Fracture Bracing

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Agenda

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- Bone Structure
- Mechanical Properties
- Types of Fractures
- Fracture Location
- General Management
- Complications

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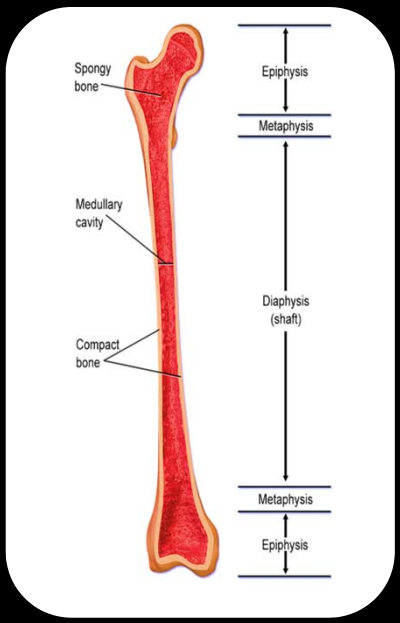
- Management of Fracture Bracing
- OTS vs. Custom Bracing
- Lower Extremity Bracing
- Upper Extremity Bracing
- Cervical Bracing
- Spinal Bracing

Bone Structure

Calcium, Collagen, and Phosphate

Long Bone Function:

1. *Support* the weight of the body
2. *Facilitate* movement via lever system



Mechanical Properties

Stress vs Strain

Stress is the force per unit area applied to the material. The maximum **stress** a material can stand before it breaks is called the breaking **stress** or ultimate tensile **stress.**

Strain is the response (or deformation) of a system to an applied **stress**

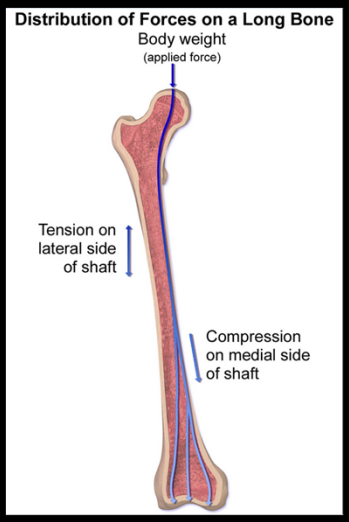
Mechanical Properties

Tension

- A force that pulls materials apart

Compression

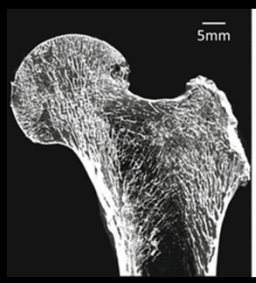
-A force that squeezes materials together

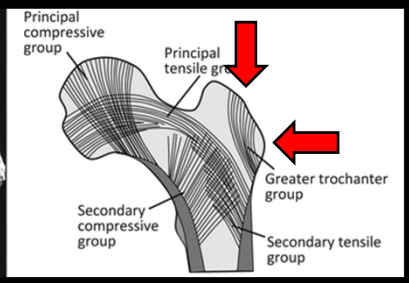


Mechanical Properties

Bone is ANISOTROPIC

- Typically STRONGEST in compression
- And WEAKEST in shear





Mechanical Properties

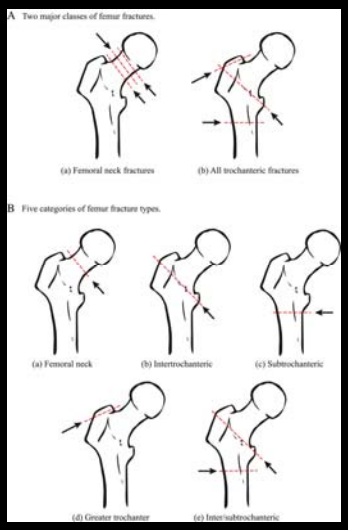
Intertrochanteric

Subtrochanteric

Inter/Subtrochanteric

Femoral Neck

Greater Trochanter



Mechanical Properties

Bone is VISCOELASTIC

- High rate of loading = high energy storage
  - Fractures result in multiple cracks
- Low rate of loading = low energy storage
  - Fractures result in single crack

Wolff's Law

"*Bone in a healthy person will adapt to the loads under which it is placed.*"

- Julius Wolff

- Bone has the ability to adapt, by changing its size, shape, and structure due to the mechanical demands placed on it.
- Bone is laid down (osteoblasts) where needed and resorbed (osteoclasts) where not needed.
- The remodeling may be either **external** or **internal**

