Don't Forget The Bubbles

WRIST EXAMINATION & PATHOLOGY

Facilitators Guide

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Topic: **Hand & Wrist Examination and Pathology**
Author: **Segn Nedd**
Duration: **2 hours**
Equipment required: **Splints, soft bandages, plaster of paris sets**

OUTLINE

- **Basics (10 minutes)**
- **Main Session (2 x15 minutes) case discussions covering key points and evidence**
- **Advanced Session (2 x 20 minutes) case discussions covering diagnostic dilemma, advanced management**
- **Sim scenario – (30 minutes)**
- **Quiz (5 minutes)**
- **Infographic sharing (5 minutes): 5 take home learning points**

PRE-READING FOR LEARNERS

Expectation is for the learners to have watched or read one of the basic anatomy/pathology
links before the session

Anatomy and Common injuries:

https://litfl.com/bscc/clinical-anatomy/hand-anatomy/

https://litfl.com/bscc/clinical-anatomy/hand-and-wrist-injuries/

https://dontforgetthebubbles.com/wrist-torus-and-greenstick-fractures/

https://dontforgetthebubbles.com/scaphoid-fractures/

Examination:

https://geekymedics.com/hand-examination/

Management:

www.rch.org.au/clinicalguide/guideline_index/fractures/Distal_radial_physeal_fractures_Emergency_Department_setting/

DFTB below elbow Backslab application:

BASICS: (FROM TEACHMEANATOMY AND LITFL)

The wrist is a common place for injuries in children often occurring following a **F**all **O**nto an **O**ut**S**tretched **H**and **(FOOSH)**. The wrist joint connects the hand to the forearm. It is made up of the radius and 8 carpal bones. Although commonly included, the ulna is not technically part of the wrist joint. The ulna articulates with the radius just proximal to the wrist at the radio-ulnar joint. It is separated from the carpal bones by a fibrocartilaginous ligament (articular disk). The wrist joint is a synovial joint. It therefore has a capsule. Its internal membrane secretes synovial fluid to lubricate the joint.

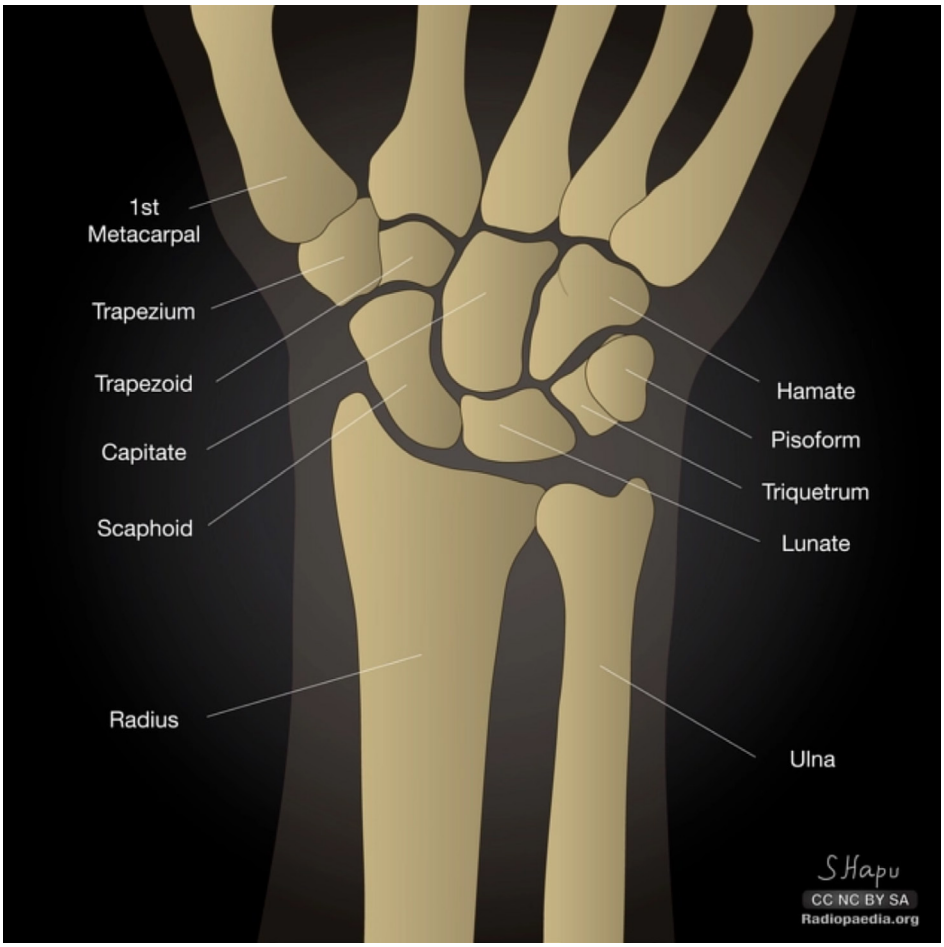
Descriptive Terms:

When describing injuries of the wrist (and hand) for documentation or referral purposes it is important to know the terminology widely in use in order to convey an accurate description to others. Injuries present on the palmar surface would be described as Palmar or Volar. Injuries on the back of the hand are dorsal. The proximal part of the wrist is more towards the forearm, whereas the distal end is towards the fingers. The thumb lies on the radial side and the little is the ulnar side.

Image from LITFL Hand anatomy

Anatomy: (from Radiopedia, NYSORA & teachme anatomy)
In order to understand what you are examining and the associated pathologies that need to be considered it is important to have knowledge of the underlying structures that form the wrist. The wrist and hand have a complex anatomy with bony structures surrounded by a matrix of soft tissues including, muscles, tendons and ligaments. It additionally has an intricate blood and nerve supply. We will focus on the structures most important when assessing paediatric wrists in the emergency department.

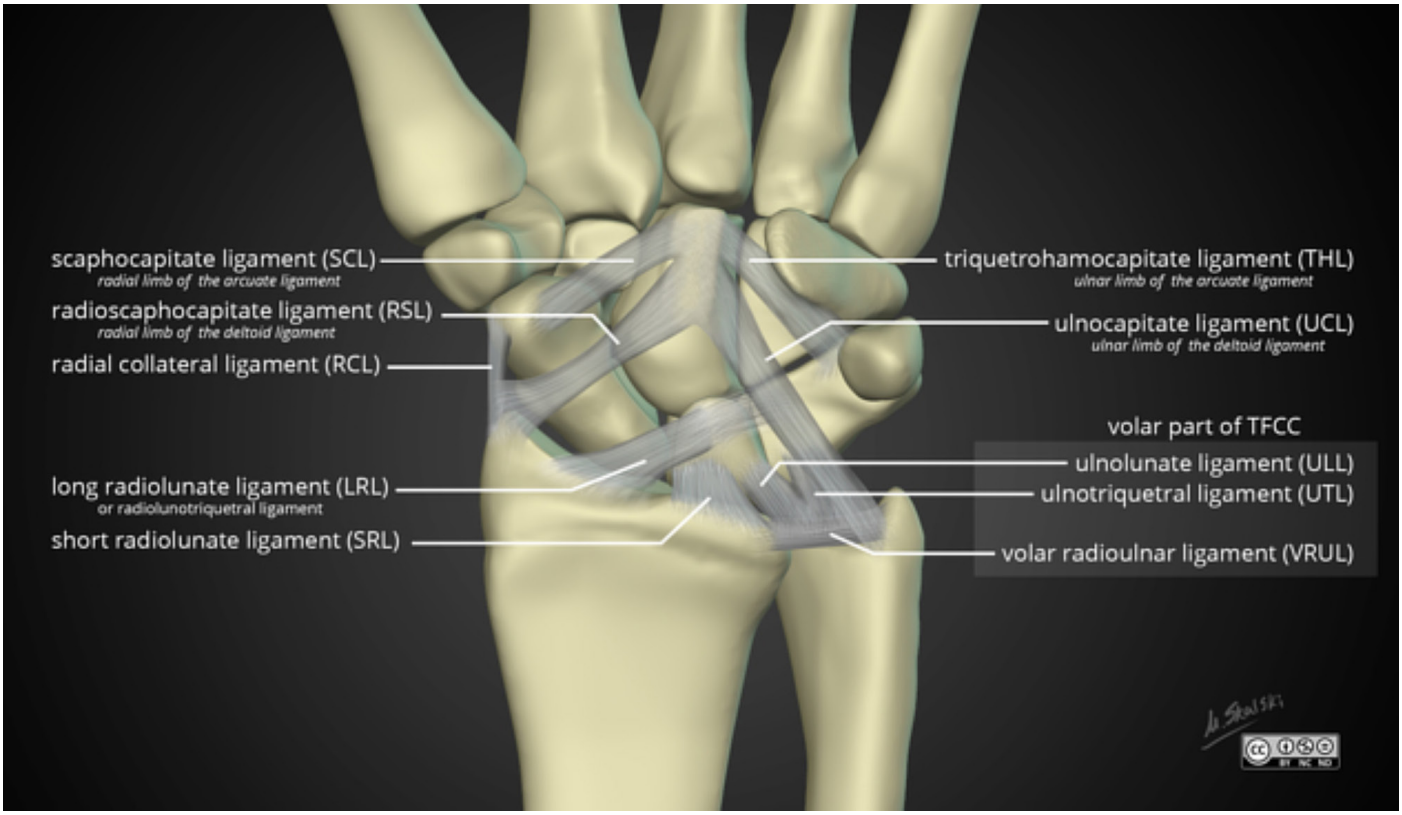
Bones: (from Radiopedia)



