



# Principles of limb immobilization: backcountry applications

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# What are we going to cover?

- ▶ Stats and general info
- ▶ **Brief** discussion of triage and orthopaedic emergencies
- ▶ Terminology: Sprains/strains and fractures
- ▶ General principles of limb immobilization
- ▶ Upper extremity
  - ▶ Anatomy
  - ▶ Common injuries
  - ▶ Immobilization strategies
- ▶ Lower extremity
  - ▶ Anatomy
  - ▶ Common injuries
  - ▶ Immobilization strategies
- ▶ Supplies and improvisation

Me driving past any trail...



- ▶ Musculoskeletal injuries make up 70-80% of all injuries reported in wilderness settings.
- ▶ Lower extremity injuries are the most common: 70% of all MSK
  - ▶ >50% are the ankle
- ▶ Fatalities: spinopelvic injuries and head trauma
- ▶ Treatment decisions:
  - ▶ Experience of the group
  - ▶ Distance from definitive care
  - ▶ Safety of the group takes precedence



# What are the goals?

- ▶ Address emergencies: anything life- and/or limb-threatening
  - ▶ Assess need to evacuate individual vs group
  - ▶ Do you need outside help?
- ▶ Ensure the **safety of the group** – this takes precedence over optimal treatment of any individual
- ▶ Make the injured person **as functional as possible**
  - ▶ Facilitates self-rescue
  - ▶ Eliminates need for outside assistance until the group is safely back to the trailhead/basecamp/cars.
  - ▶ By necessity – the care provided in the backcountry is TEMPORIZING.

# Ortho emergencies: pulseless extremity



- ▶ Major joint dislocations
- ▶ Open Fractures
- ▶ LOOK:
  - ▶ Visible deformity
  - ▶ Open wounds
- ▶ EXAMINE:
  - ▶ The “5-Ps” →
    - ▶ Acute: pain, pulselessness,
    - ▶ Minutes: cool, possibly change in color, temp
    - ▶ Paresthesias / paralysis: minutes to very late





▶ TREAT:

- ▶ Reduce as best as possible
- ▶ Cover open wounds
- ▶ Splint extremity
- ▶ GET OUT

# Ortho emergencies: open fracture

- ▶ “Compound” fractures
- ▶ Always look for open wounds
- ▶ You might not always see bone
  - ▶ Assume major open wounds over relatively subcutaneous bones are open (TIBIA TIBIA TIBIA.)
- ▶ Often dirty/contaminated
  - ▶ Addressing this in the field depends on time/distance to definitive care
- ▶ Fingertip (tuft) and Toe fractures have different rules.
- ▶ Open dislocations follow the same principles





Grade I:  
Wound is  $\leq 1$  cm  
Minimal contamination



CHSU  
CPD





Grade II  
Wound is 1-10 cm  
Moderate soft tissue injury  
+/- contamination

Grade IIIA:  
>10cm, high-energy  
Extensive soft tissue damage  
Contaminated  
Local coverage vs closure possible

Grade IIIB  
Above, but requires a flap

Grade IIIC  
Vascular injury requiring repair  
Any wound



# Ortho emergencies: open fracture

- ▶ TREAT:
  - ▶ Reduce as best as possible
  - ▶ Cover open wounds
  - ▶ Splint extremity
  - ▶ GET OUT



# Ortho emergencies: major joint dislocations

- ▶ Shoulder is the most common
- ▶ Knee can be a surgical emergency
- ▶ Hip fracture vs dislocation
- ▶ Ankles usually come with fractures
- ▶ Visible deformity
- ▶ Suspect if there's a block to motion
- ▶ Compare contralateral
- ▶ Are fingers a "major joint?"



# Should I reduce it?



- ▶ Experience level?
- ▶ Distance from definitive care?
- ▶ Threat to limb?
- ▶ Associated injuries
- ▶ Splint the extremity regardless



# Ortho emergencies: compartment syndrome

- ▶ “Extremity Claustrophobia”
- ▶ Fractures
- ▶ Envenomation
- ▶ Crush injury
- ▶ Major vascular injury (dislocations)
- ▶ Constricting bandages