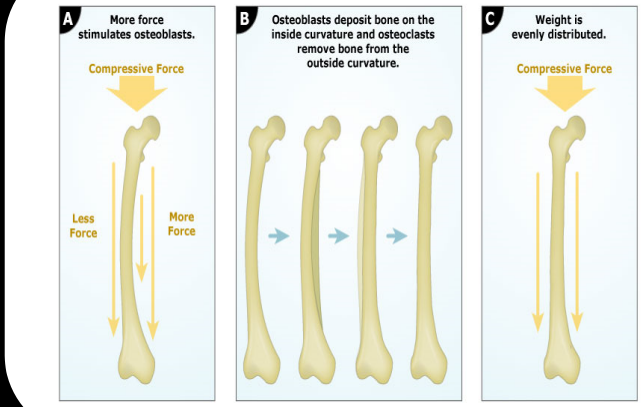
Mechanical Properties

Immediately after

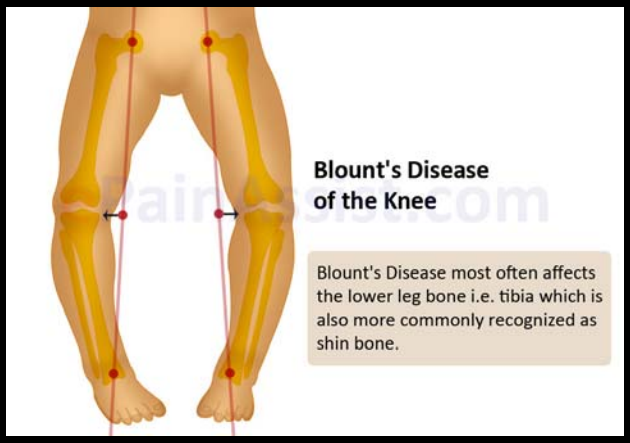
Bone Cell Growth

Absorption

Mechanical Properties

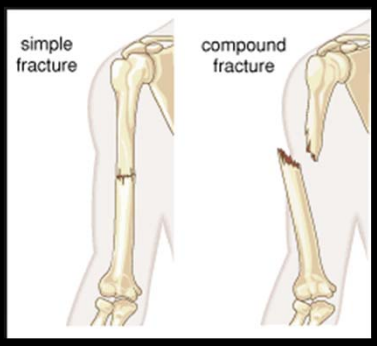


Mechanical Properties



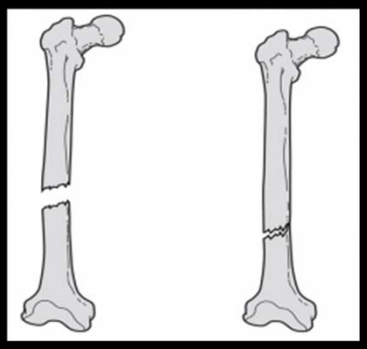
Types of Classifications

Simple vs. Compound – Simple (or closed) fracture are NOT accompanied by open skin wound whereas an open or compound fracture DOES have an open skin wound at the site.

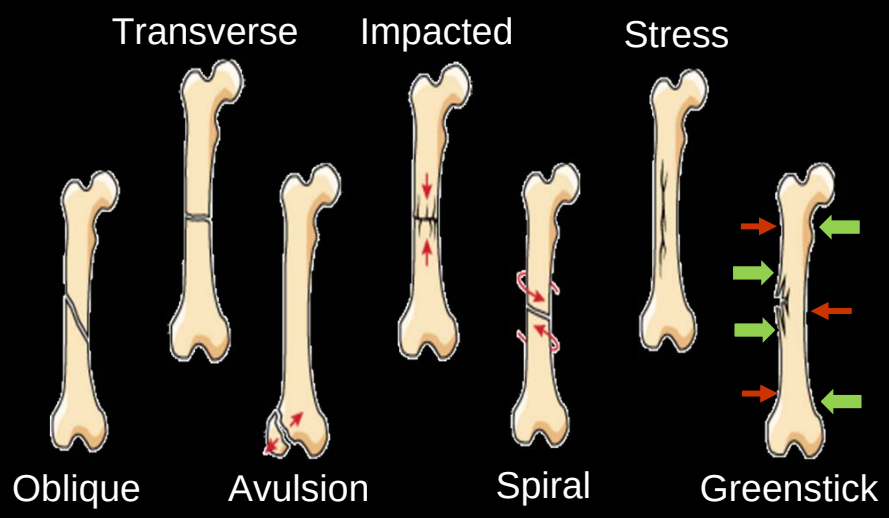


Types of Classifications

Complete vs. Incomplete – Complete fracture is associated with separation of bone into two discrete fragments. An incomplete fracture has some contact or continuity between bone fragments.