The radius is on the side of the thumb, the ulna on the side of the little finger.
A good mnemonic to remember the position of the carpal bones is to describe them starting from the base layer thumb to little finger, followed by the top layer little finger to thumb.

So Long To Pinky, Here Comes The Thumb
Scaphoid, Lunate, Triquestrum, Pisiform, Hamate, Capitate, Trapezoid, Trapezium

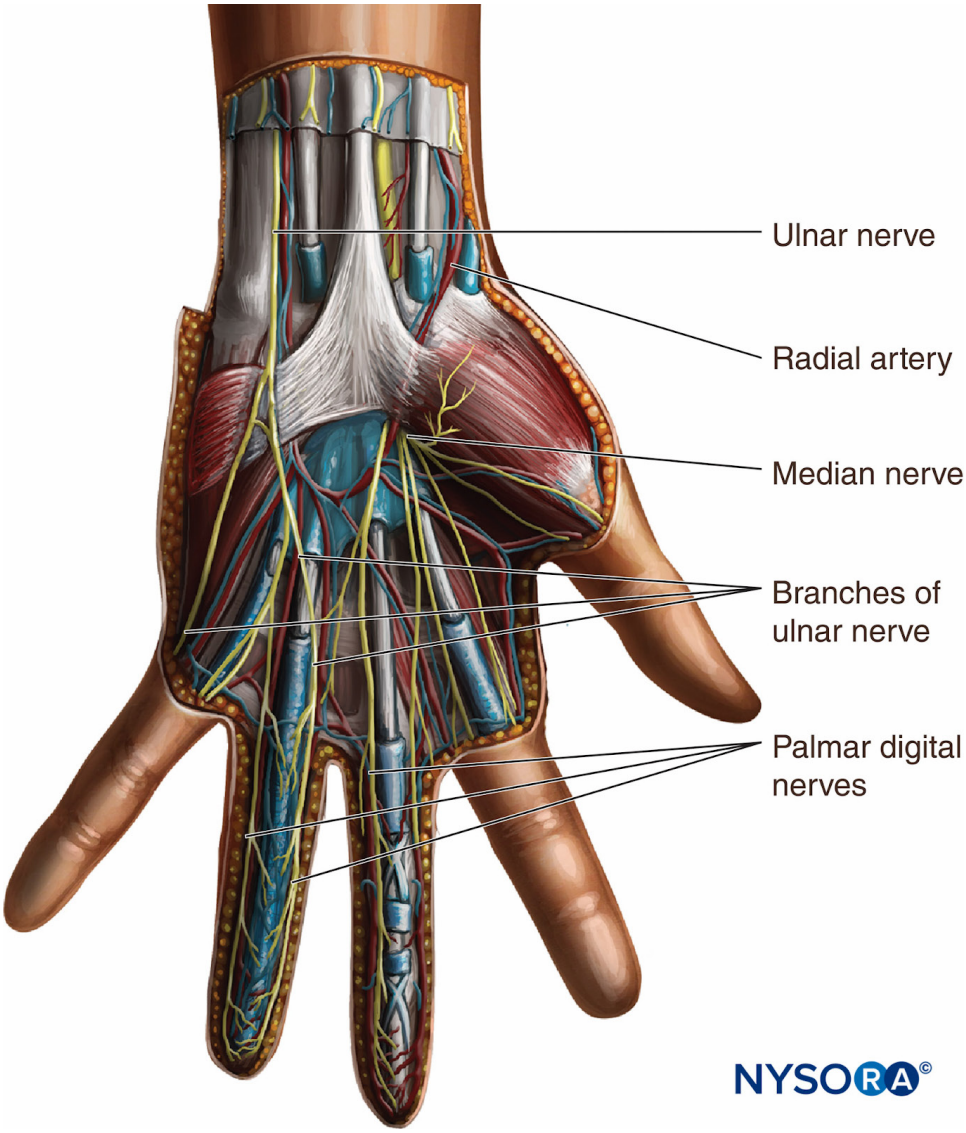
Ligaments: (from Radiopedia)

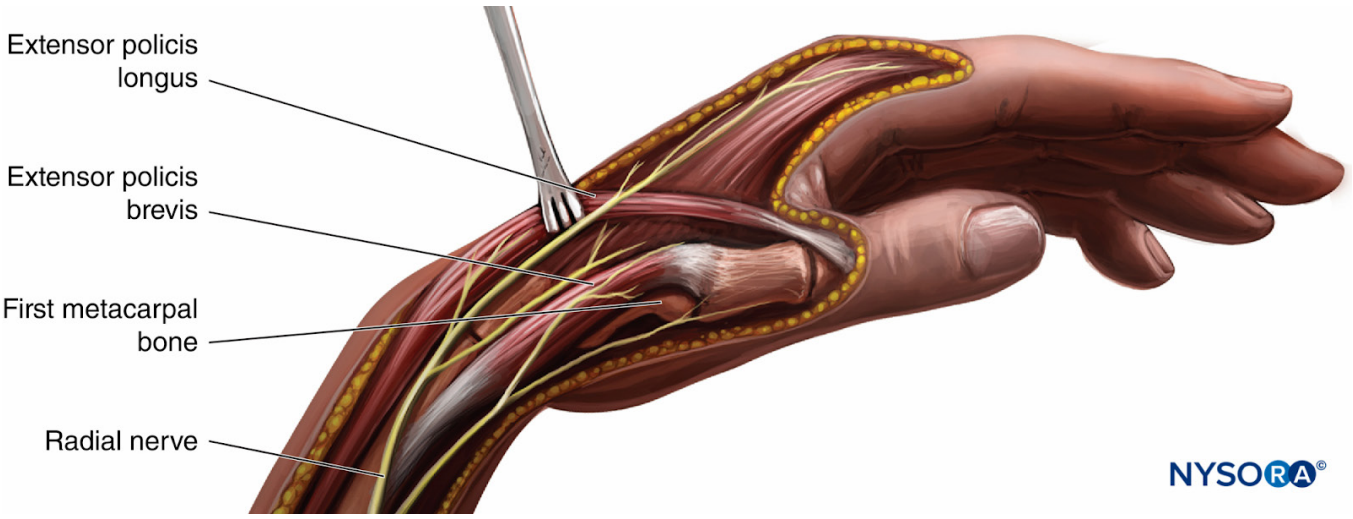


From Radiopedia

There are multiple ligaments of the wrist. These play a vital role in the stability of the wrist joint. They are specifically important in holding the carpal bones together. Those most clinically important in wrist joint stability are labelled as above. Ligaments of the wrist are not visible on X-ray and to be fully examined are best assessed with a dedicated wrist MRI. However, increases in the spacing between bones on plain X-rays can indicate a ligament injury with clinical correlation.