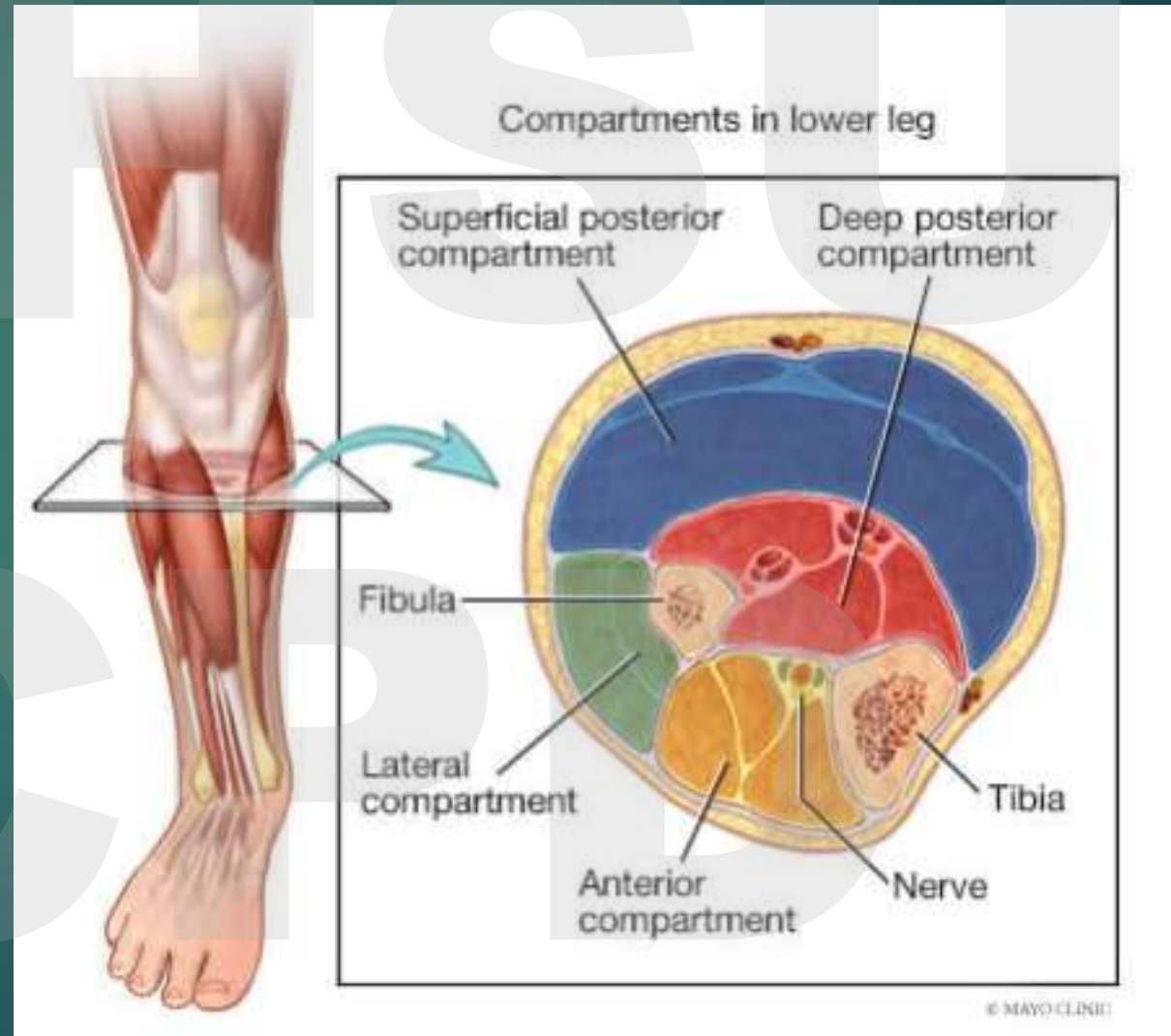


# Ortho emergencies: compartment syndrome

Compartment pressure exceeds perfusion pressure

Fascia doesn't stretch

Leg > forearm > hand > foot



- ▶ Diagnosis: The Ps again
  - ▶ PAIN OUT OF PROPORTION
  - ▶ PASSIVE MOTION PAIN
- ▶ Treatment:
  - ▶ Address open fractures/dislocations
  - ▶ Try to stop any bleeding
    - ▶ No tourniquet if no visible bleeding
  - ▶ Splint the extremity
  - ▶ GET OUT



# The orthopod's vocabulary: soft tissue injury

## SPRAIN

- ▶ Injury to a ligamentous structure, typically stabilizing a joint
- ▶ Ranges from stretching, to partial tearing to complete rupture
- ▶ Can destabilize a joint

## STRAIN

- ▶ Injury to a muscle or tendon
- ▶ Ranges from stretching, to partial tearing, to complete rupture
- ▶ Can lead to loss of volitional control of part of a limb

For the purpose of backcountry care,  
you're going to treat sprains and strains the same:  
immobilization of the injured structure alone.



# The orthopod's vocabulary: Is it a just a fracture, or is it broken?

- ▶ fracture = any structural defect in the bone involving the integrity of the cortex – regardless of severity.
- ▶ If you want to break your consulting orthopaedist's heart, call them up and say you have a compound fracture you want them to see. If you want them to love you forever, call it an open fracture.
- ▶ Descriptive terms for fractures: displaced, angulated, impacted, comminuted
  - ▶ Useful in the clinical setting. Not so much in the backcountry





# Basic immobilization principles: soft tissue injury



- ▶ If it's at a joint: immobilize the injured joint. Not critical to include joint above + joint below.
- ▶ Not at a joint: immobilization may not be needed. Assess on case-by-case basis.
  - ▶ When in doubt, first assess ability to bear weight
  - ▶ Can never go wrong with immobilization of the injured structure for pain control
- ▶ Evacuation depends on severity

# Basic immobilization principles: bony injuries



- ▶ Straighten out any deformity
  - ▶ Gentle, in-line traction
  - ▶ You're not going to make it worse
  - ▶ Patient tolerance dictates
  - ▶ Ok to immobilize still malreduced
- ▶ Injury at the level of a joint (i.e. ankle, wrist,) assess the movement / pain of the joint above and the joint below for decision-making
- ▶ If it's midshaft (tibia, forearm, humerus) → joint above + joint below

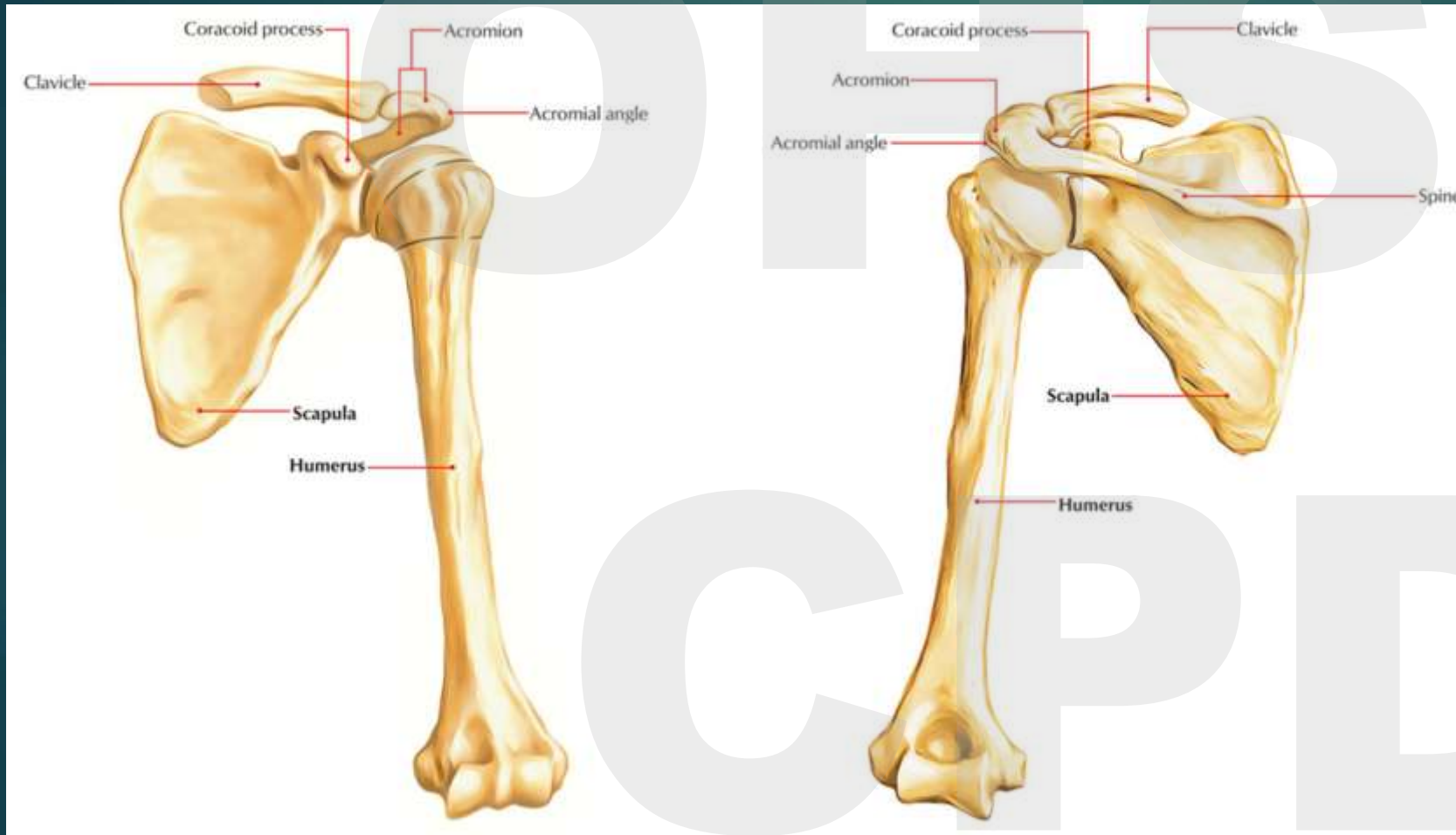
# Upper extremity injuries

Where is the most common location of injury to the upper extremity?