Types of Classifications

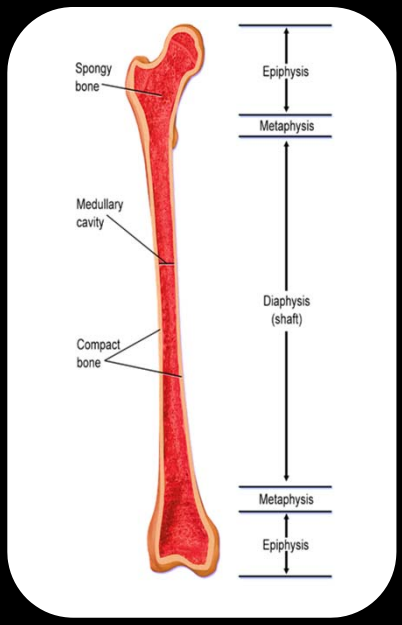


Types of Fractures

- Fracture dislocation is a fracture through or near a joint, accompanied by dislocation of that joint.
- Stress or fatigue fracture is produced by repeated overuse of a body part
- Pathologic fracture occurs through weak bone of abnormal composition. It results from normal use or mild injury to an area weakened by underlying disorders or local condition.

Fracture Location

- Diaphyseal
- Metaphyseal
- Epiphyseal
- Intra-articular



Fracture Location

Proximal

Mid

Distal

+

Humerus
Radius
Ulna
Femur
Tibia
Fibula

General Fracture Healing Times

Upper Extremity	Time to Heal
Phalanges	3-4 weeks
Metacarpals	4-6 weeks, 6 for mid-shaft
Radius	6 weeks
Ulna	4-6 weeks
Forearm	8-10 weeks
Humerus	8 weeks
Clavicle	6-8 weeks

General Fracture Healing Times

Lower Extremity	Time to Heal
Phalanges	2-3 weeks
Metatarsals	4-6 ends, 6-8 weeks mid-shaft
Tibia	16 weeks
Fibula	12 weeks
Forearm	8-10 weeks
Femoral Neck	16-20 weeks
Femoral Shaft	16-20 weeks

General Management

- Reduction
- Immobilization and maintenance of reduction
- Early restoration of function

Complications of Fractures

- Delayed union or non-union
- Infection
- Vascular compromise
- Misalignment

Contraindications to Orthotic Management

- Excessive wound drainage
- Spastic disorders
- Anesthetic limbs
- Severe soft tissue damage

Management of Functional Fracture Bracing

Sarmiento Methodology

- Guided **physiologically induced motion** to spur osteogenesis
- Period of **immobilization**
- **Hydrostatic pressure** via soft tissue compression to maintain alignment
- If you need to cross a joint, joints are to **remain free** ROM as to not create excess motion at fracture site

Functional Bracing

- Traditional casting vs Functional bracing
- Functional bracing is best applied to simple, low-energy fractures. Other methods of treatment such as external fixation and closed intramedullary nailing have become the preferred treatment for many complicated fractures.

- The objective of the fracture orthotic system is to apply a device that allows early graded function and is capable of responding to volume changes in the injured extremity after resolution of the acute symptoms.
- It is an active system that requires regular monitoring by the health care team and compliance by the patient.
- Appropriate donning and positioning, following of therapeutic regime and compliance and follow-up is crucial in successful outcome of function orthotic bracing.

OTS vs. Custom

- Deformity
- Multiple fracture control
- Long bone fracture is pathologic in nature
  - Osteogenesis imperfecta
  - Osteoporosis
  - RA
- Post surgery

Long Bone Fractures

- Tibial Fractures
- Femoral Fractures
- Humeral Fractures
- Ulnar Fractures
- Forearm Both-bone Fractures
- Clavicle Fractures
- Spinal Fractures

Tibial fractures – Closed & Open

- Reduction of fracture
- Cast or splint applied to obtain optimum alignment and correction
- Application of brace

Tibial fracture orthosis

- Light-weight, durable, easy to apply and adjustable.
- The distal attachment is to prevent the orthosis from sliding down and to avoid rotational deformities.
- The proximal femoral condylar extension assists in providing bending and rotary stability.
- Prefabricated orthosis fit 90% of the patients. Customization is needed for optimum fit.

- Freedom of movement of the ankle and knee joints facilitates physiologic contraction of musculature which promotes reduction of swelling.
- Short walks and then elevate the limb to prevent swelling
- Full range of motion of proximal and distal joint to avoid joint tightness and contractures.
- Malalignment of fracture fragments must be recognized and corrected and any shortening must be accounted.
- The orthosis is used until there is complete fracture healing and then patient is weaned from it.