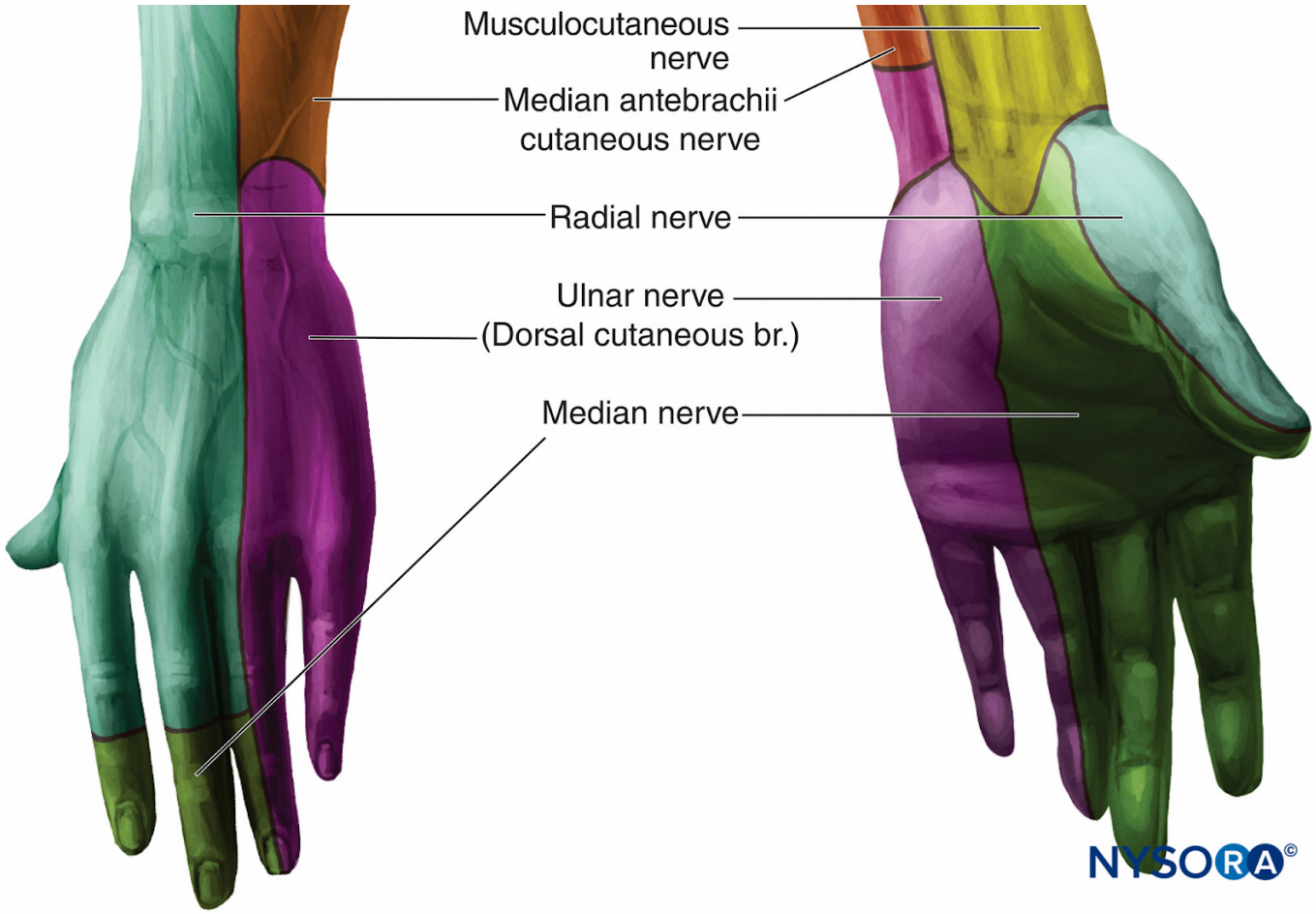
The Nervous System: (from NYSORA)



