ORTHOPAEDICS

FOR PRIMARY HEALTH CARE

LION
LEARNING INNOVATION VIA ORTHOPAEDIC NETWORKS

EDITOR: **MICHAEL HELD**

UNIVERSITY OF CAPE TOWN'S **ORTHOPAEDIC DEPARTMENT**

Orthopaedic emergencies

by Stephanie Roche, Kim Laubscher, Stefan van der Walt & Stephen Roche

Learning objectives

1. Red flags in the outpatient setting: infection, malignancy and spinal disorders.
2. Red flags in the Orthopaedics ward: fat embolism, compartment syndrome, Paediatrics: non-accidental injury.

Orthopaedic red flags

Many orthopaedic problems can be managed in the primary care setting. To practice safely at this level of care, medical officers need to know which patients to investigate and follow-up and when to refer patients for urgent or emergency management.

Initial assessment includes a thorough history of the presenting complaint and medical history (particularly concerning trauma, cancer, immunosuppressive conditions or medications), and a musculoskeletal and neurological examination. The crucial warning signs on history and examination that suggest serious pathology and which might warrant referral or specialist advice, are listed in the table.

Clinical red flags	
History:	
Local	Rapidly progressive symptoms
	Red, hot swollen joint
	Pain interrupting sleep
Systemic	Loss of appetite
	Loss of weight
	Fever
	Change in bowel or bladder function
	Weakness or change in sensation
	History of cancer
	History of intravenous drug use
	Immunosuppression
Examination	Fever >38ºC
	Inability to bear weight on joint
	Red/hot /swollen joint
	Saddle anaesthesia
	Lower motor neuron signs
	Reduced anal tone
	Bilateral upper motor neuron signs

Malignancy

Malignant tumours of soft tissue and bone should be excluded in all patients with a mass or lesion with any of the characteristics listed in the table. Imaging (ultrasound for soft tissue masses, radiograph for bony masses) and referral to a specialist should be the next step. See the specific chapter for more information.

Red flags for masses
Rapid growth
Pain
>5cm diameter
deep to fascia

Infection

Primary septic arthritis and osteomyelitis are important differentials in patients presenting with musculoskeletal pain or swelling. Delay in diagnosis (even by hours) can result in progressive joint destruction. Importantly, obvious signs of inflammation may be absent in immunosuppressed patients, and investigations may be warranted in the absence of systemic signs. In immunocompetent patients, one or more of the following features listed in the table alongside are present.

Diagnosis

- **Blood results** as above (WCC, ESR or CRP, blood culture).
- **Uric acid** and **inflammatory arthritis markers**. Gout and inflammatory arthritis will be on the list of differentials and may need to be excluded.
- **Synovial fluid aspiration** (assess the appearance of fluid, cells and differential count, crystals, Gram stain and culture) –
- **X-rays**

Differential diagnosis:

- Inflammatory arthritis, for example, rheumatoid arthritis, psoriatic arthritis (although more likely oligo- or polyarthritis, as opposed to monoarthritis)
- Osteoarthritis
- Gout, pseudogout
- Trauma (for example, haemarthrosis)

For treatment, please refer to the respective chapter on infections.

Red flags for infections		
Systemic	Temperature	>38°C
	Leukocytes	>12 000 x 109/L
	Respiratory rate	elevated
	Heart rate	elevated
Orthopaedic	Inability to weight bear	
Blood results	ESR	>40mm/ hr
	CRP	elevated

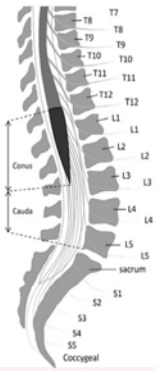
Red flags which should raise suspicion of infections.

Clinical pictures of swollen, warm, red, painful joints (Picture: Dr K Laubscher)

Spinal pathology

In addition to the general red flags mentioned at the beginning of the chapter, the following features may also suggest serious spinal pathology. Patients presenting with signs of cord compression or *cauda equina* syndrome (see figure below) need urgent referral to an orthopaedic or neurosurgical service.

Red flags for spinal disorders	
History	- Back pain in a patient < 20 or > 55 years of age. - Previous history of cancer - Immunosuppression -Thoracic pain - Pain at rest or at night - Neurological fallout - Structural deformity
Cord compression	Upper motor neuron symptoms: - Increased muscle tone - Brisk reflexes - Clonus - Weakness
Cauda equina	Lower motor neuron symptoms: - Sphincter disturbance, bladder or bowel changes, - gait abnormalities, saddle anaesthesia, sexual dysfunction, decreased tone or weakness of lower limbs, absent reflexes, diminished or absent anal wink test and a bulbocavernosus reflex



The *cauda equina* is usually located below L3 (Picture: Dr K Laubscher)

Fat embolism syndrome

Definition: Fat embolism is a rare, non-thrombotic embolism that is potentially fatal and has a mortality rate of 15%. It is a systemic dysfunction caused by the entry of fat into the circulation, most commonly from the bone marrow. The mechanism of entry into the systemic circulation is thought to be due to either a *patent foramen ovale* or via microembolism, where the fat particles are small enough to pass from the pulmonary arteries into the pulmonary veins. Patients typically develop fat embolism as a result of long bone fracture or orthopaedic surgery. It occurs 12 hours to 2 weeks following trauma or surgery. The diagnostic criteria in the following table can be used.

Management: Supportive treatment with frequent ICU admission is required.

Clinical features of fat embolism Gurd and Wilson criteria: 2 major or 1 major and 4 minor criteria = FES	
Major	1) Petechial rash 2) Respiratory symptoms plus bilateral signs with positive radiographic changes 3) Cerebral signs unrelated to head injury or any other condition
Minor	1) Tachycardia 2) Pyrexia 3) Retinal changes (fat or petechiae) 4) Urinary changes (anuria, oliguria, fat globules) 5) Sudden drop in haemoglobin level 6) Sudden thrombocytopaenia 7) High erythrocyte sedimentation rate 8) Fat globules in the sputum

Compartment syndrome

Compartment syndrome results from increasing pressure in an anatomical compartment (typically muscle compartments divided by strong fascia), where the tissue pressure exceeds the vascular perfusion pressure. The tissue becomes ischaemic and infarction will occur without urgent intervention.

Clinical features:

Can occur after any form of injury, but most commonly associated with long bone fractures or other forms of trauma

The leg's anterior compartment is most frequently affected (e.g. after tibia fracture), but any compartment can be affected (e.g. hand or forearm).

Early symptoms include **pain, paraesthesia** and swelling. Often the pain is out of proportion to what is expected from the injury. These symptoms occur as venous pressure is exceeded. Late symptoms include the other Ps: **paralysis**, absent **pulses, pallor and poikilothermia** (or cold peripheries). These symptoms occur as arterial pressure is exceeded.

The diagnosis is clinical; the management is urgent fasciotomy.

Clinical picture of a forearm with multiple gunshot injuries and fasciotomy incisions. The dusky hand indicates compromised perfusion. (Picture: Dr K Laubscher)

Deep vein thrombosis

Deep vein thrombosis (DVT) occurs when there is thrombus formation in one of the deep veins, typically of the lower limb or pelvis.

Thromboembolism to the pulmonary vasculature (pulmonary embolism) is the most feared complication and is potentially fatal. Importantly, Orthopaedic post-surgical patients are at a greater risk of DVT due to the nature of the operation (hip and pelvic surgery, for example) and because these patients are often older and immobile.

Clinical features:

- Unilateral leg swelling with or without associated erythema and distended superficial veins
- Pain (often worse on dorsiflexion of the foot)
- Warmth and tenderness on palpation
- Shortness of breath, chest pain, or both in pulmonary embolism cases (always look for a DVT in patients who develop respiratory symptoms in the ward).

Diagnosis: Compression ultrasonography

Management: DVTs can mostly be prevented with early mobilisation, compression stockings and pharmacological prophylaxis. Treatment involves anticoagulation therapy with heparin and warfarin.

Non-accidental injury in a child

The red flags listed at the beginning of this chapter should also be applied to children. Every child with a painful or swollen joint should be assessed as to whether they appear systemically unwell or not, and the degree to which they can weight bear or use the affected limb. Orthopaedic and non-orthopaedic red flags are listed in the table below.

Management

Clear, accurate and thorough documentation of all findings, which may also include sketches. By law, all suspected child abuse must be reported to the relevant authorities (police, social worker, and so on). See the specific chapter in the section on fractures in children for an approach to these patients.

Red flags for child abuse
— Multiple fractures at different stages of healing. — Fractures other than the skull or clavicle in neonates (may occur during birth). — Severe skull fractures in children under 18 months. — Long bone fractures in infants not yet walking. — Digital fractures in children under three years. — Sternal, rib or scapula fractures (suggest high energy force). — Vertebral body fractures. — Metaphyseal corner fractures (occurs when a limb is pulled, twisted or shaken). — Epiphyseal separations
— Inconsistent history, lack of witnesses for the incident or clinical findings inconsistent with the reported mechanism of injury..

Open fractures

Irrigate, stabilise and administer appropriate early antibiotics. See the chapter on ‘Orthopaedic Injuries’.

Clinical and radiological images of open fractures (Picture: Dr K Laubscher)

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Basic fracture principles

by Michael Held, Maritz Laubscher, Graham McCollum, Phinda Njisane & Vela Njisane

Learning objectives

1. Define and classify fractures.
2. Recognise fracture patterns.
3. Clinically examine a fracture.
4. Outline the basic principles of fracture management.

What is a fracture?

A fracture is an 'incomplete or complete break in the continuity of a bone'. However, this definition does not accountfor accompanying soft tissue injury.
The degree of soft tissue injury dictates fracture management and the degree of fracture healing. Therefore, a better definition would be that a fracture is 'an open or closed soft tissue injury of varyingseverity, accompanied by a break in the continuity of the adjacent underlying bone'.

Basic fracture classification

Fractures may either be 'open' or 'closed'. In open fractures, there is a breakin the continuity of the skin overlying the fracture. In closed fractures, there is no communication between the fracture and the atmosphere.

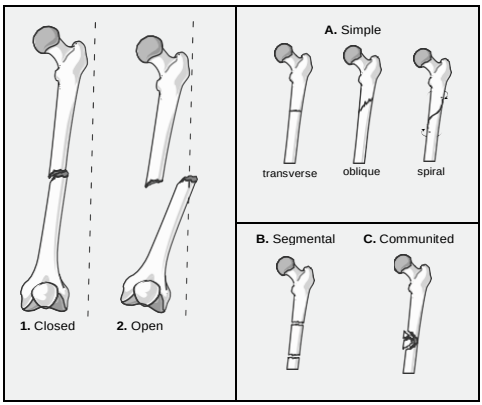
Other definitions

- **Pathological fracture:** Fracture which occurs in diseased bone. The disease weakens the bone e.g. metastatic cancer or osteomyelitis.
- **Stress fracture:** Fracture in normal bone that is subjected to repetitive loads or stress.

Fracture patterns

Complete fractures

1. **Simple**: A single fracture line. The fracture line may be transverse, oblique, saggital or spiral.
2. **Segmental**: ≥ 2 fracture lines, creating a tubular segment of the shaft.
3. **Complex/comminuted**: Multiple fracture fragments with no lateralor longitudinal stability.



Incomplete fractures

1. **Greenstick:** On bending this leadsto an incomplete break of the bone.
2. **Buckle**: A stable compression fracture.

Describing fractures

When describing a fracture, one should comment on the following:

1. **Soft tissue involvement**: open (grading) vs closed
2. **Position:** metaphysis vs diaphysis; proximal vs distal
3. The **injury/fracture** itself**:** the extent (complete vs incomplete) and the fracture pattern itself
4. **Location**: the bone involved
5. **Displacement:** length, angulation, rotation, apposition
6. Is there **growth plate** (Salter-Harris)or **auricular involvement?**
7. **Neurovascular status:** sensation and distal pulses

Diagnosis of fractures

The primary survey of the patient should always take precedence to the examination of a fractured bone, unless torrential bleeding from the fracture site is suspected.

As with all clinical examinations you muststart with history (how, when and what), followed by examination (look, feel, and move) and then special investigations.

1. **History**: How did the injury happen? When did it happen? What has been done so far in terms of management/ treatment? Note the pain, patient's activities of daily living and relevant history (medical, surgical or social).
2. **Examination**:
   - **Note vital signs**
   - **Look**: skin – wounds, bleeding, colour; soft tissue swelling, bone – deformity/alignment
   - **Feel**: deformity, swelling, tenderness and distal pulses
   - **Move**: active movement, passivemovement, abnormal range of motion/location
3. **Special investigations**: X-rays apply the Rule of Twos: 2 views, 2 joints, 2 limbs, 2 opinions, 2 occasions (see 'Approach to orthopaedic X-rays').
4. **Severity**

Fracture management

Basic principles for management priority is **life > limb > fracture**.

Generally, a fracture may require surgical intervention or non-surgical intervention. Non-surgical management involves closed reduction with immobilisation (cast or splint). Management is dependenton the fracture's stability and displacement. Surgical management can include:

- Open reduction which remains the gold standard for most intra-articularfractures.
- External fixation with pins and bars which is often used in fractures withhigh infection risk (open fractures) or in staged management of multipleinjured patients to avoid long operating times.

Examples:

A. Percutaneous pin fixation (e.g. elbow fractures in children)
B. Intramedullary (i.e. femoral nail) or extramedullary devices (e.g. plate fixation in forearm fractures)

Indications for surgical management:

- Failed nonoperative management (malunions or nonunions)
- Unstable open fractures (II–III)
- Displaced intra-articular fractures
- Salter-Harris III–V
- Multiple fratures involving pelvis femur or spine

Contra-indications for surgical management:

- Poor soft tissue quality affecting fracture or surgical approach, e.g. infection, excessive swelling, burns.
- Amputation is considered to be betterfor the patient and limb.
- Surgery or anaesthesia is contrainidcated due to patient's medical history.

Key takeaways

1. Fractures may either be open or closed.
2. Soft tissue injuries dictate fracture management and healing

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Modified images:

Fractures. Available from: https:// smart.servier.com/

Approach to orthopaedic X-rays

by Maritz Laubscher, Michael Held & Graham McCollum

Learning objective

1. Systematically describe a fracture on an X-ray.

Basics

You can remember a simple approach an XRs through the acronym **ABCS** (Adequacy, Bone, Cartilage, Soft tissue).

Specific views need to be requested depending on the suspected injured joint.

Joint	Views
C-spine	AP, lateral, open mouth (dens injuries)
Shoulder	AP, Y-view, axillary view
Elbow	AP, lateral, Greenspan (radial head and neck #)
Wrist	Scaphoid views
Pelvis	AP, inlet view, outlet view
Acetabulum	AP, judet views - objurator oblique, iliac oblique
Ankle	AP, lateral, Mortise views (talar shift and syndesmotic injuries)
Foot	AP, lateral, oblique
Markers for GSWs	help understand bullet tracts
Stress views	Done by orthopod

A. Adequacy

Is this an adequate X-ray regarding demographic information of the patient, date, time, and site/side, view or projection? (e.g. AP X-ray of the right shoulder showing distal to the midshaft of the humerus and medial to past the mid clavicle but not including the sternoclavicular joint), Rule of Twos.

The Rule of Twos: When requesting and evaluating orthopaedic X-rays, it is important to always apply the Rule of Twos:

- **2 views**: Usually AP and lateral.
- **2 joints**: Include the joint above andbelow the bone with the pathology.
- **2 limbs**: Useful for comparison, particularly in children with growth plates provided the other side is normal.
- **2 opinions**
- **2 occasions**: PaPrticularly in fracturesbefore and after reduction or application of splints/casts.

B. Bone

Assess from outside (cortex) to inside (medullary cavity) and trace the outline of the bone.

- **Density**; 'Darker', less distinct bone projection with thin cortices is described as osteopaenic. Lesions are described compared to the surrounding bone: Lytic = density is

- lower, sclerotic = density is higher, or a combination described as mixed.

Osteolytic lesion of an osteochondroma, a common and benign cartilage lesion affecting young people (Image: Thomas Hilton)

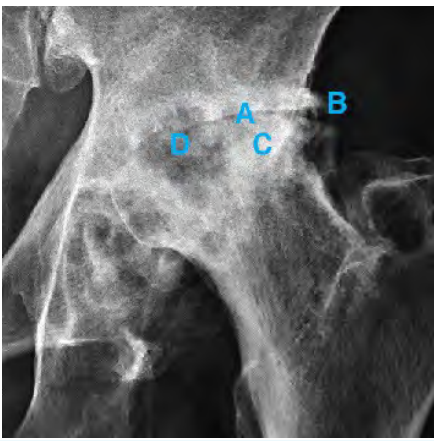
- **Fracture**: Any disruption or break in the cortex should be described according to its location (diaphysis, metaphysis, epiphysis, intra or extra articular), pattern (simple or complex/ comminuted) and displacement.
- **Displacement** describes how the distal part of the bone has moved relative to the proximal part of thebone. The displacement should bedescribed in at least 2 planes, the coronal plane as seen on an AP X-ray and the sagittal plane as seenon a lateral X-ray. The axial plane displacement is rotation and oftenneeds to be assessed clinically as it is not obvious on AP and lateral X-ray. Displacement can be described as LARA (length, apposition, rotation and angulation).

Example: The midshaft transverse tibia fracture is shifted 25% medial and 25% posterior with 10° of varus tilt and 30° of anterior tilt, there is a5mm of impaction.

C. Cartilage/joint

Assess for joint **congruency; subluxation** is when the joint is partially in tact and dislocation is when there is no contact between the articular surfaces.

Assess for signs of cartilage **degeneration or osteoarthritis**; joint space narrowing, osteophytes, subchondral sclerosis and subchondral cysts.



Osteoarthritis of the left hip

A) joint space narrowing; B) osetophytes; C) subchondral sclerosis and D) subchondral cysts

S. Soft tissue

- **Swelling** or signs of joint effusion or haemarthrosis.
- **Gas** suggesting an open wound or infection.
- **Foreign body**, e.g. glass.
- **Discontinuity** of the soft tissue line or dressings, indicating a wound.

References

Modified images

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2. Osteoarthritis: https://commons.wikimedia.org/wiki/File:Severe_(T%C3%B6nnis_grade_3)_osteoarthritis_of_the_hip.jpg

Complications of fractures

by Vela Njisane & Phinda Njisane

Learning objective

1. List and understand the common complications of fractures.

Life-threatening complications

Life-threatening complications can include massive haemorrhage, mainly in femur and pelvic ring fractures or fractures with injuries to large vessels. In hip fractures, life-threatening complications are often due to sequela of immobility such as pneumonia or thromboembolic disease.

Acute complications

Acute complications can include injuries to structures such as nerves and vessels (neurovascular injuries), the skin and soft tissue integument (degloving injuries and open fractures, fracture blisters) and compartment syndrome.

- Nerve injuries
- Vascular injuries
- Soft tissue injuries
- Compartment syndrome
- Fracture blisters (see below)

Fracture blisters

Chronic or delayed complications

- Infections (osteomyelitis)
- Delayed, non- or malunion
- Post-traumatic arthritis
- Complex regional pain syndrome

Non-union of a tibial fracture

Complications of peri- and intra-articular fractures

Avascular necrosis

- Post-traumatic arthritis
- Stiffness
- Heterotopic ossification

References

Modified images

Fracture blisters. Available from: https://commons.wikimedia.org/wiki/File:Fracture_blisters.jpg

Non-union. Available from: https://commons. wikimedia.org/wiki/File:Ganglio_ intraosseo.png

Open fractures

by Maritz Laubscher, Michael Held & Marc Nortje

Learning objectives

1. Recognise and grade an open fracture.
2. Understand the basic (non-surgical) management of an open fracture.

Introduction

Open fractures, also known as compound fractures, are fractures with a direct communication to the external environment. A wound in the proximity of a fracture should be managed as an open fracture until proven otherwise. Open fractures often occur through high energy mechanisms and are often associated with additional injuries. Common sites for open fractures are the tibia (most common open long bone fracture), ankle, phalanges, metacarpals and forearm.

Open tib/fib fracture (Image source: Dr K Laubscher)

Approach to open fractures

1. **ATLS**: Life before limb – ABCDEs, directpressure on wound to limit bleeding (partof secondary survey).
2. **Grading a fracture** (Gustilo-Anderson classification): Extent of contamination, soft tissue coverage (need for flap) and presence of vascular injury are defining features when grading the fracture.

Grade	Wound Size (cm)	Soft tissue damage, fracture comminution and contamination
I	< 1	Minimal
II	1–10	Moderate
III	> 10	Severe
A		Adequate soft tissue cover
B		Soft tissue coverage requires a flap
C		Associated arterial injury requiring surgery

3. **Early antibiotics and analgesia**

Antibiotics: Early antibiotics most important intervention to prevent infection. Studies shown delay more than 3h from injury increases infection rate.

- **Grade 1 and 2**: Narrow spectrum antibiotic covering skin commensals (gram positive organisms). Local preference – **cefazolin** (1st generation cephalosporin) for 48 hours.
- **Grade 3**: Broad spectrum cover required, including cover for gram negative organisms. Local preference

- early treatment with **co-amoxiclavor cefazolin, gentamycin (and metronidazole in case of farmyard injury)** for 5 days.
- **Tetanus toxoid 0.5 ml subcutaneous**.

Analgesia

4. **Irrigation and dressing:** As part of preparation for theatre, the wound should be cleaned with brief irrigation and sterile saline dressing should be applied. Dressing should be undisturbed until the patient is taken to theatre. Photographic documentation of the wound facilitates communication with other teams.
5. **Neurovascular check:** Reassess the neurovascular status.
6. **Reduce and immbolise** (with repeat neurovascular exam): Reduce and immobilise with a splint to reduce pain and limit further soft tissue injury.
7. **Refer to orthopaedics:** Patients must be referred to orthopaedic surgeon – obtain consent, keep NPO, X-rays etc.

During surgery

Increased time to debridement does not increase infection rates, providing initial treatment was adequate (early antibiotics and sterile dressing).

- **Debridement**: Removal of all foreign matter and excision of dead and devitalised tissue.
- No benefit shown to using other irrigation fluids like soap or antiseptic solutions. Any bony fragments which are not attached to soft tissue should be removed.
- External fixation allows maintenance of the fracture reduction while giving full and easy access to the soft tissue and wound care.
- In a hospital where the expertise or equipment is not available, open fractures can be debrided and a back slab applied. Select open fractures with clean wounds can be internally fixed in the first sitting, providing the expertise are available.
- Open fractures with clean, minor wounds can be closed primarily following initial debridement. If the wound is not closable or contaminated, it is better left open and a sterile vacuum assisted closure dressing applied.

Post-surgery

Patients should be **reassessed in 24–48 hours** for a change in dressing and assessment for further debridement. If the wound is clean, it may be closed by appropriate means. If not clean, further debridement is done and a pus swab is taken. The patient would be taken back to theatre as often as required until skin closure can be done.

Relook surgery

On relook surgery, the fracture is then treated on its merits. Options include:

1. Definitive external fixation.
2. Conversion of temporary external fixation to internal fixation.

References

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Modfied images:

1. Open fracture. Aavailable from: https://commons.wikimedia.org/wiki/File:Open_fracture_01.JPG

Approach to the multiply injured patient

by Stefan Swanepoel & Sithombo Maqungo

Learning objectives

1. A multidisciplinary approach to the multiply injured patient leads to a reduction in post-injury morbidity and mortality.
2. The assessment of any multiply injured patient starts with the primary survey assessment according to Advanced Trauma Life Support (ATLS) protocol.
3. Haemorrhagic shock is one of the central problems in patients with multiple trauma.
4. Up to 50% of musculoskeletal injuries are missed in the first assessment of a polytraumatised patient.

Introduction

Polytrauma, or the co-existence of multiple traumatic injuries in the same patient, is present in as many as 40% of trauma admissions. Polytrauma often involves young, productive individuals and represents a substantial burden to society, from both financial and human perspectives, and the residual disability in survivors can consume a significant proportion of healthcare resources.

With most hospitals in Africa receiving at least one polytrauma patient per week it is highly likely that you as a junior doctor will be involved in the care of these patients, either in the acute resuscitation phase or following surgery.

The initial presentation of a poly-traumatised patient can be quite overwhelming and familiarity with an algorithm for the assessment and initial treatment provides the treating physician with the confidence to competently manage polytrauma and ensures optimal outcomes for the patient.

Incidence and epidemiology

In Africa, injury-related mortality rates are six times (and road traffic injuries double) the global rate, and unique to our country is that pedestrians account for more than halfof all road traffic fatalities. A diagnosis of "multiple trauma" implies the presence of two or more separate injuries, at least one or a combination of which endangers the patient's life.

Multidiscipinary approach

The optimal approach to the polytrauma patient requires the involvement of a multidisciplinary team. This team is often made up of, but not limited to, trauma surgeons, intensivists, orthopaedic surgeons, radiologists, urologists, neurosurgeons and anaesthetists.

Management – ATLS approach

The approach to the multiply injured patient who has sustained orthopaedic injuries begins similarly to any other trauma patient and starts with the primary survey assessment of the airway, breathing, circulatory and neurologic status (i.e. the Advanced Trauma Life Support)

A-B-C-D-E Scheme	
A	Airway: Secure/establish airway,immobilise cervical spine
B	Breathing: Secure adequate gas exchange
C	Circulation: Secure adequate tissue perfusion
D	Disability: Identify neurological deficits.
E	Exposure: Examine whole body of a fully exposed patient, keep patient warm and manage injuries that are not life treatening.

The ATLS course contains elements of theoretical tuition, but focuses mainly on practical exercises and simulations of emergency room procedures. In the primary survey, each patient is examined systematically according to the A-B-C-D-E scheme.

Hemorrhagic shock

Haemorrhagic shock is one of the central problems in these patients and a common cause of death. Excessive bleeding carries with it not only the threat of immediate death, but also increased mortality due to multi-organ failure and sepsis. Massive blood loss often starts a cascade of shock, inflammation and coagulopathy that can worsen blood loss and halt attempts at resuscitation. The goal of management is to "find the bleeding and stop the bleeding" with simultaneous rapid and effective restoration of blood volume. Additional attention should be given to maintain functional blood composition to preserve blood function, i.e. haemostasis, oxygen carrying capacity, oncotic pressure and biochemistry. It is critical to consider injuries to 6 regions which may account for major blood loss (see table below). If the patient does not respond to nonsurgical measures then surgical haemostasis is recommended.

After the primary resuscitation is complete, the secondary management of gross deformities includes realignment and splinting of the injured limb. A Thomas splint should be applied for all femur fractures in order to realign the fracture, provide immobilisation, control muscle spasm, reduce pain, reduce the incidence of fat embolism, decrease blood loss, and prevent further damage to blood vessels, neurovascular structures and soft tissue.

Six major potential areas of blood loss	
1	Chest
2	Abdomen
3	Long bones (especially femur fractures)
4	Pelvis
5	Retroperitoneum
6	'Blood on the floor': Scalp and external sources

The presence of limb-threatening phenomena, such as compartment syndrome and a pulseless limb, should be identified early. Open injuries should be washed with saline and covered with a Betadine-soaked gauze and splinted while waiting for radiographs and a formal orthopaedic consultation. Anti-tetanus toxoid and appropriate antibiotics should be administered for all open fractures.

Commonly missed musculoskeletal injuries

More minor injuries to the musculoskeletal system are frequently missed in the context of polytrauma. After initial treatment has been carried out, it is very important to carry out a head-to-toe secondary survey to identify more minor injuries.

Studies have indicated that up to 50% of musculoskeletal injuries are missed in the first assessment. These are often picked up weeks after the initial injury and can result in considerable morbidity, particularly undiagnosed foot trauma.

An awareness of the mechanism of injury helps to focus history taking and will guide examination to the relevant parts of the body. For example, if a patient presents with a posterior hip dislocation from a dashboard injury, this may be associated with ipsilateral patellar fracture, PCL disruption, femoral fracture, acetabular fracture or a combination of these injuries.

Patient with bilateral femur and tibia fractures, a potential cause of majorblood loss

Summary

Interdisciplinary healthcare approach to the multiply injured patient can help optimise care, minimise morbidity and mortality, and ultimately provide a framework for accelerated post-injury rehabilitation course.

Initial assessment and treatment should follow a structured approach (ATLS) which prioritises life-threatening injuries. Due to the high frequency of musculoskeletal injuries, the orthopaedic surgeon forms a vital member of the team. The most important step in the management of open fractures is adequate surgical debridement.

Patient with bilateral femur and tibia fractures, a potential cause of majorblood loss

Injuries of the shoulder girdle

by Ntambue Kauta & Stephen Roche

Learning objectives

1. Red flags in the outpatient setting: infection, malignancy and spinal disorders.
2. Red flags in the Orthopaedics ward: fat embolism, compartment syndrome. Paediatrics: Non-accidental injury.

Introduction

The shoulder girdle consists of three anatomical joints, the sternoclavicular, acromioclavicular and glenohumeral joints. Acute injuries to the shoulder girdle may result in a traumatic dislocation of one of the joints or a fracture. These injuries are usually due to either high energy impact (fall, road traffic accidents, sports injuries and so on) or low energy fall in patients with weak bones.

Sternoclavicular dislocations

This is a rare injury and can be divided into anterior or posterior dislocations. Compared to an anterior dislocation, a posterior dislocation has a higher risk of damage to retrosternal structures such as the subclavian vessels. The patient may present with a hoarse voice, stridor, or compromised neurovascular status of the upper limb due to pressure on vital structures by the retrosternally positioned clavicle. Dedicated sternoclavicular joint radiographic views of both joints must be obtained and will show the dislocation.

Management

In the acute setting, anterior dislocations are treated with a simple arm sling or a collar and cuff for two weeks and early return to function.

Posterior dislocations pose a risk of injury to vital structures behind the sternum and under the clavicle. Therefore, all patients with posterior sternoclavicular joint dislocation must be admitted to the trauma ward and prepared for surgery. A closed reduction manoeuvre must be attempted by a team of cardiothoracic and orthopaedic surgeons. If the closed reduction method reduction fails, the team will proceed to an open reduction and surgical stabilisation of the joint.

Acromioclavicular dislocations

This is a common injury affecting young adults, often resulting from falls from heights or contact sports injuries.

A threatened skin overlying the clavicle and neurovascular compromise is a red flag for urgent referral. After the initial assessment, the treatment will depend mainly on the severity of the displacement of the clavicle. Patients with a prominent step deformity with up to 100% displacement on radiographs should be immobilised in a sling and referred for orthopaedic review. Patients with >100% displacement usually warrant surgical management.

X-ray shows an acromioclavicular dislocation with more than 100% displacement.

Shoulder dislocations

The glenohumeral shoulder dislocation is the most common in the human body. Patients younger than 30y may develop recurrent instability, and those older than 40 are likely to present with an acute cuff tear or avulsion fracture of the greater tuberosity.

Assessment

A clinical examination must exclude brachial plexus, axillary nerve and vascular injury. On X-rays of anterior dislocations, the humeral head displaces medially and inferiorly. Posterior dislocations can be easily missed because only physicians aware of the 'light bulb' sign can make the correct diagnosis on AP radiographs. Besides AP and Y-view (lateral X-ray of the shoulder), a modified axillary view is essential to assess this injury.

Management

Inline traction (Hippocratic method) under conscious sedation should be used to relocate the shoulder. The neurovascular assessment must be repeated and documented after the relocation.

Fracture-dislocations should have orthopaedic input before attempted reduction.

At two weeks, patients should be reassessed for residual instability or, most importantly, a traumatic cuff tear (ideally with ultrasound or MRI) which should be urgently addressed surgically.

Other rare forms of shoulder dislocations involve acute traumatic inferior dislocation and multidirectional instability, often because of generalised ligamentous laxity.

AP X-ray of acute shoulder dislocation with an associated fracture of the greater trochanter.

All acute dislocations are treated initially with an emergency room or sports field relocation followed by a course of physical therapy. Patients presenting with recurrent dislocations or patients younger than 20 years of age and involved in contact sports, should be referred to an orthopaedic surgeon for reassessment and further treatment.

Clavicle fractures

Most clavicle fractures will respond well to immobilisation in an arm sling for 4 to 6 weeks and an early gradual return to function. Full healing is to be expected in 8–12 weeks.

Absolute indications for surgery are open fracture, skin tenting, neurovascular injury requiring repair and symptomatic non-unions after conservative treatment.

Relative indications for surgery are multiple fractures, and patients' work or leisure requirements.

X-Ray showing a midshaft clavicle fracture with 100% displacement and shortening.