Femoral Fractures

- The fracture must be aligned by means of traction for a sufficient period to obtain intrinsic stability.
- Traction is also important to prevent shortening, reduce swelling and pain.
- The fracture orthosis is applied usually after 4-6 weeks post-injury.
- It is important to actively and passively mobilize the knee joint and ankle joint even during traction application.

Femoral Fracture orthosis

- Adjustable thigh section attached to polycentric knee joints to adjustable calf section and polypropylene ankle joints and foot insert.
- Suspension is achieved through the femoral condylar extensions and foot insert
- Total contact for soft tissue compression to prevent of swelling and maintain alignment is crucial.
- Monitoring angular deformation

Tibial Plateau Fractures

Intra-articular fractures are usually difficult to manage with Orthotic bracing due to loss of fracture alignment and need for secure fixation and delayed weight-bearing.

Post-surgical / post-fixation fitting is achieved with range of motion knee brace to allow limited and progressive range of motion as healing occurs.

Ankle Fractures

- Stable ankle fractures can safely be immobilized in a planti-grade position in short walking cast.
- Surgical treatment of displaced and unstable fractures is recommended to allow early range of motion and weight-bearing.
- Post-surgical treatment is achieved with Walking boot to allow initial immobilization and early weight-bearing.

Metatarsal Fractures

- Commonly seen are Metatarsal stress fractures that are treated conventionally with immobilization through Walking boot in the initial stages.
- These can then be weaned into functional foot orthotics to provide the support and stability to the injured foot. Foot orthotics can be used long term with appropriate shoes.

Toe Fractures

- Toes fractures are most commonly treat orthotically with a rigid sole, rocker-bottom shoe.
- The hard sole of the shoe prevents toe break and allows immobilization and subsequent healing of the toe fracture.
- The rocker-bottom allows easy and optimum gait without causing any deviations.

Humeral Fractures - Closed

- Initial treatment of closed fractures consists of stabilization in a splint and sling to provide comfort, correct deformities and protect injured extremity.
- As soon as acute symptoms subside, it is important to institute gravity dependent pendulum exercises for the shoulder to prevent disabling adhesive capsulitis.
- In addition, activity of forearm and hand are also recommended to expedite recovery and reduce swelling.
- Gravity, along with the dynamic corrective forces of the elbow flexors and extensors, tend to align the fracture.
- Circumferential tissue compression

Humeral Fracture orthosis

- The humeral fracture orthosis is a bivalve adjustable, light-weight device.
- Stockinette is applied over the arm to allow absorption of perspiration.
- Full range of motion of elbow and full flexion and abduction of the shoulder should be possible.
- Bracing is usually done in 1-2 weeks after injury for closed fractures and in mostly delayed in open fractures depending on symptoms.

Humeral Fracture orthosis

- Over the shoulder design is provided to provide necessary suspension and prevent rotation.
- A cuff and collar is worn in the first 1-3 weeks. While adjusting the length for the cuff and collar, the shoulder should not be shrugged. The elbow flexion is maintained to promote distraction.
- It is important to remove the cuff and collar frequently and exercise the elbow and wrist.
- Initial passive and gradual active exercises are recommended.

Ulnar Fractures

Conventional treatment is found to be beneficial where there has been little or no axial loading of the forearm and hence no injury to the distal radioulnar joint or subluxation or dislocation of the proximal radial capitellar joint.

When fracture dislocations occur, a cast is applied with elbow at 90 deg flexion and forearm in relaxed supination

Ulnar Fracture orthosis

- Prefabricated forearm fracture orthosis are available which are oval in shape, can be heated and conformed to the shape of the arm and are adjustable in tightness.
- It has indentations on the volar and dorsal surfaces to provide compression in the interosseous space.
- Full range of motion exercises of shoulder, elbow, wrist and hand are continued to prevent stiffness and contractures.

Forearm Both-Bone Fractures

- Functional bracing is beneficial after an adequate closed reduction is obtained and maintained for 2 weeks.
- Closed reduction is achieved though plaster cast with the elbow in 90 degrees of flexion and the forearm in relaxed position of supination.
- If the reduction is maintained for 2 weeks, patient can be transitioned to functional bracing.
- Considerable intrinsic stability is necessary in both bone fracture of the forearm.

Both –Bone Fracture Orthosis

- Orthotic bracing is useful after open reduction of the bones when adequate stability is achieved.
- Patient can be transitioned to a wrist splint to provide necessary support and stability as activities increase.
- Wrist splint is removable to allow range of motion exercises and cleaning of arm.

Clavicle Fractures

If the broken ends of the bones have not significantly shifted out of place, you may not need surgery. Most broken collarbones can heal without surgery.