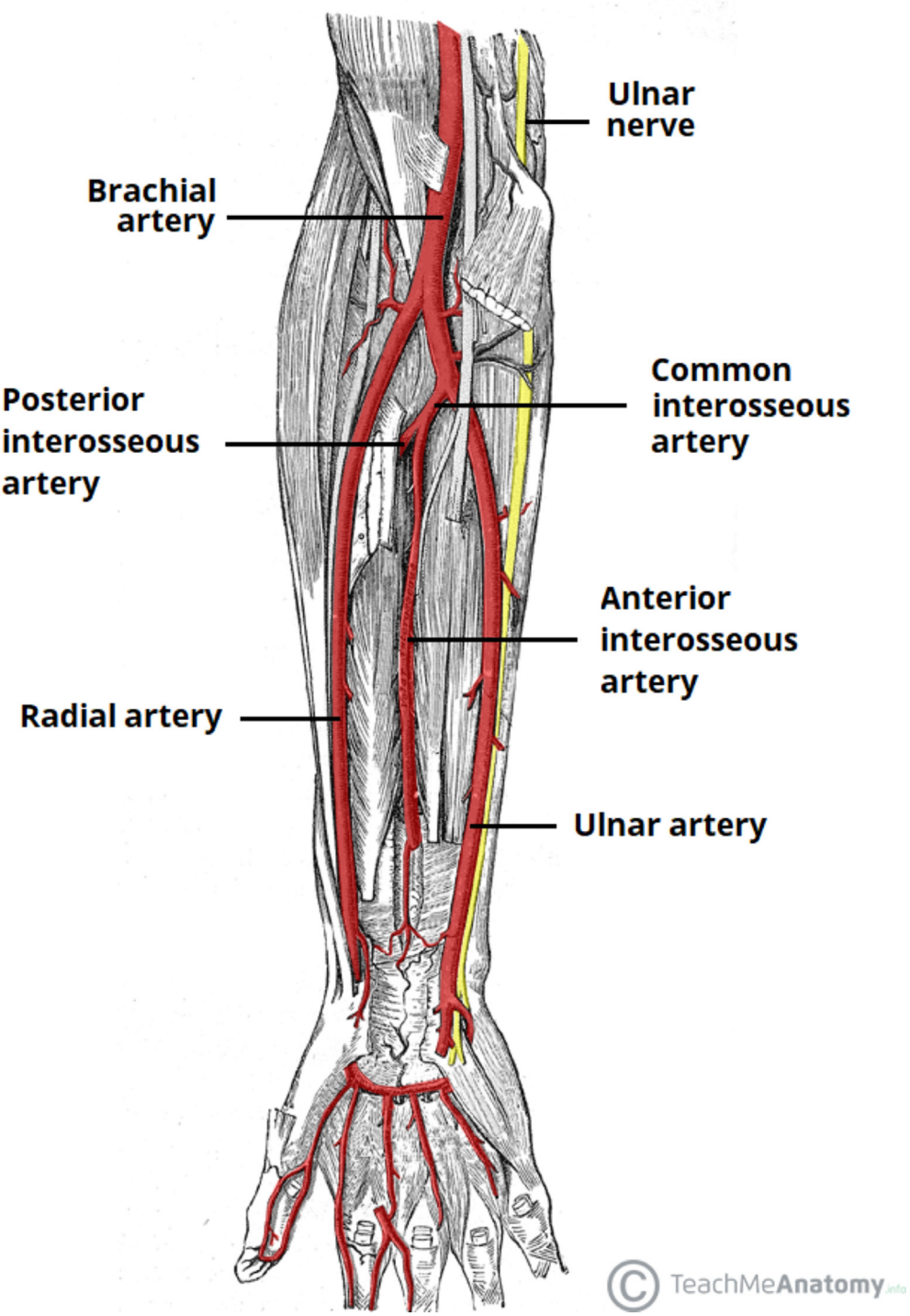


The ulna, median, and radial nerves innervate the hand.
The course of these nerves traverse the wrist. They therefore have the potential to be damaged following wrist injuries. The median, anterior interosseous nerve (a branch of the median) and the ulnar nerve specifically although rare can be compromised following wrist fractures. The nerves of the wrist and hand also have an important role in functionality of the wrist (and hand).
The radial nerve facilitates extension of the wrist and metacarpophalangeal joints.
The ulnar nerve facilitates movement of the small muscles of the hand.
The median nerve supports finger extension and anterior interosseous branch enables thumb flexion at the interphalangeal joint and flexion of the index finger at the distal interphalangeal joint.

The corresponding dermatomal innervation of the wrist and hand is illustrated below.



Vasculature: (from teachmeanatomy)



Arising from bifurcations of the brachial artery in the cubital fossa The radial and ulnar arteries (and their branches) supply blood to the forearm, wrist and hand. These two arteries merge in the hand forming the superficial palmar and the deep palmar arch.The radial artery supplies the posterolateral aspect of the forearm and is important in contributing to the blood supply of the carpal bones. The Ulnar artery supplies the anteromedial aspect of the forearm.
It mostly supplies blood to the elbow joint, but its branches do however help supply some of the deeper structures in the forearm.

Examination: From Geeky medics

The look, feel, move & function approach is generally used to examine the hand and wrist. Always offer analgesia prior to your examination of a child with an injury. As functions involve both areas they are often examined together

Look	
1	Perform general inspection
2	Inspect the dorsum of the hands
3	Inspect the palms of the hands and elbow

Careful note should be taken to ensure that full inspection is undertaken. This may identify any bruising, overlying skin changes, swelling or deformity. Remember also to always examine the joint above and the joint below.

Feel	
1	Asses and compare temperature of wrist and small joints of hand
2	Palpate radial and ulnar pulse & check capillary refill
3	Palpate thenar and hypothenar eminence
4	Asses median nerve sensation
5	Asses ulnar nerve sensation
6	Asses radial nerve sensation
7	Perform MCP squeeze
8	Bimanually palpate hand and finger joints
9	Palpate anatomical snuff box
10	Bimanually palpate the wrist joints

It is important not to miss any neurovascular compromise when examining the wrist and hand. Findings to suggest compromise may include colour change, coolness to touch, prolonged capillary refill time and altered sensation.

Move	
1	Assess finger extension
2	Assess finger flexion
3	Assess active wrist extension
4	Assess active wrist flexion
5	Assess wrist/finger extension against resistance (radial nerve)
6	Assess index finger ABduction against resistance (ulnar nerve)
7	Assess thumb ABduction against resistance median nerve)

Where possible movements should be actively undertaken by the patient. Take notice of any movements that are undertaken with difficulty or cause pain in undertaking.

Function	
1	Assess power grip
2	Assess pincer grip
3	Assess picking up small objects
4	Supination and pronation- twisting key movement or 'turning the key'

CASE SCENARIO 1

An 8 year old boy is brought to ED with his father. He had been outside roller-skating but fell over onto the concrete patio within the last hour. He is complaining of pain in his wrist and has difficulty moving it.
An X-Ray was done following triage: … Buckle fracture

From Radiopedia

What would be your approach to examining his injury?
What type of fracture do you suspect and how would you differentiate on X-ray?
What type of immobilisation would you use?

Discussion points:

What would be your approach to examining his injury?

Historic studies have shown that radial tenderness, focal swelling, or an abnormal supination/pronation were the clinical signs most often associated with correctly identifying children who had wrist fractures. In 2016 a multicenter study by Slaar et al. A clinical decision tool known as the Amsterdam paediatric wrist rules was created for use in children presenting with wrist trauma to determine clinically whether a radiograph was required or not.

The prediction model had high sensitivity and moderate specificity were 95.9% and 37.3%, respectively. It was calculated that through using this model there would be a 22% absolute reduction of radiographic examinations. Although not perfect, the use of the paediatric Amsterdam wrist rules may therefore be a useful aide memoir in facilitating clinicians to rationalise which children who present with wrist trauma to X-ray.

The clinical prediction model used eight variables to analyse those at risk of any wrist fracture. These were increasing age; sex (if male), swelling of the wrist; swelling of the anatomical snuffbox, visible deformation; distal radius tenderness on palpation; pain on radial deviation and painful axial compression of the thumb. The more of these factors that were present resulted in the increased probability of a fracture. Painful axial compression of the thumb however decreased the probability of a fracture.
This study also further analysed those with distal radius fractures. Children with increasing age, swelling of the wrist, visible deformation, distal radius tender to palpation, pain on palmar flexion, pain on supination and or painful radioulnar ballottement test were more likely to have distal radius fractures. However, pain on ulnar deviation was found to decrease the likelihood of a distal radial fracture.

Always ensure adequate analgesia is given when first assessing an injury. Ensure that the examination is systematic. It is best to use the look, feel, move, function process when examining the wrist. As with any orthopaedic examination however it is always important to also assess and assess the join above and below the affected area.

Look- for any deformity, swelling, bruising, colour change or overlying lacerations

Feel- Asses for radial tenderness, remember to assess for any signs of neurovascular compromise and check sensation in the forearm and hand. Neurovascular compromise is rare in distal radius fractures but can occur in greenstick fractures.

Move– Making tasks quick and easy to reproduce will assist in making identification of pathologies easier when assessing children. A combination of movements described by Dawson can be used to assess motor and neurological function in the hand and wrist. This can be done by starting a game of rock, paper, scissors. The addition of the O.K sign and also encouraging pronation and supination by "turning the key", turning the door handle" or "turning the lightbulb" will allow easy testing of wrist and hand movement and functionality