Proximal humerus fractures These are fractures proximal to the surgical neckline. The majority of these injuries can be treated conservatively in an arm sling or collar and cuff. **Surgical indications** include open fractures, fracture-dislocation, displaced articular segment split fractures, pathological fractures and fractures which have failed conservative treatment (100% displacement, less than 50% apposition), valgus or varus deformity of more than 30 degrees).

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Humeral shaft fractures

by Ntambue Kauta & Stephen Roche

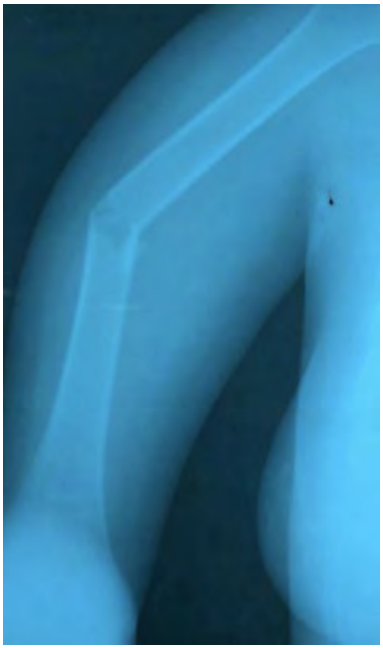
Learning objectives

1. Assess for neurovascular injuries.
2. Understand which injuries need to be referred.
3. Learn a save technique to immobilize fractures adequately.

Introduction

Humeral shaft fractures are fractures extending from below the surgical neck to the supracondylar ridge.

The mechanism of injury may be a high energy impact (falls from height, road accidents) or low energy impacts, such as a fall from standing height or trivial trauma as in pathological fractures.



Clinical assessment

- Observe the advanced trauma life support (ATLS) approach for all high energy impact patients.
- Examine and document the neurovascular status, most notably, the radial nerve.
- Document the status of the soft tissue envelop.

Management

Attempt conservative treatment in a U Slab for six weeks.

Acceptable position

- More than 50% apposition.
- Less than 30o valgus or varus deformity.
- Less than 30o anterior or posterior angulation.

Failure to achieve and maintain these position goals should dictate the surgical treatment of the fracture.

Absolute indications for surgery

- Open fractur
- Fracture with neurovascular injury requiring repair
- Failure of conservative treatment

- Nonunion
- Malunion

Relative indications for surgery

- Segmental fracture
- Pathological fracture
- Multiple fractures
- Ipsilateral shoulder or forearm fracture
- Other forms of soft tissue compromise
- Patient’s work or leisure requirements

Common complications of humeral shaft fracture

- Neurovascular injuries – high index of suspicion of radial nerve palsy is warranted for the distal third spiral fracture (Holstein Lewis fracture)
- Malunion
- Nonunion
- Joint stiffness

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Acute injuries around the elbow

by Ntambue Kauta & Stephen Roche

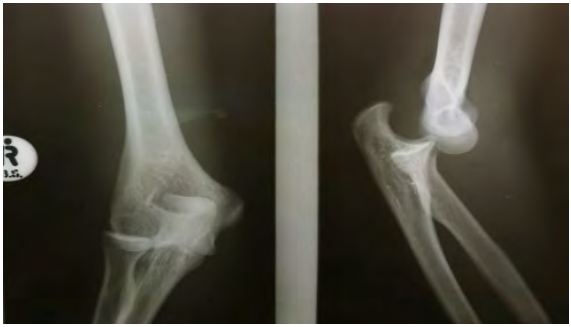
Learning objectives

1. Understand neurovascular, soft tissue and range of motion assessment.
2. Known X-Ray signs which need referral.
3. Prolonged immobilisation will lead to stiffness and needs to be avoided.

Introduction

The elbow is a complex hinge joint consisting of the radiocapitellar, ulnohumeral and proximal radioulnar joints. It allows flexion, extension and rotation of the forearm relative to the arm.

Injuries around the elbow are commonly caused by high energy impact.



The following injuries will be discussed in this chapter:

- Elbow dislocation
- Distal humeral fractures
- Radial head fractures
- Olecranon fractures

The attending physician must follow the advanced trauma life support (ATLS) management protocol for all these high energy injuries, conduct a thorough neurovascular and soft tissue assessment, and document the findings.

Elbow dislocation

The elbow joint is stabilised by strong static and dynamic anatomic structures (joint capsule, ligaments and muscles crossing the joint). It takes a high energy impact to dislocate the elbow joint.
The most common dislocation pattern is posterolateral; the proximal radius and ulnar joint are often not disrupted as both bones move out of the joint posterolaterally.

Clinical assessment

- ATLS approach.
- Neurovascular status assessment.
- Soft tissue assessment.
- For grossly deformed joints and in situations where radiology facilities are not available, every dislocated joint should be documented, reduced and followed by radiography.

Radiographic assessment

Helps to decide whether you are dealing with a simple or complex dislocation.

Simple dislocations have no associated fractures.

Complex dislocations are associated with certain fractures such as radial head, coronoid, capitellum or olecranon fracture.

The association of elbow dislocation, radial head and coronoid fractures is termed the ‘terrible triad’ due to the treatment challenges it poses to the treating surgeon.

Management

After an initial clinical and radiographic assessment, the dislocation must be reduced.
Use the standard sedation protocol available.

Simple dislocations

For posterolateral dislocation (most common), a coupling of traction on the forearm, counter traction on the arm with downward pressure on the olecranon and gentle flexion should reduce the elbow.

Reassess and document neurovascular status. Obtain control radiographs.

Assess elbow stability by gentle extension of the elbow from 90º to 30º extension.

If stable throughout this arc, the joint is deemed stable. Immobilise in an arm sling for two weeks and start range of motion.

If re-dislocation occurs at 60º, reduce the elbow again, flex to 90º, pronate the forearm and test stability. If it is stable in pronation, then immobilise in pronation using commercially available braces or an above-elbow back slab.

If re-dislocation occurs between 90º and 60º, the joint is deemed unstable, reduce it again, immobilise in a back slab and refer to the orthopaedic surgeon for further assessment and surgical consideration.

Complex dislocations

- Attempt reduction as for simple dislocations.
- Immobilise in a back slab and refer to an orthopaedic surgeon.
- Neurovascular status must be carefully assessed and documented.

Distal and intra-articular humeral fractures

- Undisplaced extra-articular fractures may still be treated conservatively, provided they remain well-aligned

(less than 15º of varus/valgus, anterior/posterior apex angulation).

- Displaced intra-articular fractures are best treated surgically to allow early range of motion and avoid elbow stiffness.
- The initial treatment is to immobilise the limb in an above elbow back slab.
- Undisplaced fractures should be treated conservatively for four to six weeks and followed by physiotherapy.

Radial head fractures

The management of isolated radial head fractures depends on the degree of displacement and the number of bony fragments.

Undisplaced fractures are treated in an arm sling for three weeks, and early range of motion is encouraged.

Angulated fractures by more than 30º should be reduced by the described technique and immobilised in an above-elbow back slab for three weeks.

Displaced isolated bony fragment from the radial head: a haematoma block with local anaesthetic is advised to relieve pain and examine for a mechanical block to pronation and supination. If there is no mechanical block, treat as for undisplaced fractures; if there is a mechanical block, the patient should be referred for surgery.

Displaced and non-reducible fractures should be referred for surgery.
Radial head fractures associated with elbow dislocation should be managed as per the complex elbow dislocation treatment protocol.

Olecranon fractures

Undisplaced olecranon fractures are treated conservatively in an above-elbow back slab for four to six weeks.

Displaced olecranon fractures debilitate the elbow extension mechanism (the triceps tendon pulls on the olecranon to extend the elbow). They warrant an open reduction and stable fixation to restore the extensor mechanism.

Other indications for surgical treatment include open fractures, trans-olecranon fracture dislocation, multiple ipsilateral or contralateral injuries.

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Forearm injuries

by Pieter Venter & Stephen Roche

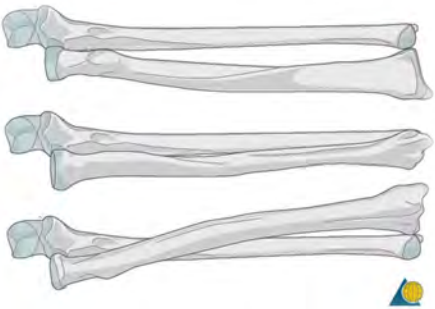
Learning objectives

1. A basic understanding of the forearm as a single joint.
2. Knowledge concerning the clinical anatomy of the forearm.
3. An approach to evaluating a patient with a forearm injury clinically.
4. An introduction to possible treatment modalities for forearm injuries.

Introduction

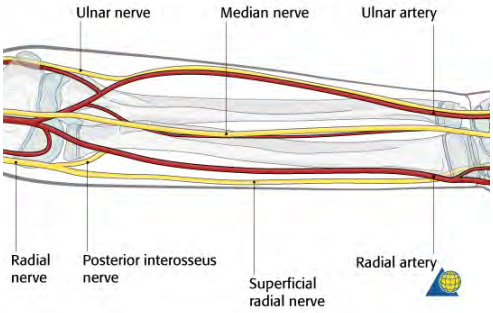
The forearm consists of the radius and ulnar bone shafts, linked by the interosseous membrane and spanned between the elbow and wrist joints. The forearm complex functions are to rotate the hand in space (supination/pronation) and the transfer of axial loading forces.

The forearm can be seen as a single joint as structural injuries between the elbow and wrist impact directly on the biomechanics of the forearm. It is essential to screen other areas of the forearm for concomitant injuries in the event of a fracture/dislocation of the radius or ulna.



Pronation of the forearm, showing the rotation of the radius over the ulna (Source: AO Surgery)

Applied anatomy



Bony, vascular and neurological anatomy of the forearm (Source: AO Surgery)

- **Bones:** Radius (radial head proximally), ulna (ulnar head distally)
- **Joints:** Proximal radioulnar joint (PRUJ), distal radioulnar joint (DRUJ), middle radio-ulnar joint/interosseous membrane (MRUJ)
- **Compartments:**
  - Anterior (flexor): Flexor muscles of hand and fingers, pronators
  - Posterior (extensor): Extensor muscles of hand and fingers, supinators (it is important to note that the biceps brachii muscle implants on the proximal radius contribute to supination).
- **Nerves:** Ulnar nerve (injury will cause claw hand), median nerve (injury will cause Benedict's sign, radial nerve (posterior interosseous nerve injury (PIN) will cause wrist drop)
- **Vessels:** Brachial artery divides at the level of the elbow into radial and ulnar arteries.

Clinical findings

History

The patient presents with symptoms of pain, swelling and deformity of the left forearm after a fall on an outstretched hand (FOOSH) from standing height.

Examination

- **Look:** Evaluate for wounds (abrasions/lacerations), bruises, blisters. Also, look for any deformity/swelling of the wrist and elbow.
- **Feel:** Neurovascular exam that includes: radial and ulnar pulses, capillary refill time, motor and sensory function of radial, median and ulnar nerves. Assess for any signs of possible compartment syndrome:
  - Pain out of proportion to the injury.
  - Pain on passive stretching of the fingers.
  - Gross swelling with tight compartments.
- **Move:** Loss of normal movement of the forearm due to deformity and pain. Assess hand, wrist and elbow movements for injury.

Additional injuries to note

ALWAYS assess the joint above and below an injury, in this case, the hand, wrist and elbow.

Specific Injuries that occur in the forearm

- **Monteggia fracture:** Proximal ulna fracture with associated radial head dislocation.
- **Galeazzi fracture:** Distal ⅓ radial shaft fracture with associated distal radio-ulnar joint (DRUJ) dislocation.

Special Investigations

Imaging

- '2 views and 2 joints': Always get a minimum of two views (AP and LAT) that include the joint above and below the injury (two joints).
  - Describe the X-ray findings:
  - Obvious injury or abnormality (fractures/dislocations).

- Fracture pattern (oblique, spiral, transverse and so on): have an impact on stability.
- LARA mnemonic:
- Location (for example, distal ⅓ radial shaft).
- Apposition/displacement (what percentage of the fracture ends are in contact).
- Rotation (for example, are the fragments lying in the same plane?).
- Angulation (for example, valgus/varus or dorsal/volar).

Non-surgical

- Isolated undisplaced or minimally displaced distal 2/3 ulna fractures (nightstick or defence fractures).
  - Moulded below elbow circular plaster of Paris with careful follow up to monitor union and position.

Surgical

- Open reduction and internal fixation (ORIF)
- External fixation
- Intramedullary nailing

Both bone forearm fracture

Monteggia fracture-dislocation

Galeazzi fracture-dislocation

Classification

- **Descriptive** (describing the fracture pattern and whether or not it is an open or closed fracture).

Management

Due to the forearm being a joint, forming an ellipse with the radius articulating over the ulna, the indications for conservative and non-surgical management are limited. Most forearm fractures, therefore, require surgical management.

Essential takeaways

- The forearm acts as a single joint and injury to one or more structure impacts significantly on its biomechanics.
- Always assess the hand, wrist and elbow for associated injuries.
- Do a proper neurovascular examination and note specific clinical findings – even if they are normal.

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Assessment

A 24-year-old male patient presents with a left sided Monteggia fracture-dislocation after a fall from a height. He complains of pain in his forearm ans elbow. Your examination shows that he has a drop wrist (cannot dorsiflex his wrist). Which nerve is most likely to be injured in this fracture pattern?

A. Ulnar nerve
B. Posterior interosseous nerve
C. Median nerve
D. Anterior interosseous nerve
E. Lateral antebrachial cutaneous nerve

A. Incorrect**.** The radial nerve divides into two branches in the antecubital fossa (deep/motor and superficial/sensory) with the deep motor branch passing through the heads of the supinator muscles to become the posterior interosseous nerve (PIN) which winds around the radial neck and innervates the muscles of the extensor (posterior) compartment of the forearm, which are responsible for wrist extension.

B. Correct. The radial nerve divides into two branches in the antecubital fossa (deep/motor and superficial/sensory) with the deep motor branch passing through the heads of the supinator muscles to become the posterior interosseous nerve (PIN). It winds around the radial neck and innervates the muscles of the extensor (posterior) compartment of the forearm, which are responsible for wrist extension.

C. Incorrect. The median nerve enters the forearm anterior to the lateral humeral epicondyle to supply the volar (flexor) compartment of the forearm.

D. Incorrect. The anterior interosseous nerve (AIN) is a terminal branch of the median nerve.

E. Incorrect. The lateral antebrachial cutaneous nerve (LABC) is a purely sensory nerve that originates from the musculocutaneous nerve and does not have any motor function.

Distal radius fractures

by Ntambue Kauta & Stephen Roche

Learning objectives

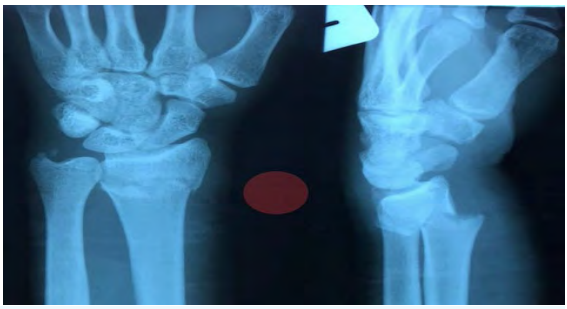
1. Understand radiologic measurements to describe a distal radius fracture.
2. Know the indications for surgical intervention.
3. Know the conservative treatment.

Introduction

Distal radius fractures follow a bimodal distribution. The low energy distal radius fracture affects older, often female, patients living with osteoporosis. The high energy distal radius fracture affects young individuals.

The clinical assessment follows the same principles of advanced musculoskeletal injury assessment.

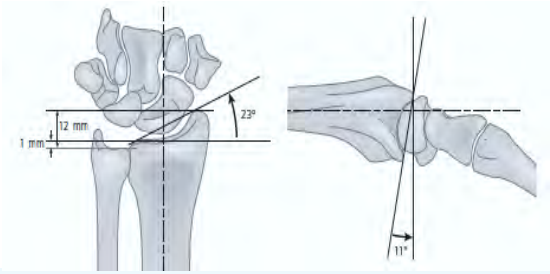
Low energy distal radius fracture



Colle's type fracture

Often an extra-articular fracture, displaying a consistent displacement pattern, including dorsal angulation, shortening, radial deviation, and radial tilt. This is the so-called Colle's fracture, and patients typically present with a 'dinner fork' deformity of the wrist. When the angulation is volar, it is called Smith's fracture.

The treatment is initially conservative. A closed reduction to reverse the deformity must be conducted, and a well moulded below-elbow plaster applied.



Normal anatomical measurements used to judge whether or not a reduction is acceptable

The radiographic criteria for an acceptable reduction of a distal radius fracture are:

- Radial length of more than 5mm.
- Radial inclination angle of more than 15o.
- Sagittal articular tilt of less than 7o dorsal tilt.

Patients are reviewed fortnightly for a fracture position check. The cast should be removed after six weeks and followed by physiotherapy.

High energy distal radius fracture

These fractures are often intra-articular and comminuted. They may present with soft tissue compromises such as open wounds or blisters.

After an initial assessment, a closed reduction should be attempted to alleviate soft tissue pressure from displaced fragments. Fractures that fail conservative treatment as per the criteria above and open fractures must be referred for surgery.

Pelvis and acetabulum fractures

by Ntambue Kauta & Sithombo Maqungo

Learning objectives

1. Unstable pelvic fractures need to be identified early as they can be life-threatening.
2. Early application of circumferential pelvis binders saves lives.
3. Low energy fractures in the elderly often signify osteoporosis.
4. Malunion leads to a reduction in the quality of life.

Introduction

Pelvis and acetabulum fractures are two distinct entities which are often discussed together; however, they coexist infrequently in the same patient. The difference between the two is anatomical, and there are management and outcome implications. **Pelvic fractures** involve the pelvic ring but do not extend to the socket side of the hip joint. These fractures may involve the sacroiliac joints (Figure1).

Acetabulum fractures involve the socket side of the hip joint (a ball and socket joint) and can extend into the socket's supporting columns (Figure2).

Both fractures can be associated with life-threatening haemorrhage, but this is rare in acetabulum fractures.

Epidemiology

There are two modes of distribution:

High energy fractures (motor vehicle accidents, fall from height) often occur in the young and active patients and are associated with other life-threatening injuries. High energy pelvic fractures represent 3–8% of all fractures seen in the emergency department and 25% of fractures seen in patients with multiple injuries.

Low energy fractures (fractures sustained from falls from a standing height) commonly occur in the elderly population. Females are affected more often than males, and there is an association with osteoporosis. These types of injuries are often isolated injuries with lower mortality.

X-Ray: Right acetabular fracture. Notice the disruption through the socket of the right hip.

Clinical assessment

The Advanced Trauma Life Support (ATLS) protocol is typically followed for assessing these injuries.

The primary survey focuses on assessing and managing life-threatening injuries. The focus is on cardiovascular and respiratory resuscitation while maintaining spinal precautions.

Certain pelvic fractures are associated with exsanguinating intrapelvic bleeding, which can be fatal. Look out for signs of haemodynamic instability.

The secondary survey is a more comprehensive assessment, including taking a full history and a complete head-to-toe clinical examination.

It is particularly important to examine soft tissue around the hip in acetabular fractures and the anogenital area for open wounds in open pelvis fractures.

A rectal and or vaginal digital examination is necessary to rule out open fractures that may be communicating with the recto-anal or vaginal canal.

A thorough neurovascular examination of the lower limbs is mandatory, and the findings should be documented.

Radiological assessment

Pelvis fractures

The pelvis is a ring, therefore always assess the anterior and posterior halves of the ring for associated injuries.

Unstable injuries:

These are present with a wide gap between the pubic symphysis (‘open book’ fracture) with disruption of the sacroiliac joint (SIJ). Another unstable injury is proximal displacement of one hemipelvis in vertical shear fractures. These injuries are associated with a higher rate of intrapelvic bleeding, haemodynamic instability and death.

Acetabulum fractures may be simple or complex (multiple fracture lines through the walls, columns or both, of the hip socket, or associated with a hip dislocation).

X-Ray image of an ‘open book’ pelvic injury. Note the wide separation of the pubic symphysis and the widening of the left sacroiliac joint compared to the right.

Initial management

Recognition of an ‘open book’ or vertical shear-type pelvis fracture means life-saving measures per the ATLS protocol must be implemented

The immediate application of a pelvic sling (a sheet wrapped around the pelvis centred over the trochanters) or commercially available pelvic binder in the emergency room will help reduce the pelvis volume and contain bleeding.

If in doubt about the fracture configuration, a pelvis binder should still be applied. It can always be removed later if it is not required. There is no place for applying an external fixator during the resuscitation phase; pelvis binders are very effective and easier to apply.

Hemipelvis proximal migration is initially treated with skin or skeletal traction. Commence **deep vein thrombosis prophylaxis** once the patient is haemodynamically stable.

Definitive management

A single, minimally displaced pelvic ring fracture is treated non-surgically with initial bed rest in hospital until the pain is under control and then mobilisation with graduated weight-bearing over 4-6 weeks.

A double and displaced ring injury (fracture anteriorly and SIJ disruption or sacral fracture) typically constitutes an unstable injury pattern. It is best treated with surgical stabilisation of both anterior and posterior injuries.

Undisplaced acetabular fractures are treated non-surgically with short bed rest followed by toe touch weight bearing on the affected side for six weeks. Displacement of more than 2 mm at the joint surface (step or gap) requires surgical reduction and stabilisation.

X-ray image: pelvis vertical shear-type injury. Notice the cephalad migration of the left hemipelvis associated with left sacral alae fracture.

Complications

Early

Exsanguinating haemorrhage is often seen in ‘open book’ or shear type pelvic injuries. Neurological injuries, such as L5 nerve root injury due to sacral fractures and shear-type fractures. Deep vein thrombosis (DVT) is another early complication.

Late

Acetabular fracture malunion will lead to osteoarthritis requiring a hip replacement later. Avascular necrosis of the femoral head if there was an associated hip dislocation. Heterotopic ossification. Pelvic fracture malunion may cause chronic pain, compromise the birth canal, patient gait and overall quality of life.

Hip fractures and dislocations

by Johan le Roux, Kim Laubscher & Michael Held

Learning objectives

1. Low-energy hip fractures are often associated with significant osteoporosis.
2. Patients with hip fractures need a comprehensive medical investigation and care.
3. Timely surgery and early mobilisation reduce complications and mortality in hip fractures.

Introduction

Fractures of the acetabulum and proximal femur are considered hip fractures. These injuries, and hip dislocations, are debilitating and must be treated urgently to allow the patient to regain mobilisation and avoid the morbidity and mortality associated with being bedridden.

Assessment

Clinical

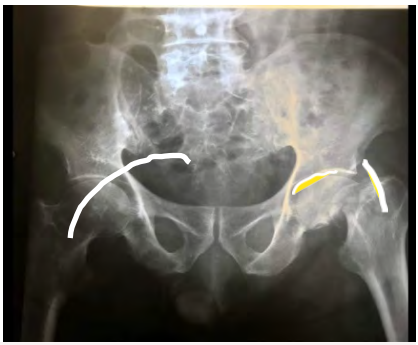
Most patients with hip injuries have groin pain. In some patients with undisplaced or impacted fractures, mobilisation is still possible. Patients with displaced fractures or hip dislocations are usually not able to bear weight or raise a straight leg. The pull of the hip muscles will leave the leg in a particular position.

With fractures, the leg is held in external rotation, abduction. With posterior dislocation (90% of dislocations) the leg held in flexion, adduction, internal rotation. Most commonly, the leg is shorter than the contralateral side.

Imaging

AP and lateral X-ray of the hip and a full-length femur film are needed to exclude associated injuries. **Disruption of Shenton's line, loss of joint congruence, and a difference in femur head shape are indirect signs of an injury.**

In non-displaced cases, the fracture may be occult and not visible on X-rays. MRI is the gold standard for occult fractures. If this cannot be arranged within 24 hours, a CT scan is the next best choice. In hip dislocations, CT scans help visualise associated fractures of the acetabulum, femur head or neck, and exclude loose bodies in the joint.

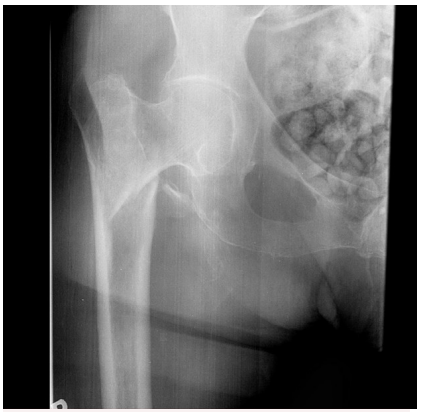


X-ray pelvis (AP): Left hip fracture with disruption of the Shenton's line (yellow)

Relevant anatomy

The hip capsule originates from the acetabular margin and attaches on the greater and lesser trochanters and the intertrochanteric line. The femur neck is intracapsular, surrounded by synovial fluid, and not covered in periosteum, making the healing potential of these **femoral neck fractures** very poor. Another problem is the disruption of the medial circumflex femoral artery (the main blood supply to the femoral head), leading to avascular necrosis of the femoral head. The fractures can be grouped into *displaced or undisplaced* fractures, which guide surgical treatment.

Peritrochanteric fractures occur between the lesser and greater trochanter. Therefore, they are extra-articular and do not cause medial circumflex femoral artery disruption and have a low risk of avascular necrosis.



AP right hip: Peritrochanteric fracture with an intact femur neck.

Hip dislocation treatment

These are usually high-energy injuries with other associated injuries. A structured ATLS approach should be used during examination and initial treatment. Urgent closed reduction in line with the deformity under adequate analgesia and sedation are crucial. Neurovascular examination and documentation before and after reduction are mandatory. If unable to achieve closed reduction, closed reduction under general anaesthesia and muscle relaxant in theatre is the next step. If still unsuccessful, open reduction must be performed.

Femoral head fracture

These are rare fractures and are usually associated with hip dislocations. The hip dislocation must be reduced initially. The fracture can be treated conservatively if it is in a non-weight bearing area, non-displaced and not associated with other injuries. Otherwise, fixation is required.

AP X-ray pelvis: Left hip dislocation. The Shenton's line is disrupted. The hip is internally rotated (lesser trochanter is not visible), and the femoral head appears smaller than the contralateral side (closer to the X-ray film).

Hip fracture treatment

After excluding other injuries (especially distal radius fractures and head injuries) and after neuromuscular structures are assessed, the patient should be made comfortable and evaluated for a general anaesthetic (see table). The race against time starts now as early mobilisation leads to improved outcomes if patients are treated within 48 hours of injury, thus preventing life-threatening complications such as DVT/PE, urinary tract infections and pneumonia.

This is considered a surgical emergency and most centres plan the operation on the **next available surgical list**. A continued, coordinated orthogeriatric and multidisciplinary management of these patients with investigations for osteoporosis and fall prevention remains the gold standard, which few receive.

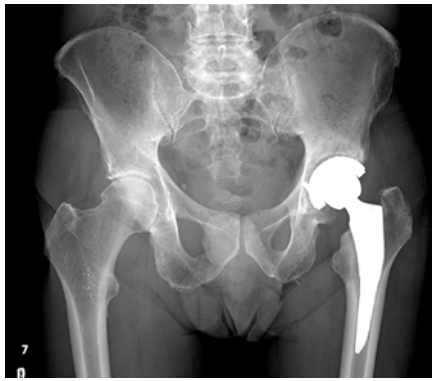
Operative treatment

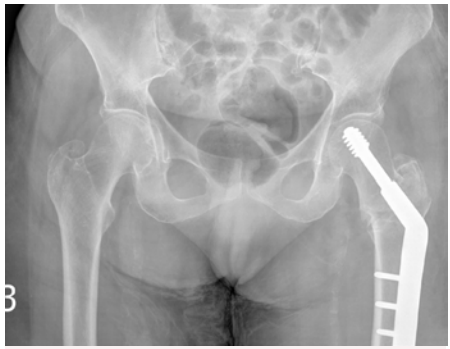
Non-operative treatment is only considered in patients who are unfit for anaesthesia and surgery.

For **neck of femur fractures**, open reduction and internal fixation are indicated for most physiologically young patients. Undisplaced fractures are treated with cannulated screws or a sliding hip screw. Arthroplasty is indicated for elderly patients with displaced fractures.

For **peri-trochanteric fractures,** a dynamic hip screw is done in stable fracture patterns. In unstable fractures, a cephalomedullary nail is indicated. (oblique fractures which would displace with dynamic compression of the hip screw, fractures with subtrochanteric extension or medial comminution)

Investigations for patients with hip fractures
Skin traction with low weight (2kg)
Analgesia
Rehydration
Monitor urine output
Chest X-ray
Full blood count
Arterial blood gas (with respiratory compromise)
Echocardiogram
Cross-match





AP pelvic X-rays: Total hip replacement (above) and dynamic hip screw (below).

Femur fracture

by Michael Abramson & Graham McCollum

Learning objectives

1. Emergency management of femur fractures.
2. Signs of fat embolus syndrome.
3. Correctly communicate the injury to the team.

Introduction

Femur fractures are usually a result of high energy injuries. A high index of suspicion for other injuries is essential. Close adherence to advanced trauma life support (ATLS) principles is critical. An adult can lose up to two litres of blood following a femur shaft fracture and early, aggressive resuscitation is paramount.

Check closely for open wounds. Any laceration on the affected leg should be treated as an open fracture and managed accordingly. A femur fracture is a clinical diagnosis, and the initial splinting and resuscitation should be initiated before obtaining X-rays. You don't need an X-ray.

Clinical findings

History

Mechanism and time of injury, past medical history (smoker, diabetics or other comorbidities, job requirements).

Examination

ATLS. Examine for other injuries and perform a neurovascular examination. A careful examination of the pelvis (including pelvis and PR stability if there is pelvic tenderness) is mandatory). C-spine should be protected in high energy injury until cleared clinically. Assess for hypovolemic shock.

Exclude Fat Embolism Syndrome (FES) (Chapter: Orthopaedic emergencies)

Additional injuries to note

Depending on the mechanism of injury, it is vital to exclude spine, pelvis, tibia and chest injuries, especially for high energy injuries. Focus on potentially lethal injuries first (open pelvis, tension pneumothorax, cardiac tamponade, multiple long bone fractures, unstable c-spine)

Imaging

Two views are needed (AP and lateral, joint above and below included). A Thomas splint should be applied BEFORE X-ray. Exclude neck of femur fractures which occur in 10% of femur shaft fractures.

Lodox image of a patient with a diaphyseal femur and ipsilateral tibia fracture. A Thomas splint has already been applied.

Classification

It is essential to communicate the fracture with the team and to document the injury adequately. Documentation should be done based on:

1. The anatomic area of the fracture: diaphysis, metaphysis, intra-articular.
2. Fracture pattern: simple, complex (comminuted), spiral, oblique, transverse.
3. Communicate, 'LARA' parameters for conservative treatment do not apply to the femur (**l**ength, **a**pposition, **r**otation, **a**ngulation).

Management

1. Early resuscitation, including fluids and analgesia. Aim for a mean arterial pressure >60mmHg.
2. A Thomas splint must be applied to **all** femur shaft fractures **before** X-rays (reduced blood loss, pain and FES).
3. There is a very limited role for conservative treatment (unless the patient is not fit for theatre).
4. For initial stabilisation, skin traction in the form of a Thomas splint is indicated for comfort and to decrease the need for blood replacement therapy. Skeletal traction and 'balanced traction' is an option if delays of more than 12h are anticipated before the patient can receive surgical management.
5. Most femur fractures will need osteosynthesis, either with an intramedullary (nail) or extramedullary (plate) fixation.

Image of a common scenario in the emergency unit. The Thomas Splint is adequately sized, both in length and width. Access to assess the neurovascular function of the foot is provided. The next step is a radiographic assessment, continuous fluid monitoring, analgesia and referral to orthopaedic surgery for definitive management

Essential take-aways

- Femur fractures are high energy injuries.
- A Thomas splint and fluid resuscitation save lives.
- The majority of patients need surgery.

Assessment

What is the most critical urgent strategy in femur fractures?

A. Call an orthopaedic surgeon.
B. Apply a Thomas splint.
C. Manage fluids.
D. Administer morphine.

(B) is correct, as a Thomas splint reduces blood loss, pain and risk for FES.

Knee dislocations

by Sithombo Maqungo, Abdalslam Andisha & Mlekeleli Duma

Learning objectives

1. Describe the clinical findings associated with knee dislocation.
2. Perform a closed reduction of knee dislocation effectively.