The hand is the most commonly injured part of the upper extremity – includes lacerations, bites, burns, fractures and dislocations.



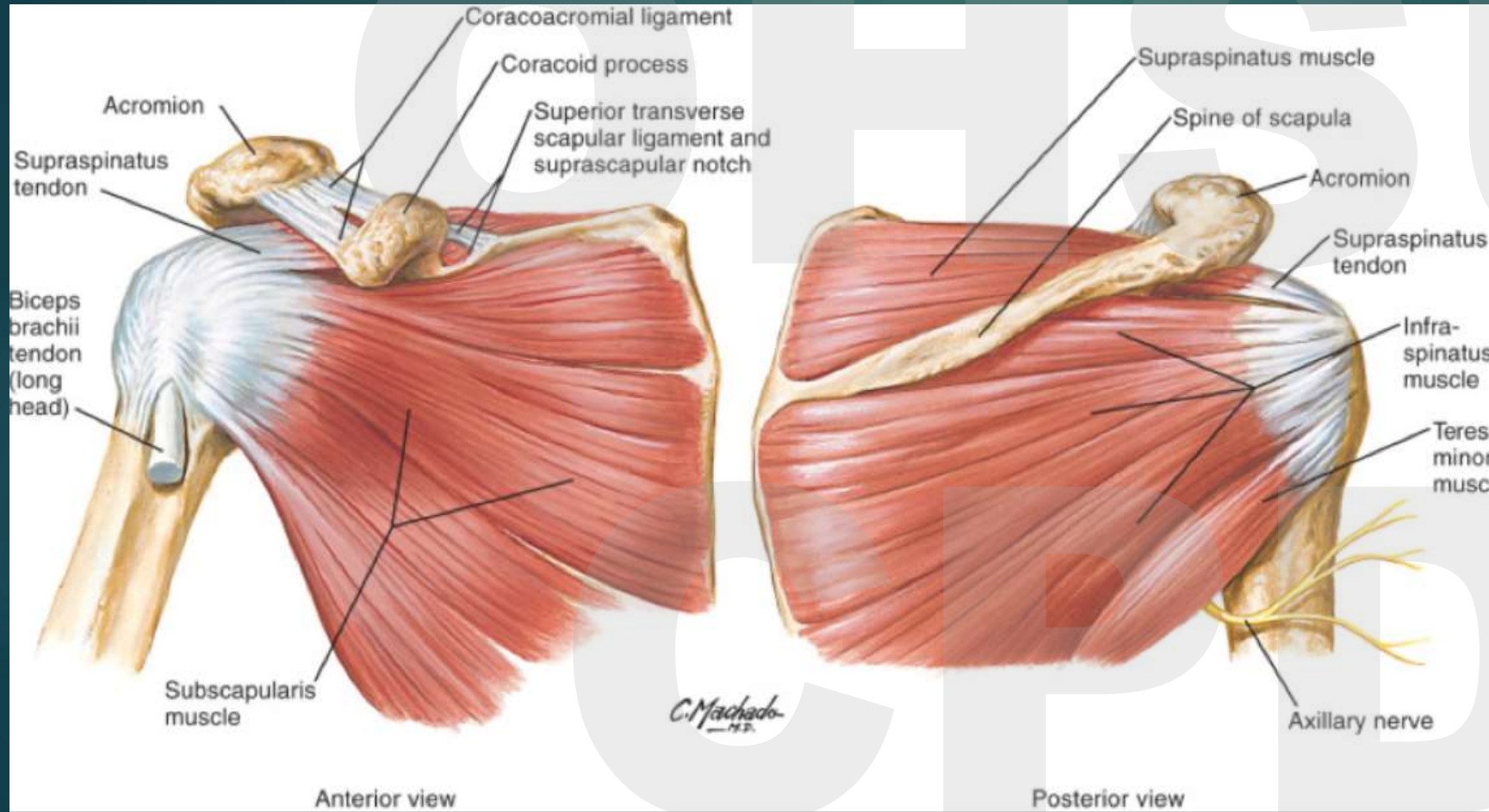
# Upper extremity injuries: shoulder



- Fall on an outstretched arm
- Fall with a direct blow at the shoulder
- Traction injuries (climbing)



# Upper extremity injuries: shoulder



- Fall on an outstretched arm
- Fall with a direct blow at the shoulder
- Traction injuries (climbing)
- Shoulder sprain/strain does not need immobilization unless pain control is an issue



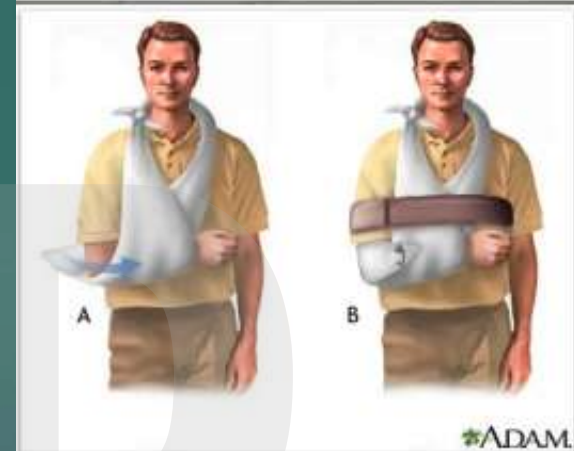
# Shoulder girdle fractures

- ▶ Proximal humerus
- ▶ Scapula
- ▶ Clavicle
- ▶ These are often stable
  - ▶ Sling and swathe immobilization
  - ▶ keep wrist and hand freely mobile
- ▶ Make sure neurovascular (and cardiopulmonary) status is checked
  - ▶ Small chance of PTX with a clavicle fracture



## Procedure, part 1

To create a sling and swathe, begin with a triangular cloth or bandage draped under one arm and over the opposite shoulder.