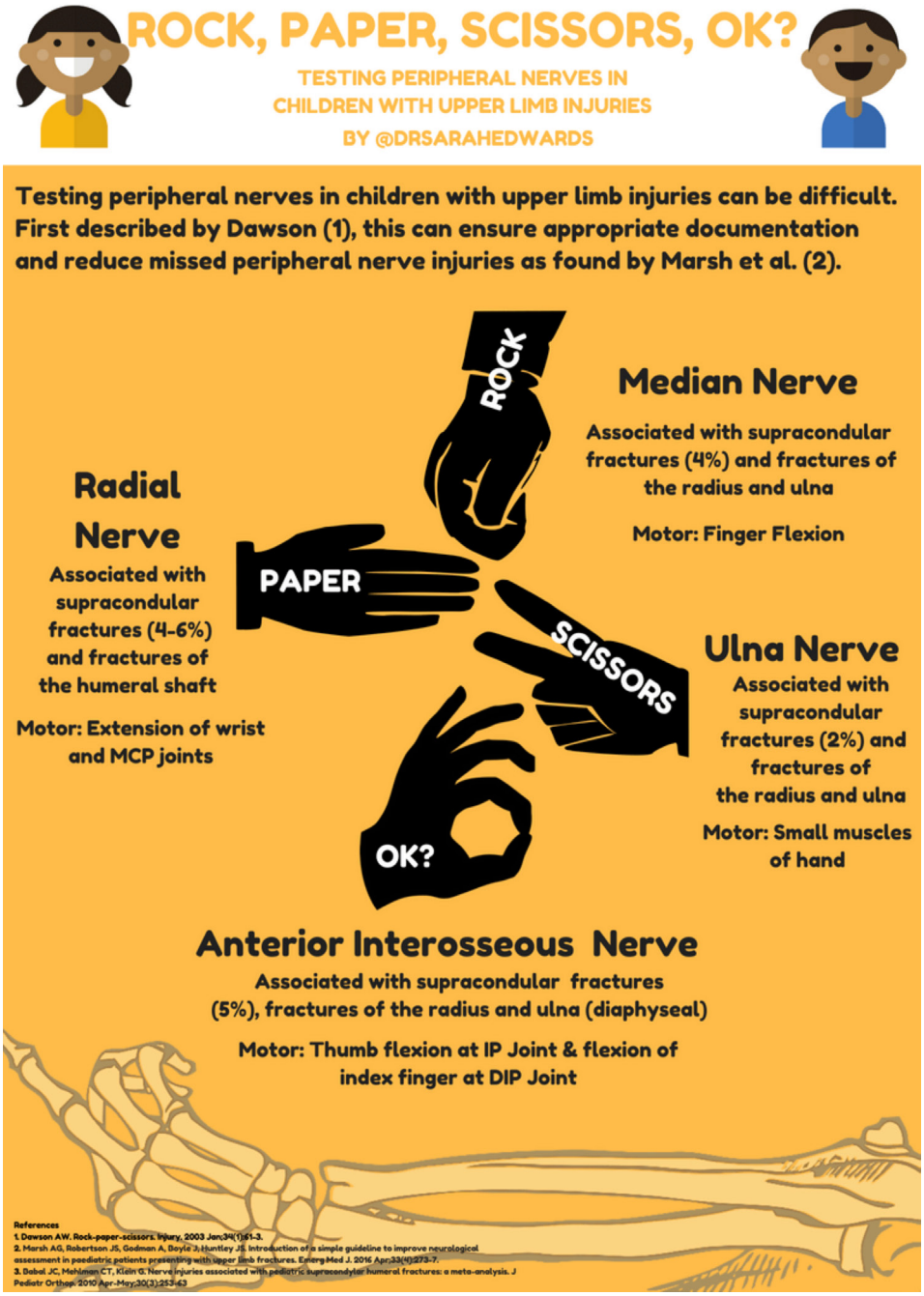


Image courtesy from peminfographics

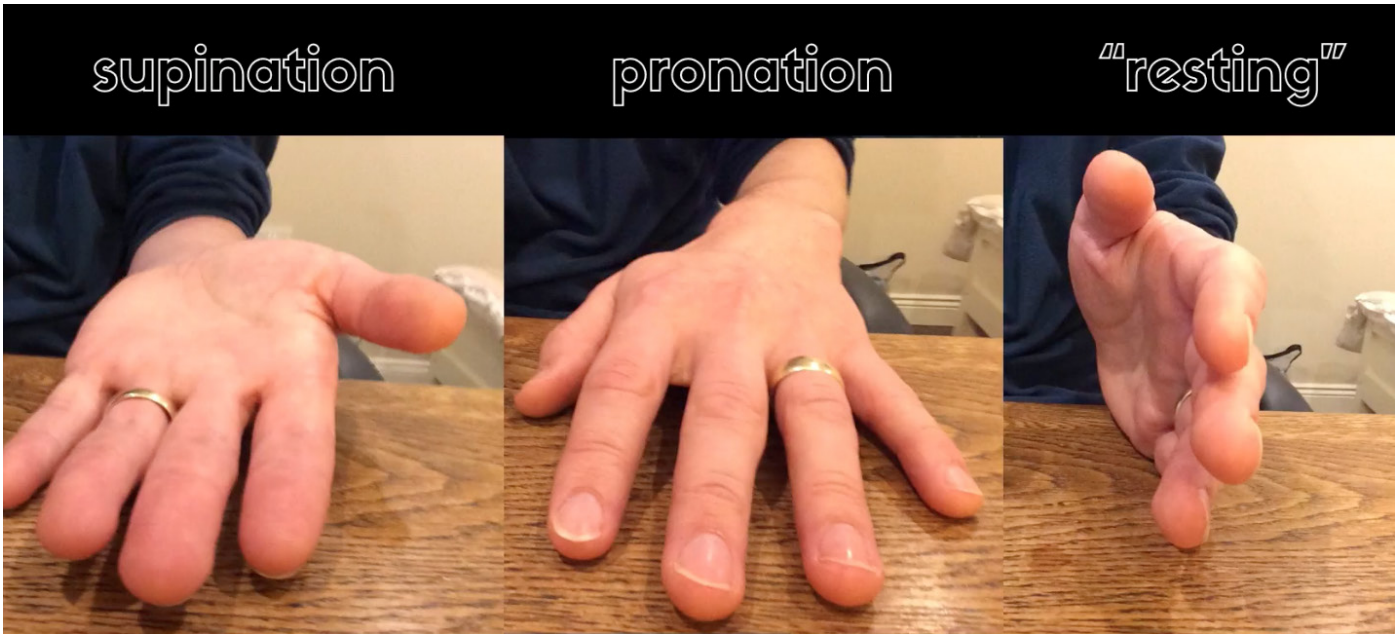


Image from LITFL Hand anatomy

What type of fracture do you suspect and how would you differentiate on X-ray?
Types of distal radius and ulna fractures
(from DFTB and Radiopaedia)

Buckle fractures are common in children especially in the 5-10 year old age range. Following a fall (often onto an outstretched hand) the force is transmitted from the carpus to the distal radius and as this is the point of least resistance fractures occur. Fractures are also often around the dorsal cortex of distal radius.

Greenstick fractures are incomplete fractures of the long bones in children. They are usually only seen in those under 10 years of age. The integrity of the bone cortex is breached on the convex side. The concave surface remains intact. It resembles the break that occurs when a young green branch of a tree is bent and breaks incompletely. One side snaps whilst the other side is still intact.

Buckle/torus and greenstick fractures are often discussed together as they have similarities; they are unique to children due to their softer compressible bones. However they also have clear differences.

Buckle/Torus fractures:

- In buckle fractures only one side of the bone is affected, strictly speaking both sides are affected in a torus fracture. However the terms are often used interchangeably
- In buckle/torus fractures the bone cortex crumples/buckles but does not crack
- Buckle/torus fractures are caused by longitudinal force through a long bone often following a fall a FOOSH
- Buckling of the bone occurs due to paediatric bone softness

Greenstick fractures:

- In greenstick fractures there is a clear cortex breach but only on one side of the bone
- There may also be some degree of angulation
- There may be visible deformity in greenstick fracture where often not present in a buckle fracture

More difficult to recognise distal radius fracture features on Lateral wrist Xrays include:

- A crinkle, or any irregularity of the cortex of the dorsal aspect of the distal radius
- In an impacted and undisplaced fracture, the only abnormality may be a very slight increase in the density of the radial metaphysis and/or loss of the normal palmar tilt of the radial articular surface

What is the normal palmar tilt of the radial articular surface?