Introduction

Knee dislocations are traumatic injuries associated with a high rate of vascular injury. Treatment is generally emergent reduction and assessment of limb perfusion. However, there is a subset of patients, especially those with a high BMI, who can also sustain knee dislocations from low energy falls and a high index of suspicion is required in this regard. Often these injuries will lead to ligament laxity and stiffness.

Clinical assessment

The patient presents with knee pain, joint deformity, swelling and effusion.

Patients who sustain a knee dislocation that spontaneously reduces will show subtle signs of the injury such as abrasions and effusion. A suspicion of a patella dislocation or subluxation should be kept in mind.

A **vascular examination** needs to be performed to rule out popliteal artery injury. *Dorsalis pedis* and posterior tibial artery pulses should be evaluated.

If the pulse is absent, perform immediate closed reduction as this represents a threatened limb. A reduction should be performed before radiography. If the pulse is still absent after reduction, inform the vascular surgeon and go to the operating room for exploration. The orthopaedic surgeon will also be involved to assist with limb stabilisation, often using an external fixator.

Angiographic assessment is mandatory in centres where available. A sequential assessment of the Ankle Brachial Index (ABI) is needed in all cases with a pulse present. This is the ratio of the blood pressure measured at the level of the ankle or the arm. The normal value is above 0.9. The vascular status of the limb should be evaluated and documented before and after the reduction. A neurologic examination should be part of the assessment; sensory and motor function of the peroneal and tibial nerves must be assessed.

Imaging

Obtain **AP and lateral X-ray views**. With reduced knees, irregular/asymmetric joint space is often an indicator of ligament damage. Associated fractures can also be excluded. (See X-ray).

Picture of X-ray: An anterior knee dislocation is seen on these images.

A **CT angiogram** is often performed to rule out popliteal artery injury (See CT scan). Renal function should be optimised before injection of the contrast.

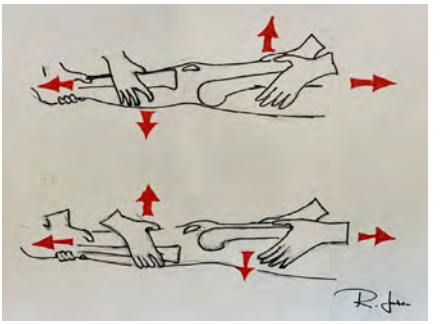
Picture of CT scan: Injected arterial contrast shows obliteration of the popliteal artery.

An **MRI** is invaluable in knee dislocations as the soft tissue injuries are better identified, which aids surgical management planning. Injuries to the periarticular/ intra-articular ligamentous structures (cruciate and collateral ligaments, posteromedial and postero-lateral corner structures) and chondral and meniscal injuries are better identified. (See MRI scan)

Reduction

Traction and gentle manipulation of anterior or posterior translation is the best method to reduce a knee dislocation.

Posteromedial dislocation can be associated with buttonholing of medial femoral condyle through the joint capsule. This makes closed reduction very problematic, and open reduction in the operating room is often needed.
The knee should be splinted at twenty degrees of flexion to maintain the position after reduction.



Schematic: Reduction techniques for knee dislocations.

Essential take-aways

A dislocated knee should be treated as an emergency as it represents a threatened limb.

Immediate reduction should be undertaken without waiting for radiography.

Popliteal artery disruption is seen in 20% to 60% of cases.

A dislocated knee may be part of multiple injuries in a patient and, therefore, ATLS principles should form part of the initial assessment and management of the patient.

Knee dislocations are disabling injuries, and they need appropriate early care to reduce morbidity.

Ankle and plafond fractures

by Johan le Roux, Michael Held & Stefan Wever

Learning objectives

1. Understand the indications for surgery based on soft tissue and X-Ray assessment.
2. Know the conservative management plan for appropriate fractures.
3. Understand the significance of the Weber classification with regards to the syndesmosis.
4. Exclude occult injuries which are associated with ankle fractures.

Ankle fractures

When a fracture of the lower limb involves the medial malleolus of the distal tibia, the distal part of the fibula (lateral malleolus) or the posterior part of the distal tibia (posterior malleolus), it is classified as an ankle fracture. A distinction must be made between isolated stable fractures which can be treated conservatively, and unstable fractures, usually caused by a rotational injury, which needs to be treated surgically.

Anatomy

The ankle consists of the three malleoli discussed above, which form the slot into which the talus fits. Besides the bony anatomy, the soft tissue stabilisers are the lateral collateral ligaments, medial collateral (deltoid) and the anterior and posterior tibiofibular ligaments. If one of these structures is injured in isolation, it is usually a stable injury. If a combination of these structures is damaged, it is an unstable injury where the talus can displace in relation to the tibia.

Clinical evaluation

The ankle has a poor blood supply and soft tissue coverage, and it is crucial to note any soft tissue damage, such as swelling, abrasions, blisters or open fractures.

In ankle trauma without an obvious fracture, tenderness over the following areas could indicate an occult fracture or tendon tear.

- Medial or lateral malleolus
- The base of the 5th metatarsal
- Navicular
- Peroneal tendons around the lateral malleolus
- Tibia-fibular syndesmosis
- Anterior process of the calcaneus

Fractures with obvious displacement or dislocation need to be reduced before X-rays.

Clinical picture of an ankle fracture dislocation. Must be reduced urgently prior to doing X-rays. If left untreated will develop an internal pressure sore and convert a closed to an open fracture.

Radiology

X-rays should include an AP, lateral and mortise view (15o internal rotation). On the mortise view, there should be symmetrical joint space around the talus. The clear medial space should be <4mm. The tibiofibular clear space should be <6mm at a level 1cm proximal to the joint. An X-ray of the whole lower limb should be done to exclude a high fibula fracture.

An external rotation stress radiograph or gravity stress radiograph will assess the integrity of the deltoid ligament (positive if >5mm medial clear space or talar tilt) in unclear cases.

A ‘pull-off’ injury of the medial malleolus causes a transverse fracture pattern, and a ‘push-off’ injury causes an oblique or spiral fracture pattern. Rupture of the syndesmosis is assumed when there is separation (diastasis) between the tibia and fibula.

Classification

There are different classifications with low inter- and intra-observer reliability, but they help to communicate the injuries.

Weber classification

This classifies lateral malleolus fractures according to the level of the fracture concerning the syndesmosis.

Weber A

The lateral malleolus is fractured below the syndesmosis, which remains intact.

Weber B

This is the most common type of ankle fracture and causes a transverse fracture of the medial malleolus and oblique fracture of the lateral malleolus at the level of the syndesmosis. Part of the syndesmosis may be ruptured.

Weber C

The syndesmosis is always ruptured, and the fibula fracture is spiral and a few cm proximal to the ankle joint.

Example of a Weber C ankle fracture. Associated syndesmosis injury likely and needs fixation.

Non-operative treatment

Non-operative treatment is indicated for isolated and stable fractures.

An initial reduction under sedation or general anaesthesia may be done if displaced. The plaster needs to be adequately applied and moulded (see respective chapter). The ankle must be elevated until the swelling subsides. In severely swollen ankles, patients should be admitted for regular soft tissue checks. Otherwise, the patient should be seen in the fracture clinic after two weeks to confirm reduction with a follow-up X-ray. A full circular plaster must be applied once the swelling has subsided until bony union (6–8 weeks).

Surgical treatment

ORIF is necessary when an acceptable reduction cannot be achieved or maintained. This is indicated with:

- Talar shift
- Displaced isolated medial or lateral malleolar fractures.
- Most bimalleolar fractures (needs to be decided on an individual basis by the orthopaedic surgeon).
- Posterior malleolar fracture with >20-25% of joint involved or 2mm step-off.
- Open fractures

The initial reduction and plaster slab must be done at the first presentation to a medical facility. After that, the patient can be referred to an orthopaedic unit.

Tibial plafond fractures

A distal tibia fracture is termed a tibial plafond fracture and not an ankle fracture if it involves more of the tibia than just the posterior malleolus. These fractures are usually not caused by rotation, but by the talus moving upwards, usually at a much greater force than that seen in ankle fractures. Here, soft tissue swelling is often more dangerous than the fracture itself and is best dealt with by urgent orthopaedic referral. Unless it is completely stable and not displaced, these fractures typically require open reduction and fixation.

Assessment

A 58-year-old female with diabetes presents with a bimalleolar ankle fracture to the ER. The fibula is fractured above the level of the syndesmosis. Management of the injury should include:

A. Below knee circular cast with crutches for 2 weeks followed by a moonboot for another 4 weeks.
B. Fixation of the lateral malleolus only and cast application.
C. Medial and lateral malleolus surgical fixation with immediate weight bearing.
D. This is a stable injury and can be treated in a cast for 8 weeks.
E. This is an unstable injury that needs medial and lateral fixation as well as fixation of the syndesmosis followed by casting for 6 to 8 weeks.

Answer:

A. Incorrect – moonboot does adequately immobilise fracture.
B. Incorrect – This is an unstable injury with an associated syndesmosis injury that needs surgical fixation.
C. Incorrect – See above answer. After fixation of an ankle fracture 6 weeks of casting is still recommended.
D. Incorrect – Seen answer (B) and (C).
A. Correct

Lower limb soft tissue injuries

by Kirsty Berry, Shaun De Villiers & Marc Nortje

Learning objectives

1. Have an approach to lower limb soft tissue injuries.
2. Diagnose common soft tissue injuries in lower limbs.
3. Understand the basic management principles of these injuries.

Introduction

Ligament, tendon and muscle injuries of the hip, knee and ankle are common conditions seen in emergency departments and general practice. The majority of these injuries can be treated with conservative management. It is essential to identify injuries that should be referred to an orthopaedic surgeon for possible surgical intervention or further work-up.

Groin injuries

Also known as an adductor strain.

Clinical findings

History

Most often young athletes complain of groin pain following an injury while playing sport (most often running). It is more common in males than in females.

Examination

- Tenderness in the groin.
- Antalgic gait.
- Pain on resisted adduction of the hip, passive end of range abduction of the hip (adductors stretched), or both.

Additional injuries to note

It is essential to rule out non-orthopaedic causes such as inguinal hernias.

Special investigations

Imaging

- X-rays are normal.
- MRI – show changes in the adductor (oedema or tear); most often not indicated.

Management

Non-surgical

- RIC(E):
  - Rest
  - Ice
  - Compression
- Physiotherapy for rehabilitation and return to activity.

Surgical

- Rarely indicated.

Ligament and meniscal injuries of the knee

Applied anatomy

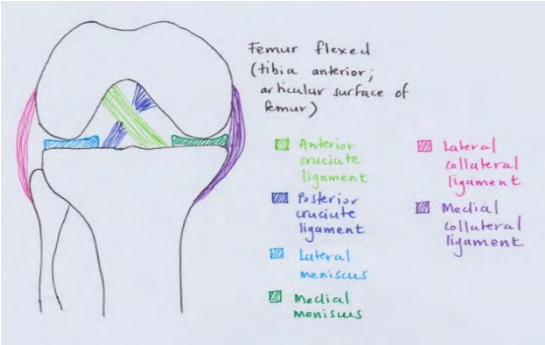


Image 1

The stability of the knee is dependent on bony anatomy, joint capsule, ligaments, menisci and surrounding muscle. The most commonly injured structures in the knee are the ligaments and menisci that can lead to ongoing pain, difficulty with daily and sporting activities and instability. The ligaments of the knee are the anterior and posterior cruciate ligaments and medial and lateral collateral ligaments. Both medial and lateral menisci contribute to stability function and articulation of the knee joint. Image 1 shows the anatomy of the ligaments and menisci.

Clinical findings

History

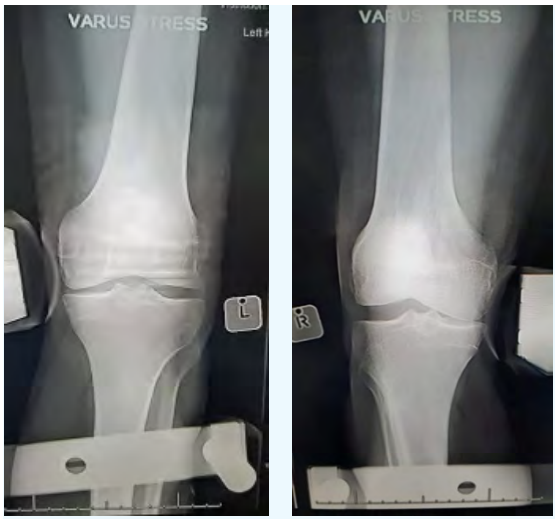
- **Anterior cruciate ligament** – the typical history is twisting the knee with the ankle fixed and immediate swelling.
- **Posterior cruciate ligament** – an anterior force to the tibia in a flexed knee. Dash-board injury is the most common mechanism.
- **Medial (MCL) and lateral (LCL) ligament injuries** – valgus (MCL) or varus (LCL) force applied to the knee.
- **Multi-ligament injuries** – most often seen in high-velocity motor vehicle accidents or patients with a high BMI and low-velocity injuries.
- **Meniscal injuries** – the typical history is twisting motion on the fixed ankle with delayed swelling.

Examination

- **Look**
  - Swelling is typical of all injuries around the knee.
- **Feel**
  - Joint effusion may be seen with all injuries and can be assessed with the patella tap test. Tenderness over the MCL or LCL collateral may indicate an injury in this area. Anterior lateral or medial pain on palpation may point to lateral or medial meniscal injuries, respectively.
- **Move**
  - Range of motion of the knee may be limited (normal 0–130).
  - Anterior and posterior draw test – ACL and PCL
  - Lachmann and reverse Lachmann – ACL and PCL
  - Varus and valgus stress tests – lateral and medial collateral ligaments, respectively
  - McMurray's meniscal injuries

Additional injuries to note

- May be associated with vascular injuries (especially in multi-ligament injuries); vascular assessment is essential.
- High suspicion of reduced knee dislocation in patients with multi-ligament knee dislocations.
- Poly-trauma patients must be assessed closely in the case of a swollen knee and normal X-rays.



(A) *(B)*

Images (A) and (B) are varus stress views of the left and right knees. The right knee shows an increased lateral joint space indicative of lateral collateral injury.

Special investigations

Imaging

- Plain film X-rays may be normal.
- Horizontal beam lateral (HBL) view may show an effusion (lipohaemarthrosis).
- Stress views are useful in diagnosing ligament injuries (compare to the contralateral side).
- Soft tissue swelling can be seen on plain film X-rays.
- An MRI is the gold standard for assessing soft tissue injuries.

Management

Non-surgical

- Rest
- Ice
- Compression
- Elevation
- Crutches with partial weight-bearing for pain management
- Analgesia (including NSAIDs where indicated)

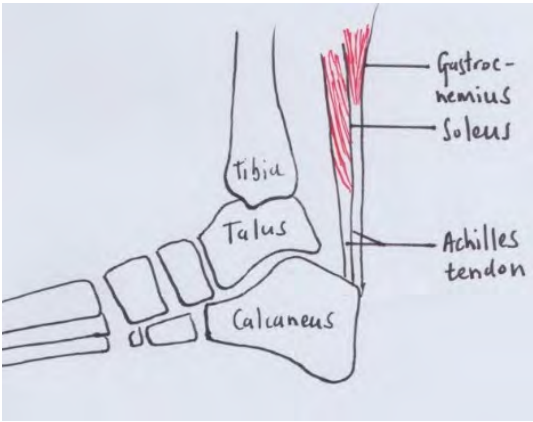
Surgical

- Failure of conservative management in the non-athlete, with ongoing pain and instability after six weeks.
- Multi-ligament knee injuries.
- ACL and meniscal injuries.
- Surgery includes arthroscopic or open repair or reconstruction of ligaments;

debridement, repair or replacement of menisci.

Achilles' tendon rupture

Applied anatomy



The Achilles tendon is the confluence of the soleus and gastrocnemius muscles of the posterior compartment of the leg. It inserts onto the posterior aspect of the calcaneus tuberosity. Its primary function is plantar flexion of the ankle joint.

Clinical findings

History

Most often, a low-velocity injury. The foot is either forced into extreme plantarflexion or dorsiflexion from a maximal plantarflexed position. A popping sound may be heard at the time of injury. The patient may have pain in the heel or calf and difficulty walking. The so-called 'weekend warrior' is vulnerable to this type of injury. The use of fluoroquinolones and steroid injections around the ankle has been associated with Achilles' tendon rupture.

Examination

- Tenderness and ecchymosis around or proximal to the insertion of the tendon.
- A gap in the tendon on palpation.
- Inability to actively plantarflex.
- Thompson test – pathognomonic.

Ecchymosis and gap in the Achilles tendon

Differential diagnosis

- Ankle sprain
- Ankle fractures
- Calcaneus fractures

Special investigations

Imaging

- X-rays are normal.
- Ultra-sound – confirm the clinical diagnosis; determine the size of the gap

and differentiate between partial and complete tears.

- MRI – helpful if the clinical diagnosis is unclear or for surgical planning in chronic tears.

Normal lateral ankle X-ray

Management

All patients with Achilles' tendon rupture should be referred to an orthopaedic surgeon.

Non-surgical

Serial casting progressing from plantar flexion to neutral every two weeks for 6–12 weeks has shown good outcomes in the low demand patient with acute tendon rupture.

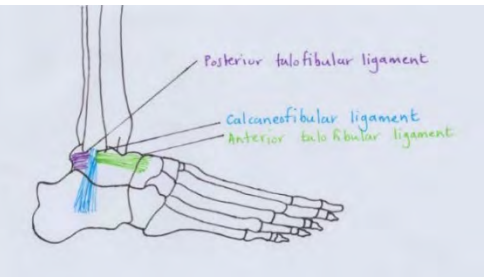
Surgical

- An open or percutaneous repair can be considered for closed injuries.
- Open injuries with direct laceration rather than tear should be repaired primarily.
- Tendon reconstruction and transfers are surgical options in chronic tears.

Intraoperative view of the Achilles' tendon gap following closed rupture

Ankle sprain

Applied anatomy



Ankle sprains involve injury to the lateral ligament structures of the ankle, specifically the anterior talofibular (ATFL) and the calcaneofibular ligaments (CFL).

Clinical findings

History

Inversion on a plantarflexed foot. The patient often reports ‘twist of the ankle’.

Examination

- Oedema and ecchymosis around the lateral aspect of the ankle.
- Tenderness over the lateral ankle (both lateral malleolus and talus).
- Inability to weight-bear.
- Anterior draw test for the ankle may be positive.
- Talar tilt test – inversion (especially end of range) causes pain.

Ecchymosis and swelling associated with a lateral ligament injury

Additional injuries to note

- Fractures of the ankle (lateral malleolus) and tarsal bones (especially talus and calcaneus) must be ruled out.
- Syndesmosis injuries can present as high ankle sprains (positive squeeze test).

Special investigations

Imaging

- X-rays – normal bony anatomy; soft tissue swelling may be evident.
- MRI – only indicated in chronic injuries or where the diagnosis is unclear.

Management

Non-surgical

- The majority of injuries improve with non-surgical intervention. The mainstay of treatment is ‘RICE’:
  - Rest
  - Ice
  - Compression
  - Elevation
- Non-weight or partial weight-bearing for pain relief.
- Physiotherapy

Surgical

- Indicated where conservative measures have failed.
- Arthroscopy of the ankle for diagnosis and debridement of the joint.
- Repair or reconstruction of the ATFL or tendon rerouting.

Essential takeaways

1. Ankle strains are the most common of all lower limb soft tissue injuries.
2. History and clinical examination are essential for diagnosis.
3. Non-surgical management of these injuries is the mainstay.
4. Achilles' tendon ruptures and ligament and meniscal injuries to the knee should be referred to an orthopaedic surgeon for further assessment and possible surgical intervention.

References

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Assessment

1. A 24-year-old male rugby player is injured during a game when his foot is locked on the ground, and his knee is twisted. The knee swells up immediately, and he is unable to bear weight. The most likely structure injured is:

   A. Posterior cruciate ligament
   B. Medial meniscus
   C. Anterior cruciate ligament
   D. Lateral collateral ligament
   E. Patella tendon

(C) is correct, as this is the typical history described by the patient with an acute ACL injury

2. A 54-year-old male is running at his daughter's school in the father-daughter race. Halfway down the track, he hears a pop and is unable to continue running. Which of these is not a risk factor for Achilles' tendon rupture:

   A. Systemic steroid use
   B. Course of ciprofloxacin for UTI a week ago
   C. Cortisone injection into the tendon two weeks before the injury
   D. Age
   E. Alcohol consumption

(E) is correct – alcohol has not been linked to Achilles' tendon rupture. All the others are known risk factors. A Cortisone injection should never be given due to the risk of rupture.

3. A 20-year-old gymnast twisted her ankle following landing off the bar apparatus. She has swelling, ecchymosis and pain on the maximal passive inversion of the foot. What is the next most appropriate management for her injury:

   A. Immediate referral to an orthopaedic surgeon.
   B. Weight-bearing – continue to excercise through the pain and re-assess in a week.
   C. Early anterior talofibular ligament repair.
   D. Ice pack over the area, compression bandage with Robert Jones-type bandage, crutches for non-weight bearing and no gymnastics.
   E. Tendon rerouting surgery to prevent recurrence and early return to sport.

(D) is correct, as the majority of all ankle sprains can be treated conservatively

Upper limb soft tissue injuries

by Kirsty Berry, Shaun De Villiers & Marc Nortje

Learning objectives

1. Have an approach to upper limb soft tissue injuries.
2. Diagnose common soft tissue injuries of the upper limb.
3. Understand basic management principles of these injuries.

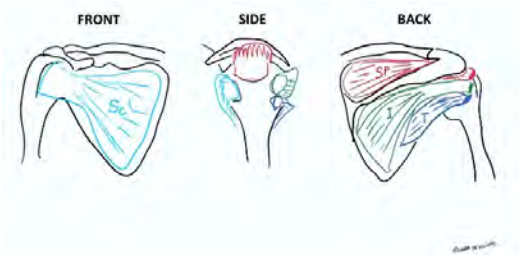
Introduction

Most of the ligament, tendon and muscle injuries of the upper limb can be treated by trying conservative management. The majority of these injuries present to the general practitioner and emergency units and not the specialist orthopaedic surgeon.

Rotator cuff injuries

Tears of the rotator cuff tendons tend to occur in people over the age of 50 years and may be due to general attrition of the tendon with age. There may or may not be an associated injury.

Applied anatomy



Rotator cuff muscles around the shoulder

The rotator cuff consists of four muscles, the subscapularis (Sc), supraspinatus (Sp), infraspinatus (I) and teres minor (T). These muscles are responsible for the movements of the glenohumeral joint.

Muscle	Action	Strength testing
Supraspinatus	Initiates abduction	Weakness to resisted elevation in Jobe position
Infraspinatus	External rotation	External rotation in 0° abduction
Teres minor	External rotation	External rotation in 90° abduction and 90° external rotation
Subscapularis	Internal rotation	Internal rotation in 0° abduction

Actions of the rotator cuff muscles

Clinical findings

History

Pain

- Insidious onset.
- Often night pain.
- It is exacerbated by overhead activities.

- In the event of a traumatic tear, the pain and weakness are acute.

Weakness

- Loss of active range of motion with greater passive range of motion.

Examination

The same as for impingement syndrome, but there is additional weakness on the resisted movement of the rotator cuff muscles.

Additional injuries to note

The bruised shoulder with normal X-rays following trauma:

- The patient has an occult fracture or a torn rotator cuff. Subscapularis tears are most commonly missed and are tested with the Belly Press and Gerber's lift-off test.
- If the patient is no better after ten days, another careful examination and further imaging such as an ultrasound or MRI are necessary.

Imaging

X-rays

Shoulder – look for:

- Calcific tendonitis of the supraspinatus tendon insertion.
- Cystic changes in greater tuberosity are a sign of a chronic tear.
- Proximal migration of the humerus can be seen with chronic RCT (acromiohumeral interval <7 mm).
- Type III (hooked) acromion

Ultrasound

- Suspicion of rotator cuff pathology.
- Able to perform dynamic examination.
- Relatively low cost, if available.

MRI

Expensive, so only use in a young patient with traumatic tears or pain or weakness attributable to a rotator cuff tear that does not improve with conservative management.

Management

Non-surgical

- Physiotherapy, activity modification, NSAIDs, subacromial corticosteroid injections.
  - The first line of treatment for most tears.

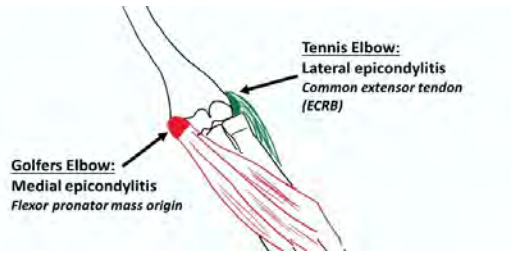
Surgical

- Failure of conservative treatment.
- Repair of rotator cuff +/- subacromial decompression (open or arthroscopic).

Tennis and golfer's elbow

This is an overuse syndrome of the lateral epicondyle (tennis elbow) and medial epicondyle (golfer's elbow).

Applied anatomy



The flexor-pronator mass origin is affected in golfer's elbow, and the common extensor tendon is affected in tennis elbow

Overuse injuries due to eccentric overload at the common extensor tendon lead to tendinosis and inflammation at the origin of ECRB, commonly known as tennis elbow. The same pathology exists for the medial epicondyle where the flexor-pronator mass origin is involved and is known as golfer's elbow.

Clinical findings

History

Pain

- Insidious onset.
- It is localised over medial or lateral epicondyles.
- Worse with wrist and forearm motion and gripping.

Examination

- Point tenderness 5-10mm distal and anterior to the medial epicondyle (golfer's) and tenderness at ECRB insertion into lateral epicondyle (tennis).
- Provocative tests:
  - Lateral epicondyle: resisted wrist extension with the elbow fully extended.
  - Medial epicondyle: pain with resisted forearm pronation and wrist flexion.

Imaging

X-rays

- Usually normal.
- May show calcification in the tendons.

Ultrasound

- Not necessary for diagnosis.
- Allow dynamic examination.
- Operator-dependant.
- Shows areas of focal degeneration, but mostly normal.

MRI

- Not necessary for diagnosis.
- Standard of care for medial epicondylitis.

Management

Non-surgical

- Rest, ice, physiotherapy, activity modification, bracing and NSAIDs.
  - The first line of treatment for most.

Surgical

- Open debridement of origin.

Essential takeaways

- Tears of the rotator cuff tendons tend to occur in people over the age of 50 years.
- The bruised shoulder, with a normal X-ray after trauma, should be investigated.
- Tennis elbow and golfer's elbow are primarily diagnosed with clinical examination and history.
- Non-surgical management is the first line of treatment with most.

References

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Assessment

A 40-year-old man presents to the clinic with three months of right elbow pain. He started playing squash four months previously. On examination, he is tender over the lateral aspect of the elbow and pain increases with resisted wrist extension. Which of the following muscles is involved in the pathophysiology of this disease?

A. FCU – Flexor carpi ulnaris.
B. FCR – Flexor carpi radialis.
C. FDS – Flexor digitorum communis.
D. ECRB – Extensor carpi radialis brevis.

(D) is correct, as the patient presents with lateral epicondylitis which involves the origin of the ECRB. The other muscles are all flexor muscles and are involved in medial epicondylitis.

Common soft tissue injuries

by Stephanie Roche, Archie Rachuene & Stephen Roche

Learning objectives

1. Classification of common soft tissue injuries.
2. Management of common soft tissue injuries.
3. Indications for referral and further investigation.

Background

Soft tissue injuries are very common, particularly in patients who are active and involved in sports but can also occur as a result of trauma or repetitive everyday activities. They can broadly be divided into two categories: acute and overuse injuries. The following lists common examples of each:

1. Acute soft tissue injuries (generally due to trauma, such as a sudden fall)
   a. Sprain
   b. Strain
   c. Contusions
2. Overuse injuries
   a. Tendinitis
   b. Bursitis

Acute injuries

Sprain

A sprain can be defined as a stretch, tear or both, in a ligament.

The most commonly affected joints are the ankles, wrists and knees (see the relevant chapters for more information, for example, ACL tears of the knee). Clinical features include pain of varying severity, bruising and inflammation (swelling, erythema, warmth).

Strain

A strain involves stretching, tearing or both, of the muscle, tendon or both. Contrastingly, these injuries typically affect the posterior thigh (hamstring), feet and back. Clinical features include pain, signs of inflammation and muscle spasm, weakness or cramping sensations.

Contusion

A contusion occurs due to a blunt force injury, which causes crushing of the underlying connective tissue and muscle and damage to local blood vessels. Management is supportive, as above.

Clinical evaluation

History

Acute trauma or sports injury. Pain, swelling and loss of function.

Examination

- Look: Swelling, bruising, deformity
- Feel: Warm inflamed joint, effusion
- Move: Limited range of motion (ROM)

Special tests

Refer to specific chapters Neurovascular examination.

Investigations

Plain X-rays: first-line (refer to Ottawa ankle rules).

Common overuse injuries

Tendinitis (acute)

Tendon inflammation as a result of repetitive micro trauma.

Tendinosis (chronic)

Tendon degeneration in response to overuse.

Bursitis

Bursitis is inflammation of the bursa. Bursae are fluid-filled sacs lined with synovium which reduce friction between adjacent tissues that slide past each other during normal movement (such as tendons, ligaments and bone). Clinical features of bursitis include pain (worsened with movement), swelling, erythema and decreased range of motion. Knowledge of anatomy is essential to identify the affected soft tissue structure. The sites of commonly affected bursae should be palpated to exclude bursitis in patients presenting with joint or limb pain.

Joint	Tendinosis	Bursitis
Shoulder	▪ Rotator cuff tendinopathy ▪ Biceps tendinitis/tendinosis	▪Subacromial bursitis ▪Scapulothoracic bursitis (medial scapula pain/winging scapula)
Elbow	▪ Lateral epicondylitis (tennis elbow) ▪ Medial epicondylitis (golfer's elbow)	▪Olecranon (rule out gout and infections)
Knee	▪ Popliteus tendinopathy ▪ Iliotibial band syndrome ▪ Patellar tendinopathy	▪Pre-patellar bursitis (rule out infection)
Ankle	▪ Achilles tendinopathy, Rupture	▪Calcaneal and retrocalcaneal bursitis

Common overuse injuries

Management

- Assess and rule out serious injuries, limb-threatening injuries and complications, if present manage appropriately.
- Joint/immobilisation/splint.
- Ice packs
- Compression
- Limb elevation
- Analgesia and anti-inflammatory drugs
- Corticosteroids (oral and intra-articular injections

Indications for referral for special investigations or further management

Acute

- Excessive bleeding
- Expanding haematoma
- Joint effusion (for example, knee haemarthrosis)
- Excessive swelling or compartment syndrome
- Associated neurovascular deficits

Chronic

- Joint instability
- Loss of function
- Persistent pain or intermittent joint effusion
- Signs of infection (fever, effusion, sinuses)

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Lohr KM. Bursitis. Medscape. 2018 [cited 29 May 2019]. Available from: https://emedicine.medscape.com/article/2145588-overview

Levy DB. Soft tissue knee injury clinical presentation. Medscape. 2016 [cited 29 May 2019]. Available from: https://emedicine.medscape.com/article/826792-clinical#b4

OrthoInfo. Sprains, strains and other soft tissue injuries [Internet]. 2015 [cited 28 May 2019]. Available from: https://orthoinfo.aaos.org/en/diseases--conditions/sprains-strains-and-other-soft-tissue-injuries/

Assessment

An 18-year-old male presents with injury to his right knee following a tackle during a soccer match. He reports severe pain and loss of function. Clinical examination reveals massive knee effusion, bruising and reduced distal pulses. Plain x-rays are normal. Which of the following is the most appropriate action?

A. Splint the limb and observe overnight in the emergency unit.
B. Splint the limb, provide analgesia and discharge home.
C. Splint the limb, provide analgesia and emergency referral for special investigations and review by a specialist (vascular surgeon and orthopaedic surgeon).
D. Splint the limb and refer for specialist review at the next available clinic day.
E. Analgesia, intra-articular steroids and splint.

Option (C) is correct. The patient might have had knee dislocation, which is now reduced but presenting with signs of vascular injury and internal knee injuries requiring emergency treatment. Other options fail to recognize the urgency of his condition.

Foot fractures

by Stefan Wever

Learning objectives

1. Understand the basic anatomy of the foot.
2. Diagnose a foot fracture.
3. Manage a foot fracture.

Introduction

Foot fractures comprises 10% of all fractures and is the most common foot injury seen by general practitioners. The metatarsal and toes are most commonly affected.