It is common to lose some shoulder and arm strength. Gentle exercises to prevent stiffness and weakness are crucial. More strenuous exercises are started gradually once the fracture is completely healed.

If the broken ends of the bones have significantly shifted out of place, your doctor may recommend surgery.

Clavicle Fracture Orthosis

- Most clavicle fractures can be treated by wearing a sling to keep the arm and shoulder from moving while the bone heals.
- Figure 8 Clavicle brace helps maintain appropriate position and allows the clavicle to heal faster and is easily adjustable. Correct positioning and donning is important for optimum benefit.
- Most clavicle fractures take about 6-8 weeks to heal.

Spinal Fracture Devices

- Controlling pain by limiting motion and unloading discs, vertebrae and other spinal structures by compression.
- Stabilizing weak or injured structures by immobilizing the spine post-surgically.
- Providing three-point force systems to provide correction or prevent progression of a deformity.

Types of Spinal Bracing

- Flexible orthoses or corsets
  - low pain
  - degenerative disc disorders or postural deformities
- Rigid orthoses
  - front and back rigid panels
  - complete immobilization of the specific area of the spine

Cervical Braces

- Cervical collars provide some mechanical restraint to flexion, extension and (to a lesser degree) lateral flexion and rotation.
- Works as a reminder to limit head and neck motions
- Mostly for minor injuries of the cervical spine where immobilization is needed or for post-operative stabilization and support of the cervical spine.

Cervical Braces

- It should be applied snug to prevent any movement in the cervical spine.
- It should be worn all the time unless otherwise instructed by the physician.
- It comes with an extra set of pads for cleaning purposes.
- Be watchful of any pressure areas or redness.

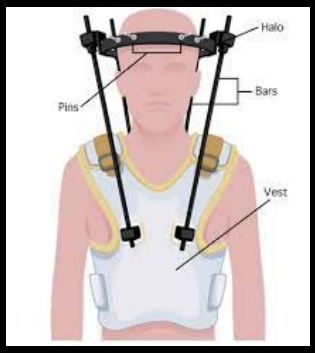
Cervical Thoracic Braces

- Lower cervical or upper thoracic spine injury
- Anterior section consisting of sternal plate with mandibular support and posterior section with an inter-scapular plate, posterior uprights and occipital support.
- The anterior and posterior sections are usually connected by shoulder and axillary straps.
- Restricts flexion and extension of the head and cervical spine as well as lateral movements and rotation.

Cervical Thoracic Braces

- It is height and volume adjustable to custom fit it to any patient
- It comes with extra set of pads for cleaning and replacement
- It should be applied snug to prevent any movement in the cervical and thoracic spine.
- It should be worn all the time unless otherwise instructed by the physician.

Halo Cervical Orthosis



- Halo immobilizes the head and cervical spine. It can provide distracting force that aids in spinal stabilization and reducing axial loading.
- Its basic components are a Halo ring, distraction rods and distal padded vest. Four pins are placed equally around the skull.
- Once the halo pins and the vest are secured in place, radiographic images are taken to ensure appropriate alignment of spine.

Halo Care

- Use cotton swabs (Q-tips) with soap and water or hydrogen peroxide to clean the skin around the pins twice a day.
- Clean the area and the skin around your vest everyday with an alcohol-moistened towel every 2 or 3 days. Do not use soaps, lotions, or powders under your vest. Do not take a shower – use sponge baths to clean the rest of your body. Wash your hair with dry shampoo products or tuck a towel around your neck and lean over a sink, but do not get the vest wet.

Halo Complications

- Infection at the pin site
- Pin loosening
- Balance issues
- Sleeping problems
- Neck muscle weakness

TLSO

- Rigid bivalve TLSO are recommended for immobilization of the spine during recovery from a fracture or after a spinal surgery.
- Made of rigid plastic with complete padding for comfort
- They are custom made from measurements and are fit on the next day
- Straps on either side allow adjustability and snug fit with volume changes

TLSO

- TLSO should be worn at all times when out of bed
- They should be donned snug to prevent any movement within the brace
- The brace should be worn until the fracture heals completely or unless otherwise advised by the physician

Conclusion

- Functional Fracture bracing applications and outcomes vary depending on the type, classification, location and severity of the fractures amongst other factors.
- Multiple fracture orthotic options are available in the off-the-shelf as well as custom category. These need to be thoughtfully prescribed for fracture management or post-surgical stabilization in order to achieve optimum results. Fitting and rehabilitation with these fracture braces needs to be closely monitored to prevent complications and achieve faster and optimum healing.

Thank You

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