## Procedure, part 2

Tie the two ends of the cloth behind the neck, as shown at left. Pin the remaining elbow corner up onto the body of the sling. Use another bandage, a belt, or a strap/webbing to secure the arm to the chest, as shown at right.

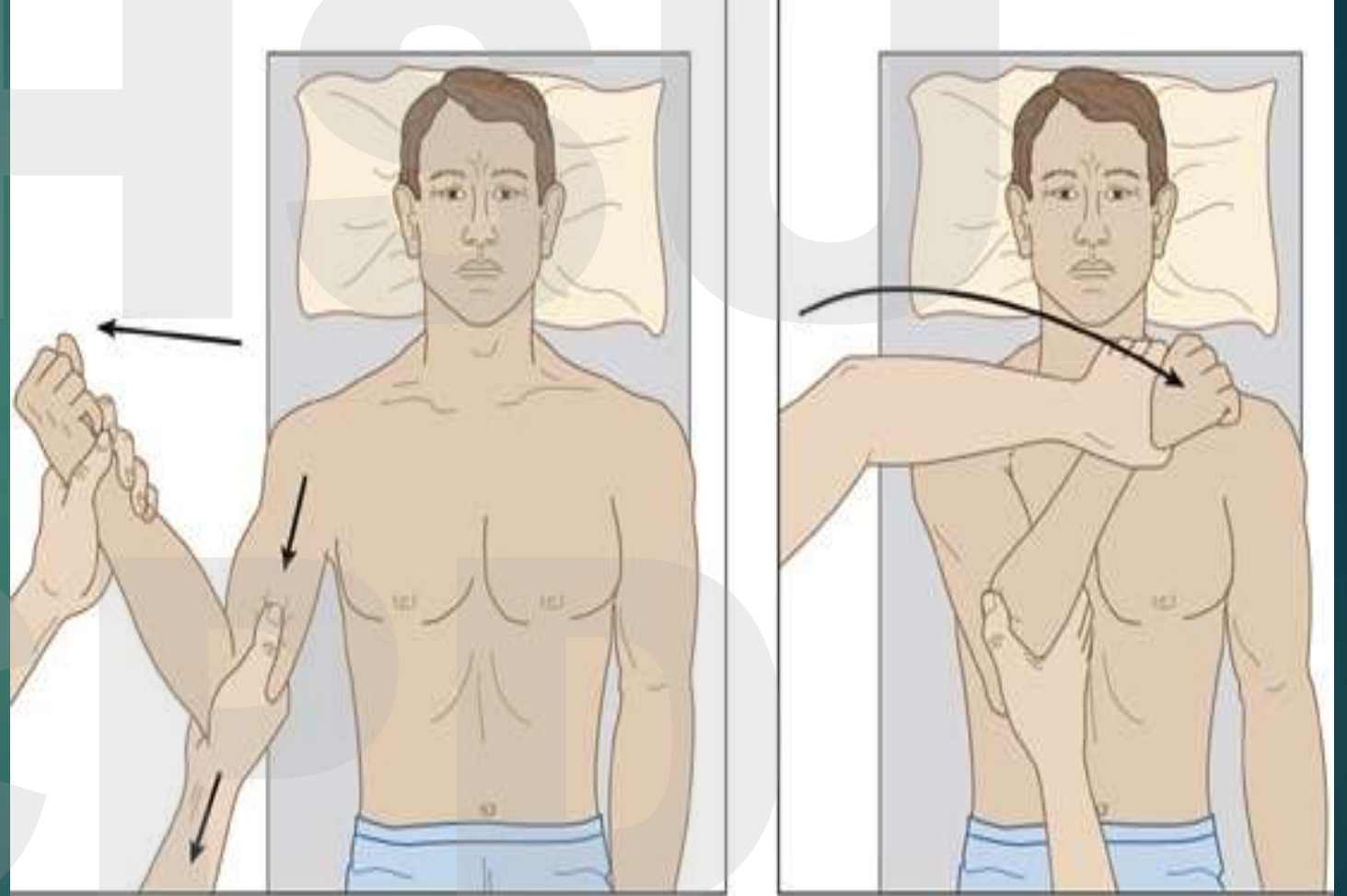
# Upper extremity: shoulder dislocation

- ▶ The most commonly dislocated major joint
- ▶ Classified by directionality – which direction the humeral head goes with respect to the glenoid
  - ▶ Anterior is the most common
- ▶ Fall, direct blow
- ▶ Immediate pain and inability to move the shoulder
- ▶ +/- visible deformity
  - ▶ “squaring” in an anterior dislocation



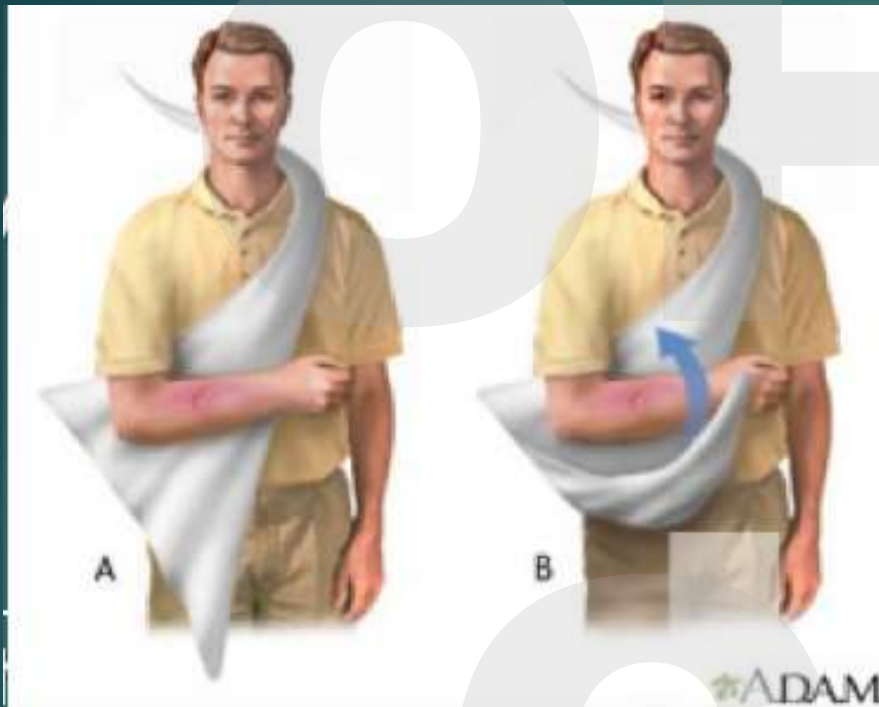


- ▶ Examine the whole extremity
  - ▶ Axillary nerve status
  - ▶ Consider fractures
- ▶ Your “moves” depend on directionality.
  - ▶ If you don't know any techniques, immobilize the shoulder in situ and evacuate
- ▶ Sling and Swathe





# Shoulder/arm: sling and swathe



## Procedure, part 1

To create a sling and swathe, begin with a triangular cloth or bandage draped under one arm and over the opposite shoulder.