Applied anatomy

The foot consists of 26 bones, which make up the forefoot (metatarsals, phalanges), midfoot (tarsal bones) and hindfoot (talus, calcaneus). Within the foot, the Lisfranc joint connects the forefoot and midfoot and the Chopart joint connects the midfoot and hindfoot.

Clinical findings

- **History:** Patient typically presents with a painful swollen foot following an injury. Typically the patient cannot bear weight on the affected foot.
- **Examination:** Swollen, possible deformity, ecchymoses (classically with lisfranc injury) present. Palpation reveals bony tenderness over the affected area. Comparison to the uninjured foot elicits abnormalities.
- **Additional injuries to take note of:** Remember to examine the knee, hip and back for associated injuries with calcaneus fractures sustained by falling from a height. Exclude compartment syndrome of the foot.

Plantar ecchimoses often associated with lisfranc injury

Lisfranc injury with dorsal displacement of the metatarsal bones

Imaging

- Important to rule out fractures.
- If possible, request weight bearing X-rays when lisfranc injuries are suspected.

Specific fractures

Calcaneus

- Often high energy injury (fall from height / motor vehicle accident) with associated injuries.
- Look for associated injuries (spine, hip and knee).

Lisfranc

- The midfoot joint is a complex structure that needs extreme stability. Even subtle injuries can lead to long-term problems.
- Injuries can be pure ligamentous or associated with a fracture.
- High energy associated with bony fractures and low energy often with twisting-type sports injuries.
- Often missed, high suspicion if plantar ecchymosis and inability to weight bearing.

Fifth metatarsal base

- Fractures of the base are common.
- Three types exist with type 2 having a increased risk of non union.

Phalynx

- Common injury from direct blow to the foot.
- Most can be treated with buddy strapping only.

Management

Non-surgical

- Indications:
  - Undisplaced or minimal displaced fractures.
  - Hard-soled shoe/ Cast and crutches for 4–6 weeks.
- Elevation, rest, ice, non-steroidal anti-inflammatory drugs.
- Calcaneus fractures need prolonged non-weight bearing up to 3 months.

Surgical

- Indications:
  - Open fractures.
  - Lisfranc injury with displacement.
  - Displaced calcaneus fractures.
  - Some type 2 fifth metatarsal fractures.
- Surgical treatment includes open reduction and internal fixation using wires, screws and plates.

Key takeaways

- Foot fractures are common and most can be treated conservatively.
- Lisfranc injuries can occur without an associated fracture.
- Calcaneus fractures can have associated injuries.
- Base of fifth metatarsal fracture is the most common metatarsal fracture.

Assessment

A 21-year-old rugby player presents after injuring his foot in a scrum. The dorsum of the midfoot is swollen with plantar ecchymosis. He is however able to weight bear on the foot with pain. What is the most likely diagnosis?

A. Ankle fracture
B. Ankle sprain
C. Achilles tendon injury
D. Lisfranc injury
E. Unlikely to have any injury

Answer: (D) is correct. Plantar ecchymosis is associated with a Lisfranc injury.

Approach to an injured child

by Marc Nortje & Ashley Arakkal

Learning objectives

1. Understand how to approach an injured child to identify injuries.
2. Recognise, assess and manage life threatening injuries.

Initial assessment

Examination (ABCDEs):

1. **Airway and immobilise cervical spine:** Make sure airway is open. The easiest way is to see if the patient can talk. Deal with any airway problems immediately, use suction if needed. Employ jaw thrust and chin lift, oropharyngeal airway, intubate if required.
2. **Breathing:** Observe respiratory rate and oxygen saturation. Expose and inspect chest for external signs of trauma, asymmetrical chest movements. Palpate chest for crepitus or surgical emphysema. Percuss and auscultate for air entry bilaterally and added sounds. Administer face mask oxygen, intubate and ventilate, perform needle thoracotomy, intercostal drain as needed.
3. **Circulation:** Assess pulse rate, blood pressure, capillary refill and the warmth of peripheries. Look for signs of bleeding, especially chest, abdomen, retroperitoneum, pelvis and long bones. Control any major external bleeding with direct pressure. Manage shock, insert two large bore (at least 16 gauge) intravenous cannulas. If this cannot be rapidly achieved, obtain intraosseous access. (anterior medial tibia). Start IV fluid resuscitation if in shock, transfuse blood if needed. Consult a trauma surgeon if surgical intervention is required for shock.
4. **Disability:** Assess GCS (Glasgow Coma Scale) pupil size and responsiveness. Assess gross motor and sensory function in all four limbs. If you suspect a spinal injury, a full neurological assessment is vital at the earliest opportunity. Check for priapism, loss of anal sphincter tone and the bulbocavernosus reflex. Check blood glucose.
5. **Expose the patient:** Log-roll the patient. Examine the back of the head, back, buttocks and axilla. Then cover and keep the patient warm.
6. **Secondary survey:** A secondary survey is carried out after the primary survey and immediate management of potentially life-threatening injuries to identify all other injuries. Perform a systematic head-to-toe examination, including head, face, neck, chest, abdomen, pelvis and extremities. Look for deformities

of limbs that may indicate fractures, examine for any open wounds around the fracture. Examine the neurovascular status of the injured limb and exclude compartment syndrome.

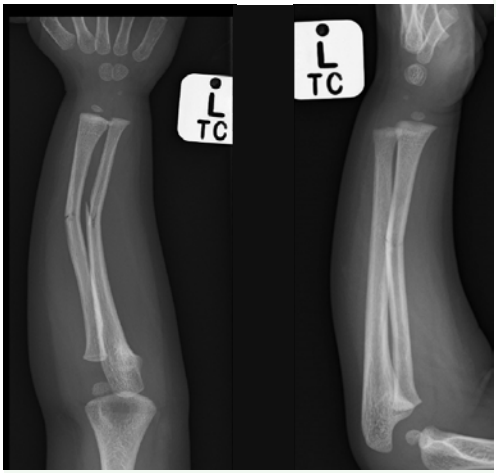
History (AMPLE):

1. **A**llergies
2. Current **M**edications
3. **P**ast medical history
4. **L**ast meal
5. **E**vents leading to injury

Special investigations

If there is an isolated injury of the arm with suspected fracture, an X-ray of the affected limb, including the joint above and below the injury is most appropriate. Depending on other injuries, further X-rays or CT scans may be needed.

Example



(A: AP view & B: lateral view)
Radius and ulnar greenstick fracture

Management

- **Non-surgical:** Appropriate management of the fracture would be a reduction and the application of plaster of Paris as a splint.
- **Pharmacological:** Adequate analgesia is important.
- **Surgical:** Depending on the specific

Fracture, surgery may be indicated.

Post-reduction X-rays

Paediatric fractures: A general approach

by Anria Horn

Learning objectives

1. Understand the differences between adult and paediatric fractures.
2. Identify greenstick, buckle and growth plate fractures.
3. Understand the basic principles of managing paediatric fractures.
4. Exclude non-accidental injuries (NAI).

Clinical assessment

1. **History:** In very young children, get additional history from parents or caregivers. Determine the time and mechanism of the injury. Be wary of changing stories and an implausible history. Fractures in non-walkers should raise suspicions of NAI.
2. **Examination:** Assess the child from head-to-toe using the 'look, feel and move' approach. In small children look for pseudo-paralysis (unwillingness to move a limb) and refusal to weight bear. Also look for swelling, deformity and bruising. Feel for tenderness or crepitus.
3. **Special investigations:** Start with X-rays of the affected limb or limbs. Also, apply the rule of 2:2 views (AP and lateral), two joints (above and below). In the case of uncertainty, two sides to compare to the normal side.

How are children's bones different from adult bones?

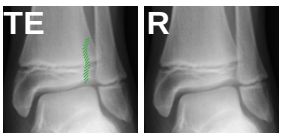
Children have **growth plates** that may be confused with fractures; an X-ray of the contralateral side for comparison can assist if you are not sure. Children's bones are also **elastic** and can bend without breaking. They also have **remodelling** potential. The closer the fracture to the growth plate, the greater the remodelling potential.

Growth plate injuries

In children, the weakest point around a joint is the growth plate. In adults, it is usually the ligaments of the joint.

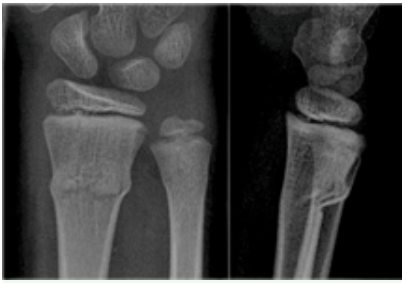
Growth plate fractures occur in typical patterns and are described using the Salter-Harris classification. The word SALTER (I – **S**traight across, II – **A**bove, III – **L**ower, IV – **T**hrough **E**verything and V – c**R**ush) is a useful acronym to remember this classification.

- Type II fractures are by far the most common
- Type III and IV are intra-articular fractures and require anatomical reduction.
- Type V is associated with a high rate of growth disturbance.



Greenstick and buckle fractures

- **Buckle fractures** occur when the thin cortex buckles under the force of a fall, but no displacement occurs, and continuity of the cortex is not disrupted.



Buckle fracture of the distal radius

- **Greenstick fractures** occur when a force breaks one cortex, but the other remains intact and acts as a hinge.

Greenstick fracture of the radius with an associated buckle fracture of the distal ulna

Principles of management

- Buckle fractures, regardless of which bone is involved, can be managed with simple immobilisation in the form of a backslab, cast or removable splint. Immobilisation for the upper limbs is typically 2 – 3 weeks and the lower limbs 3 – 4 weeks.
- All diaphyseal fractures, including greenstick, should be reduced and immobilised until union is achieved. Immobilisation can be in the form of a plaster cast (tibia fractures), a backslab (fractures around the elbow) or a sling (clavicle and proximal humerus fractures).
- Residual deformity can be accepted depending on the location of the fracture and the age of the child.
- Typical time to union is three weeks for the upper limb and six weeks for the lower limb.
- Operative treatment is seldom indicated and will be dealt with in separate chapters.

Resources

Modified images:

Tib/fib growth plate. Available from: https://commons.wikimedia.org/wiki/File:Tib_fib_growth_plates.jpg

Non-accidental injuries in children

by Stewart Dix-Peek

Learning objectives

1. Recognise and document signs of child abuse on clinical examination and X-Ray.
2. Examine for occult injuries associated with non-accidental injuries.
3. Do not discharge a child with suspected non-accidental injuries.
4. Notify relevant authorities (i.e. social worker, police service, support service).

Approach to children with suspected non-accidental injury

Intentional trauma to a child or neglect with subsequent trauma. Below is an approach to children with suspected non-accidental injuries.

Risk factors

Parents

- Age
- Low level of education
- History of sexual abuse/NAI as a child
- Absent father
- History of psychiatric illness
- Divorce/separation of parents
- Mother separated from parents
- Drug/alcohol abuse

Fracture pattern

The following fracture patterns are suspicious of NAI:

- Any fracture in a baby <6 months (60% chance of NAI)
- Femur fracture in <1 year old (50% chance of NAI)
- Old and new injuries are highly suspicious (Caffey's syndrome)
- Rib fractures (posteromedial fractures are highly suspicious)
- Metaphyseal injuries

Injury pattern

- Fractures associated with a head injury
- Suspicious bruising
- Unusual burns (cigarette, perineal)
- Facial trauma

Investigations

- Detailed history (including collateral history)
- Consider skeletal survey in the non-verbal child (generally <3 years)
- CT brain
- Ophthalmology for retinal haemorrhages
- Social worker investigation

Duty of care

- All NAI suspected by a medical practitioner have to be reported
- Usually, this is via the Department of Social Services
- Documentation of findings is essential and will be necessary for court proceedings
- The medical practitioner acts as an advocate of the child's rights rather than the parents'

Proximal upper limb fractures in children

by Anria Horn

Learning objectives

1. Identify and describe common upper limb fractures in children.
2. Understand how to manage these fractures conservatively.

Clinical assessment

Children tend to sustain fractures in predictable locations. The most common mechanism of injury for all upper limb fractures is a fall on an outstretched hand (FOOSH). The most common fractures are clavicular > distal radius (+/- ulna) > supracondylar fractures. The growth plate is a weak spot in children's bones, and fractures often occur through and around them. It is important to know what normal growth plates and ossification centres look like to identify these fractures.

Clavicular fractures

Clavicular fractures are the most common in children and are a common birth injury. One should exclude neurovascular injury as there is close proximity to the brachial plexus and large vessels.

Management

Conservative management, involving a collar and cuff or arm sling, is indicated for all clavicular fractures in children. However, conservative management should not be applied to open clavicular fractures or those associated with vascular injury (rare).

Humeral fractures

Spiral humerus fractures in small children are suspicious for non-accidental injury. In all of these fractures, one should exclude axillary nerve (proximal humerus) or radial nerve (midshaft) injury.

Management

- These fractures can mostly be treated with simple immobilisation in a collar and cuff or U-slab. Three weeks of immobilisation is usually adequate.
- A large degree of angulation can be accepted. Remodelling is robust and, as a non-weight bearing limb, small amounts of residual deformity are acceptable

.

Fractures around the elbow

There are many ossification centres around the elbow appearing at different timesas the child matures. These ossification centres may look like fractures to the inexperienced eye. The acronym CRITOE/ CRMTOL is useful to remember the ossification centres and when they appear. The appearance of the ossification centres is summarised in the table and images below.

C	Capitellum	1–2 years
R	Radial head	3–4 years
I/M	Internal/medial epicondyle	5–6 years
T	Trochlea	7–8 years
O	Olecranon	9–10 years
E/L	External/lateral epicondyle	11–12 years

Ossification centres

Management principle: It is important to note that you should never use a circular cast for elbow fractures, always a backslab.

Supracondylar fractures

There is a weak spot above the humeral condyles at the level of the olecranon and coronoid fossae. Injuries here are typically FOOSH.

Clinical examination and investigations

- Diffusely swollen elbow
- Exclude vascular and neurological injury
  - Arteries: Brachial artery. Check radial pulse and hand perfusion.
  - Nerves: Median > ulnar > radial.
- X-rays: AP and lateral and a contralateral views of the elbow or both in cases of uncertainty.

The Gartland Classification (Grade I–III) is used to grade these fractures.

I. Undisplaced fracture

Here one may only see the fat pad sign. The fat pad sign is appreciated on the lateral view X-ray. Usually, an anterior fat pad can be seen. The presence of a posterior fat pad on X-ray is abnormal.

Grade 1 supracondylar fracture evidenced by the presence of a posterior fat pad. It is undisplaced as the anterior humeral line passes through the capitellum.

II. Partially displaced with intact posterior periosteal hinge

If the anterior humeral line crosses the capitellum, no reduction is required, and management is as for Type 1.

III. Completely displaced fracture

Here there is a completely displaced fracture (See below: the anterior humeral line does not pass through the capitellum). There is a high risk of neurovascular injury (an orthopaedic emergency). These patients require urgent reduction and referral for operative management.

Grade II supracondylar fracture

Complications may include:

- Compartment syndrome of the forearm. Also known as Volkmann's ischaemia.
- Neurological injury (the median nerve most commonly injured)
- Malunion leading to gunstock deformity (cubitus varus)

Fractures of the forearm and wrist

by Anria Horn

Learning objectives

1. Identify and describe forearm fractures in children.
2. Manage Monteggia and Galleazi fractures.
3. Understand conservative management of forearm fractures.
4. Gauge acceptable deformity in paediatric forearm fractures.

Forearm fractures in children

- Very common fracture.
- Caused by a fall on an outstretched hand (FOOSH) with a rotational component. Single bone fractures are usually a result of direct trauma.
- Present with clinical deformity, pain and swelling.
- Exclude neurological and vascular compromise.
- X-rays: AP and lateral including wrist and elbow.
- **Must exclude Monteggia and Galeazzi fractures.**

Fracture description:

1. Complete vs incomplete (greenstick) vs plastic deformity.
2. Open vs closed.
3. Distal vs diaphyseal vs proximal
4. Shortening
5. Angulation (apex volar/dorsal/radial/ulnar)
6. Translation
7. Rotation

Monteggia and Galeazzi fractures

The radius and ulna form a ‘ring’ of sorts. Therefore, shortening and marked angulation of the one bone has to be accompanied by fracture of the other bone OR dislocation on either end of the unbroken bone.

Useful mnemonic: GRUM - Galeazzi Radius Ulna Monteggia

Monteggia fractures

This is a displaced ulna fracture, usually proximal, with a radial head dislocation. To identify a radial head dislocation, check that the capitellum and radial head are aligned on AP and lateral X-rays.

Angulated and shortened ulna fracture with intact radius and radial head dislocation

The radial head is not aligned with the capitellum

Galeazzi fractures

Isolated radial fracture with distal ulna dislocation.

Extremely rare in children as distal ulna physeal fracture more likely.

Displaced distal radius fracture with volar dislocation of the distal ulna

The treatment for Galeazzi and Monteggia fractures usually involves anatomical reduction and fixation of the fractured bone. This leads to spontaneous reduction of the dislocated joint. These fractures should always be referred urgently.

Conservative management of paediatric forearm fractures

The majority of paediatric forearm fractures can be managed conservatively in plaster, with or without closed reduction.

All fractures proximal to the distal radial physis should be immobilised in an above-elbow cast to control elbow movement.

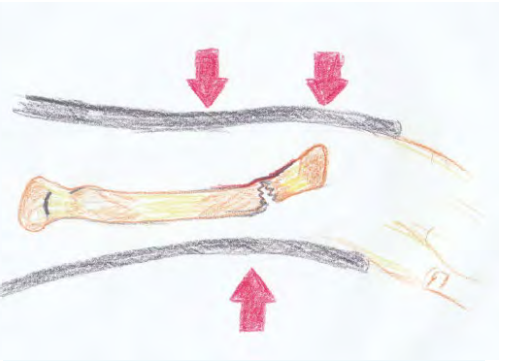
Due to remodeling, certain degrees of angulation, shortening and rotation can be accepted.

Acceptable degrees of deformity in paediatric forearm fractures

	< 9 years	≥ 9 years
Distal forearm	25°	15-20°
Mid and proximal shaft	15°	10°
Rotation	0°	0°
Shortening	1cm	1cm

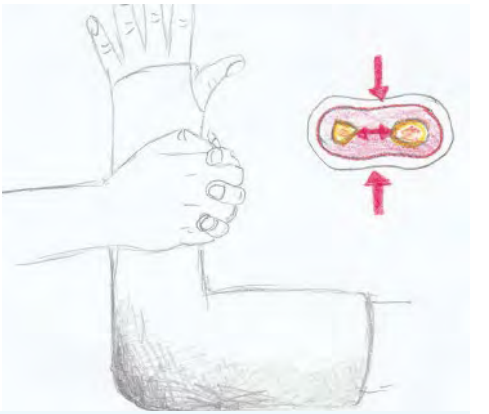
Reduction of displaced / angulated fractures

1. Check the neurovascular status of the limb and document it.
2. The patient needs to be sedated and relaxed.
3. The deforming force needs to be reversed. Most commonly this requires traction and flexion (volar angulation).
4. Three-point moulding is employed to ensure maintenance of the reduction once achieved.



Three-point moulding for apex volar fracture

5. Interosseus moulding will help restore the radial bow.



Interosseous moulding

6. X-rays are performed to confirm adequacy of reduction
7. Patient is observed for a few hours to exclude features of compartment syndrome.
8. NB: Educate parents regarding elevation, swelling and warning signs of compartment syndrome.
9. Arrange follow-up after one week to check the position of the fracture.

What to do if excessive swelling/ features of compartment syndrome:

1. Elevate the limb.
2. Encourage finger movement.
3. Split/bivalve the cast and the padding.
4. Refer urgently if no alleviation of symptoms.

Indications for referral and surgery

1. Unacceptable deformity following attempted closed reduction.
2. Recurrence of deformity.
3. Open fractures.
4. Pathological fractures.
5. Neurological or vascular compromise.
6. Galeazzi and Monteggia fractures.
7. Older children (≥ 13) with limited remodeling potential.

References

Pace JL. Pediatric and Adolescent Forearm Fractures: Current Controversies and Treatment Recommendations. J Am Acad Orthop Surg 2016;24:780–788

Roth KC, Denk K, Colaris JW et al. Think twice before re-manipulating distal metaphyseal fractures in children. Arch Orthop Trauma Surg 2014; 134:1699–1707

Assessment

When a child presents with a forearm fracture, it is important to (choose the most correct answer):

A. Interview the family through to exclude non-accidental injury.
B. Take X-rays of the joint above and below to exclude Monteggia or Galleazi fractures.
C. Take X-rays of the contralateral limb to compare.
D. Not apply a circumferential cast due to the risk of compartment syndrome.
E. Refer all patients for orthopaedic assessment, even if the fracture is undisplaced.

The correct answer is (B) - take X-rays of the joint above and below to exclude Monteggia or Galleazi fractures.

A. Forearm fractures are usually not suggestive of NAI.
C. Only take contralateral X-rays in instances of doubt.
D. Circumferential casts are indicated for most fractures, patients should be warned about the risk and signs of compartment syndrome.
E. Undisplaced and buckle fractures do not require orthopaedic referral.

Fractures of the shoulder, humerus and elbow

by Anria Horn

Learning objectives

1. Common paediatric upper limb fractures; recognising patterns.
2. Fractures around the elbow
3. Non-operative management

Common upper limb fractures

- Children tend to sustain fractures in predictable locations.
- The most common mechanism of injury for all upper limb fractures is a fall on an outstretched hand (FOOSH).
- The most common fractures are clavicle > distal radius (+/- ulna) > supracondylar.
- The growth plate is a weak spot in children's bones and fractures often occur through and around them.
- It is important to know what normal growth plates and ossification centres look like.

Clavicle fractures

- These are the most common fractures in children.
- Exclude neurovascular injury as close proximity to brachial plexus and large vessels.
- Common birth injury.
- Conservative management indicated for all clavicle fractures in children. This involves a collar and cuff or arm sling.
- Exceptions: Open clavicle fractures, vascular injury (both exceedingly rare).

Humerus fractures: Proximal and diaphyseal

- Rule out axillary nerve (proximal humerus) or radial nerve (midshaft) injury.
- Spiral humerus fractures in small children are suspicious for NAI.
- These fractures can largely be treated with simple immobilisation in the form of a collar and cuff or U-slab.
- Three weeks of immobilisation is usually adequate.

A large degree of angulation can be accepted. Remodeling is robust and as a non-weight bearing limb a small amount of residual deformity is acceptable.

Fractures around the elbow

There are many ossification centres around the elbow appearing at different times as the child matures. These ossification centres may look like fractures to the inexperienced eye. The acronym CRITOE/CRMTOL is usuful to remember the ossification centres and when they appear.

CRITOE/ CRMTOL

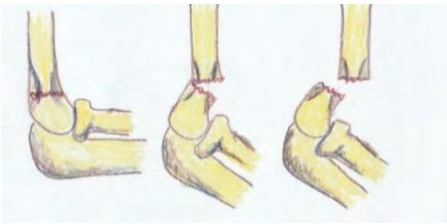
Appearance of ossification centres:

C - Capitellum (1-2 yrs)
R - Radial head (3-4 yrs)
I/M - Internal/medial epicondyle (5-6 yrs)
T - Trochlea (7–8 yrs)
O - Olecranon (9-10 yrs)
E/L - External/lateral epicondyle (11–12 yrs)

NB: Never use a circular cast for elbow fractures; always use a back slab.

Supracondylar fractures

- Weak spot above the humeral condyles at the level of the olecranon and coranoid fossae.
- Typically FOOSH.
- Clinical: Diffusely swollen elbow. Exclude vascular and neurological injury.
- Arteries: Brachial artery. Check radial pulse and hand perfusion.
- Nerves: Median > ulnar > radial.
- X-rays: AP and lateral elbow. Contralateral only in cases of uncertainty.



Grade I *Grade II* *Grade III*

Grade I

- Undisplaced fracture.
- May only see fat pad sign. This is indicative of fluid (blood) in the joint.
- Treatment: Simple immobilisation in above elbow back slab for 3 weeks.

Grade II

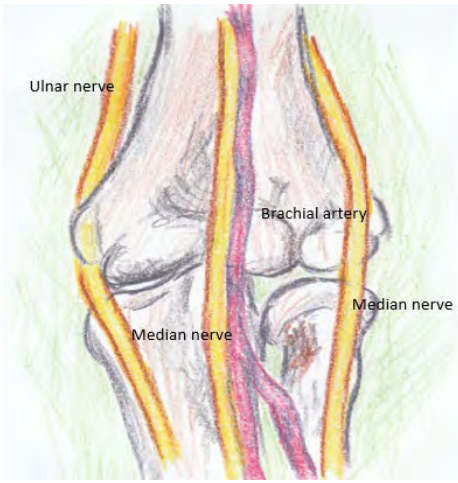
- Partially displaced, posterior periosteal hinge intact.
- If the anterior humeral line crosses the capitellum, no reduction is required and management is as for Type 1.
- For displaced Type 2 fractures, closed reduction with or without wire fixation is indicated.

Lateral X-ray of Type 2 supracondylar fracture with the anterior humeral line not crossing the capitellum

Grade III

- Completely displaced fracture.
- High risk of neurovascular injury. Orthopaedic emergency!
- Needs urgent reduction and referral for operative management.

Elbow anatomy



Displaced Type 3 supracondylar facture

Complications

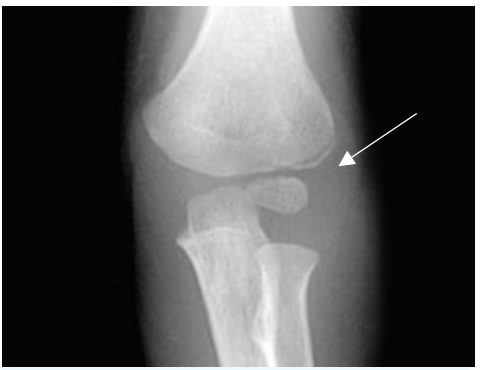
- Compartment syndrome of the forearm. Also known as Volkmann's ischaemia.
- Neurological injury. Median nerve most commonly injured.
- Malunion leading to gunstock deformity.

Gunstock deformity (cubitus varus)

Lateral condyle fractures

- These fractures are commonly missed so look out for them!
- All these fractures need to be immobilised and referred for possible surgical fixation.

Widely displaced lateral condyle fracture



Minimally displaced lateral condyle fracture

Dislocations and medial epicondyle fractures

Elbow dislocations should be reduced once identified.

Steps to reduction:

1. Neurovascular examination documented.
2. Sedation and analgesia.
3. 2 people involved.
4. Longitudinal traction for 3–5 minutes.
5. Elbow flexion with downward pressure on distal humerus.
6. Immobilisation in above elbow back slab.
7. Control X-rays.

The medial epicondyle is often avulsed at the time of dislocation.

Medial epicondyle avulsion following elbow dislocation

Following reduction it may be incarcerated in the joint. Actively exclude this!

Medial epicondyle fractures may be treated conservatively regardless of displacement.

Medial epicondyle incarcerated in joint

NB: All irreducible elbow dislocations or incarcerated epicondyles should be urgently referred.

Proximal radius and ulna fractures

Less common than distal humerus fractures. Look out for them!

Proximal radius fractures occur through the growth plate or the radial neck.

Fractures of the radial neck and head can be managed conservatively if <30° degrees angulation.

Proximal ulna or olecranon fractures are very rare in children.

As they are usually intra-articular, they should be referred following immobilisation in an above elbow back slab.

References

Evol K, Koval K, Zuckerman J.2010. Handbook of Fractures, 4th Edition. Lippincott Williams & Williams. Philadelphia, USA.

Assessment

Regarding supracondylar fractures of the humerus in children, which statement is incorrect?

A. Supracondylar fractures are usually caused by a FOOSH
B. Neurovascular injury is common and the ulnar nerve is most frequently involved.
C. Grade I fractures only needs simple immobilization
D. There is a weak spot above the condyles at the level of the olecranon and coronoid fossae.
E. Displaced grade 2 fractures are treated as Grade 3 fracturs with reduction and percutaneous wiring.

(B) is incorrect, as the median nerve is most commonly injured.

Lower limb injuries in children

by Stewart Dix-Peek & Benjamin Blankson

Learning objectives

1. Identify and diagnose lower limb paediatric fractures.
2. Institute emergency management protocols for the fracture in an acute setting.
3. Understand the definitive management protocols for various lower limb fractures.

Introduction

Fractures make up about 10–25% of all injuries in the paediatric population1. Of these, lower limb fractures make up approximately 15.9%2 and the prevalence increases with age1,2. These are mostly due to high-energy trauma from motor vehicle accidents (MVAs), sports injuries, falls from heights and non-accidental injuries (NAI) among others2. A study conducted in the Red Cross War Memorial Hospital revealed falls from height (39%) as the major cause of femur fractures in the toddler group (peaking at 2 to 3 years). Next was MVA peaking at 4 to 5 years (33.7%); struck by foreign objects (11%); NAI, pathological fractures and sporting injuries followed in descending order3.

This chapter will focus on highlighting lower limb fractures in a child and various protocols for management. Generally, patients need to be assessed initially and stabilised according to ATLS principles.

Specific injuries

Hip fracture

Overview

Hip fractures are rare in children. They usually occur from high-energy trauma, particularly MVA and a high index of suspicion is needed to diagnose them. X-ray (AP and lateral views) are essential to make the diagnosis, and a CT scan may be indicated for occult fractures. Below is a table summarising how hip fractures are classified.

Classification	
Type I	Transepiphyseal fracture, with or without dislocation of the femoral head.
Type II	Transcervical. Usually displaced.
Type III	Cervicotrochanteric
Type IV	Intertrochanteric

Treatment

- Acutely immobilise in traction
- **Type I:**
  - Closed reduction with smooth pin fixation in the younger child or cannulated screws or threaded pins in the older child.
  - If closed reduction is not possible,
  - open reduction is indicated.
- **Type II and III**
  - Undisplaced: spica cast.
  - Displaced: closed reduction and cannulated screws. In the younger child, avoid crossing the physis with screws, and if closed reduction fails, open reduction is indicated.

- **Type IV:** Traction in abduction, or open reduction and internal fixation if irreducible or unstable.

Hip dislocation

Overview

Posterior dislocations account for 80% of hip traumas. Low energy injuries cause traumatic hip dislocations in the younger child (2–5 years) due to associated ligamentous laxity. In older children (11–15years), dislocated hips are caused by higher energy injuries and have a higher association with acetabular fractures, although this is rare. Dislocations are more common than fractures in the paediatric population.

Right hip dislocation

Clinically

- **Posterior dislocation:** Typically flexed, adducted, internally rotated hip.
- **Anterior dislocation:** Typically extended, abducted, externally rotated hip.

Conduct a careful neurovascular evaluation with particular attention to the sciatic nerve. Ipsilateral femoral shaft fracture should be excluded before manipulation.

Investigations

If an acetabular fracture is identified on the pre- or post-reduction X-rays, Judet (45° obturator and iliac oblique) views should be obtained. If an intra-articular fragment or incongruent reduction is present, a CT scan is indicated.

Treatment

Exclude an ipsilateral femur fracture before reduction. Assess neurovascular status (especially sciatic nerve function) both before and after reduction. Acutely, attempt closed reduction under procedural sedation, as this is usually successful. In delayed or neglected cases, traction for 3–6 days should be attempted before open reduction if an initial attempt of closed reduction was unsuccessful. Once the hip is reduced, immobilise in traction for 4–6 weeks.

Open reduction is rarely necessary; surgical intervention is indicated in:

- Failed closed reduction
- Nonconcentric reduction
- Displaced acetabular fractures
- Intra-articular fragments
- Sciatic nerve palsy occurring post-reduction where it was normal before reduction.

Complications

- Avascular necrosis (3–15%) decreased incidence under age 5
- Nerve injury - sciatic or gluteal nerve
- Coxa Magna - not associated with functional limitation
- Redislocation

Femoral shaft fractures

Overview

Femoral shaft fractures present with a bimodal distribution peaking at 2–4 years and mid-adolescence, predominantly in males. In the neonate, fractures are mainly due to birth trauma and non-accidental injury. In children under one year, 50% are due to non-accidental injury and, in adolescents, most are due to MVA.