In a lateral view of the distal forearm
The distal radius, the lunate and the capitate articulate with each other and lie in a straight line, like an apple in a cup sitting on a saucer.
The radius holds the lunate (cup) and the cup contains the capitate (apple)
The articular surface of the radius has a palmar tilt and is usually about 10 degrees with a normal range of 2-20degrees

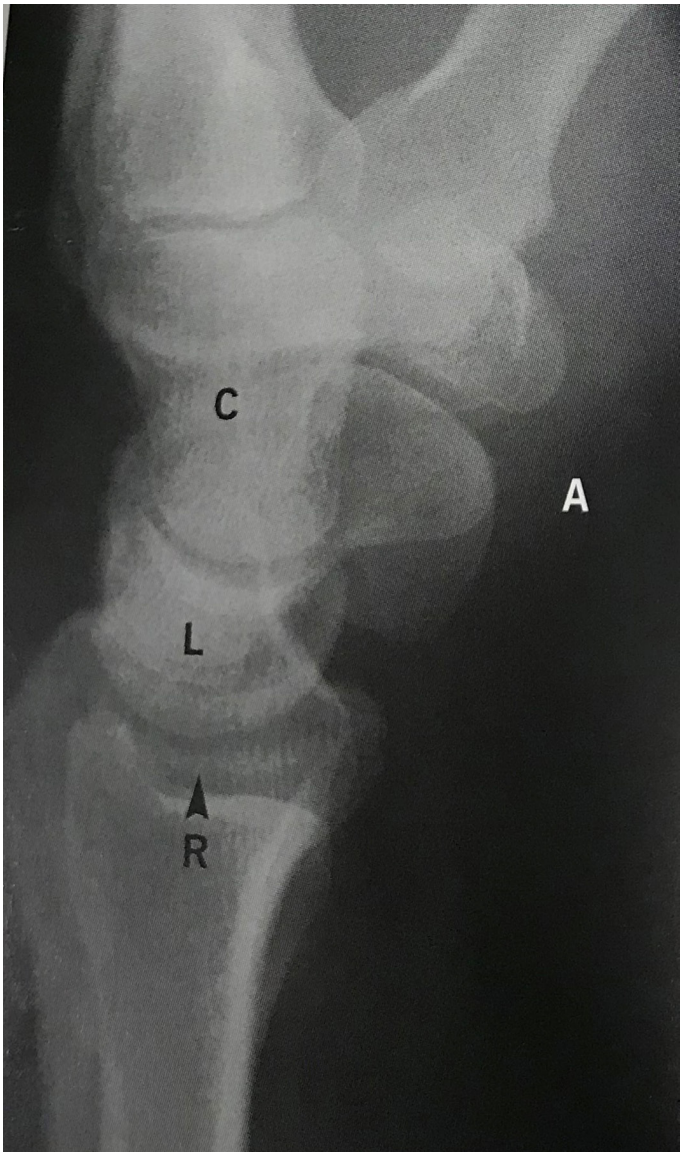


Figure A: Lateral radiograph. Normal wrist. The radius (R), the lunate (L) and the capitate (C) lie in a straight line. A= Anterior. Note the palmar tilt of the articular surface of the radius.

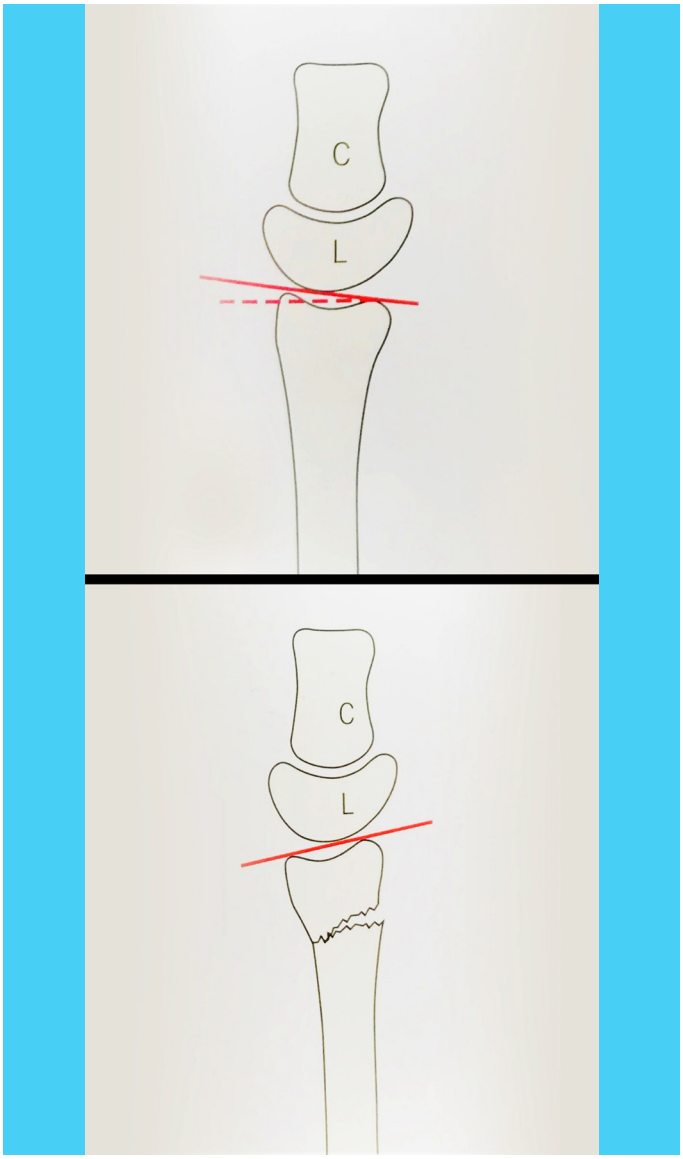


Figure B: Normal palmar tilt in the top figure, abnormal tilt of radial articular surface in bottom figure, fracture.

What type of immobilisation would you use?

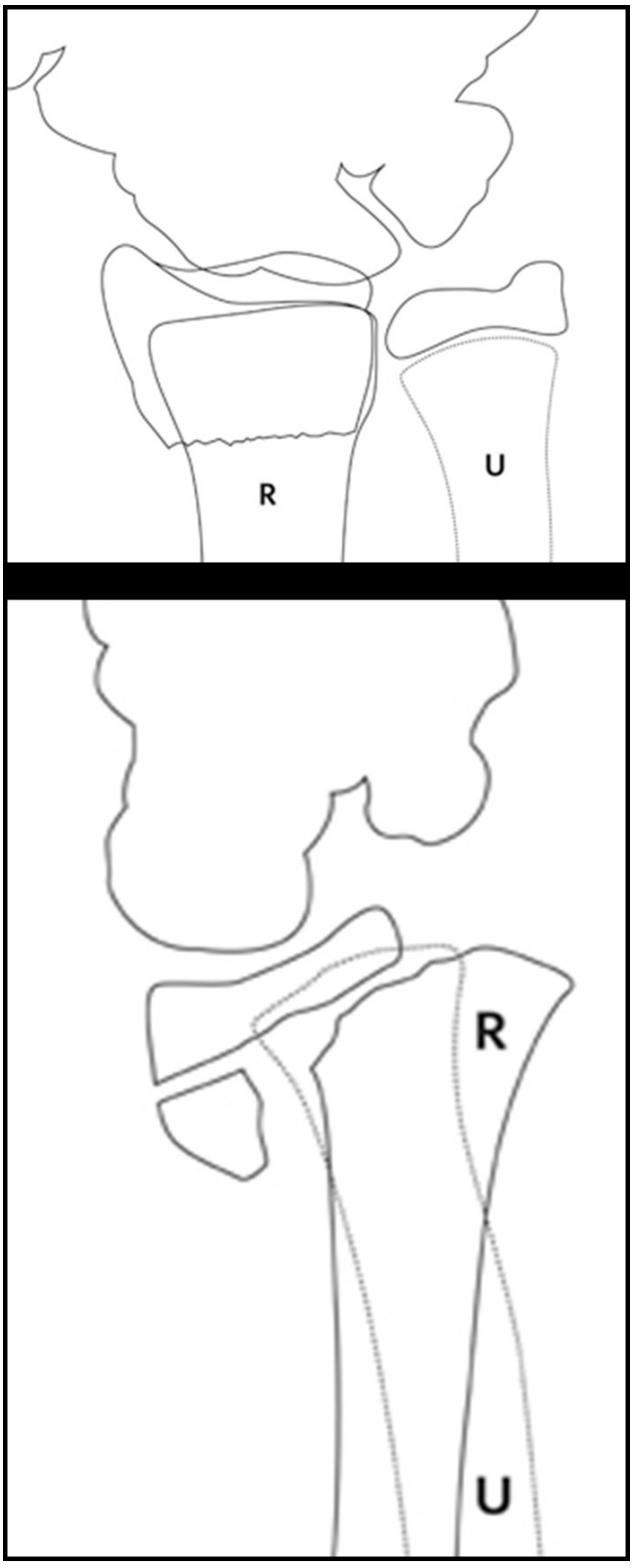
Controversies in management:

