3) Gently externally rotate to unlock, then internally rotate & adduct while guiding head to glenoid. 2) Sling & Swathe
Acromioclavicular joint injury	Fall onto shoulder	AP/Axillary Lat shoulder. Occ. compare with AC Joint View	Sling Rarely need repair
Sternoclavicular joint injury	Direct trauma or axial load of arm	CXR vs SC Joints Occ. CT scan of chest to determine ant. or post.	**If anterior** 1)Try reduction with hyper-extension of scapulae over roll. **If posterior** 2)Beware of impingement on mediastinal structures. May need operative reduction. 3) Sling

INJURY	MECHANISM	X-RAYS	TREATMENT
Hip Dislocation (An orthopaedic emergency which must be reduced ASAP)	If posterior (head up & out) likely a knee into the dashboard. If anterior (head down & in) abducted and externally rotated	AP Pelvis Lateral of affected hip. Generally obtain a CT scan of the hips with 3mm cuts to rule out intra-articular fragments after reduction.	**If posterior** 1) Patient supine 2) Axial traction with hip flexed to 90 degrees 3) Gently adduct and internally rotate, followed by external rotation and abduction. **If anterior** 1) Axial traction with hip flexed 2) Gently externally rotate and abduct, followed by internal rotation and adduction.
Knee Dislocation (An orthopaedic emergency. Must be reduced ASAP)	A twisting, or hyper-extension/flexion injury.	AP/Lat Knee (Generally don t wait for the Xray before reduction)	1) A combination of axial traction, rotation, and shifting the TIBIA anterior or posterior. 2) Medial/Lateral splints or knee immobilizer 3) **A post-reduction ar-teriogram is mandatory to rule out an intimal tear.**
Patellar Dislocation	Patella is usually dislocated laterally	AP/Lat Knee Sunrise View (To rule out osteochonddral fragment in PF joint)	1) Usually a gentle medial force with the knee extended will reduce. 2) Knee imm-obilizer

Table of Contents

Introduction

Orthopaedic Emergencies

How to Describe an Injury

X-Ray Pearls

Commonly Used Medications

Analgesia & Sedation

Regional Anesthesia

Joint Aspiration

Spine Trauma

Compartment Syndromes

Splints

Spine Fractures

Other Common Injuries

Most Extremity Fractures

Pelvic Fracture Disruption

Acetabular Fractures

Hip Dislocations

Open Fractures

Logistics

ACETABULAR FRACTURES

1) Relocate femoral head if able without invasion of skin.
2) Assess stability of hip acutely with at least 90^0 of flexion and pressure of knee.
3) Radiography:
    - AP, iliac and obturator obliques of entire pelvis.
    - AP of injured hip
    - AP and lateral of the entire ipsilateral femur
    - CT scan of entire pelvis
4) Schedule ORIF acetabulum and request:
    - Major bone
    - Large and small AO/ASIF instruments
    - Large AO screw set
    - Longer small AO screw set
    - Large retractors
    - Large reduction forceps
    - Acetabular-Pelvic instrument sets and Reconstruction plates
    - Jackson table
    - C-arm with 12 inch camera
    - Cell saver
    - Large operating room
5) Consult Anesthesiology prior to surgery for special hemodynamic support
6) Consult therapists pre-op for teaching for post-op incentive spirometry and exercises
7) Transfuse only to prevent orthostatic symptoms during rehabilitation
8) Rehabilitation:
    - See Table I
9) Heterotopic ossification prophylaxis should be considered with either:
    - Indocin 25mg po tid with food
    - Single dose radiation

    Begin as soon after surgery as possible.
10) Before discharge, CT scan through acetabulum and hardware only, to rule out intra-articular hardware.
11) F/U at 6 weeks and 3 months after injury then at 3 month intervals for 2 years, with AP Pelvis, both obliques pelvic x-rays.
12) Hip rating score at every visit.

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Pelvic Fracture-Disruption

0) Trauma team for at 24 hours of observation. If CT of abdomen needed acutely obtain slices described below.
1) Use spine board and/or MAST's for transport and transfers to splint pelvic fragments.
2) If hemodynamic stability:
    - Not obtained despite >50%EBV replacement; peritoneal lavage and/or immediate laparotomy with anticipation of catastrophic large bore vessel injury.
    - Obtained but requires >500ml/h of fluid and/or blood products to maintain;
        - CT scan for source of continued hemorrhage,
            - if intra-peritoneal laparotomy and internally fix pelvis,
            - if retroperitoneal, wrap pelvis with sheet and towel clip slices
                - if wrapping effective, replace with external fixator or C-clamp. if not angiogram Superior Gluteal artery, embolize as necessary. .
    - Obtained and maintained with <500ml/h of replacement; obtain inlet and outlet radiographs
        - if fracture pattern or exam (push-pull of lowers, compression of ASIS's and Patrick's) indicates instability, CT scan with 3mm
3) Call OR and request for ex fixation:
    - Jackson table
    - C-arm with 12 inch camera
    - C-clamp or ex-fix trays
    - Ortho basic tray

    For posterior internal fixation schedule ORIF pelvis and request:
    - Major bone
    - Large and small AO/ASIF instruments
    - Large AO screw set
    - Longer small AO screw set
    - 7.3mm cannulated screws
    - Large retractors
    - Large reduction forceps
    - Acetabular-Pelvic instrument sets and Reconstruction plates
    - If anterior approach planned; fracture table
    - C-arm with 12 inch camera
    - Cell saver
    - Large operating Room
4) Consult Anesthesiology immediately for eventual special hemodynamic Support in OR

Pelvic Fracture-Disruption (continued)

5) Until posterior aspect of pelvis judged stable, patient should not sit higher In bed than 45^0
6) Request aggressive chest PT and incentive spirometry
7) Transfuse only to prevent orthostatic symptoms during rehabilitation
8) Rehabilitation:
   See Table I
9) F/U at 6 weeks and 3 months after injury then at 3 month intervals for 2 years, with AP Pelvis, inlet and outlet x-rays.