Classification

Descriptive	Anatomical
• Open/compound • **Pattern:** spiral, transverse, short oblique, long oblique, butterfly fragment, comminuted • Displacement • Angulation	• Subtrochanteric • Shaft • Proximal 1/3 • Midshaft • Distal 1/3 • Supracondylar (metaphyseal)

Treatment

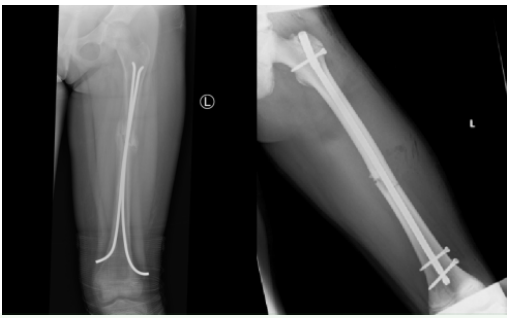
The table below summarises the accepted angulation in a femur fracture.

Age	Varus/valgus	Anterior/posterior
0–2 years	30°	30°
2–5 years	15°	20°
6–10 years	10°	15°
>11 years	5°	10°

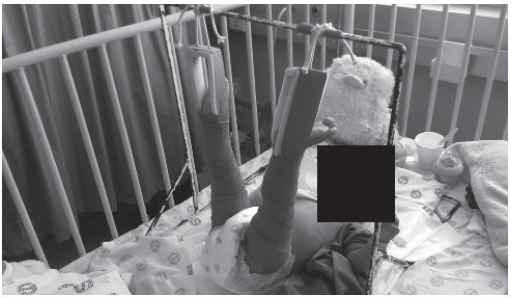
Below are guidelines to management of femur shaft fractures; however, these may vary between facilities, depending on the preference and expertise of the surgeons.

Age	Treatment	Duration	Comments
Neonates	Pavlik harness	3 weeks	
<2yr/ <12kg	Gallows traction	3–6 weeks	Compartment syndrome risk
2–8 years	Early spica cast	4–8 weeks	
8–12 years	Traction	6–8 weeks	
	Retrograde IM nails	Partially weight bearing to full as pain permits	Removal at 6 months
>12 years	Prograde IM nails		Trochanteric entry point. Locked nail
	Special circumstances		
Compound fractures	External fixator/plate with preliminary debridement, antibiotics		
Severe head injury	ORIF (done once patient's condition stabilised)		

IM nails = intramedullary nails



X-rays of (A) Retrograde IM nail and (B) Prograde IM nail



Gallows traction

Complications

- **Malunion:** Remodelling will not correct any rotational deformity. Younger patients remodel better than older patients, and sagittal plane deformities remodel better than coronal plane deformities.
- **Non-union** is rare. Should it occur, bone graft and plate or IM nail fixation is indicated.
- **Limb length discrepancy:** As a result of either shortening or overgrowth. 1 cm of overgrowth can usually be expected, and early shortening of 1–2 cm is acceptable. Up to 2 cm of leg length discrepancy is well tolerated.
- **Avascular necrosis of the femoral head:** may occur with antegrade nailing of femoral fractures through the piriformis fossa. For this reason, a trochanteric approach is recommended before skeletal maturity.

Knee injuries

Overview

In the immature skeleton, physes fail before ligaments under tensile load. Ligamentous injuries are therefore uncommon before skeletal maturity. Two-thirds of the longitudinal growth of the lower limb occurs in the distal femur (10 mm/year), followed by the proximal tibia (6 mm/year). Injuries to the physes may lead to premature growth arrest or angular deformity.

Distal femur fracture

Ligamentous and tendinous structures insert on the epiphysis, leaving the physis unprotected. Injury is usually due to indirect forces: varus/valgus hyperextension/hyperflexion, usually resulting in a Salter-Harris II type injury.

Radiological evaluation

AP and lateral films should be ordered. Oblique views are needed when in doubt or to visualise the fracture better. Stress views may be necessary to identify undisplaced fractures. In infants, separation of the distal femoral physis may be missed. The ossified centre of the epiphysis should always be in the line of the femoral anatomic axis on AP and lateral.

Classification

Salter-Harris	Displacement
Type I: Easily missed. Stress views may be necessary.	Hyperextension injury – anterior
Type II: Most common type. Usually varus or valgus injury.	Hyperflexion injury – posterior
Type III: Intra-articular. Often best seen on AP X-rays as the physeal component is in the sagittal plane.	Varus injury – medial Valgus injury – lateral
Type IV: Rare injury but a high incidence of linear physeal bar formation.	
Type V: Diagnosis usually made retrospectively.	

Distal femur fracture: (A) Salter Harris type I fracture of distal femur; (B) Stress view with valgus force; (C) Stress view with varus force

Treatment

- **Undisplaced fractures:** Above-knee POP with the knee in extension
- **Hyperflexion injuries:** MUA and maintain position with above-knee POP with the knee in extension
- **Hyperextension injuries:** MUA impractical to maintain reduction by keeping knee flexion; therefore, cross-pin using smooth k-wires or Steinmann pins from the epicondyles to the metaphysis.
- **Varus/valgus injuries:** MUA and cross pins
- With **Salter-Harris III and IV injuries**, open reduction is necessary to restore the articular congruity unless the fracture is undisplaced.

In the older child with a large metaphyseal spike (Thurston-Holland fragment), the fragment may be used to maintain reduction with cannulated lag screws.

Complications

Early

- **Vascular injury:** Usually with hyperextension injury. The cool, pulseless foot pre-reduction requires urgent reduction. If it resolves, it requires observation for 48–72 hours to exclude intimal tears. The cool pulseless foot post-reduction requires urgent angiography.
- **Peroneal injury:** This is usually associated with varus injuries. The patient should be put in an ankle-foot orthosis until the nerve recovers to prevent an equinus foot deformity. Persistent nerve palsy at three months should be evaluated with electromyography and possibly exploration.

Late

Physeal closure: 50% of physeal injuries in the distal femur will result in arrest. This is due to the interdigitating nature of the distal femoral physis. The physeal injury will present with a bar manifesting as angular deformity or limb length discrepancy.

References

Modified images:

Dislocated hip. Available from: https://commons.wikimedia.org/wiki/File:Dislocated_hip.jpg

Clubfoot (Congenital talipes equinovarus)

by Stewart Dix-Peek & Japie de Wet

Learning objectives

1. Will be able to identify a clubfoot.
2. Will be able to differentiate a true clubfoot from a positional foot deformity.
3. Know the basic management principles of a clubfoot.

Introduction

Clubfoot (congenital talipes equinovarus) is an idiopathic deformity of the foot of unclear aetiology. It is the most common musculoskeletal congenital disability with an overall incidence of 1:1000. The male: female ratio is approximately 2:1, and 50% of the cases are bilateral. A genetic component is strongly suggested with a familial occurrence of 25%

Applied anatomy

Soft tissue and bony deformities contribute to the characteristic deformity noted in a clubfoot.

Muscle contractures (CAVE)

Midfoot

- Cavus (tight intrinsics, flexor hallucus longus, flexor digitorum longus).

Forefoot

- Adductus of the forefoot (tight tibialis posterior).

Hind foot

- Equinus (tight Achilles tendon).
- Varus (tight Achilles tendon, tibialis posterior and tibialis anterior).

Bony deformity

The talar neck is displaced medially and deviated plantarly. The calcaneus (hind foot) is in varus and rotated medially. The navicular and cuboid bones are displaced medially

Clinical findings

History

- Birth history: Normal vs Caesarean section, duration of pregnancy, pre- or perinatal complications.
- Developmental history and milestones.
- Family history: Spinal defects, clubfoot in the family.
- Previous treatment: conservative (casting) or surgery.

Examination

Look

- Syndromic features: Facial, disproportionality.
- Spinal defects.
- Lower limbs: affected limb smaller and atrophied.
- Foot: smaller posterior and medial crease
  - Hind foot equinus and varus
  - Midfoot cavus

- Forefoot adduction

Feel

- Palpable talus head (uncovered).
- Empty heel.

Move

- Mobile or rigid.
- Correction of adduction and equinus.
- Anterior tibialis and abductor response.
- Record ROM for plantar flexion and abduction.

Note: A deformity that completely corrects into abduction and dorsiflexion is positional/postural and not a true clubfoot deformity (intra-uterine position).

Neurovascular

Standard lower limb neurovascular examination.

Special investigations

- Radiology: X-rays usually not needed.
- Clubfoot deformity can be diagnosed intra-uterine with ultrasound.

Commonly associated conditions

- Arthrogryposis
- Myelodysplasia

Images of children with bilateral clubfeet, highlighting the deformity of pes cavus, adductus, varus and equinus. A series of plaster applications illustrates the progressive correction with treatment

Management

Non-surgical

Ponseti method, including serial casting correcting in sequence the cavus, adductus, varus and equinus. This may include an Achilles tenotomy. Follow-up with foot abduction braces or Dennis Brown boots is also necessary.

Surgical

Soft tissue

- Posterior medial release, Achilles tendon lengthening, Tibialis anterior transfer

Bone

- Medial column lengthening and lateral column shortening
- Talectomy
- Triple arthrodesis

Essential takeaways

- Specific deformity of the clubfoot (CAVE).
- Difference between a postural and clubfoot deformity.
- Management: Ponseti casting.

References

Lovell and Winter's Paediatric Orthopaedics 7th edition, pp. 1410–1428

Malhotra, R et al. Ponseti technique for the management of congenital talipes equinovarus in a rural set-up in India: experience of 356 patients. Children 2018, 5(4), 49. https://doi.org/10.3390/children5040049

Recommended reading

Malhotra, R et al. Ponseti technique for the management of congenital talipes equinovarus in a rural set-up in India: experience of 356 patients. Children 2018, 5(4), 49. https://doi.org/10.3390/children5040049

Bone and joint infection basics

by Michael Held & Maritz Laubscher

Learning objectives

1. Know the pathophysiology and differences between children and adults.
2. Know the risk factors.
3. Understand the most common pathogens and know how to approach

Introduction

Bone and joint infections can be **acute** or **chronic**. Acute infections should be treatedas orthopaedic emergency. Especially for children and immunocompromised patients infections, acute infections canlead to severe systemic illness and can have detrimental long term morbidity if not treated urgently. **Osteomyeltits** (infection of bone) can be divided into acute, sub-acute and chronic. In sub-acute osteomyelitis, infection lasts from one to several months, after which chronicity begins. Chronic osteomyelitisis characterised by progressive bone destruction and new bone apposition.

Pathophysiology

Hematogenous

Compared to children, adult osteomyelitisis rarely hematogenous, i.e. originated ortransported by blood. When it occurs, it usually affects the spine. It is caused by microorganisms that seed the bone in the event of bacteremia. The most common organism found in hematogenous spread is Staphylococcus aureus. Hematogenous infections are most common in children.The metaphysis is the most common site because it is rich in blood supply (althoughthis has sluggish flow) and is an actively growing part of bone. It also has relatively fewer phagocytes than the physis or diaphysis.

Contiguous spread

This mode of contamination can be associated with previous surgery, an old non healing wound (diabetic foot, neuropathic ulcer) or a previous trauma. Infection spread by contiguity from adjacent tissue to bone.

Direct inoculation

Open fractures, penetrating injuries or bone surgeries can be a direct source of infection, resulting in osteomyelitis.

Risk factors

- Recent trauma or surgery
- Immunocompromised patients
- IV drug use
- Poor vascular supply
- Systemic conditions such as diabetes and sickle cell anaemia
- Peripheral neuropathy

Classification

Osteomyelitis may be classified based on the duration of illness (acuteversus chronic) and the mechanism of infection (haematogenous versus non-haematogenous).

Bacteriology and antibiotics

The most common infecting organism is staphylococcus aureus in all age groups, which accounts for 80–90% of positive cultures. The table below shows common organisms of different age groups and patient populations with antibiotic choice, but this should be guided by local authorities.

Patient cohort and bacteriology		Antibiotics
Neonates	S. aureus (MRSA), Group B strep Gram negatives	Cloxacillin (Fusidic Acid) 3rd gen cephalosporin
6 months – 4 years	S. aureus, K. kingae, H. influenzae (rare)	Cloxacillin + Ampicillin/3rd gen cephalosporin
> 4 years	S. aureus	Cloxacillin
Adults (acute)	S. aureus	
Penicillin allergy		Clindamycin
immunocompromised	S. aureus, S. pneumoniae, pseudomonas, fungal	Cloxacillin + 3rd gen cephalosporin Cloaxillin + 3rd gen cephalosporin
Sickle cell disease	S. aureus, Salmonella	Cefazolin is an alternative to Cloxacillin (if not available)
contiguous chronic osteomyeliti	The most common causative organisms are: Enterobacteriaceae sp. Staphylococcus sp. Pseudomonas aeruginosa Enterococcus sp. In 45% of infections multiple organisms cultured	Common organisms of different age groups and patient populations with antibiotic choice
heamatogenous chronic osteomyelitis	Staphylocossus aureua is the most common organism involved in adults (60-90%)	

Acute bone infection in adults

by Pravesh Panchoo & Maritz Laubscher

Learning objectives

1. Define acute osteomyelitis.
2. Recognie a patient presenting with acute bone infection.
3. Know the management of acute bone infections.
4. Exclude immunocompromise and assess nutritional status.

Introduction

Bone infection also known as osteitis or osteomyelitis can be divided into acute, sub-acute and chronic osteomyelitis.

Acute osteomyelitis has an onset of 2 weeks or less. In subacute osteomyelitis, infection lasts from one to several months, after which chronicity begins. Chronic osteitis is characterised by progressive bone destruction and new bone apposition..

Pathophysiology

Haematogenous

Haematogenous spread in adults is rare. When it occurs, it usually affects the spine.

Microorganisms seed to bone in the event of a bacteremia. The most common organism found in hematogenous spread is Staphylococcus aureus.

Contiguous spread

Infection spread from adjacent soft tissue to bone. It is mostly associated with non- healing wounds (diabetic foot, neuropathic ulcer, venous stasis ulcer).

Direct inoculation

Open fractures, penetrating injuries or bone surgeries can be a direct source of infection resulting in acute osteomyelitis.

Microbiology

Staphylococcus aureus is the most common organism involved.

Enterobacter, enterococcus, Pseudomonas and streptococcus species are sometimes isolated.

Unusual organisms are sometimes isolated in specific population: Salmonella in patients with Sickle cell disease, fungal infection in immunosuppressed patients.

Clinical findings

History is important to categorize type of host and onset.

Symptoms

- Pain: Usually dull pain, even at rest and at night (RED FLAG). Can limit weight bearing.
- Fever: Varies from low to high grade fever, can be associated with chills and rigors in case of sepsis.

Physical examination

General examination: Should inform about the host status of the patient.

Local examination: Erythema, tenderness and oedema usually present. There can be an area of fluctuation, indicative of an associated soft tissue abscess. Presence of surgical scars should raise suspicion.

The patient refuses to weight bear if the lower limb is affected. The joints above and below must be assessed to exclude associated septic arthritis.

Acute bone infection in a patient following external fixation for a tibia fracture

Radiographs

Anteroposterior and lateral views of the affected limb. May be normal in early infection. At a later stage periosteal reaction can be seen. Can also identify air around soft tissue suggestive of an infection. Involucrum and sequestrum are features of chronic osteomyelitis.

Radiograph of osteomyelitis in the distal humerus with a periosteal reaction

Brodie abscess

A Brodie abscess consists of a region of suppuration and necrosis encapsulated by granulation tissue within a rim of sclerotic bone. Brodie abscess occurs in the setting of subacute osteomyelitis in
the metaphysis of long bones, typically in patients <25 years of age. It is usually of hematogenous origin but can also occur in the setting of trauma.

The most common pathogen is S. aureus. The most common site is the distal tibia; other sites include the femur, fibula, radius, and ulna.

Radiograph and coronal MRI image of a Brodie's abscess in the distal tibia

Computer tomography (CT) scan

CT is more sensitive than conventional radiography for assessing cortical and trabecular integrity, periosteal reaction, intraosseous gas, soft tissue gas, and the extent of sinus tracts. It is useful in chronic osteomyelitis and may be the most useful modality to evaluate for the presence of osseous sequestrum and involucrum.

Magnetic resonance imaging (MRI)

MRI is the imaging modality with greatest sensitivity for the diagnosis of osteomyelitis. After radiographic evaluation, MRI is generally considered the study of choice for further assessment. It is useful for obtaining images delineating the extent of cortical destruction characteristic of osteomyelitis, as well as to evaluate for presence of bone marrow abnormality, soft tissue inflammation (such as in the setting of cellulitis, myositis, and/or ulceration) and ischemia. MRI may demonstrate abnormal marrow edema as early as 1 to 5 days following onset of infection.

Laboratory investigations

- **White cell count:** raised white cell count with neutrophilia
- **Erythrocyte Sedimentation Rate (ESR):** normal range 0-10. Elevated in 90% cases. A decrease in ESR shows good response to treatment.
- **C-Reactive Protein (CRP):** normal range <4. Most sensitive blood marker, elevated in 97% cases. Decreases faster than ESR.
- **Blood cultures:** their utility is mainly in hematogenous osteomyelitis where it is positive in about 50% cases.
- A workup for immunocompromise and malnutrition must be included if unknown (i.e. **HIV, HBA1C, Albumin**)

Microbiology

Tissue and bone samples sent during debridement help identifying the causative organism and guide antibiotic treatment.

Complications

- Sinus tract formation
- Contiguous soft tissue infection
- Abscess
- Septic arthritis
- Systemic infection
- Chronic osteomyelitis

Treatment

Non operative

Assessment for systemic signs of an infection is crucial and patients must be resuscitated in severe acute bone infections.

Antibiotic therapy alone without surgical debridement is an option in hematogenous osteomyelitis. It is then either guided by the result of blood culture or empirical, aiming at the most common organism (staphylococcus aureus). The duration of treatment is 4–6 weeks.

Operative

Surgical debridement for management of osteomyelitis consists of removal of necrotic material and culture of involved tissue and bone. A satisfactory soft tissue envelope overlying the site of infection must be re-established for successful treatment, either via direct closure or flap coverage. In the setting of non-viable or injured bone and/or infected fluid collections, surgical debridement is a cornerstone of therapy. Antimicrobial therapy alone is not effective for cure of infected, necrotic bone

Key takeaways

- Acute bone infections in adults mostly caused by direct inoculation or contiguity
- Staphylococcus aureus is the most common organism involved
- Radiographs can be normal at the beginning, so high index of suspicion needed.
- MRI is presently considered the most sensitive examination for detection of early infection

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Chronic bone infections in adults

by Thomas Hilton, Mohammed Daoub, Len Marais, Nando Ferreira & Luan Nieuwoudt

Learning objectives

1. Define acute osteomyelitis.
2. Recognise a patient presenting with acute bone infection.
3. Know the management of acute bone infections.
4. Exclude immunocompromise and assess nutritional status.

Introduction

Infection of the bone or osteitis/osteomyelitis (OM) can be divided into the subtypes - acute, sub-acute and chronic. According to the temporal classification, acute OM has a duration of under two weeks, sub-acute OM one to three months and chronic for more than three months. Clinically, acute osteomyelitis is characterised by the absence of sequestrum, sub-acute osteomyelitis by Brodie's bone abscess and chronic osteomyelitis by sequestra and involucrum or foreign material (such as orthopaedic implants).

Microbiology

- Chronic osteomyelitis is typically characterised by bacterial biofilms on sequestra (dead bone) or foreign bodies (such as orthopaedic implants).

- A biofilm is a complex aggregation of microorganisms in which cells adhere to each other in a fluid matrix on a solid substrate. The biofilm consists of microorganisms in various states of activity, an extracellular polymeric substance produced by organisms which contain extracellular DNA, proteins, polysaccharides. The structure of the biofilm helps bacteria to evade the host's immune defence mechanisms and antibiotics.

- Apart from the microorganisms embedded in a biofilm, bacteria also show an adaptive stress response and formation of dormant persister cells that provide a survival advantage during an antimicrobial challenge.

- The bacteria may also hide in the bone microstructure and, in some instances, they (Staphylococcus aureus, for example) may internalise themselves in osteoblasts, thus becoming intracellular organisms.

- These mechanisms enable the causative organisms to persist in an asymptomatic host, and the infection can reactivate and become clinically evident years after the primary infection.
(See the table in the chapter Bone and Joint Infections - Basics for Specific

Organisms.)

Risk factors for poor prognosis

Despite surgical debridement and long-term antibiotics, the recurrence rate of chronic OM in adults can still be as high as 30%. Certain risk factors lead to poor prognosis (see table).

Risk factors poor prognosis
Previous surgery or trauma
Smoking
Corticosteroid use
Diabetes Mellitus
Immunocompromise
IV drug abuse
Poor vascular supply
Peripheral neuropathy
Malnutrition
Chronic renal failure/Dialysis

Classification

Cierny and Mader (1984) classified chronic OM according to the infection's anatomic distribution and the host's physiological status. The **anatomic** areas are:

1. Medullary (bone marrow only)
2. Superficial (cortex)
3. Localised (medulla and cortex, stable)
4. Diffuse (medulla and cortex, unstable)

The **host** is divided into:

A - Healthy (No comorbidities)

B_L: - Local compromise

B_S - Systemic compromise

C - Poor host status (surgical treatment carries higher morbidity than the disease itself)

Diagnosis

History

The duration and severity of symptoms such as pain, pus drainage or functional impairment that is the inability to walk and so on, must be established. Find out about previous
treatment or surgery and comorbidities

Examination

Evaluate vital signs (fever, tachycardia, tachypnoea and hypotension suggest sepsis) and signs of systemic disease.

Local

Erythema, tenderness and oedema are commonly seen. Discharge or a draining sinus is common in chronic OM. The soft tissue condition including scarring or Lipodermatosclerosis, abscess formation or cellulitis must be noted.

The vascular status of the limb must be assessed.

Any skeletal instability, pathological fracture or fracture non-union must be noted. The range of motion, limping or being unable to bear weight because of pain are signs of instability.

Sinus formation in chronic OM

Radiographs:

AP and lateral views of the affected limb often show bone resorption with a sclerotic rim around the infected bone, disuse osteopenia, periosteal reaction, lucency (lysis around hardware/ implants) and sequestrum and involucrum formation.

CT scan and MRI:

Valuable in diagnosis and surgical planning by identifying necrotic bone.

Laboratory analysis:

WCC, ESR, CRP may not always be raised in chronic osteomyelitis.

Staging of the host:

- FBC to screen for anaemia
- Tests for renal function, liver function, serum albumin, HIV serology and CD4 count as indicated

Identification of causative organisms:

- Blood culture is often negative but may be used to guide antibiotic therapy in acute haematogenous osteomyelitis.
- Sinus tract culture is not recommended. Culture of bone and soft tissues obtained surgically from the infection site remains the gold standard for guiding antibiotic therapy.

Management

The management of chronic osteomyelitis is complex, and cases should ideally be referred to orthopaedic units specialising in treating chronic bone infections.

Optimisation of the patient:

This should entail the cessation of smoking and alcohol abuse, nutritional support (high protein diet for patients with low albumin level), blood sugar control and anti-retroviral therapy for HIV+ve patients.

In patients with acute flare-ups (cellulitis or abscess formation), systemic antibiotics are required to control the infection. Definitive surgery is typically delayed until the soft tissue condition improves.

Local treatment:

Colostomy bags over the sinus protect the skin from excoriation. Acute abscess formation requires urgent incision and drainage with

tissue sampling for MCS, followed by directed intravenous antibiotics.

Surgical

During surgery, a tissue biopsy for culture and microscopy is taken, all necrotic and devitalised tissue is debrided, and implants are removed. Skeletal stability is typically achieved by external fixation. Soft tissue reconstruction is then performed, which may involve plastic surgery.

Following surgery, empiric intravenous antibiotics are given until the culture results become available, after which directed oral antibiotics are given for six weeks. The antibiotic regime should include agents that exhibit appropriate activity against biofilm-based organisms.

In severe cases, surgical reconstruction may not be possible, and amputation may need to be considered

Non-surgical

Chronic suppression with antibiotics may be useful for patients where surgery is not feasible. This requires an opinion from a bone infection unit.

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Orthopaedic infections in children

by Anria Horn

Learning objectives

1. Identify the key features in the clinical history suggestive of an orthopaedic infection.
2. Know which special investigations to request.
2. List the Kocher Criteria and know its relevance to the diagnosis of septic arthritis.
3. Understand the principles of antibiotic management.

Introduction

Children are particularly prone to developing bone and joint infections. This is because of the unique anatomy around tgrowth plates, leading to sluggish and turbulent blood flow in these areas. Bone and joint infections in children are almost always haematogenous.

The worldwide incidence ranges from 1/800 to 1/5000. The incidence is higher in developing countries.

Boys are more commonly affected than girls, and younger children are more commonly affected than older children.

Acute orthopaedic infections in children should be treated as emergencies.

Clinical findings

History

Patients will usually present with a vague history of trauma. This often leads to delayed diagnosis as infection is not considered. There will be a history of limping and pain, inability to weight bear and pseudoparalysis if the upper limb is involved. Ask about a history of an upper respiratory tract infection or recent skin infection, as it is often associated. There may also be a history of fever.

Examination

Start with a general examination including vital signs. Raised temperature and pulse rate is suggestive of infection. Examine the whole body for infectious cutaneous lesions or other obvious sources. Local examination follows the ‘look, feel, move’ principle:

Look: Swelling, erythema, sinus or pustule

Feel: Warmth, fluctuance, effusion (joint), tenderness

Move: Patients with septic arthritis are very reluctant to move their joints. If the joint moves easily, consider adjacent osteitis or cellulitis.

Special investigations

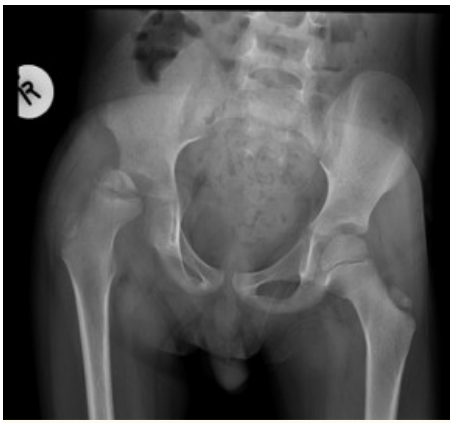
Radiographs of the affected limb should be requested. In acute infections, X-rays are typically normal but may show soft tissue swelling or an effusion. In the case of septic arthritis of the hip, subluxation may be evident. It takes on average 2 weeks for X-ray changes to appear following an acute infection.

Blood cultures should be taken in all patients with suspected bone or joint infection.

Full blood count, ESR and CRP should be requested. White cell count and platelets are typically raised, as is the ESR and CRP.

Bone scan is useful to detect occult infections of the spine and pelvis and in the young child where it is difficult to localise the site of the infection. Use is limited by availability.

MRI has a very high sensitivity and specificity for detecting infection, but use is limited by availability and cost.



Right hip subluxation as a result of septic arthritis

Kocher Criteria

Originally described to differentiate septic arthritis of the hip from a transient synovitis. Nonetheless useful in determining whether limb pain is caused by infection or something else.

Kocher Criteria	
non-weight bearing	or pseudoparalysis
ESR	> 40mm/hr
WCC	< 12 x 10^9/L
Pyrexia	Temp >38.5°C

The number of criteria present predicts the likelihood of infection:
1 = 3%, 2 = 40%, 3 = 93%, 4 = 99%

Bacteriology and antibiotics

The most common infecting organism is staphylococcus aureus in all age groups, which accounts for 80–90% of positive cultures. The table in the chapter ‘Bone and Joint Infections Basics’ shows common organisms of different age groups and patient populations with antibiotic choice, but this should be guided by local trends.

Management

Non-surgical management is seldom indicated. In very early onset osteitis without collection of pus, antibiotic management alone is acceptable. If no infecting organism is identified, empiric antibiotics as listed in the table above should be prescribed for 6 weeks.
Surgical management is nearly always indicated to release the pus.
In septic arthritis, a small arthrotomy is performed and the joint irrigated copiously. Pus swabs are taken as well as synovial samples. These are sent for culture and sensitivities as well as TB testing.

In osteitis, the affected bone is surgically approached and any extra-osseus pus is released. If not pus is found in cases with a high suspicion of osteitis, holes may be drilled in the bone to assess for and release intramedullary pus. Following surgery, patients are started on antibiotics as described above: 6 weeks for osteitis and 4 weeks for septic arthritis. Empiric antibiotic treatment can be changed depending on culture results or poor clinical response.

Complications

Untreated septic arthritis will lead to destruction of the joint cartilage and severe arthritis. In the hip and elbow, it may lead to avascular necrosis of the femoral and radial head, respectively. Acute osteitis, even if treated adequately, may lead to pathological fracture, growth disturbance and the development of chronic osteomyelitis.

Essential takeaways

- Orthopaedic infections are common in children and should be actively excluded in any child that presents with limb pain or limping.
- Special investigations are helpful in establishing the diagnosis, but the
- presentation is mostly clinically obvious.
- Urgent surgical management is indicated in patients diagnosed with septic arthritis or acute osteitis with a pus collection.
- Staph aureus is the most common infecting organism and antibiotic treatment should always include cover for this organism.

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Hand infections

by Ian Koller, Pieter Jordaan & Neil Kruger

Learning objectives

1. Early recognition and appropriate action save hand function.
2. Severe hand infections need STAT empiric IV antibiotics PRIOR to theatre and PROMPT referral for surgical drainage.
3. All patients with diabetes and HIV should be given Augmentin as their antibiotic treatment.
4. Oral flucloxacillin is appropriate for local infections not requiring IV antibiotics.
5. Antibiotics cannot penetrate abscesses – these need to be drained surgically.
6. Hand sepsis in a diabetic or immunocompromised is an emergency.
7. Specimens, preferably tissue, should be sent for microscopy and culture with every infection requiring surgical management.
8. Hand infections cause stiffness, which must be proactively managed to restore function.

Introduction

Definition

Hand infections cover any bacterial, viral, mycotic or other agent infecting the hand. There are **5 main hand infections**, all of which have a predominant bacterial (staph or strep) aetiology.

Main hand infections	
1	Tenosynovitis of flexor tendons
2	Deep palmar space abscess
3	Webspace abscess
4	Felon
5	Paranychia

The first two are severe hand infections that require immediate empiric IV antibiotics (covering staph and strep – e.g. Cloxacillin), admission to hospital and theatre booking on the emergency list for incision and drainage.

Background

Hand infections are very common in the general population, especially in professions involving work where cuts and scrapes on the hands are common (e.g. manual labourers, such as brick layers), as these are a portal for bacterial entry.

Infective tenosynovitis of flexor tendons

This is less common than other hand infections and presents with deep seated pain along the length of the volar aspect of the finger extending up to the distal palm. It is acutely painful and the finger is kept in a position of mild flexion. Patients will resist passive extension of the finger, as any movement of the tendon within the sheath is severely painful.

The infection can spread proximal to the carpal tunnel and can then spread along other tendons. It is very important to examine the whole hand and forearm to exclude proximal spread of infection.

Kanavel's 4 signs of flexor tenosynovitis
1. Pain along the flexor tendon sheath
2. Finger held in a flexed position
3. Fusiform swelling of the digit
4. Extreme pain and resistance to passive extension of the digit

Four classic signs described by Kanavel to aid the diagnosis of an infective tenosynovitis.

Management

All patients with this diagnosis need immediate IV antibiotics (empirically before theatre!), admission to the ward and booking on the emergency list for incision and drainage.

Surgical technique

A 1.5cm–2cm transverse incision just proximal to the A1 pulley an oblique incision of similar length is made midway over the volar aspect of the distal phalanx to provide access to the proximal and distal aspects of the flexor tendon sheath. Proximally a small feeding tube (NGT or drip cannula) is introduced into the sheath and copious amounts of water or saline are syringed through the sheath (must see it run out of the distal incision continuously), until the solution is completely clear and the sheath rid of all pus/murky/turbid fluid or collections. If proximal spread has occurred, this should also be dealt with surgically.

Fusiform swelling of ring finger

Deep palmar space infection

An infection of the deep palmar space where the pus gets trapped deep in the hand is an emergency. Penetrating injury to the palm is a common cause. Presentation and recognition of this is often delayed as it is somewhat concealed and the obvious fluctuance not there. The hand appears very swollen, but the swelling may appear to be located dorsally, rather than palmar. The swelling may be more radial or ulnar, as this space is separated by a fibrous sheath running longitudinally along the 3rd metacarpal. The natural concavity of the palm may be lost as the pus collects between the volar flexor tendons and the metacarpals dorsally.