Rest, support and analgesia are the mainstay of treatment for buckle fractures. Buckle fractures often heal well without complication. There is however much variance in how these are treated in different departments. Removable splints are widely used for up to 3 weeks in children old enough to keep them on (hard casts may be required in younger children). There is however uncertainty as to whether immobilisation is actually really needed or if early mobilisation to reduce stiffness is preferable. **The FOrearm fracture Recovery in Children Evaluation (FORCE)** Study is currently in its final stages. It will evaluate outcomes (pain, functional improvement and complications) between encouragement of use of the wrist, an optional bandage, and a point of contact for any ongoing concern versus hard splints use and local hospital outpatient fracture follow up (https://force.octru.ox.ac.uk/).

Buckle fractures often heal well with minimal complication. There is however a risk of refracture General advice includes avoidance of sports for three to six weeks and contact sports for 6 weeks post injury. You should also refer to your local guideline on the management of buckle fractures.

CASE SCENARIO 2

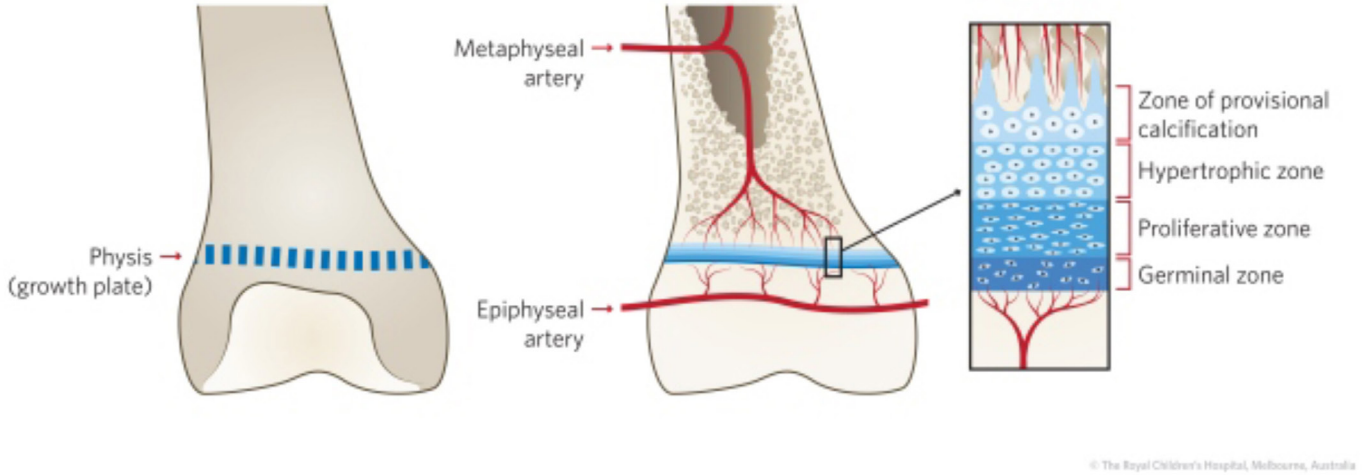
A 12 year old girl is brought to ED with her mother. She was jumping on her trampoline but fell out. She had immediate pain and has not been able to use her left hand since. Her mum gave her some paracetamol and ibuprofen prior to arrival. An X-Ray was then done and is as follows:



What does this fracture show?
How would you further classify this type of fracture?
How would you manage these fractures?
Mum asks you if she should let her 6 year old daughter use the trampoline. What is your advice?

Discussion:
(from Royal Children's Hospital Melbourne)

In contrast to adult bones, children's bones are still developing. They have cartilaginous discs which separate the epiphysis from the metaphysis of long bone. This area is called the growth plate (physis). Physeal injuries are very common in children and can account for up to 15-30% of all bony injuries. Physeal injuries occur most commonly in the pre-adolescent growth spurt age.



From The Royal Children's Hospital Melbourne

Physeal fractures are classified by the Salter-Harris classification.
A Type II fracture is the most common type. Distal radial physeal fractures are uncommon in children younger than five years. The most common mechanism of injury is a fall on an outstretched hand. Extension of the wrist at the time of injury causes the distal fragment to be displaced dorsally (posteriorly). Commonly this also causes an associated ulna fracture (greenstick, physeal or styloid).
Always give appropriate Analgesia prior to assessment and X-ray.
Ensure both AP and lateral views are undertaken of the wrist AND distal forearm.

SALTER-HARRIS CLASSIFICATION

Adapted from the emergency department guidelines for Distal radial physeal fractures at the Royal Children's Hospital Melbourne

Classification	Classification	Pathology	X-ray findings
Straight across Type 1	A fracture occurs through the growth plate. There is complete separation of the epiphysis from the metaphysis without any bone fracture. These fractures can be difficult to see on x-ray and are primarily diagnosed on clinical findings - namely localised tenderness. There is rarely any further growth disturbance		 

Above

Type 2

Fracture occurs through the growth plate and metaphysis.

It is above the growth plate (proximal part of the distal radial head).

It is also rarely associated with growth disturbance

Lower

Type 3

Fracture occurs through the growth plate and epiphysis.

It is below the growth plate (most distal part of the radial head).

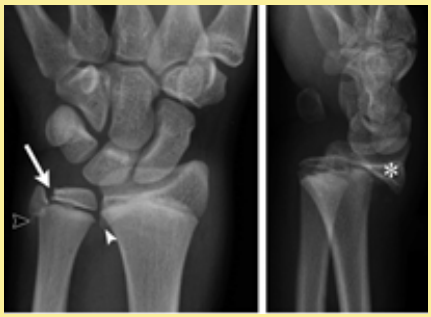
It has a medium risk of growth disturbance

Through

Type 4

Fracture occurs through the growth plate, metaphysis AND epiphysis.

It has a high risk of growth disturbance



ERasure

Type 5

Crush injury of the growth plate erases any space for further bone growth.

It is not often visible in an acute injury but is usually recognised later because of growth arrest and progressive deformity.

Management & Referrals: (from Royal children's hospital melbourne & first10em) Type II is the commonest type of Salter-harris fracture and accounts for around 75% of physeal fractures. Reduction is required for distal radial physeal fractures that are angulated >20 degrees. Salter-Harris type I and II injuries rarely cause growth problems. The risk of growth arrest is higher in type III-V injuries.
The risk of physeal arrest is rare in young children but the risk is higher if the child is near the end of growth. It is therefore increasingly important to correct any angulation in adolescents especially where there is less than two years of growth remaining.

For type I and II injuries, closed reduction may be required. A fracture clinic review is required within five days with x-ray. RICE advice and instruction to monitor for any swelling should be given.
This as there is a risk of early compartment syndrome due to restriction by the cast.