## Procedure, part 2

Tie the two ends of the cloth behind the neck, as shown at left. Pin the remaining elbow corner up onto the body of the sling. Use another bandage, a belt, or a strap/webbing to secure the arm to the chest, as shown at right.



# Sling and swathe: get creative



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# Sling and swathe: get creative



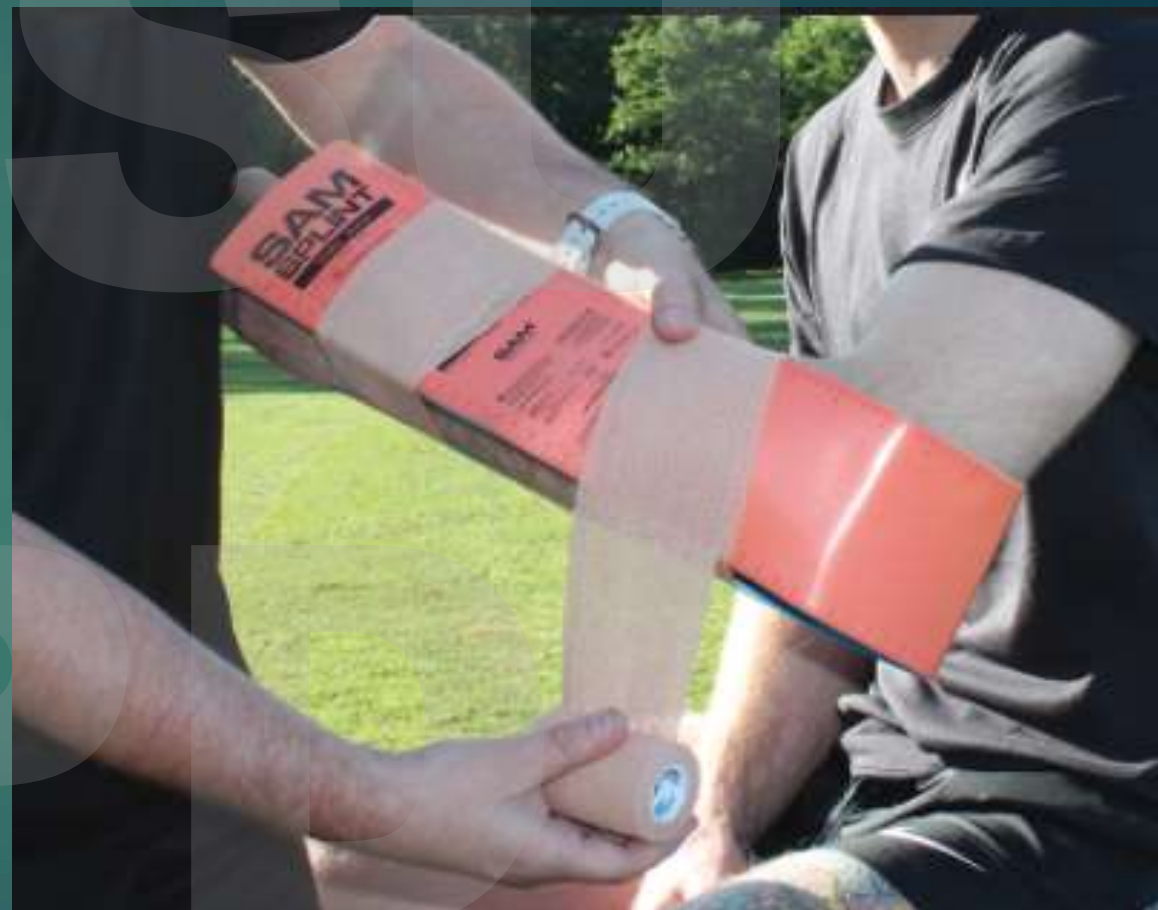
# Other upper extremity fractures

- ▶ Humeral shaft
  - ▶ Gentle in-line traction if angulated
  - ▶ CHECK NV STATUS – radial nerve
  - ▶ Sling and swathe – joint above and below
- ▶ Elbow dislocation
  - ▶ Can be difficult to reduce
  - ▶ Gentle elbow extension OK
  - ▶ Immobilize elbow and wrist, consider a sling
- ▶ Forearm and hand fractures
  - ▶ Deformities are common
  - ▶ Gentle in-line traction OK
  - ▶ Splint –
    - ▶ joint above and joint below
    - ▶ bulk hand splint in position of function