Management

Admission to hospital, immediate empiric IV antibiotics, and booking on the emergency list for incision and drainage is required. Incisions are over the point of

maximum fluctuance, or over the point of maximum swelling, trying to stay longitudinal or oblique. Use a scalpel through the skin and then a blunt dissecting scissors to access the abscess cavity (less risk to nerves). Perform a thorough debridement of any devitalised tissue and copiously irrigate the cavity to clear of all the pus and debris. Apply a Betadine-soaked dressing into the cavity and wrap it well with velband and kling bandage. Prescribe pain medication (Paracetamol, ibuprofen and tramadol) and antibiotics (Cloxacillin/Co amoxiclav 1g 6hrly) until MCS results are back. Do a wound inspection at 3 days after the initial surgery to assess response and need for re-debridement.

Deep palmar space infection

This presents as a swelling on the volar aspect of the distal palm between the fingers, classically causing them to splay apart due to the space occupying effect. It may break through dorsally onto the extensor surface, where it often may blister and spread along the looser dorsal fascial planes.

Management

This may be managed as day case surgery with discharge home the same day if no systemic signs of sepsis are present. Management consists of a longitudinal volar incision between the fingers from the base of the webspace, big enough to admit a finger to deloculate and release the pus. Avoid crossing the apex of the webspace, as this can cause scarring and contracture of the fingers, decreasing their abduction ability or span. Dress the wound as for other abscesses. Prescribe pain and anti- inflammatory medication and flucloxacillin 500mg 6hrly for 1 week or until cleared. Do a wound inspection at 3 days after the initial surgery to assess response and need for re-debridement.

Felon

A felon is a pulp space abscess of the distal phalanx of any finger. It is often secondary to small cuts or a penetrating injury to the finger. The patient usually presents with a swollen terminal digit and acute, severe throbbing pain which often keeps them awake at night. Unless released, this pain will worsen due to ischaemia and then suddenly abate as the tissues necrose. The fingertip contains numerous enclosed small fibrous compartments which cannot expand much and hence rapidly become painful with the swelling. The key to successful management lies in early recognition and surgical release thereof. If unchecked, the infection may cause necrosis of the tissues and osteomyelitis of the terminal phalanx. Always do an X-ray to check beforehand as once osteomyelitis has set in it is very difficult to save the phalanx and ablation should be considered.

Management

If no osteomyelitis on X-ray, a longitudinal incision over the point of maximal fluctuance should be made under digital block. It is important to release the fibrous septae to decompress the affected area. Remainder of management is as for a webspace abscess above. Do not excise a

diamond as this results in significant scarring, takes longer to heal and risks further tissue damage.

Paranychia

This is an infection of the nail fold at the junction of the nail plate and bed. It is more common in patients that work with water regularly or have excoriated skin due to detergents/paint or other agents. It presents as pain, erythema and swelling along the edge of the nail, with a pus collection often visible.

Management

In the early stages with no pus collection, the edge of the nail fold can be milked away from the nail plate repeatedly, and adjuctive antibiotics given as for an abscess collection.If there is a pus collection, blunt dissection under the nail fold to the cavity must be performed under ring block. A section of the nail plate may need to be removed to facilitate drainage. The rest of management is as for a webspace abscess.

Special investigations

Consider an X-ray in all cases as this may show up any retained foreign body and can exclude or confirm the presence of osteomyelitis prior to treatment. In early cases where there is uncertainty about whether there is a clear collection, an ultrasound can be useful. Check renal function, blood glucose and HIV status in severe infections. Uncontrolled diabetics and patients with chronic renal failure often get severe infections, which are difficult to control and can lead to amputation and systemic sepsis. It is very difficult controlling the infection if you do not manage the underlying disease.

Pitfalls

1. Missing severe hand infections.
2. Not checking patients for underlying medical conditions which may be driving the infection.
3. If a patient presents with early infection and you suspect there is no pus collection, you treat them with antibiotics, but if after 2–3 days they are not getting better, there is usually a collection that you are missing.
4. Not referring patients early enough.
5. Not managing the potential stiffness early to avoid long-term loss of function once the sepsis clears.

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HIV in orthopaedic patients

by Peter Botha, Simon Graham & Maritz Laubscher

Learning objectives

1. Identify common musculoskeletal conditions in HIV patients.
2. Diagnose and manage complications related to HIV and ARVs.
3. Understand the indications for surgical management and urgent referral.

Introduction

Human Immunodeficiency Virus (HIV) is a retrovirus that targets CD4+ T cells, specifically affecting humoral immunity in our immune system. Without treatment, the infection advances with CD4+ T cells falling below a certain level and resultant susceptibility to HIV complications and opportunistic infections. Since the introduction of antiretroviral (ARV) agents, HIV- infected patients now live normal lives and have a life expectancy comparable to people without HIV.

How HIV affects orthopaedic surgery

- Specific musculoskeletal conditions are associated with HIV and its treatment
- Perioperative optimisation needs to be implemented in HIV-positive patients
- There is a risk to healthcare workers from blood exposure

Implant-associated infections

There is no clear evidence that HIV infection increases implant-related infections. However, there is some evidence showing an increased infection rate with orthopaedic implants in HIV+ve individuals with low CD4+ counts and open fractures.

TB osteomyelitis and septic arthritis

The spine is the most common site of involvement. Joints are more commonly involved than bones.

Non-tuberculosis osteomyelitis: The bacteriology of osteomyelitis includes the same causative organisms as in HIV-ve individuals. Fungi are rare causes of osteomyelitis in HIV+ve individuals.

Septic arthritis: Bacterial and atypical organisms are causative.

Avascular necrosis / osteonecrosis

The femoral head is the most common site of involvement. Both the HI virus and ARV therapy have been implicated.

The incidence is 4% in the HIV+ve population, and 35–80% have bilateral involvement.

Other risk factors to be excluded are alcohol, oral corticosteroids, hyperlipidaemia, coagulopathies, smoking, chemotherapy, trauma and inflammatory arthropathies.

Decreased bone mineral density (BMD)

HIV+ve individuals have an increased risk of

decreased BMD and bone mass. The HI virus and ARVs are both involved, Tenofovir being most implicated.

HIV associated arthropathies

- Primary HIV arthropathy

Transient (symptom duration < six weeks); single joint involvement (lower limbs). X-ray shows non-erosive lesions. A joint aspiration reveals a non-inflammatory process. The treatment is symptomatic (analgesia, NSAIDS and intra-articular corticosteroids).

- Seronegative spondyloarthropathies

Psoriatic arthritis and reactive arthritis are more common in HIV-infected patients.

Myopathies

Muscle pain is a common problem in HIV patients. ARV therapy is associated with weakness, myalgia and myopathy.

Infectious pyomyositis

This is a common complication of advanced HIV disease. Staphylococcus Aureus is the most common causative organism. Patients present with a painful, swollen limb and muscles and systemic features of infection. Investigations should include blood cultures, FBC, CRP and creatinine kinase levels. An MRI scan is most useful (enhanced fluid collections), contrasted CT is an alternative. Early diagnosis is crucial for treatment and aggressive management with intravenous antibiotics should be started along with incision and drainage of any collections.

Primary/non-infectious myositis

Patients present with proximal muscle weakness that is often symmetrical.

Neoplasms

Certain neoplasms have an increased incidence in HIV+ve individuals.

Non-Hodgkin's lymphoma

A neoplasm of lymphoid cells predominantly involving the axial skeleton with a 60 times higher risk in the HIV population.

Kaposi's sarcoma (KS)

KS is the most common HIV associated malignancy. It rarely involves the musculoskeletal system.

Perioperative optimisation

The issues of concern are the influence of HIV on the outcome and treatment of polytrauma, open and closed fractures and elective surgery such as total joint replacements. HIV does not preclude patients from undergoing elective surgery. A lot of the published research is based on individuals not receiving antiretroviral therapy, and more information would be available in future.

Potential perioperative complications in HIV positive individuals:

- Polytrauma: Higher risk of pulmonary, renal and infective complications.
- Implant sepsis (see earlier comments)
- Delayed or non-union of fracture:

No proven increased risk. HIV-positive individuals also more likely to have other risk factors for poor surgical outcomes, such as:

- Malnutrition
- Other opportunistic infections

Any patient undergoing surgery in a high prevalence area (such as South Africa) should be encouraged to undergo an HIV test. Any HIV-positive individual undergoing elective surgery should have an adequate workup, including:

- CD4+ count and viral load: Caution is advised with the use of orthopaedic implants in patients with low CD4+ counts and high viral loads.
- Nutrition: Test and optimise.
- Screening for opportunistic infections (particularly TB).

Risk to healthcare workers

Occupational exposure to HIV is a risk to healthcare workers. Orthopaedic surgery carries a high risk of exposure to blood when treating open wounds and in the operating theatre. Contact precautions must always be used when in contact with bodily fluids of patients. When exposure occurs, post-exposure prophylaxis (PEP) should be initiated immediately until the patient's HIV status is known. With PEP, the risk of seroconversion from occupational exposure is minimal.

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Tuberculosis of the spine

by Robert Dunn

Learning objectives

1. Identify clinical features of spinal tuberculosis.
2. Recognise imaging features of spinal tuberculosis.
3. Approach to definitive diagnosis.
4. Understanding medical therapy and surgical indications.

Introduction

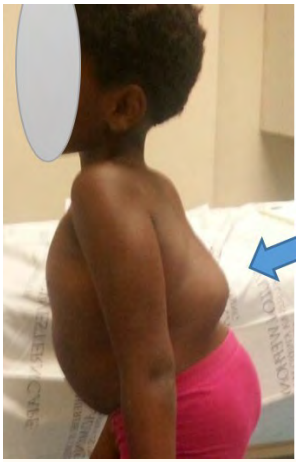
Tuberculosis (TB) is a devastating infection in the developing world with 10.4 million new cases and 1.8 million deaths globally in 2015. South Africa has one of the highest prevalences at 1%, predominately in the socio-economic poorer communities, but TB is increasinglyseen among immigrants in the Western world. In Sub-Saharan Africa the co- existence of HIV drives the disease further. TB reaches the musculoskeletal system by haematogenous spread in roughly 5%of cases, half of which result in spinal tuberculosis (sTB).

Clinical presentation

Patients with a history of immune-comprise from malnutrition and particularly HIV are at increased risk. Known contacts increase the likelihood, but with the widespread prevalence patients may not be aware of their contact.

Constitutional symptoms of weight loss, fatigue and night sweats may be present. There is an insidious onset of back pain inthe area of involvement, most commonly thoracic. The pain is often not severe until late and spinal destruction has occurred. There may be radicular pain radiating around the chest or down the legsdepending on thoracic or lumbar involvement, respectively. When there is advanced abscess formation or bony collapse and spinal cord compression, patients will experience progressiveweakness and deteriorating ambulatory function, with associated loss of sensationand eventually incontinence.

On examination they may be cachectic but surprisingly many remain overweightdespite the chronic illness. They may be pyrexial but often not. There may be a draining sinus over or adjacent to the spine, groin or a fluctuant mass. There maybe evidence of a gibbus, i.e. posterior bonyprominence of the exaggerated spinous process due to vertebral body destruction, collapse and kyphosis.



A four-year-old child with a thoracolumbar gibbus due to kyphotic collapse of the spine

A neurological examination may reveal a sensory level, below which there is alteredor absent sensation indicating the level of disease. Motor involvement will confirm this. Depending on the level of spinal cord involvement and stage of disease, the neurological status may initially be flaccid before becoming more typical upper motor neuron like with spasticity.

Diagnostic workup

Basic bloods may reveal an anaemia of chronic disorders – normocytic, normochromic. The white cell count is invariably normal incontrast to pyogenic infections. There may be a lymphocytosis on the differential until associated with HIV, when there may be a lymphopaenia. The platelets are often raised. In children a provocative intra-dermal inoculation with attenuated TB (Mantoux, Tine, Heaf) may indicate active disease if there is an excessive response at 48 hours. Unfortunately due to BCG vaccination and likely exposure in the community, all patients will respond making interpretation qualitative. Likewise very ill patients with suppressed cellular immunity may not respond despite having active disease.

A chest X-ray may confirm associated active pulmonary TB; it is generally not the case, but subtle evidence of previous TB maybe evident. AP and lateral spine X-rays may be normal in early disease but unlikely as most presentlate. The typical features are para-spinal abscess, para-discal vertebral body collapseand kyphosis. This differentiates sTB from pyogenic discitis where the latter is usually far more painful, earlier disc destruction with disc height loss and minimal bony destruction. A CT scan may be useful in delineating bony destruction, but generally a MRI is far more useful as it confirms the paraspinal abscess, thespinal cord compression and spinal cord signal

– which correlate with neurological function. The MRI will also identify non-contiguous lesion seen in up to 16% of sTB.

Typical X-ray features of sTB with paraspinal abscess shadow on the AP X-ray (left) and vertebral body collapse on the lateral X-ray (middle) and MRI (right).
Note the two body involvement, as evidenced by visualising the pedicles and posterior elements. The MRI confirms the anterior column destruction, pus anteriorly and epidurally compressing the compressing the spinal cord in a myelopathic patient.

Differential diagnosis

TB is the great mimicker and can be confusedwith many other pathologies. It needs to be differentiated from other causes of infection and tumours. Tumours generally involve one body, whereas sTB two (one either side of the disc). However on occasion sTB can involve one body leading to confusion. A large associated abscess on theMRI generally points to TB. Pyogenic spondylodiscitis, staphylococcal aureus and the gram negatives typically causeacute, severe pain, as opposed to the insidious onset of sTB. Bacteria generally cause disc pathology with loss of disc height on X-ray and hyperintense signal in the disc on MRI. The disc is generally preserved until late in sTB. Due to the more acute nature of pyogenic infection, there is less bony destruction and seldom kyphosis. Less commonly parasitic infections such as Hydatid (echinococcus), fungi and rare bacteriasuch as 'cat scratch disease' can cause spine infection. Thus despite TB being common, a wide differential should be obtained.

Definitive diagnosis

A biopsy is mandatory to confirm the diagnosis. This may be done as an outpatient via CT guided biopsy with a suitably large core needle under local anaesthetic and sedation. The yield is operator and sample size dependant. Otherwise an open biopsy can be performed in theatre as an isolated procedure or part of a surgical debridement, spinal cord decompression and reconstructionprocedure. Tissue and pus should be sent for MC&S, TB culture, PCR (GeneXpert) and histology. The MC&S will confirm a bacteria cause, whereas TB culture remainsthe most sensitive and gold standard for TB diagnosis. It unfortunately takes up to 6 weeks for the result, whereas Gene Xpert is 90–95% sensitive and specific in1–2 days.

Histology is diagnostic if AFBs are seen, which is seldom, as sTB is a pauci-bacterialdisease, but suggestive if there are necrotising granuloma present. TB drug sensitivities are confirmed on GeneXpert and culture.

Management

Medical

The mainstay of management is medicalwith combination agent Rifafour – rifampicin, isoniazid, pyrazinamide and ethambutol. We recommend all drugs for a minimum of 9 months due to the poor penetration ofparaspinal pus and granuloma. Should the patient feel clinically better, gain weight, ESR normalise and X-ray show signs of healing (sclerosis), we wouldstop and observe 3 monthly. Should there be ongoing concern, the drugs would be continued. During this period, vigilance should be maintained for the drug side effects of visual impairment and hepatitis. As vision cannot be assessed in young children, the ethambutol is omitted. In patients with co-existent HIV, the ESR usually remains high and can be ignored ifthe patient is otherwise improving. During this period dietary optimisation ismandatory.

Surgery

Surgical indications for sTB

- for diagnosis (biopsy)
- to drain a large abscess that would otherwise take a long time to resorb
- decompress the spinal cord in the cases of functional impairment
- to stabilise a mechanically unstable / kyphotic spine

Surgery with above indications will usually involve resection of diseased tissue, restoration of normal spinal alignment, reconstruction typically with an allograft humeral shaft from the bone bank, and support of the correction with titanium screws and rods. Surgery is always supported by medical therapy. With this approach, almost all spinal TB patients will recover neurologically, even those that have lost full motor and sensory function.

Approach to bone sarcomas

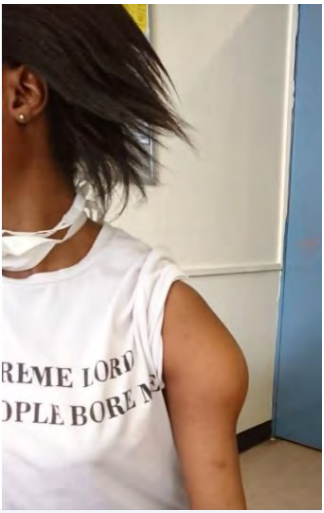
by Thomas Hilton, Len Marais, Nando Ferreira & Luan Nieuwoudt

Learning objectives

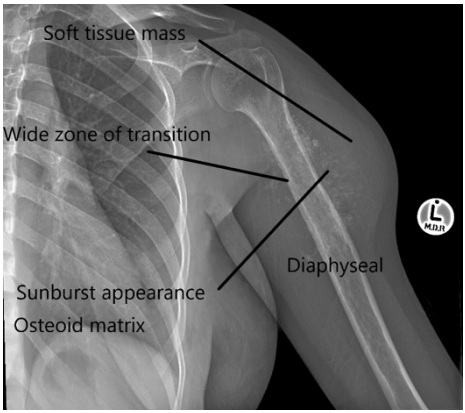
1. Evaluate a bone sarcoma.
2. Formulate a description of a X-ray.
3. Develop a radiological differential diagnosis for a bone tumour.
4. Outline a basic initial management plan.
4. Understand the indications for surgical management and urgent referral.

Case presentation

A 12-year-old female patient presents with a swelling on the left upper arm. The mass was first noted about 2 weeks ago and is painful at rest. She has had no previous trauma to the shoulder region and has no other medical problems. The mother states that she has had a couple of episodes of low-grade fever over the past 2 weeks, without any other symptoms. Examination reveals a large, firm, non-tender mass located deep to the fascia. There is no neurovascular deficit.

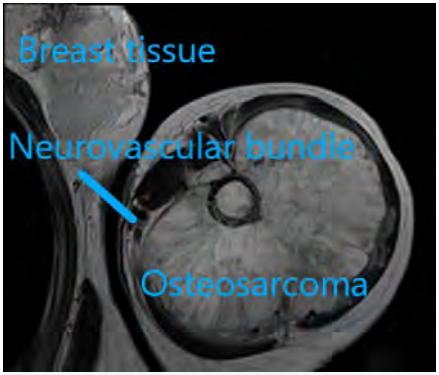


Clinical photograph depicting the swelling on the lateral aspect of the upper arm. There are no changes in the overlying skin.

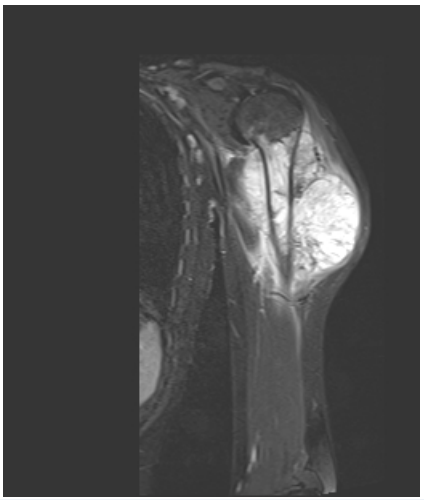


Anterior-Posterior (AP) X-ray of the patient's left upper arm and shoulder showing a diffuse lytic lesion in its shaft/ diaphysis extending in a centrifugal (in all directions) manner. Working from the outside in, there is extensive soft tissue extension from the bone, the matrix of the lesion shows cloud-like / ill-defined amorphous ossification in parts. There is a wide zone of transition between the normal bone and diseased bone, meaning that the border between them is not easily defined. The lesion is lytic in nature giving the humerus a moth-eaten appearance.

These are all features of a malignant bone sarcoma.



A MRI showing an axial image of the above patient's mass. It shows a large soft tissue mass originating from the left humerus. The neurovascular bundle is displaced medially, as are the surrounding muscles of the upper arm. Hopefully neoadjuvant chemotherapy will help to reduce the size of the lesion and allow limb salvage.



A MRI image showing a coronal view of the patient's tumour. It looks different from the image above because the sequence of the MRI is different. It shows the extent of the tumour up and down the arm. This is a fluid-sensitive sequence and helps to show inflammation and oedema caused by the tumour.

Post-operative X-ray showing wide resection of the tumour. The skeletal defect has been reconstructed with a modular reverse total shoulder tumour prosthesis.

History

Ask for important components in the history such as:

Duration: How long has the mass been there?

Progression: Is it enlarging? Does it ever decrease in size? Is the size constant?

Associations: Is the mass painful, and if so, when? Any other symptoms associated with the mass? Any fever, night sweats or loss of weight?

Etiology: History of trauma? Symptoms suggestive of infection, i.e. fever, etc? Previous/other masses? Previous medical history? Previous surgical history?

Examination

Structure your examination into inspection, palpation and movement.

Look

- Site: Determine location of the mass
- Superficial or deep to the fascia?
- Size: width x length x depth
- Shape: What is the shape of the lesion?
- State of overlying skin: Are there any skin changes?

Feel

- Temperature: Does the overlying skin feel warm?
- Consistency: Soft, spongy, rubbery hard, bony hard? Does it fluctuate? Is it pulsatile?
- Margin: Indistinct or clearly defined border?
- Tenderness: Is it tender?

Move

- -Surrounding structures: Is it attached to the skin or underlying bone? An intramuscular mass becomes more difficult to feel and less mobile when the muscle in which it is located contracts.
- Any lymphadenopathy?
- Range of motion of adjacent joints.

Regional neurovascular examination

Examine distal pulses and peripheral nerve function.

Systemic examination

- General examination.
- - Identify any other areas of involvement (metastases).

Special investigations

Plain film X-rays

On X-rays you will gain important information (see chapter on approach to orthopaedic X-ray). Specifically look for:

- Identify view, patient and date
- Is the patient skeletally mature?
- Single or multiple lesions
- Bone involved
- Part of bone involved (epiphyseal, metaphyseal or diaphyseal?)
- Medullary, cortical or periosteal
- Lytic, mixed or sclerotic appearance
- Appearance of tumour matrix (ossified or calcified)
- Zone of transition (narrow or wide, i.e. clearly demarcated or not)
- Cortical destruction, thinning or expansion?
- Periosteal reaction present?
- Pathological fracture?
- Soft tissue extension?

MRI scan

The MRI scan is important to differentiate sarcomas from infections and to evaluate soft tissue components, and the integrity ofthe neurovascular bundle. This is often a diagnostic modality which is performed at specialised centres.

Systemic staging

A CT scan of the chest and abdomen, as well as a technetium bone scan allow assessment of the patient for skip lesions or metastases and stage the progression of the disease.

Differential diagnoses

Infections (bacterial, TB, fungal, parasitic)and traumatic causes (fracture callus, myositis ossificants, seroma/hematoma) are important

differential diagnoses for undiagnosed masses. Benign aggressive tumors of the bone can also be associated with a mass (i.e. giant cell tumour, aneurysmal bone cyst). The most common malignant bone tumors are osteosarcoma, Ewing's sarcoma, and chondrosarcoma.

Management

- The workup and **referral is urgent**, as bone sarcomas double in size every 28 daysand urgent referral to bone sarcoma unit forfurther workup and biopsy is mandatory.
- The **MRI** scan must be done before the biopsy so as not to interfere with the interpretation of the MRI scan.
- Discussion of all investigations in a **multi-disciplinary team**, including medical oncologists, radiologists, pathologists and surgeons is important to ensure the bestoutcome for the patient.
- General treatment pathway will include **diagnosis and local and systemic staging**(looking for metastatic disease), followed by neoadjuvant chemotherapy, followed bysurgery and adjuvant chemotherapy.
- Surgical treatment will consist of **either tumour resection and reconstruction** (limb salvage) or amputation.
- More than 90% of cases are amenable to limb salvage which involves the resectionof the tumour with a cuff of normal tissueto minimise the risk of local recurrence and reconstruction of the limb.
- There are many ways to do this but one of the more popular methods is with an endoprosthesis which is inserted into the space left by the tumour to give structure to the limb and allow function. An example is given below.

Essential takeaways

- Young patient with a short history of a large swelling of the body – consider bone sarcoma.
- Deep, firm, non-tender, large mass – consider bone sarcoma.
- Pervasive, wide zone of transition, lytic bone lesion – consider bone sarcoma.
- Urgent referral to bone sarcoma unit for diagnosis and management.

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1. Browse NL. An Introduction to Symptoms and Signs of Surgical Disease. 2nd ed. London, UK: Edward Arnold; 1991.
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3. Puri A. The principles of surgical resection and reconstruction of bone tumours. Orthop Trauma. 2010;24(4):266- 75.

Common bone tumours

by Thomas Hilton, Len Marais, Nando Ferriera & Luan Nieuwoudt

Learning objectives

1. Identify common benign and malignant tumours.
2. Understand treatment pathway for benign and malignant bone sarcomas.
3. Appreciate urgency and importance of early, appropriate referral.

Introduction

As a general rule, bony lesions are rare. They are broadly divided into benign (non-cancerous) and malignant (cancerous) growths of connective tissue. Malignant lesions are termed sarcomas. This is different to the malignant growths of epithelial cells, termed carcinoma. They behave very differently from each other. Sarcoma is present in many different ways, shapes and forms.

The underlying principle is to refer the patient to a specialist centre for management. Never assume the growth is nothing to worry about. Anything bigger than a golf ball must be considered malignant until proven otherwise. Urgent referral is important as the doubling time of a sarcoma is 28 days and the work-up to make the diagnosis and stage the patient can be lengthy, further delaying treatment. The sooner treatment is started, the better the outcome.

Applied anatomy

Sarcomas arise from a particular connective tissue cell and their histopathology is often given a diagnosis according to the cell line they develop into. For example, an osteosarcoma is a malignant tumour of a bone forming cell as it resembles bone, although not quite the same, under the microscope.

Sarcomas grow centrifugally in a uniform and outwards direction and respect fascial barriers (these divide muscles and vital structures into compartments). They are also heterogenous in nature, which means that an osteosarcoma will have many different areas behaving in a different manner which is not uniform throughout. Also, an osteosarcoma in one patient is very different to an osteosarcoma in another patient in terms of is growth, location, metastatic potential, etc. This makes them very hard to study and is very different to carcinomas, which are uniform in nature and have invasive growth that does not respect fascial barriers.

Definition of terms

Lesion – A region in an organ or tissue which has suffered damage through injury or disease.

Benign – Not harmful.

Malignant – Cancerous.

Chemotherapy – Classically intravenous cytotoxic treatment designed to kill cancer cells.

Neoadjuvant chemotherapy – Chemotherapy given before surgery.

Adjuvant chemotherapy – Chemotherapy given after surgery.

Biopsy – Sampling of a tumour to obtain a histopathological diagnosis.

Lytic/lysis – The disintegration of tissue by a process. In bone this means a cavity is formed and on X-ray this looks darker when compared to surrounding bone.

Sclerotic/sclerosis – abnormal hardening of tissue. On X-ray this looks more white/ dense when compared to surrounding bone.

Classification

One of the more common systems used is the Enneking classification system.

Benign tumours are split into

Latent – e.g. enchondroma or non-ossifying fibroma

Active – e.g. unicameral bone cyst or osteoblastoma

Aggressive – e.g. aneurysmal bone cyst or giant cell tumour of bone

Malignant tumours are graded according to histological percentage of cellular atypia. Intra vs extra compartmental involvement as well as metastases present (or not) are also taken into account.

Assessment

History

- Bone tumours are often slow growing, non-tender and located deep, which leads to late detection.
- Pain can point towards a risk of fracture or compression of neurological structures.
- Function may be compromised if the mass located juxta-articular.
- Constitutional symptoms are not always present, but include night sweats, fever, loss of weight, cough.

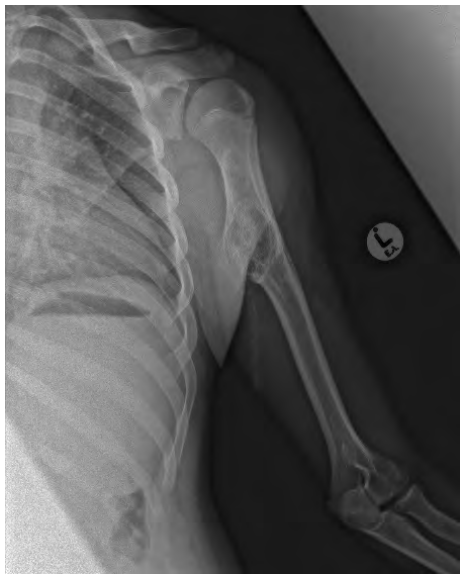
Examination

- A general examination should evaluate wasting, anaemia (lymphadenopathy usually not present as sarcomas do not spread through lymphatic system primarily).
- A local examination should assess for skin changes. The mass is usually deep, firm, immobile and non-tender. Large masses >5cm should be taken seriously.

X-rays

Certain tumors have specific features onX-rays. Below are the most common tumours and their appearances.

Benign bone tumours



Osteochondroma. A common and benign cartilage lesion affecting young people. Often on the surface of bones or near tendons around the knee, proximal humerusor proximal femur.

Aneurysmal bone cyst (ABC). A benign neoplastic lesion with multiple blood-filled cavities and a membranous inner lining. Must be differentiated from a sub-typeof osteosarcoma called a telangiectatic osteosarcoma. This is a malignant lesion ofbone and the treatment is very different foreach lesion.

Giant cell tumour: A benign aggressivelesion of bone that has a soap bubble appearance on X-ray. Often found around the knee. It is usually metaphyseal and eccentric in the bone. It is named after its predominant cell type, which is of course the giant cell.

Malignant bone tumours

Osteosarcoma. There are many types of osteosarcoma but the most common is the classic intramedullary type which usually originates from the intramedullary cavity of the metaphyseal area of long bones. It is the most common type of bone sarcoma overall. It is most often found in teenagers and young adults. Any pathological fracture in a young person must be considered malignant until proven otherwise. The treatment of an osteosarcoma is classically neoadjuvant chemotherapy – surgery – adjuvant chemotherapy. The biopsy to diagnose bone sarcomas should be done by a sarcoma specialist to prevent difficulties with future surgery and spread of the tumour locally. The 5-year survival for patients with osteosarcoma is between 60% and 70%.

Ewings sarcoma. The most common bonesarcoma found in children. This lesion is often diaphyseal and described as having an onion skin like appearance on X-ray. It is also found commonly on flat bones such as the scapular, ribs and bones of the pelvis. It is very sensitive to chemotherapy and also radiotherapy which is unusual for a bone sarcoma.

Chondrosarcoma. A primary malignancy of bone composed of chondrocytes or cartilage cells which have a varying degreeof malignancy. The appearance on X-ray is often described as popcorn-like due to the calcification of areas in the tumour. This tumour can be treated in many waysdepending on a biopsy, so it is best to refer the patient to a specialist centre.
The MRI scan is important to differentiate sarcomas from infections and to evaluate soft tissue components, and the integrity ofthe neurovascular bundle. This is often a diagnostic modality which is performed at specialised centres.

Management

Non-surgical

Enneking latent (e.g. enchondroma) requireno active management. Surveillance is occasionally advised.
Enneking active (e.g. unicameral bone cyst)can include observation or local treatment, which usually includes a marginal curettage (scraping away of the lesion) and adjuvant therapy, i.e. bone cement/graft, phenol
Enneking aggressive (e.g. ABC or GCT) usually require treatment which can rangefrom marginal curettage to endoprostheticreplacement.

Essential takeaways

- Sarcomas arise from connective tissue, are rapidly growing and heterogenous in nature.
- They are divided into benign and malignant conditions.
- Early referral to a specialist unit is imperative.
- Benign lesions are usually observed or treated locally.
- Malignant lesions will require staging, work-up for surgery and chemotherapy and wide resection of the tumour with adjunctive oncological treatment.

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2. Triana F, Errani C, Toscano A, Pungetti C, Fabbri D, Mazotti A, et al. Current Concepts in the Biopsy of Musculoskeletal Tumors. J Bone Joint Surg Am. 2015;97:e7(1-6).
3. Puri A. The principles of surgical resection and reconstruction of bone tumours. Orthop Trauma. 2010;24(4):266- 75.