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Hip Dislocation

0) Check stability with at least 90^0 of flexion and pressure on the knee.
1) Radiography:
   AP and true lateral of the injured hip before the reduction if hemodynamics stable.
   AP and lateral of the entire ipsilateral femur
   AP and true lateral of the injured hip and CT scan of the hip joints after the reduction
   If there is an acetabular fracture, include all other radiographs in that protocol.
1) If there is an acetabular fracture use that protocol starting at 4
2) If the reduction is unstable without fractures obtain orthosis that limits motion to safe range and begin PT for active ROM of hip, knee and ankle.
3) Rehabilitation:
   See Table I
4) F/U every 3 months with AP pelvis and lauenstien lateral of both hips and MRI at 6 month intervals until 2 years after injury, then x-rays only annually.

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Open Fracture

SYSTEMIC **SOFT TISSUE** **BONE**

Look for other injuries
(vascular, neural, cardiac,
abdominal)

Save all accompanying parts. Do not reduce unless neurovascular compromise present. Splint to prevent further injury. X-ray out of plaster with physician direction.

ER

Check tetanus status and environment
Of injury (barnyard, lake, etc.) DT
And/or hypertet prn.

Antibiotics see below

Always consider primary amputation if there is neural or vascular compromise

To OR urgently, timing dependent on severity of soft tissue injury, neurovascular status, etc.

OR

Apply tourniquet do not inflate

Observe blood loss, use tourniquet
Only if excessive

Culture wound aerobic and anaerobic then
Dress sterilely

Scrub wound thoroughly using lavage before and after draping.

Debride layer by layer (skin subcutaneous)
Muscle and bone, see bone ends and clean them.
Open limb with longitudinal incisions to
Expose necrotic and contaminated tissues.
Incise all fascial planes readily available and
Make separate incisions if necessary to open
All muscle compartments.
Culture wound again after debridement.

Consult Dr. Weikert or Plastic Surgery (Re: flaps,etc)

Open Fracture

Tibia **Forearm** **Femur** **Humerus**

Grade I (minimal soft Tissue damage, i.e. no Stripped bone)				
Gross Contamination	unreamed nail	reduce & splint	IM Nail	reduce & splint
No Gross Contamination	unreamed nail	plate	IM Nail	reduce & splint
Grade II (mild soft Tissue damage, i.e. <3cm of stripped bone)				
Gross Contamination	ext. fix.	Reduce & splint	IM Nail	reduce & splint
No Gross Contamination	unreamed nail	plate	IM Nail	reduce & splint
Grade III (more soft Tissue damage plus any Nerves, vessels, tendons Etc.)				
Gross Contamination	ext. fix.	Reduce & plate	reduce & ext. fix.	Reduce & ext. fix.
No Gross Contamination	unreamed nail	Reduce & plate	IM Nail	Reduce & plate

Generalities:

- Fixation done should not necessitate more bone stripping than done by injury.
- Make longitudinal incisions to expose underlying tissues for debridement, avoid distally based flaps.
- Interfragmentary lag screws especially useful in comminuted tibia fractures to convert unstable to stable fracture patterns allowing compression with external fixateur and early weight bearing.
- External fixateur pin holes (skin) 2cm longitudinal incisions packed with gauze.
- Multiply injured patients require increased bony stability.
- High-energy wounds (especially missile-related) should be externally fixed.

OPEN FRACTURE

SYSTEMIC	SOFT TISSUE	BONE
POST OP I		
Continue antibiotics as per open Fracture antibiotic protocol. Start calorie counts. Send dietary consultation for High calorie, high protein diet. If calorie count is not greater than 40 kilocalories per kilogram, start hyperalimentation or enteric feedings.	schedule return to OR 24-48 hours if necessary	
OR		
Restart antibiotics and continue 24 hours after each debridement	Repeat debridement and flap coverage Culture wound	Fixation (previously splinted forearm)
POST OP 2		
Stop antibiotics for most 24 h p 2^{nd} debridement	schedule return to OR 48-72 hours if necessary	

ANTIBIOTICS

Initial Prophylaxis

- Ancef 1 gram IV q8hours and Gentamicin 2mg/kg IV then 1.6mg/kg q 12 h for 24 hours after each debridement
- Add Penicillin 5million units IV q4 hours if the injury enviornment included farm or standing water
- Penicilin allergies subsitute Vancomycin 1g q12h IV for pcn and ancef

Repeat with each debridement if cultures negative otherwise change to match cultured bacteria's sensitivities

OPEN FRACTURES

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