# Upper extremity splinting



# Upper extremity splinting



## Elbow flexed

Include a sling or a posterior arm splint to immobilize the elbow

Rolled up socks, glove, other object in the palm:  
**position of function**

Make sure it isn't too tight  
– check circulatory status frequently

# Upper extremity splinting: improvization

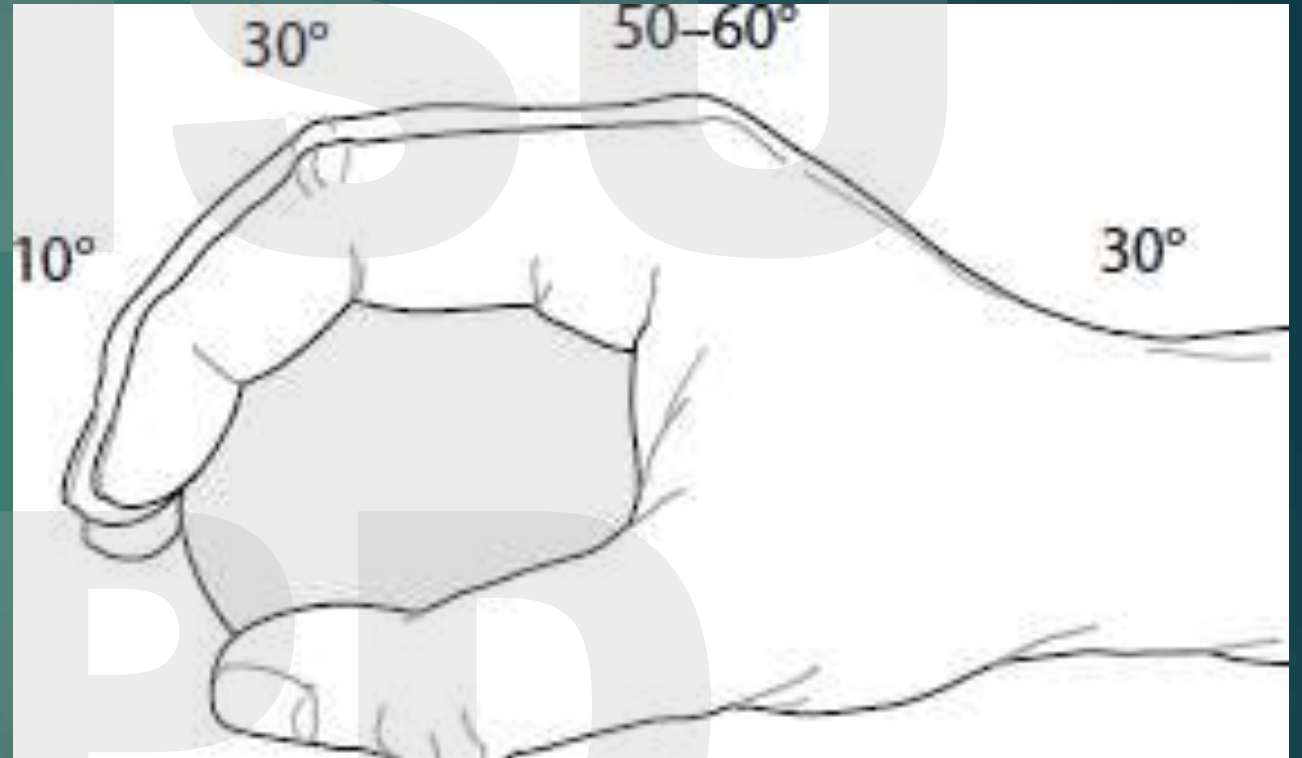


- Maps
- Backcountry permits
- Magazines
- Flip flops
- Shoe inserts/orthotics
- Towels
- Clothing
- Sticks
- Bras –  
straps/elastic/padding
- Get creative!



# Hand specifics

- Finger dislocations are very common
- OK to reduce – reverse the deformity
- Buddy taping is helpful
- Popsicle sticks, regular sticks, pencils/pens
- When in doubt – immobilize the hand in the “**position of function**”
  - Least likely to cause harm for the widest variety of injury
  - Put the hand in this position and wrap it up



# Lower extremity injuries

## Above the knee

- ▶ Higher energy
- ▶ High likelihood of evacuation
- ▶ Hip / pelvis fracture
- ▶ Hip dislocation
- ▶ Femur fracture
- ▶ Not going to cover much on this – most of these people will not be able to walk/self-evacuate in any capacity.

## Knee and below

- ▶ Spectrum of severity
- ▶ Ankle sprains are #1
- ▶ Knee sprains (various ligamentous and meniscus injuries) #2
- ▶ Knee vs patellar dislocations
- ▶ Patellar injuries
- ▶ Tibia fractures
  - ▶ High energy
  - ▶ High risk of open fracture or compartment syndrome
- ▶ Foot and ankle fractures



# Hip fractures and dislocations

- ▶ High energy injuries
- ▶ Unless you REALLY know what you're doing, don't try to reduce these
  - ▶ OK to pull gentle in-line traction to reduce gross deformity
  - ▶ Secure to contralateral leg (padding, tape, bandages) and carry vs. potentially crutch out – can't bear weight
- ▶ Evacuate



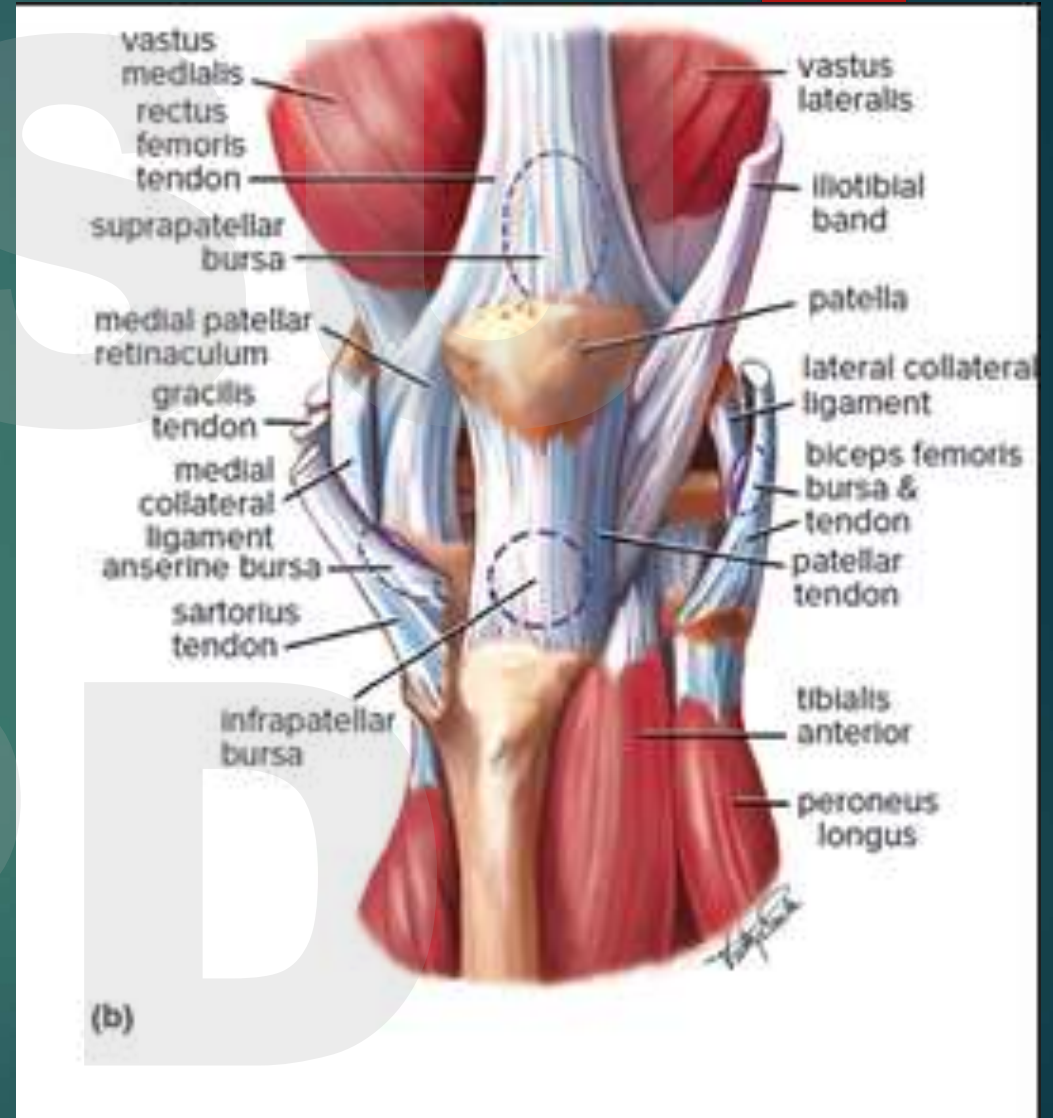
# Femur fractures



- ▶ High energy mechanism – make sure to look for other injuries
- ▶ Can't really "splint" the femur well, unless the fracture is close to the knee
- ▶ Padding and can secure to contralateral leg
  - ▶ The "BUFF" splint: Big, Ugly, Fat, Fluffy
- ▶ Evacuate: these need urgent surgery