Acute tendon injuries

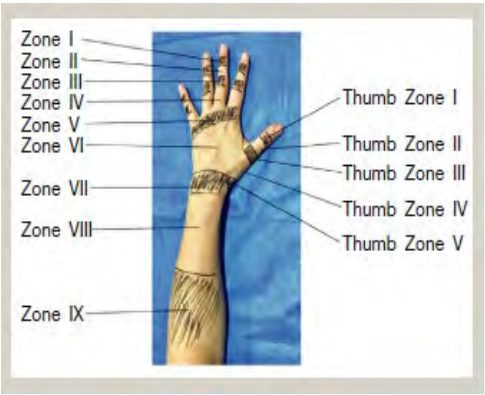
by Pieter Jordaan, Neil Kruger & Ian Koller

Learning objectives

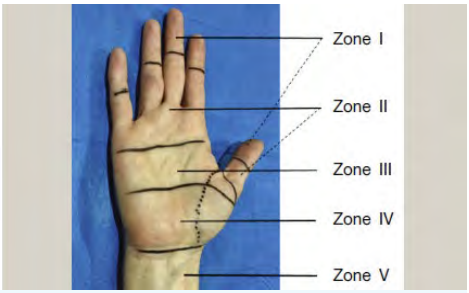
1. A penetrating wound associated with a deficit in tendon function should be regarded as an acute injury to either the tendon or nerve supplying the muscle-tendon unit.
2. Thorough knowledge of anatomy and hand function is essential to recognise these injuries.
3. All suspected tendon injuries should be referred for specialist review.

Definition and anatomy

Any injury leading to tendon dysfunction should be assessed for a tendon injury. The specific forearm anatomy and function of each tendon will not be discussed here, but it should be revised to understand tendon injuries better. Tendon injuries are broadly divided into extensor and flexor injuries subdivided into zones. Injuries in the proximal forearm that result in tendon dysfunction are more likely to be nerve injuries.



Extensor tendon zones



Flexor tendon zones

Mechanism of injury

In the majority of cases, the mechanism of injury is penetrating trauma. Closed tendon ruptures occur in Mallet finger injuries, acute Boutonniere deformity, EPL rupture in distal radius fractures and extensor tendon ruptures in rheumatoid arthritis.

Differential diagnosis

- Nerve injury leading to dysfunction (nerve and tendon injury often coexist).
- Pain inhibition.
- Underlying fractures or dislocations.

Diagnosis

The diagnosis is made by taking a good history and examining each tendon individually.

History

Patients with penetrating hand or forearm injury will usually present due to the recent trauma. In closed ruptures, patients may give a history of preceding pain, followed by acute worsening pain or feeling of tearing, associated with a sudden loss in function.

Examination

Look for the specific area of the laceration which will guide you as to what injuries to expect.

For the extensor tendons, there will be an evident extensor lag (inability to extend the digit fully) or resisted extension will be weak or painful. This can also indicate a partial injury. The tendon injury may be some way from the entrance wound in penetrating trauma. It may even be on the other side, for example, flexor injuries from a dorsal stab that penetrates the interosseous membrane

The Mallet injury (closed extensor rupture of the insertion on the distal phalanx) causes an inability to extend the distal phalanx actively. An acute Boutonniere deformity (closed rupture of the central slip off the base of the middle phalanx) is a rare injury. It is associated with a weak extension of the middle phalanx confirmed with Elson's test.

For the flexor tendons, each tendon should be examined individually, including FDS and FDP of each finger. Closed flexor ruptures are rare, but can be associated with inflammatory conditions (RA) or following plating of distal radius fractures or can occur as a Jersey finger (a closed injury where the FDP insertion avulses of the base of the distal phalanx). Flexor tendon injuries are often associated with nerve injuries, and these should be actively excluded.

Certain injuries will leave no functional deficit, for example, an injury to palmaris longus or if only a single wrist extensor or flexor has been injured.

Special investigations

You do not need special investigations to diagnose acute tendon injuries. A baseline X-ray should be performed to exclude underlying fractures or retained foreign bodies. If there is doubt about a closed rupture, an ultrasound may be useful.

Management

All suspected tendon injuries should be referred.

Non-surgical

- Closed Mallet and Boutonniere injuries can be managed in a splint.

Surgical

- All other tendon injuries are managed with surgical repair or reconstruction and a strict therapy regime. Outcome after surgery depends significantly on

the patient's compliance with rehabilitation instructions.

- If no rehabilitation is available, the patient should be referred to a specialist centre as repair without post-operative rehabilitation is of minimal benefit to the patient.

Complications

- Stiffness and permanent functional impairment.

Pitfalls

- Missing tendon injuries due to a lack of careful examination of each individual tendon or insufficient knowledge of anatomy.
- Missing associated nerve injuries or underlying fractures.

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Assessment

A 20-year-old male presents with a stab wound to the back of his hand and inability to extend his index finger. What tendon or tendons has he injured?

A. EPL
B. EDC to the index finger
C. EIP
D. EDC to the index finger and EIP
E. EDC to the index finger, EIP and ECU

The correct answer is (D), EDC to the index finger and EIP.

Metacarpal and phalangeal fractures

by Neil Kruger, Pieter Jordaan & Duncan McGuire

Learning objectives

1. The majority of metacarpal and phalangeal fractures can be managed non-surgically.
2. It is a myth that all phalangeal fractures can be managed with buddy-strapping only.
3. Open hand fractures should be managed the same as all other open fractures.
4. Never splint the metacarpophalangeal joint (MCP) in extension.

Definition

A fracture is defined as a cortical discontinuity of bone, resulting in compromising the normal mechanical properties.

Background

Almost all fractures of the metacarpals and phalanges result from direct or indirect blunt or sharp force trauma. In rare circumstances, the underlying bone may be pathological (due to a disease process such as infection or tumour) and fracture when lesser forces are applied.

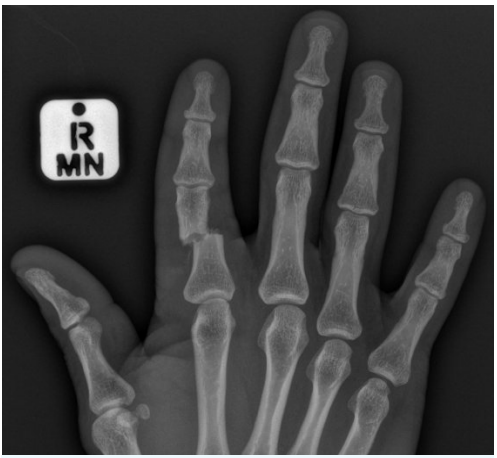
Common fractures of the metacarpals include:

- The base (which may occur with dorsal dislocation of the metacarpal relative to its proximal articulating carpal bone. Be sure to always check the lateral X-ray for this).
- The shaft.
- The metacarpal neck (classically the ‘boxer’s fracture’ of the 5th metacarpal due to a punching mechanism).

Phalangeal fractures can occur in the proximal, middle or distal phalanx. Fractures in these locations are described according to their soft tissue covering (open or closed), morphology (transverse, oblique, or comminuted), and the site of the fracture (base, shaft or head).

When deciding on management, it is essential to define the amount of shortening, angulation (in the sagittal and coronal plane) and rotation and apposition (percentage of bone ends in contact). These form part of the decision to offer surgery or conservative management.

Little finger metacarpal neck fracture (Boxer's fracture)



Index finger proximal phalanx fracture

Clinical findings

History

The history is usually straightforward, with a specific incident of acute trauma. Remember to do a thorough secondary survey down to fingers and toes in polytrauma patients, as fractures of the hands and feet are commonly missed when concentrating on life-threatening injuries.

Examination

Often the deformity is obvious, with severe pain and swelling present. If in doubt, gentle palpation will cause pain, with crepitus and movement at the fracture site. Look very carefully for open wounds and treat any open wound in the setting of a fracture as an open fracture; never assume that the wound does not communicate with the fracture. Do a careful neurovascular examination and check for tendon injuries.

No degree of rotation is acceptable. The best way to assess rotation is to flex the joint distal to the fracture to 90° gently and compare the alignment to the neighbouring fingers. Alternatively, all fingers should point towards the scaphoid tubercle with full flexion of the MCP and proximal interphalangeal (PIPJ) joints.

Special investigations

Imaging

X-ray is mandatory in clinically suspected fractures to confirm the diagnosis and define the fracture morphology to help decide on treatment. Occasionally CT scans are required in the case of complex fractures.

Management

Metacarpal fractures

Management depends on whether the fracture is open or closed, whether intra- or extra-articular and on the displacement. If open, it requires a thorough debridement in theatre, and then mostly some form of stabilisation is needed, depending on the fracture morphology and

location. In open injuries, remember to look for lacerations of tendons, vessels and nerves specific to the site of injury.

If closed and intra-articular, an open reduction is required to restore the congruity of the joint surface.

If closed and extra-articular, management is decided according to the displacement (length, alignment, rotation and apposition).

For all closed extra-articular metacarpal fractures, the values for conservative treatment of a fracture are:

- Length: <2–5mm loss of height.
- Apposition: >50% apposition.
- Rotation: No rotation.
- Alignment: Depends on the finger involved and the position of the fracture.

An easy way to remember is for shaft fractures, from index to little finger the acceptable angulations are up to 10°, 20°, 30° and 40° respectively. From index to little finger, they are the same for neck fractures, except the little finger can tolerate up to 60° of angulation.

Conservative management involves a splint and buddy taping. Generally, the metacarpophalangeal joints can be left free and motion encouraged to prevent stiffness. The fracture characteristics dictate operative management, and if needed, an open reduction and internal fixation are performed with K-wires, plates or screws.

Phalangeal fractures

Phalangeal fracture management is similarly determined by whether they are open or closed, intra- or extra-articular and on the degree of displacement.

If open, it is treated with the same principles as for a metacarpal fracture and then mostly with subsequent fixation, either using K-wires, screws or a plate if necessary.

If closed and intra-articular, unless undisplaced, it requires open reduction and internal fixation to restore articular congruency.

If closed and extra-articular, the management is decided on by the displacement.

Acceptable parameters are:
Length: <2mm shortening
Apposition: >50% apposition
Rotation: None
Alignment: <20° in any plane

If the position is not acceptable, the fracture can be reduced under ring block, splinted (see below) and a check X-ray performed.

When treating proximal phalanx fractures conservatively, they are reduced and immobilised in a dorsal backslab with the MCPJs pushed to maximal flexion and the IPJs held in full extension until the cast is hard. This is important because the natural deforming forces will pull the distal fragment into extension, which will lead

to a malunion if the MCPJ is not fully flexed. Active flexion of the IPJs should be performed in the cast to prevent stiffness. If a hand therapist is available, a splint can be used. Middle phalanx fractures can be managed similarly. Distal phalanx fractures are usually best treated in a splint immobilising the distal interphalangeal (DIP) joint.

In all conservatively managed fractures, remember to do check X-rays after one week to check for loss of reduction.

Pitfalls

1. Missing open fractures.
2. Missing associated tendon, nerve or vascular injuries.
3. Not assessing rotation correctly.
4. Splinting the MCPJs in extension, leading to extension contractures.
5. Assuming a proximal phalanx fracture is stable and therefore only buddy strapping it, leading to malunion.

References

Hammert WC, Calfee RP, Bozentka DJ, Boyer MI, 2010. ASSH Manual of Hand Surgery; Lippincott, Williams and Wilkins (Wolters Kluwer); Philadelphia, USA.

Miller MD, 2008. Review of Orthopaedics, 5th edition; Elsevier; Philadelphia, USA.

Wolfe SW, Hotchkiss RN, Pederson WC, Kozin SH, Cohen MS, 2017. Green's Operative Hand Surgery, 7th Edition; Elsevier; Philadelphia, USA.

Assessment

A young male patient fell and sustained a closed fracture of his index finger proximal phalanx. You give him a ring block for analgesia and ask him to make a fist. His index finger overlaps his middle finger. The ideal management is:

A. Buddy strap index to the middle finger and see in three weeks.
B. Buddy strap and apply a dorsal splint with the wrist slightly extended, the MCPJ maximally flexed and the IPJs in extension.
C. Reduce the fracture, buddy strap and apply the same splint as in 'b' and get a check X-ray to confirm the position.
D. Refer to physiotherapy for mobilisation.
E. Refer the patient immediately.

The correct answer is (D), reduce the fracture, buddy strap and apply the same splint as in '(B) and get a check X-ray to confirm the position.

Scaphoid fractures

by Pieter Jordaan, Neil Kruger & Duncan McGuire

Learning objectives

1. Maintain a high index of clinical suspicion; acute fractures can be missed on plain X-ray.
2. Repeat X-ray after 10-14 days if a scaphoid fracture is suspected.
3. Untreated scaphoid fractures can lead to non-union.
4. A scaphoid non-union can lead to wrist arthritis.

Definition and anatomy

The scaphoid is the most commonly fractured carpal bone. The scaphoid's blood supply enters from distal and flows retrograde, making the scaphoid vulnerable to avascular necrosis and non-union.

Scaphoid wrist fracture, associated with a peri-lunate dislocation

Mechanism of injury

A fall on an outstretched hand, with wrist extension and axial load on the wrist.

Differential diagnosis

- Distal radius fracture.
- Scapholunate interosseous ligament injuries.
- Thumb metacarpal base fractures or dislocations.

Diagnosis

Maintain a high index of suspicion.

History

The patient will present with radial sided wrist pain following trauma with the injury mechanism as described above.

Examination

Observe for swelling over the dorsum of the wrist and the anatomic snuffbox. Palpate the dorsum of the wrist over the proximal scaphoid, in the anatomic snuffbox and volar over the scaphoid tubercle for pain. Circumduction of the thumb will be painful as well as axial compression of the thumb.

Special investigations

Imaging

Plain X-rays, asking for scaphoid views and should include a posteroanterior (PA) and lateral of the wrist, ulnar deviation PA and supination oblique views.

A CT scan is suitable for fracture morphology, but should only be requested by the treating surgeon.

MRI is the most sensitive investigation for picking up occult scaphoid fractures.

If a scaphoid fracture is suspected clinically, but the X-ray does not show a fracture, then the patient must be placed in a backslab and seen again after 10-14 days for a repeat examination and X-ray. If earlier confirmation is required, then an MRI scan should be performed.

Management

Non-surgical

The majority of undisplaced fractures will heal if immobilised in a below-elbow cast. No benefit has been shown if the thumb is included in the cast (traditional scaphoid cast).

Surgical

All displaced fractures should be treated surgically with either percutaneous or open reduction and screw fixation.

Complications

- Non-union
- Avascular necrosis
- Wrist arthritis

Pitfalls

- Missed scaphoid fractures.

References

Hammert WC, Calfee RP, Bozentka DJ, Boyer MI; 2010; ASSH Manual of Hand Surgery; Lippincott, Williams and Wilkins (Wolters Kluwer); Philadelphia, USA.

Miller MD; 2008; Review of Orthopaedics, 5th edition; Elsevier; Philadelphia, USA.

Wolfe SW, Hotchkiss RN, Pederson WC, Kozin SH, Cohen MS; 2017; Green's Operative Hand Surgery, 7th Edition; Elsevier; Philadelphia, USA.

Assessment

A 20-year-old mountain biker presents after a fall and complains of radial-sided wrist pain. He is very tender in the anatomic snuffbox, and any thumb movement is painful. What is your next step?

A. Refer to an orthopaedic surgeon.
B. Splint the wrist and tell him to rest.
C. Do a CT wrist.
D. Do a wrist X-ray, including scaphoid views.
E. Do a wrist MRI.

The correct answer is (D), do a wrist X-ray including scaphoid views.

Carpal tunnel syndrome

by Pieter Jordaan, Neil Kruger & Ian Koller

Learning objectives

1. Diagnosis is largely clinical and can often be made on history alone.
2. Exclude common differential diagnoses and recognise associated conditions.
3. Be able to prescribe conservative measures in early disease.
4. Severe or failed conservative cases require a referral (acute post-traumatic CTS urgent).

Definition and anatomy

Carpal tunnel syndrome is the most common compressive neuropathy of the upper limb. It is caused by compression of the median nerve as it passes through the carpal tunnel. The carpal tunnel contains nine flexor tendons and the median nerve. The tunnel roof is the flexor retinaculum (transverse carpal ligament), which attaches to the scaphoid and trapezium radially and the hamate and triquetrum ulnarly. The floor consists of the proximal carpal row.

Causes and associations

The actual cause is unknown, but it is thought to occur due to prolonged wrist flexion and patients present with night-time symptoms initially due to abnormal sleeping posture. There are multiple associations:

- Pregnancy
- Diabetes
- Rheumatoid arthritis
- Hypothyroidism
- Tenosynovitis of the flexor tendons
- Amyloidosis

Differential diagnosis

- C6 radiculopathy (symptoms will include the dorsum of the first webspace).
- Peripheral neuropathy.
- Pronator syndrome (rare, median nerve compression in the forearm).
- Thoracic outlet syndrome.

Diagnosis

The diagnosis is mostly a clinical one and can often be made on a good history alone.

History

The syndrome has a very typical history, especially in the early phases. In the early morning, patients are woken with symptoms of pain, paraesthesia, and numbness in the fingertips of the thumb, index, middle and radial side of the ring finger with the index and middle finger most commonly affected. They often mention their fingers feel swollen. They say they have to shake their hands to improve symptoms. In established disease, the numbness can be constant, and

patients struggle to pick up objects. Pain may radiate up the forearm to the elbow.

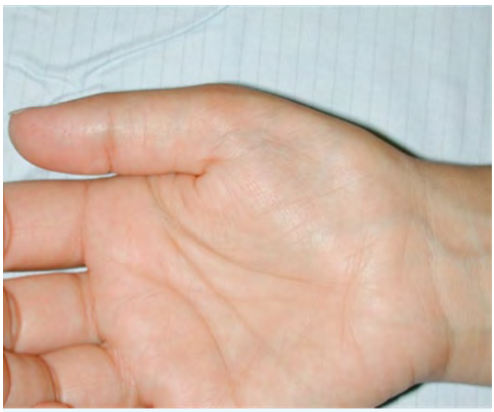
Examination

Look for wasting of the thenar eminence. Sensory testing will be normal in early disease and show decreased sensation in the median innervated fingers later in established carpal tunnel syndrome. Remember the proximal palm is innervated by the superficial palmar branch and should not be involved as this branch of the median nerve does not pass through the carpal tunnel. Test thumb abduction power, specifically noting abductor pollicis brevis contraction.

Special tests

- **Tinel** - tapping over the course of the median nerve will produce tingling in the median nerve distribution when the tapping occurs over or just proximal to the carpal tunnel.
- **Phalen** - Prolonged deep flexion of the wrist will reproduce symptoms after 30 - 60 seconds.
- **Durkan** (most sensitive test) - digital compression over the carpal tunnel reproduces symptoms after 30 - 60 seconds.

Location of the carpal tunnel



Thenar wasting

Special investigations

The diagnosis is clinical and can often be suspected on history alone, and therefore special investigations are not necessary. In atypical cases, nerve conduction studies (NCS) or electromyography (EMG) can be requested.

Imaging

Imaging studies have a limited role in the diagnosis unless carpal tunnel compression secondary to other pathology is suspected.

Management

Patients with associated medical problems should first be managed medically, especially those with hypothyroidism. Pregnant patients should be managed conservatively where possible as the disease often resolves postpartum.

Non-surgical

Mild disease is when there are only intermittent symptoms such as at night or only with certain activities.

Moderate disease is present in those with persistent objective sensory changes but no motor weakness.

Severe disease is considered when motor weakness is evident, and sensation is severely decreased or absent. It is important to note that severe disease is often pain-free due to almost complete sensory loss. A factor that unfortunately further delays presentation as patients think that reduction in pain is evidence of improvement.

Splinting at night works especially well in mild disease with night-time symptoms only. Full time splinting can be used in pregnancy.

Steroid injection into the carpal tunnel can relieve symptoms, but usually only provides temporary relief and risks intraneural injection with nerve damage and chronic pain. A good response to an injection is a good prognostic indicator that surgery will be successful.

The hand therapist has a role in conservative management such as when ergonomic factors are thought to be contributory, or custom splints are required.

Surgical

Patients who have failed conservative measures, have constant symptoms, wasting or weakness should be referred for carpal tunnel release. Patients with symptoms lasting longer than six months have a significantly poorer response to steroid injection and should also be referred. Surgery entails simple division of the transverse carpal ligament. An examination of the carpal tunnel at the time of surgery excludes any secondary causes such as significant synovitis and masses such as ganglions and so on.

Complications

Severe established carpal tunnel syndrome can lead to permanent symptoms of numbness, paraesthesia, weakness and even neuropathic pain.

Carpal tunnel surgery is very successful, but complications can occur, such as persistent pain at the incision area known as pillar pain. The syndrome can also reoccur.

Pitfalls

- Missing the underlying condition that may be present as the cause of carpal tunnel syndrome.
- Misdiagnosing C6 radiculopathy or peripheral neuropathy as carpal tunnel syndrome.
- Misdiagnosing cubital tunnel syndrome (ulnar nerve compression at the elbow) as carpal tunnel syndrome.

References

Hammert WC, Calfee RP, Bozentka DJ, Boyer MI, 2010. *ASSH Manual of Hand Surgery;* Lippincott, Williams and Wilkins (Wolters Kluwer); Philadelphia, USA.

Miller MD, 2008. *Review of Orthopaedics*, 5th edition; Elsevier; Philadelphia, USA.

Wolfe SW, Hotchkiss RN, Pederson WC, Kozin SH, Cohen MS, 2017. *Green's Operative Hand Surgery*, 7th Edition; Elsevier; Philadelphia, USA.

Assessment

A 60-year-old female presents complaining of waking early in the mornings with a swollen numb hand and having to shake it out. What is your next management step?

A. Urgent nerve conduction studies.
B. Refer for urgent surgery.
C. Prescribe NSAIDs and tell her it will get better.
D. Refer to the hand therapist for a splint.

The correct answer is (D), refer to the hand therapist for a splint.

Dupuytren's disease

by Neil Kruger, Pieter Jordaan & Ian Koller

Learning objectives

1. Be able to recognise Dupuytren's disease.
2. Be able to explain the course of the disease.
3. Realise that it can involve different areas such as the feet and Peyronie's disease.
4. Refer appropriately.

Definition

Dupuytren's disease is usually a progressive, benign fibromatosis of the fascial bands of the palm and digits causing palpable pathological cords and nodules. These cords lead to contractures of the metacarpophalangeal (MCPJs), and proximal interphalangeal joints (PIPJs), the distal interphalangeal joints (DIPJs) are rarely involved. It is not a disease of the tendons.

Background

Dupuytren's is a disease that originates from the Scandinavian Peninsula, the so-called Viking disease. There is a much higher incidence in people of Northern European descent. The relevant associations to note are high alcohol intake and consequent liver disease, smoking, family history, glycogen storage diseases, epilepsy and diabetes.

Symptoms or presentation

Dupuytren's disease is twice as common in males as females, starts at a younger age in males (55 years) and is also more aggressive in males. The incidence increases with increasing age. In rare cases, an aggressive form of the disease occurs in younger patients and may affect their plantar fascia (Ledderhose disease), MCPJs (Garrod's knuckle pads) and genitals (Peyronie's disease). This form is known as the Dupuytren's diathesis. Earlier onset disease is usually more aggressive and has a higher recurrence rate.

Critically it is overwhelmingly a ***painless*** disease, but nodules can occasionally be sensitive (pain should alert to other cause). Patients usually complain of either cosmetic deformity or difficulty opening the hand to grasp objects.

Diagnosis

The diagnosis is a clinical one, with palpable, thick cords running longitudinally in the palm and proximal fingers causing the contractures. The cords may form deep pits or thickened nodules along the cord where they insert into the fascia near the skin. There is no need for special investigations. The most common involved digit is the ring finger and MCPJ. Involvement of the radial side of the hand is atypical and more likely to be aggressive and recurrent.

Classic Dupuytren's disease affecting the ring

Main questions to ask the patient

1. What is your main concern? Functional or cosmetic?
2. How long has this taken to come about, that is how rapidly is it progressing?
3. Is there any associated pain?
4. Have you lost any sensation to the fingers (the cords can sometimes compress the digital nerves)?
5. Can you put your hand flat on the table (Heuston's tabletop test)?
6. Is there anyone in your family with a similar problem?

Management

Non-surgical

If the patient can put their hand flat on the table, they probably do not need surgery. The disease is progressive, but finger extension stretches and night extension splints may benefit them, even though there is no evidence for it.

There is some evidence that radiotherapy can slow the progression of the disease, specifically in younger patients who present early.

Surgical

Surgery is reserved for those in whom the flexion deformity is impacting their work or daily activities. Progressive contracture of the PIPJs should be surgically released at an earlier stage than the isolated MCPJ contractures. Sometimes patients may present late, and the flexion contracture is so severe they cannot open their finger or fingers at all, and hygiene is an issue. These patients should be referred for assessment.

Once the diagnosis has been made, it is the patient's choice as to whether they want surgery, as it is a benign condition. Some patients with severe deformity decline surgery and should just be made aware of the progressive nature of the disease and that it is difficult to get a full correction in severe contractures.

Surgical options

1. Percutaneous needle fasciotomy.
2. Collagenase injection (inject the collagenase and 48 hours later break the tendon by stretching under local anaesthesia) – not available in South Africa.
3. Open fasciectomy can be partial, or complete with or without excision of the overlying skin (dermofasciectomy).

4. Amputation is the last option for patients with severe disease and recurrence after multiple surgeries and is usually the patient's choice.

It is impossible to cure Dupuytren's disease by completely resecting all the cords. Recurrence is, therefore, inevitable. However, intuitively the more the disease is resected, the longer the intervening period before recurrence. Recurrence rates for percutaneous needle fasciotomy are about 67% after two years. It is about 50% after three years for limited fasciectomy and a dermofasciectomy, 30% after five years.

Complications

1. Recurrence
2. Iatrogenic nerve injury
3. Skin or wound breakdown
4. Infection
5. Incomplete joint release
6. Iatrogenic tendon injury (rare)
7. Vascular compromise from iatrogenic injury or arterial spasm with extension

Pitfalls

1. Failure to diagnose the condition.
2. Failure to counsel patients adequately about the disease to understand the natural history.
3. Failure to recognise young patients with severe disease who require early intervention and monitoring.
4. Not recognising the spiral cord and its intimate association with the digital nerve around it.

References

Hammert WC, Calfee RP, Bozentka DJ, Boyer MI, 2010. *ASSH Manual of Hand Surgery;* Lippincott, Williams and Wilkins (Wolters Kluwer); Philadelphia, USA.

Miller MD, 2008. *Review of Orthopaedics*, 5th edition; Elsevier; Philadelphia, USA.

Wolfe SW, Hotchkiss RN, Pederson WC, Kozin SH, Cohen MS, 2017. *Green's Operative Hand Surgery*, 7th Edition; Elsevier; Philadelphia, USA

Assessment

A very concerned 60-year-old male patient presents with a nodule in his palm. He cannot straighten his ring finger fully and says he vaguely remembers his father having a similar problem.

You:

A. Request an urgent MRI to exclude malignancy.
B. You tell the patient there is no need to worry and there is no treatment needed.
C. You reassure the patient that it is a benign condition, which will likely progress and then refer him if he has functional limitations.
D. You give the patient a steroid injection.
E. You diagnose a trigger finger and refer him for surgery.

The correct answer is (C), reassure the patient that it is a benign condition, which will likely progress and then refer him if he has functional limitations.

Thumb base/carpo-metacarpal joint osteoarthritis

by Pieter Jordaan, Neil Kruger & Duncan McGuire

Learning objectives

1. Common and debilitating cause of thumb pain in the elderly.
2. Diagnosis is clinical but confirmed with X-ray.
3. Early disease can be treated conservatively.
4. Advanced disease or failed conservative measures require referral.
5. Treatment is symptomatic and for pain relief.

Definition and anatomy

Osteoarthritis between the trapezium and thumb metacarpal.

Causes and associations

This is generally a degenerative condition but can be seen after trauma in younger patients. The disease is more common in postmenopausal women. It is the second most common site of osteoarthritis in the hand behind the finger distal interphalangeal joint.

Differential diagnosis

- De Quervains's tenosynovitis.
- Scapho-trapezio-trapezium (STT) joint arthritis.
- Rheumatoid arthritis.

Diagnosis

History

Patients present with radial-sided wrist pain or pain at the base of the thumb aggravated by loading the joint, such as trying to open a jar or tap and writing.

Examination

The hand can appear normal, but usually, the base of the thumb appears squared off (the metacarpal base is subluxated), with adduction of the thumb. In advanced cases, the thumb MCP-joint will be hyperextended.

There is tenderness over the joint line with decreased range of motion.

Special test

Grind test – reduction of the thumb, with gentle downward pressure on the base of the thumb metacarpal, combined with axial loading reproduces the pain.

Special investigations

Imaging

X-ray showing subluxation, joint space narrowing, sclerosis and osteophytes, with a Robert's view on the right

An X-ray can be used to confirm the diagnosis. Views of the base of the thumb, including a PA, lateral, and Robert's view (hyper-pronated) should be done. This will show subluxation of the carpometacarpal joints (CMCJs), with joint space narrowing, sclerosis, osteophytes and cysts.

Management

Non-surgical

First-line therapy is rest and NSAIDs and referral to a hand therapist for lifestyle modification and assistive devices. They can also provide the patient with a splint, which is very effective. If this fails, the patient can be offered an intra-articular steroid injection.

Surgical

Failed conservative measures or advanced severe disease will require surgery. There are many options, but the most reliable results are achieved with a trapezium excision with or without ligament reconstruction and tendon interposition, specifically in older, less active patients with advanced disease. Arthroplasty is an option but is not proven to be better than trapezium excision in the long term.

Post-traumatic arthritis in manual labourers will do better with a fusion of the CMCJ joint, and in young patients with early disease, a metacarpal osteotomy can be performed.

References

Hammert WC, Calfee RP, Bozentka DJ, Boyer MI; 2010; ASSH Manual of Hand Surgery; Lippincott, Williams and Wilkins (Wolters Kluwer); Philadelphia, USA.

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Wolfe SW, Hotchkiss RN, Pederson WC, Kozin SH, Cohen MS; 2017; Green's Operative Hand Surgery, 7th Edition; Elsevier; Philadelphia, USA.

Assessment

A 67-year-old female patient presents with radial-sided wrist and thumb pain. She is unable to open her honey jar at home. Her thumb appears adducted, and squaring is noted at the base of the thumb metacarpal. Which of the following will be the best to confirm your suspected diagnosis?

A. Full blood count and ESR.
B. Finkelstein test.
C. Ultrasound.
D. PA and lateral X-ray of the thumb.
E. PA, lateral and Robert's view of the thumb.

The correct answer is (E), PA, lateral and Robert's view of the thumb.

Wrist ganglions

by Neil Kruger, Pieter Jordaan & Duncan McGuire

Learning objectives

1. A ganglion is a benign mass.
2. They are usually pain free, but occasionally cause discomfort or pain.
3. The diagnosis is clinical.
4. If you are not certain of the diagnosis, rather refer or send for further investigations.

Definition

A ganglion is a fluid filled sac whose wall is made up of a lining that has no cells. It usually originates from a joint.

Background

Wrist ganglions are common, occurring predominantly on the dorsum of the wrist. They vary in size. They may also wax and wane (get bigger and then smaller again). They have been described originating from every joint in the hand, but the most common origin is from the dorsal scapholunate joint.

They may occur volarly where they usually originate from the radiocarpal joint. These are often intimately related to the radial artery.

Diagnosis

The diagnosis is mainly a clinical one.

History

A typical history is of a non-painful mass which may increase and decrease in size over time. Occult ganglions on the dorsum of the wrist are small and usually present with pain on wrist extension. They are usually not visible due to their small size. Pain is due to impingement or posterior interosseus nerve irritation.

Examination

The mass is well defined, fluctuant, non-tender and trans-illuminates. Flexion of the wrist can sometimes unmask a small dorsal wrist ganglion. Wrist movement should be checked and compared to the opposite side. Extension may be slightly decreased depending on the size of the ganglion, but flexion is usually normal.

Special investigations

Investigations are usually unnecessary but, if there is doubt about the diagnosis, an ultrasound or MRI may be performed.

Classification

The classification is based on location - either dorsal or volar.

Management

Dorsal ganglions

No treatment is required as ganglions often resolve on their own and are usually asymptomatic except for the cosmetic aspect. Aspiration may be attempted but

the recurrence rate is high. Surgical excision may be done but there is a recurrence rate of around 5%.

Volar ganglions

Again, usually no treatment is required. Aspiration should not be attempted due to the risk of injury to the radial artery. The recurrence rate after excision is about 10%.

Complications

- Recurrence
- Infection
- Scarring
- Tendon and arterial injury

Pitfalls

- If uncertain of the diagnosis, MRI or ultrasound should be performed

References

Hammert WC, Calfee RP, Bozentka DJ, Boyer MI; 2010; ASSH Manual of Hand Surgery; Lippincott, Williams and Wilkins (Wolters Kluwer); Philadelphia, USA.

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Wolfe SW, Hotchkiss RN, Pederson WC, Kozin SH, Cohen MS; 2017; Green's Operative Hand Surgery, 7th Edition; Elsevier; Philadelphia, USA.

Assessment

A 22-year-old female patient presents with a mass on the dorsum of the wrist that has been there for years, without a history of trauma. Since starting CrossFit, it causes discomfort when she does press-ups. Your most likely diagnosis is:

A. Scapholunate interosseus ligament tear
B. Scaphoid fracture
C. Osteochondroma
D. Giant cell tumour
E. Dorsal wrist ganglion

The correct answer is (E), dorsal wrist ganglion.

A general approach to orthopaedic history and examination

by Stefan van der Walt, Stephanie Roche & Stephen Roche

Learning objectives

1. Develop an approach to assessing a joint, history and examination.
2. Understand the terminology used to describe alignment.

General approach to assessment of any joint

Steps include taking a history, examining the joint, examining other systems if indicated (for example, general or respiratory examination), and investigations after that. This chapter will not focus on any of the investigations.

History

Common presenting complaints in orthopaedics include:

Pain

Using the approach taught in other disciplines can also be used to assess pain in a joint, for example, 'SOCRATES'

S: Site

Where is the pain?

Always consider referred pain when dealing with a joint, especially from the joint above or below.

O: Onset

When did it start?

Did it begin suddenly, or has it slowly been getting worse? (For example, acute onset in trauma or septic arthritis, or more chronic history in osteoarthritis).

C: Character

Is it a sharp, throbbing, dull or burning pain?

(For example, burning pain could suggest a neuropathic cause unrelated to the joint).

R: Radiate

Does the pain move anywhere?

Look for dermatomal or nerve root patterns.

A: Associated features

Do you have a fever?

(For example, fever in septic arthritis).

T: Time course

Is the pain worse in the mornings?

Does it get worse with activity? (This can help distinguish mechanical as opposed to non-mechanical or inflammatory joint pain).

E: Exacerbating or relieving factors.

Does the pain improve with analgesics?

(Often pain from a non-benign lesion is not relieved with analgesics). Is the pain worse in a specific position or with certain movements?

S: Severity.

A scale from 0-10 often helps.

Swelling

- Is the actual joint swollen or is the whole limb or part of the limb swollen?
- When did it start? Did it happen suddenly or over a longer time?

Deformity

- When did it start?
- Is it getting worse?

Instability

- What do you mean when you say your joint or limb feels “unstable”?
- When does your joint give way?
- What causes it to become unstable?

Stiffness

- What do you mean by ‘stiffness’?
  - Often deformities or previous surgery will limit the range of motion of a joint, which may be described as stiffness. Try to understand what your patient is referring to.
- When are your joints stiff? In the morning (how long) or after activity?
  - Prolonged morning stiffness may suggest an inflammatory process, whereas morning stiffness <30 minutes is usually less specific.
- Is there pain or swelling associated with the stiffness?
- Is your joint ‘locking’ or ‘jamming’?
  - This can point to mechanical obstruction.

Joint noises

- Crepitus: This suggests intra-articular roughness and is often is a clue to osteoarthritis.
- Click: Intra-articular bands. Fibrosis from previous surgery can cause these bands.

Weakness

- Weakness is often used to describe a variety of problems; elicit the patient’s real concern.
  - Is the patient tired?
  - Is it only the limb affected or the whole body?
  - Is the weakness they describe a description of activity limitation due to stiffness?

Functional limitations

- What could the patient do before that they cannot do now?
- Ask about daily living activities; walking around in the house or to the shops, washing, completing tasks at work and exercising.

Besides the primary presenting complaint, the following questions should also be asked:

Systemic enquiry (see the chapter on Red Flags for more detail).

- Any associated constitutional symptoms?
- Any bowel and bladder changes?

Orthopaedic history

- Previous surgery?
- Previous injuries?
- Previous septic arthritis?
- Any rheumatological problems?

- Congenital abnormalities or childhood orthopaedic disorders?

General medical and surgical history

- Comorbidities, previous illnesses, previous operations.
- Medications, for example, Simvastatin can cause myalgia, Pyrazinamide may cause joint pain.
- Previous treatment plans and how well they worked for the patient (including physiotherapy, occupational therapy, surgery and medications).

Family history

- Cancer (could this patient have a malignancy or bone metastasis?).
- Rheumatological disorders.

Social history

- Smoking (can affect healing, anaesthetic risk, risk of lung cancer and metastasis).
- Alcohol intake (associated with gout).
- Hobbies, for example, sport (are they still able to do things that they enjoy?).
- Living conditions
  - Will this patient's home environment be safe for them post-operatively?
  - Are there environmental factors contributing to their illness?
  - Are there family members at home who can support or care for them?
  - Effects of symptoms on daily life (see functional limitation notes above).
- Financial
- Is this patient still able to work? Should they be booked off for light duty?
  - Does this patient qualify for a disability grant?

Examination

The examination begins from the moment the patient is seen. Observe the level of consciousness (particularly in trauma), and assess for any syndromic features, obvious deformities or gait abnormalities. You should immediately see if a patient is generally unwell (for example, septic arthritis, osteomyelitis) and the degree to which they can bear weight. Next, you must look, feel and move the joint.

Look

Ensure that your patient is adequately exposed; you must be able to see the entire limb and compare left to right. If possible, look at the joint from the front, back and side. If examining the lower limb, look at the joints while the patient is standing, seated or recumbent.

Skin

- Erythema, for example, septic arthritis.
- Sinuses.
- Scars from previous surgeries (open vs laparoscopic).
- Hairy patches, for example, occult spina bifida.
- Rashes, for example, psoriasis.

Swelling

- Try and identify if the joint, the surrounding area or the entire limb is affected.

Deformity and posture

- Assess for symmetry between left and right.
- Look for any obvious rotation or limb length discrepancy (see terminology below).
- Importantly, does the joint look anatomically normal?

Muscles

- Is there any obvious wasting?
- Are there any fasciculations? (Lower motor neuron sign).

Feel

Temperature

- Place your hand on the joint, and then above and below it, to feel if the joint itself is warm in comparison.
- Warmth suggests increased blood flow, for example, inflammation or vasodilation.
- The area may feel cool in cases of disuse or paralysis.

Tenderness

- Ask the patient to point to exactly where the pain is.
- Gently feel for the area of maximal tenderness, carefully observing the patient's reaction to palpation.

Anatomy

- Feel for any deformities, and localise important landmarks.
- Feel along the joint line, bony points relevant to the joint and the adjacent ligaments and tendons (you need to know your anatomy for this!).

Swelling/s

Try and determine where the swelling is (intra- vs extra-articular) and what it consists of:

- Fluid.
- Soft tissue.
- Hard tissue (for example, bone, calcifications).
- Gas.
- Foreign body.

Move

Active movement

The patient should move the joint/s themselves first; this is known as active movement.

- Active movement may be limited by pain, weakness (due to tendon, muscle or nerve pathology), stiffness, contractures or bony abnormalities.
- You should assess if there is a decreased or increased range of motion.

Passive movement

- You should then try to move the joints yourself; this is known as passive movement as the patient is not exerting any effort to move the joint.
- In cases of weakness or stiffness, the passive range of movement might be significantly greater than the active; therefore comparison between the two is important.
- Assess for any pain, paying attention to when the pain occurs.
  - Throughout the movement. Suggests acute inflammation or damage to the joint cartilage.

    - At the end of the range of movement. May be due to stretching of the capsule, for example, joint effusion.
    - Specific arc of movement. Usually a localised pathology, for example, rotator cuff tears of the shoulder.
- Feel the joint as you move it, to elicit crepitus (characteristic of osteoarthritis, felt as a crunching sensation below your hand and often with associated sounds).

Pitfalls

- Not taking a full history.

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Plaster of Paris casts

by Nicholas Kruger & Pieter Venter

Learning objectives

1. Know the different clinical applications of plaster of Paris.
2. Know the steps in the application of a plaster of Paris cast.
3. Understand what the basic set of upper and lower limb casts are and when to apply them.
4. Describe the different braces used in orthopaedic surgery.

Introduction

The correct application of plaster of Paris (POP) is a necessary skill for any clinician. It still has a definite place in managing orthopaedic injuries, even in the age of modern surgical advances.

It is widely used pre-operatively for temporary immobilisation and stabilisation of fractures, post-operatively for protection of fixation and soft tissue resting, correcting deformities and definitive management of specific injuries.

The origin of the name plaster of Paris is because the quarries from which it was mined were near Paris in France.

When POP is mixed with water, the more soluble calcium sulphate returns to its insoluble form, giving off heat and cool to cold water should be used for the mixture to limit the chance of thermal injury.

After application and moulding, it is imperative to maintain the position you wish to obtain for three to five minutes, which is how long the POP will take to set initially after wetting. After that, the plaster will ultimately harden after 36 – 48 hours.

Skill: Plaster of Paris application

Setup

Preparation is crucial. Gather all the necessary components together (number of rolls of POP, water, cotton padding, OrthoWool™ and so on) before starting the procedure.

Note: all wounds need to be adequately dressed/covered before application of a cast.

Step 1: Examination

Do an examination of the limb to be splinted.

- Neurovascular examination.
- Quality of skin in the area where the plaster will be applied (for example, wounds, blisters, bruising).
- Ensure that radiographs of the limb (plus the joints above and below) have been reviewed.

Step 2: Positioning

The patient and the person applying the plaster should both be comfortably positioned for the procedure.
The limb that is to be placed in the cast should be held in the correct position. Specific casts need more than one set of hands, so get an assistant to help.

Step 3: Stockinette

If available, use Stockinette to cover the skin of the affected limb, 3–4 cm longer at the ends so it can be folded back under the POP.

Step 4: Cotton wool padding

Starting distally, wrap the padding proximally and overlap each layer by 50%.

Apply additional padding over areas with bony prominences.

Use a ‘figure of 8’ technique around joints to prevent wrinkling and unnecessary compression (for example, around the elbow to prevent cubital fossa pressure).

Step 5: Plaster application

Ensure that the limb is in the correct position for applying the cast.

Soak the plaster roll in the bucket of water until bubbles cease to rise, remove from the water and gently squeeze the excess water from the roll, without drying it thoroughly.

Apply the POP on top of the cotton wool padding from distal to proximal, without applying tension to the roll, overlapping each layer by 50%. Use the ‘figure of 8’ technique around joints and prevent wrinkling of the plaster by smoothing the layers down with your palm. Ensure immobilisation of the joints above and below the injury. A slab splint (back slab) is usually applied and secured with a cling bandage to allow for swelling in the acute setting.

Step 6: Moulding the plaster

The cast must be moulded around the limb, without causing soft tissue injury to ensure adequate immobilisation and stability. When using casts to splint fractures, a three-point pressure technique must be used (one pressure point countering the apex of the fracture, one distally and one proximally on the opposite side of the fracture apex).

During this step, the limb must be correctly positioned, and the position maintained for three to five minutes for the cast to set. Also ensure that the edges are smoothed out and will not irritate nearby structures (for example, the thumb base in a forearm cast).

Step 7: Clean the limb

Clean exposed areas of skin with water and dry with paper towels.

Step 8: Repeat examination

Repeat a neurovascular examination and inspect that the cast does not hinder any movements other than those needed for injury management.

Step 9: Radiography

Repeat radiographs if any manipulation was done and to confirm the correct position of the underlying bone.

Step 10: Patient education

Counsel your patient:

- On why the cast was applied, when they should follow up and for how long they can expect the cast to stay on.
- Do not put anything down the cast to scratch; the skin might be injured and get infected.
- Do not let the cast get wet.
- Frequently move the fingers or toes of the immobilised limb.
- Elevate the casted limb to prevent swelling.

Also, counsel them on when to seek immediate medical attention:

- Increased pain and swelling.
- Numbness or increasing pressure in the casted limb.
- Unusual smell of any drainage.
- Colour change of the digits distal to the cast.
- The cast breaks or comes off.

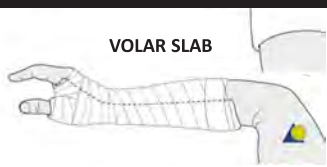
How to remove a cast safely

- Using an oscillating electric POP cast saw, make two longitudinal cuts along opposing surfaces of the cast, avoiding areas where the bone is prominent.
- The saw cut is prgressed by ‘dabbing’ it along, not sliding, as this may scratch the skin.
- Once the vertical cuts have been made, loosed the cast with a plaster spreader.
- Complete the division of the plaster and the padding with plaster scissors, with careful attention not to injure the underlying skin.
- The saw is noisy and may scare patients, especially children. Reassure them by demonstrating the saw on your palm before applying the POP.

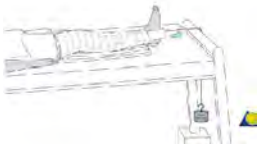
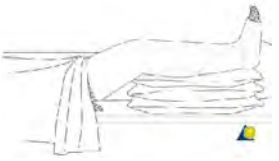
PLASTER APPLICATION: UPPER LIMB

AREA AFFECTED	SITE	MANAGEMENT	COMMENTS
HUMERUS	PROXIMAL	**SHOULDER IMMOBILISER (SLING)**	
	SHAFT	**U-SLAB** 	FROM AC JOINT, AROUND ELBOW, INTO AXILLA (ELBOW IN 90˚ FLEXION) COLLAR & CUFF 6 x 150mm POPs
	DISTAL (INCLUDING ELBOW)	**ABOVE ELBOW BACKSLAB** 	FROM PROXIMAL ARM TO 1ST PALMAR CREASE (ELBOW IN 90˚ FLEXION) 4 x 150mm POPs
RADIUS & ULNA	SHAFT	**PRELIMINARY:** ABOVE ELBOW BACKSLAB **UNDISPLACED ULNA/RADIAL HEAD (ALL RADIUS SHAFT #'s NEED ORIF):** ABOVE ELBOW CIRCULAR CAST 	**ABOVE ELBOW BACKSLAB** (AS ABOVE) **ABOVE ELBOW CIRCULAR CAST:** FROM PROXIMAL ARM TO 1ST PALMAR CREASE (INCORPORATE WRIST) 
	DISTAL (RADIUS)	**PRELIMINARY:** **'SUGAR TONG' SPLINT**  FROM 1st PALMAR CREASE AROUND ELBOW OVER DORSUM OF HAND 4 x 150mm POPs	**DEFINITIVE:** **BELOW ELBOW CIRCULAR POP**  FROM 1ST PALMAR CREASE TO PROX 1/3 OF FOREARM 3 x 100mm POPs

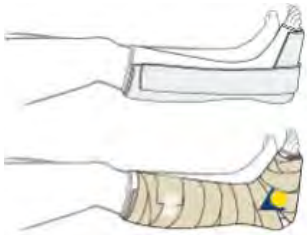
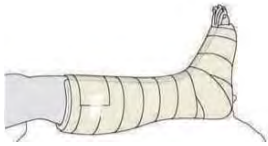
PLASTER APPLICATION: UPPER LIMB

AREA AFFECTED	SITE	MANAGEMENT	COMMENTS
HAND	CARPALS	**VOLAR SLAB** 	**VOLAR SLAB** FROM 1ST PALMAR CREASE TO PROX 1/3 OF FOREARM 3 x 100mm POPs
	METACARPALS & PHALANGES	**Z-SPLINT** 	FUNCTIONAL POSITION OF WRIST (30˚) & MCPJs (90˚) FROM DISTAL PHALANX TO MID-FOREARM 3 x 100mm POPs
	THUMB	**PRELIMINARY:** THUMB SPICA SLAB  **DEFINITIVE:** THUMB SPICA POP 	FROM DISTAL PHALANX (MUST IMMOBILISE INTERPHALANGEAL JOINT) TO MID-FOREARM 2 x 50mm POP FOR THUMB 3 x 100mm POPS FOR FOREARM

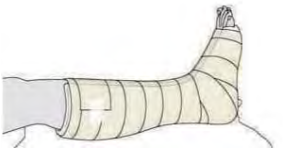
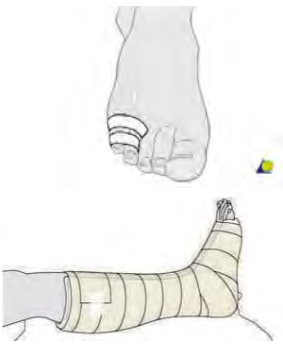
PLASTER APPLICATION: LOWER LIMB

AREA AFFECTED	SITE	MANAGEMENT	COMMENTS
FEMUR	NECK OF FEMUR/ INTERTROCHANTERIC REGION	**PRELIMINARY SKIN TRACTION** 	WEIGHT APPLIED TO TRACTION SHOULD BE 10% OF BODY WEIGHT (UP TO MAX. OF 4.5kg) *NB: MOST WILL REQUIRE ORIF* **FEMUR SHAFT FRACTURES REQUIRE THOMAS SPLINT**
	SHAFT		
	DISTAL	**ABOVE KNEE BACKSLAB** 	FROM PROXIMAL THIGH (GLUTEAL FOLD) (KNEE IN 20-30˚ FLEXION) 8 x 150mm POPs
PATELLA		**ABOVE KNEE BACKSLAB (ANKLE SPARING)** 	FROM PROXIMAL THIGH (GLUTEAL FOLD) TO ABOVE MALLEOLI (FULL EXTENSION) 8 x 150mm POPs
TIBIA	PROXIMAL (INCL. PLATEAU)	**PRELIMINARY:** ABOVE KNEE BACKSLAB (ANKLE INCLUDED) 	**ABOVE KNEE BACKSLAB:** FROM PROXIMAL THIGH (GLUTEAL FOLD) TO MTPJ (KNEE IN 20-30˚ FLEXION, ANKLE IN 90° DORSIFLEXION 9-10 x 150mm POPs
	SHAFT	**DEFINITIVE:** ABOVE KNEE CIRCULAR CAST (SHAFT ONLY) 	**ABOVE KNEE CIRCULAR CAST:** FROM PROXIMAL THIGH (GLUTEAL FOLD) TO MTPJ (KNEE IN 20-30˚ FLEXION, ANKLE IN 90° DORSIFLEXION 12 x 150mm POPs

PLASTER APPLICATION: LOWER LIMB

AREA AFFECTED	SITE	MANAGEMENT	COMMENTS
TIBIA	**DISTAL** ***(PLAFOND/PILON)***	**BELOW KNEE BACKSLAB:** 	FROM JUST BELOW KNEE (ABOVE FIBULA NECK) TO MTPJ ANKLE IN 90° DORSIFLEXION 5 x 150mm POPs
MALLEOLI (ANKLE)	**TALAR SHIFT PRESENT**	**BELOW KNEE BACKSLAB WITH MALLEOLAR U-SLAB:** 	**BELOW KNEE BACKSLAB:** FROM JUST BELOW KNEE (ABOVE FIBULA NECK) TO MTPJ ANKLE IN 90° DORSIFLEXION 5 x 150mm POPs **MALLEOLAR U-SLAB:** FROM MID-LOWER LEG & LOOP AROUND HEEL TO COVER MEDIAL & LATERAL MALLEOLI. 3 X 100MM POPs *NB: REDUCE TALAR SHIFT WITH MEDIAL PRESSURE WHEN PLASTER IS STILL WET*
	TALAR SHIFT ABSENT	**PRELIMINARY:** **BELOW KNEE BACKSLAB**  **DEFINITVE:** **BELOW KNEE CIRCULAR CAST** 	**BELOW KNEE BACKSLAB:** FROM JUST BELOW KNEE (ABOVE FIBULA NECK) TO MTPJ ANKLE IN 90° DORSIFLEXION 5 x 150mm POPs **BELOW KNEE CIRCULAR CAST:** FROM JUST BELOW KNEE (ABOVE FIBULA NECK) TO MTPJ ANKLE IN 90° DORSIFLEXION 5 x 150mm POPs *NB: CONSERVATIVE Rx IN CAST ONLY INDICATED FOR UNDISPLACED LATERAL MALLEOLI FRACTURES WITH NO MEDIAL TENDERNESS & NO TALAR SHIFT* IF SWELLING ALLOWS

PLASTER APPLICATION: LOWER LIMB

AREA AFFECTED	SITE	MANAGEMENT	COMMENTS
FOOT	TARSALS METATARSALS	**PRELIMINARY: BELOW KNEE BACKSLAB**  **DEFINITVE: BELOW KNEE CIRCULAR CAST** 	**BELOW KNEE BACKSLAB:** FROM JUST BELOW KNEE (ABOVE FIBULA NECK) TO MTPJ ANKLE IN 90° DORSIFLEXION 5 x 150mm POPs **BELOW KNEE CIRCULAR CAST:** FROM JUST BELOW KNEE (ABOVE FIBULA NECK) TO MTPJ ANKLE IN 90° DORSIFLEXION 5 x 150mm POPs IF SWELLING ALLOWS
	PHALANGES	**'BUDDY STRAPPING' & BELOW KNEE BACKSLAB** 	**'BUDDY STRAPPING':** USING 2 x 5-10mm PIECES OF ELASTOPLAST, TAPE AFFECTED TOE TO ADJACENT TOE **BELOW KNEE BACKSLAB:** FROM JUST BELOW KNEE (ABOVE FIBULA NECK) TO MTPJ ANKLE IN 90° DORSIFLEXION 5 x 150mm POPs

Plaster application images © AO Foundation, Switzerland

Source: AO Foundation Online Surgery Reference (www.aofoundation.org)
Access Emergency Medicine (www.accessemergencymedicinemhmedical.com)

Essential takeaways

- Proper application of a plaster cast is an invaluable skill that is still widely used in orthopaedics.
- Be aware of the setting times of POP to maintain the intended position.
- Patient education regarding POP care and danger signs.

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Slings

by Duncan McGuire

Learning objective

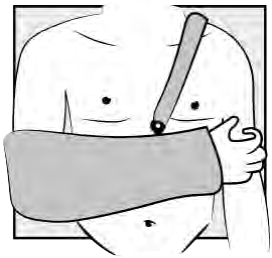
1. Understand the basic types of slings used for upper limb injuries.

Introduction

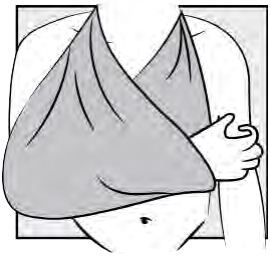
There are three types of slings used for upper limb injuries in orthopaedics:

1. Shoulder immobiliser
2. Collar and cuff
3. Broad arm sling

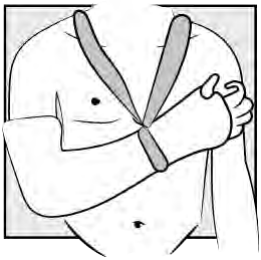
When applying, position the elbow in the corner of the shoulder immobiliser. Ensure that the strap at the back of the neck is adequately padded so that the sling is comfortable. For a properly positioned sling, the forearm should be in a horizontal position parallel to the ground when standing.



Broad arm sling



Triangle sling



Collar and cuff

Shoulder immobiliser

This is most commonly prescribed after an injury or surgery to a shoulder or an elbow. The shoulder immobiliser comes pre-packaged in various sizes. The part of the sling that the forearm rests in is made of material and it encloses the forearm with velcro straps. There is a strap that extends from the forearm component around the neck and back onto the forearm component. There is an optional strap that goes around the body to prevent the arm moving away from the body. This strap is usually only used when the intention is to not allow shoulder abduction.

Collar and cuff

The collar and cuff is made from sponge. It has a loop that goes around the neck and another loop through which the hand passes. The arm is supported with the wrist resting in the loop. The loop around the wrist should be loose enough that the patient is able to put in and take out their hand themselves.

The collar and cuff is very easy to apply and is cheaper than the shoulder immobiliser. It does not support the elbow, so in certain conditions where elbow support is required, the shoulder immobiliser may be better. Examples of this include clavicle fractures and acromioclavicular joint injuries. The collar and cuff is ideal for conditions where there is a plaster of Paris cast, brace or bulky bandage around the upper arm or elbow, where the bulkiness would interfere with the elbow fitting into the shoulder immobiliser. Examples include humerus fractures that are immobilised in a U-slab and where there is a bulky bandage around the elbow following surgery.

Wound debridement

by Luan Nieuwoudt, Leonard Marais, Nando Ferreira & Thomas Hilton

Learning objectives

1. Describe the pre-, intra- and post-operative principles concerning open fracture management and wound debridement.
2. Discuss a stepwise approach to the intra-operative technique of wound debridement.

Case presentation

A 24-year-old male is brought to the emergency department following a pedestrian-vehicle accident (PVA). After excluding all acute life-threatening injuries, you conclude that he sustained an isolated open fracture of the left tibial diaphysis. The lower limb shows an 8cm x 4cm anterior-medial wound with exposed bone (Figure 1).

Clinical picture showing open fracture of tibial diaphysis with exposed bone fragments

Assessment

History

Obtain a focused relevant surgical and medical history:

- Event, what happened, mechanism of injury.
- Complaints and symptoms.
- Past medical history.
- Medications.
- Allergies.
- Last oral intake or time of last meal.

Examination

- ATLS approach.
- Primary survey: Assess and address all life-threatening injuries involving the patient's airway, breathing and circulation. Stop any external bleeding with direct pressure. Cursory neurological assessment and expose patient as necessary for a full examination. Prevent hypothermia by limiting exposure to the environment.
- Secondary survey: Careful, systematic examination of the head, maxilla-fascial region, spine, chest abdomen, pelvis, perineum (PR/PV examination as indicated), full neurological assessment and musculoskeletal assessment of each limb.

In terms of the local examination of the injured lower leg:

Look

- Site, size and shape of the wound.

- Bleeding.
- Degree of wound contamination.
- Associated injuries including knee, ankle and foot examination.
- Abnormal swelling of individual compartments of the lower leg and foot could indicate compartment syndrome.
- Consider taking a photograph of the wound to prevent unnecessary removal of dressings.

Feel

- Assess individual compartments for signs of compartment syndrome.
- Palpate dorsalis pedis and tibialis posterior pulses and compare to the contralateral limb.
- Examine foot sensation.

Move

- Defer active movement of any fractured or dislocated limb.
- Test active flexion and extension of toes to test motor function (as pain allows).

Special investigations

- Arterial blood gas with lactate as indicated to assess ventilation and perfusion.
- FBC, U and E and creatinine and other blood tests guided by medical history.
- Anteroposterior (AP) and lateral X-ray views of the tibia (Including knee and ankle).
- Chest X-ray if there is any suspicion of chest injury on examination.
- Have a low threshold to obtaining pelvic and cervical spine radiographs.

Management

Pre-operative management

Pre-operative management entails primary management of the patient in the emergency department while undergoing fluid resuscitation. Control of haemorrhage can be obtained with direct compression on the wound as needed. The following steps must be taken:

- Broad-spectrum antibiotics and anti-tetanus prophylaxis (see open fracture management principles).
- Analgesia.
- Remove gross contaminants in the wound.
- Copious irrigation with saline until macroscopically clean.
- Apply sterile moist (saline) dressing, gauze and bandage (do not suture the wound).
- Re-align limb and splinting. Apply above-knee back slab.
- Prepare patient for surgical debridement in theatre.

Surgical or intra-operative management

Surgical debridement entails the sharp removal of all devitalised, damaged or infected tissue and foreign matter from a wound. Devitalised tissue and foreign material promote the growth of microorganisms, constitute a barrier for the host's defence mechanisms and should be removed1. Wound debridement is the most critical aspect of open fracture management and should be done within 24 hours of the injury. Inadequate debridement usually leads to fracture-related infections or chronic osteomyelitis.

Early adequate surgical debridement is best done by an experienced team of healthcare workers, including an orthopaedic surgeon, in the following stepwise manner:

- Pre-surgery soapy solution wash of the affected limb and a tourniquet is applied but not inflated.
- Limb prepped with chlorhexidine solution as per standard technique.
- The wound edges are extended as needed to expose the whole zone of injury. This needs to be done in consultation with a plastic surgeon not to jeopardise any future soft tissue flaps.
- Surgical debridement is done systematically using forceps, tissue scissors, scalpel, diathermy and curettes, from superficial to deep. Starting with skin, followed by fat, fascia, muscle and, lastly, bone from the periphery of edges to the centre of the wound to encompass the whole 'zone of injury'. All devitalised soft-tissue and bone (using the 'tug-test') are removed until only viable tissue remains. Both the proximal and distal bone fragments are delivered through the wound to clean the medullary canals.1

- Viability of muscle tissue is assessed according to the 4 Cs:
  - Colour (viable muscle is bright red).
  - Consistency (ischaemic or necrotic muscle becomes soft and friable).
  - Contractility (viable muscle tissue contracts when stimulated with diathermy or pinched with forceps).
  - Capillary bleeding (ischaemic or necrotic muscles has minimal bleeding).
- The following factors are assessed to evaluate if a bone fragment is viable:
  - Attachment to soft tissue (tug test).
  - Punctate bleeding of the bone when the tourniquet is released.
  - Necrotic bone becomes white or ivory and brittle, while viable bone has a slight pink hue and texture similar to living wood.
- Remain relatively conservative with the resection of skin and bone as these structures can be difficult to reconstruct. However, all non-viable tissue needs to be excised. If in doubt, consult a senior or re-examine tissue at wound inspection in theatre after 48 hours.
- Following this, copious, large volume, saline irrigation is used to lavage the wound to remove most microscopic contaminants. At least three to 9 litres or more are recommended until clean. High-pressure, low-pressure or ultra-low pressure lavage systems are all acceptable methods2.
- The debridement aims to turn a contaminated wound as close to possible to a sterile wound allowing the insertion of internal or external fixation, if appropriate, with the least risk of sepsis.
- At the end of the debridement, the wound is classified using the Gustilo-Anderson classification3.
- Moist, non-stick saline dressings or a bead-pouch technique could be used

post-debridement for wound coverage4.

- The wound is usually not primarily closed, especially in Grade III fractures, and a delayed re-look and wound closure is performed after 48 hours post initial surgery. The wound should not be left open for more than five days post-injury.
- The fracture is then stabilised using internal or external devices. See open fracture management.

Post-operative management

- Limb elevation to decrease swelling.
- Duration of antibiotic therapy is controversial. One to two days post definitive wound closure is a safe practise5,6.
- Mobilisation of the patient with physiotherapy can be commenced once soft tissue allows.

Essential takeaways

- Meticulous pre-, intra- and post-operative principles need to be adhered to for the prevention of fracture-related infection.
- The stepwise approach to intra-operative surgical debridement will yield the best possible outcome.
- Adequate soft tissue and bone debridement are reliant on surgical exposure, and the delivery of the fracture/bone ends through the wound to enable removal of foreign material.
- Adjuncts such as antibiotics, fracture stabilisation and irrigation should always be used.

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Editor: Michael Held
Conceptualisation: Maritz Laubscher & Robert Dunn
Cover design: Carlene Venter (Creative Waves Brand Design)
Developmental editing and design: Vela Njisane and Phinda Njisane

ABOUT THE BOOK

Informed by experts: Most patients with orthopaedic pathology in low to middle-income countries are treated by non-specialists. This book was based on a modified Delphi consensus study* with experts from Africa, Europe, and North America to provide guidance to these health care workers. Knowledge topics, skills, and cases concerning orthopaedic trauma and infection were prioritised. Acute primary care for fractures and dislocations ranked high.

Furthermore, the diagnosis and the treatment of conditions not requiring specialist referral were prioritised.

* Held et al. Topics, Skills, and Cases for an Undergraduate Musculoskeletal Curriculum in Southern Africa: A Consensus from Local and International Experts. JBJS. 2020 Feb 5;102(3):e10.

THE LION

The Learning Innovation via Orthopaedic Network (LION) aims to improve learning and teaching in orthopaedics in Southern Africa and around the world. These authors have contributed the individual chapters and are mostly orthopaedic surgeons and trainees in Southern Africa who have experience with local orthopaedic pathology and treatment modalities but also in medical education of undergraduate students and primary care physicians. To centre this book around our students, iterative rounds of revising and updating the individual chapters are ongoing, to eliminate expert blind spots and create transformation of knowledge.

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This textbook is not intended as a substitute for the medical advice of physicians. The reader should regularly consult a physician in matters relating to his/her health and particularly with respect to any symptoms that may require diagnosis or medical attention.

The information in this book is meant to supplement, not replace, Orthopaedic primary care training. The authors, editor and publisher advise readers to take full responsibility for their safety and know their limits. Before practicing the skills described in this book, be sure that your equipment is well maintained, and do not take risks beyond your level of experience, aptitude, training, and comfort level.

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