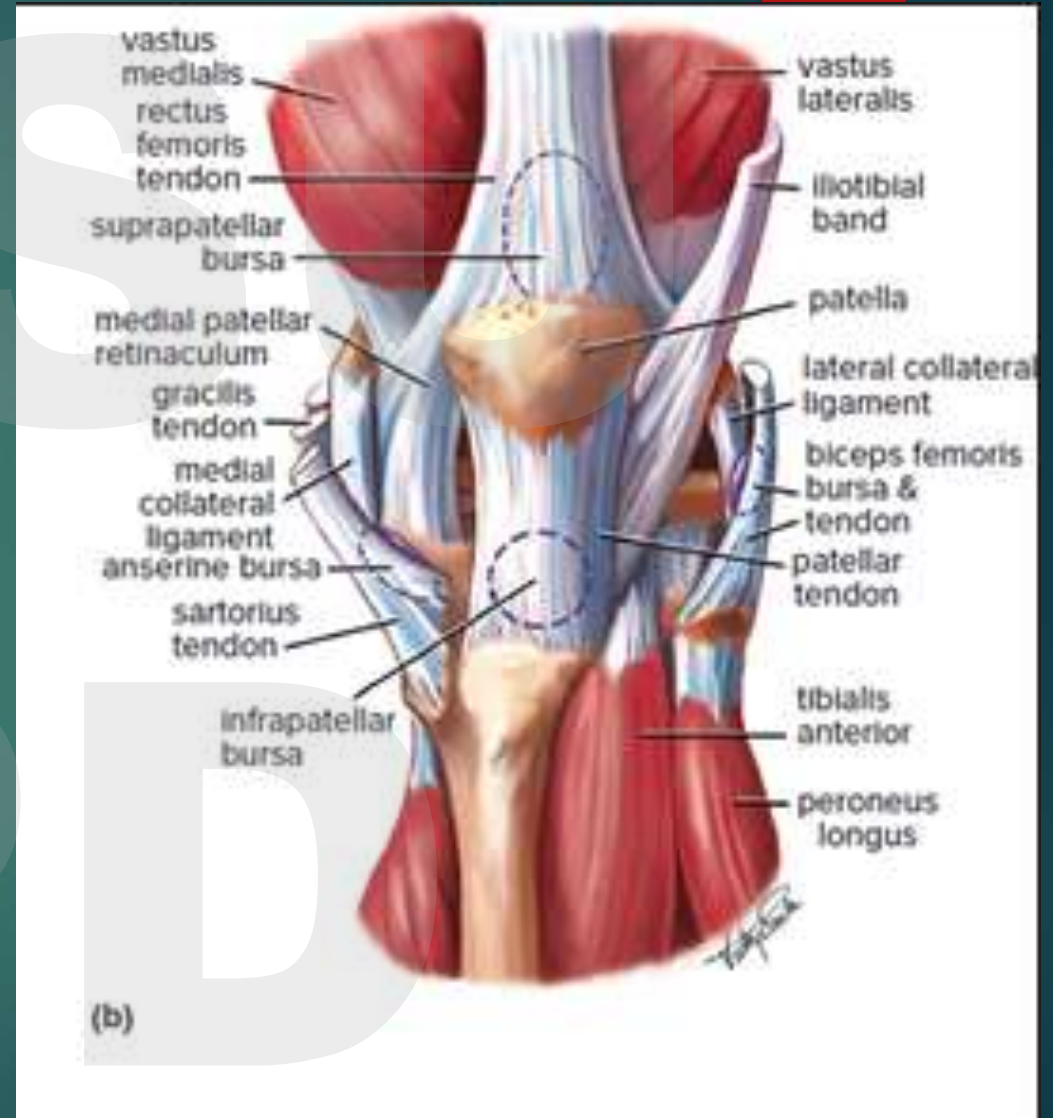
# Injuries about the knee

- ▶ 3 major categories
  - ▶ Soft tissue: patellar “tendon,” quadriceps tendon, other ligamentous structures
  - ▶ Dislocation: patella versus tibiofemoral joint
  - ▶ Fracture: distal femur, proximal tibia, patella



# Injuries about the knee

- ▶ Quad/patellar tendons
  - ▶ Forceful quadriceps contraction
  - ▶ Loss of extensor mechanism
  - ▶ BUFF splint, crutch it out
- ▶ Ligaments and meniscus
  - ▶ “pivoting,” plant-and-twist, “bending” injuries
  - ▶ Not emergent, but painful.
  - ▶ BUFF splint, crutch it out
  - ▶ EXCEPTION: knee dislocation





# Injuries about the knee: Dislocations

- ▶ A "knee" dislocation: tibiofemoral joint
  - ▶ Multiligamentous knee injury
    - ▶ At least 3: ACL/PCL/MCL/LCL
  - ▶ Highly unstable
  - ▶ High risk of vascular injury and associated fracture
  - ▶ OK to pull gentle in-line traction; also ok to leave in situ as long as there's a distal pulse. Keep checking
  - ▶ Emergency – splint and get out





# Injuries about the knee: Dislocations

- ▶ Patellar dislocation
  - ▶ Painful, typically stable
  - ▶ Usually easy to reduce
    - ▶ Pressure on the side of the patella sticking up
    - ▶ Gently flex the knee
  - ▶ OK to weight-bear, +/- evacuation



# Knee fractures

- ▶ Distal femur
- ▶ Proximal tibia
- ▶ Patella
- ▶ Gentle in-line traction if there is deformity
- ▶ BUFF splint and evacuate
  - ▶ With the exception of a clear patella fracture, you don't want these people trying to walk



# Lower extremity: below the knee



- ▶ Treatment and evacuation need depends on severity
  - ▶ Ankle sprains are the most common
  - ▶ All else: Primarily fractures. Tibia, fibula, bones of the feet
  - ▶ Toes? What about toes?

# A word on ankles

- ▶ Ankle sprains are the most common wilderness injury (blisters are second)
- ▶ Very wide spectrum of severity
  - ▶ “rolling” the ankle
  - ▶ Tibiotalar dislocation with multidirectional instability
- ▶ Swelling and bruising happen quickly
  - ▶ What do I do about the shoe?
- ▶ Typically the patient’s ability to weight-bear will dictate treatment
  - ▶ ACE wrap
  - ▶ BUFF splint





# Universal / generalized splinting principles

- ▶ Immobilize joint above/below: safest bet
- ▶ Neutral limb alignment whenever possible
- ▶ BUFF – use what you have, padding > rigidity
- ▶ Neurovascular assessment before and after splinting – pay attention to changes in pain

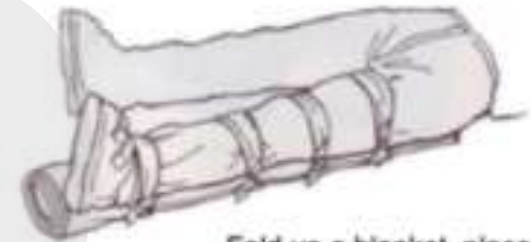
## Improvised Splints for Leg & Foot Injuries



For a foot or ankle injury, place a folded blanket around the bottom and sides of the foot and lower leg. Then secure it around the foot with cravats.



Roll a blanket around the injured leg, and secure it with cravats.



Fold up a blanket, place it underneath the injured leg, then secure with cravats.

Wait, a BUFF splint?

BIG

UGLY

FAT

FLUFFY

Padding >> Rigidity



# Lower extremity splinting: improvization

- ▶ Hiking poles
- ▶ Sticks
- ▶ Blankets
- ▶ Sleeping pads
- ▶ Tent poles
- ▶ Rain fly
- ▶ Tent footprint
- ▶ Jackets
- ▶ Sweatshirts
- ▶ Socks can be used to tie
- ▶ Bras – straps, elastic, pads
- ▶ Ropes/straps/bungees



Use a strap  
around the  
shoulder to keep  
splint from falling  
down



# Supplies and equipment: in an ideal world



- ▶ ACE wrap, SAM splint
- ▶ Gauze and kerlix – varying sizes
- ▶ Trauma shears / sharp knife
- ▶ Antiseptic wipes and chlorhexidine scrub
- ▶ Heavy duty tape and medical tape
- ▶ Absorbent padding and bandages
- ▶ Drugs: NSAIDs, Acetaminophen, Benadryl, loperamide, lidocaine, sudafed
- ▶ Salt and glucose powders
- ▶ Disposable scalpel, basic suture kit
- ▶ Large-bore needle, syringe
- ▶ Gloves
- ▶ Blister pads
- ▶ SWAT-T tourniquet





[Wildernessmedical.com](http://Wildernessmedical.com)

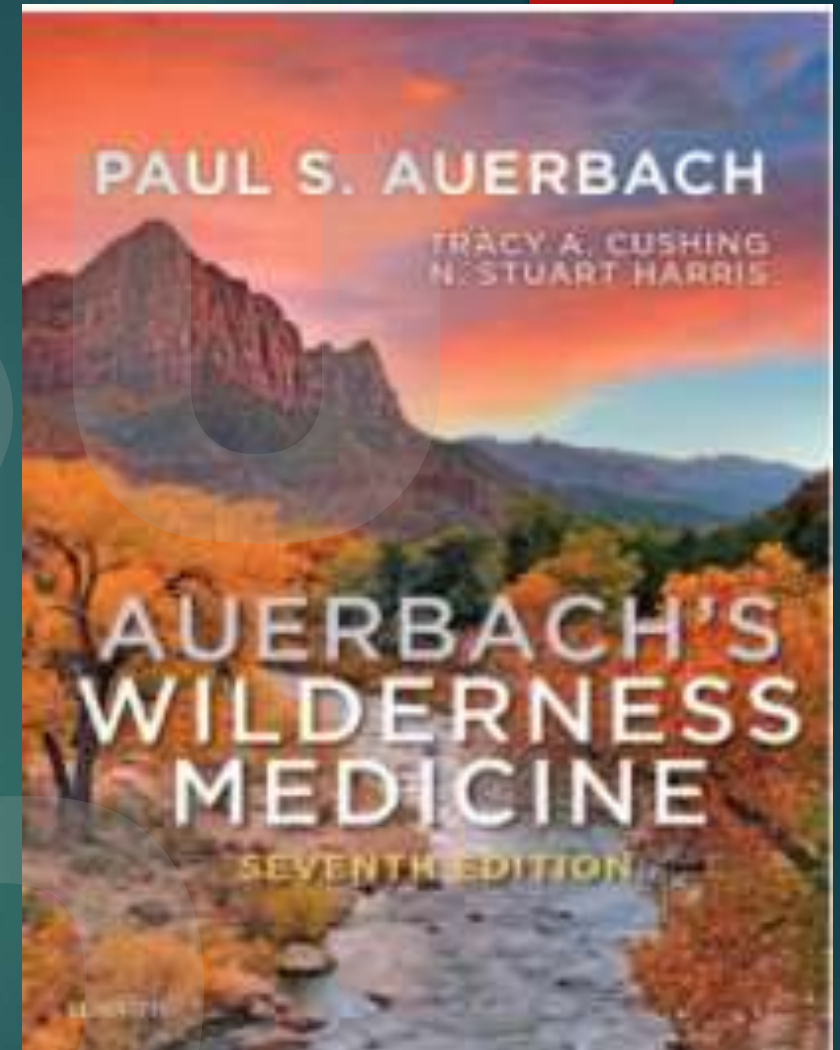
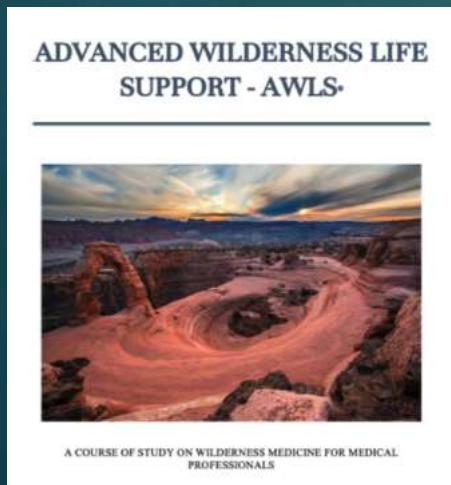
[Store.nols.edu](http://Store.nols.edu)

[Adventuremedicalkits.com](http://Adventuremedicalkits.com)

[Backcountry.com](http://Backcountry.com)

# Recommended References

- ▶ Wilderness Medicine. Auerbach PS, ed. 7<sup>th</sup> Edition
- ▶ Advanced Wilderness Life Support: the AWLS certification textbook
  - ▶ Various certification courses available
- ▶ Wilderness Medical Society: wms.org



<https://www.backpacker.com/skills/how-to-build-a-backcountry-knee-splint/>



Thanks!

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