Urgent orthopaedic review is required when there is an open fracture, a fracture

is associated with neurovascular compromise (most notably in the median nerve distribution), any Salter-Harris type III and IV (lower or through) fracture is seen. Additionally referral should be made when there is an associated fracture in the same upper limb or if there is any difficulty achieving acceptable reduction.
This should only be attempted with adequate supervision or clinical competence. However, for children presenting with distal radial physeal fractures after 5 days since the injury closed reduction should not be attempted and specialist input from the appropriate orthopaedic team must be arranged.
After any reduction or immobilsation of a fracture, repeat x-rays should be undertaken.

Safety Advice: (from RSPA and gppaedstips)
Trampolines are thoroughly enjoyed by children of all ages. Especially in current times many families have invested in trampolines for their gardens.
However injuries sustained whilst playing on trampolines contribute greatly to injury presentations in the children's emergency departments.
There are however steps that can be taken to try and minimise the chances of injuries occurring. The first advice would be that children should take turns to bounce. 60% of injuries have been found to have occured when more than one person is on the trampoline. Often it is the smallest (lightest) person who is (five times) more likely to be injured. If they are not alone they should be of similar age and size.

The Royal Society for the prevention of Accidents suggests that Trampolining is only suitable for children over six years of age when they can are sufficiently developed to control their bouncing. Adult supervision cannot prevent all injuries but may prevent children engaging in dangerous practices. Additionally having some formal training such as joining a local trampolining club to learn new skills will help children who are keen to learn how to attempt advanced trampolining skills and tricks safely.

ADVANCED CASE SCENARIO 1

A 14 year old boy was skateboarding and dismounted. Landing on his outstretched hand. He had significant pain in his wrist around the distal radius but following analgesia in the emergency department an X-ray was undertaken. No fracture was identified and he was reassured that he had sustained a soft tissue injury. He was discharged with RICE advice.

Questions:

What are thoughts surrounding soft tissue injuries in children and how should they be defined and managed ?

Are there any other pathologies you should consider when X-rays appear normal?

Four weeks later he is still in pain - The original X-ray is re-reviewed - scaphoid fracture is seen.

From Radiopedia

Discussion:

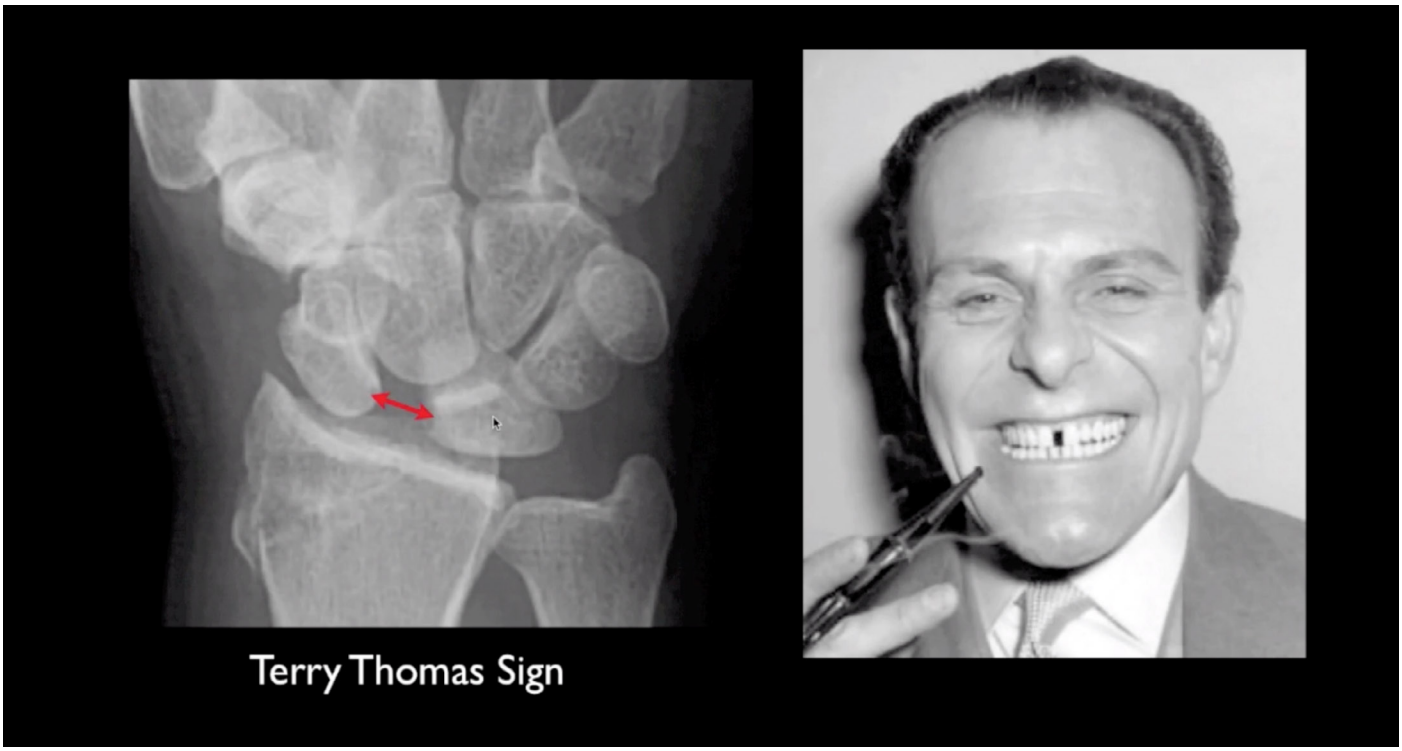
Many times when there are no overt fractures on an X-ray we conclude that the patient has a "soft tissue" injury or sprain. A scaphoid series (not wrist views) should be requested when there is 'snuffbox tenderness'.
Even when bony pathology cannot be identified on X-rays it is important to consider that the muscles, ligaments and tendons of the wrist that if damaged can have a significant impact on a child's ability to undertake daily activities especially if the injury is to their dominant hand. As with any injury presenting to the emergency department pain should always be assessed and managed. Fractures through the waist (middle) of the scaphoid jeopardise the blood supply of the proximal fragment. If the patient is managed incorrectly then non-union, delayed union or avascular necrosis of the proximal fragment may result.

Elvey et al. undertook a single centre study which undertook MRI of patients who had presented in the two weeks prior with wrist injuries.
X-rays undertaken at the time had however not identified any fracture.
Although a small study of 57 cases; following MRI over 75% of cases had a positive finding on MRI, There were no cases at all of isolated soft-tissue injury. Occult fractures and bony contusions (focal oedema and haemorrhages which occur following microfracture) accounted collectively for almost 70% of the pathologies seen on MRIs in these children. Following MRI almost ⅓ of cases required additional further management changes.
This study raised questions about the best modality and timing of imaging in children presenting with wrist pain following an injury. Fracture lines may not be apparent in children on initial X-rays and may only become visible weeks later following callus formation.
Alternative imaging options considered have included ultrasound, CT and nuclear medicine scintigraphy. The cost-effectiveness, time constraints, risk-benefit analysis of radiation exposure and operator feasibility in the emergency setting is however difficult to justify. Additionally, some of these modalities have excellent sensitivity, but low specificity and operator-dependency.

It is important to remember that even when no injury is seen on X-ray wrist injuries often classified as sprains can have clinical sequelae. At 5–6 weeks in the Elvey et al. study children who had had occult cortical fractures typically had resolution of their pain. However, those who had bone contusions typically had continued pain on palpation.

Carpal instability injuries: (From LITFL)
Some non-fracture pathologies are visible on x-ray but sometimes missed. Scapholunate injuries include scapholunate dissociation which is caused by damage of the ligament between the scaphoid and lunate bones. It is very uncommon in children but may occur in adolescent age groups. These will often be very painful.

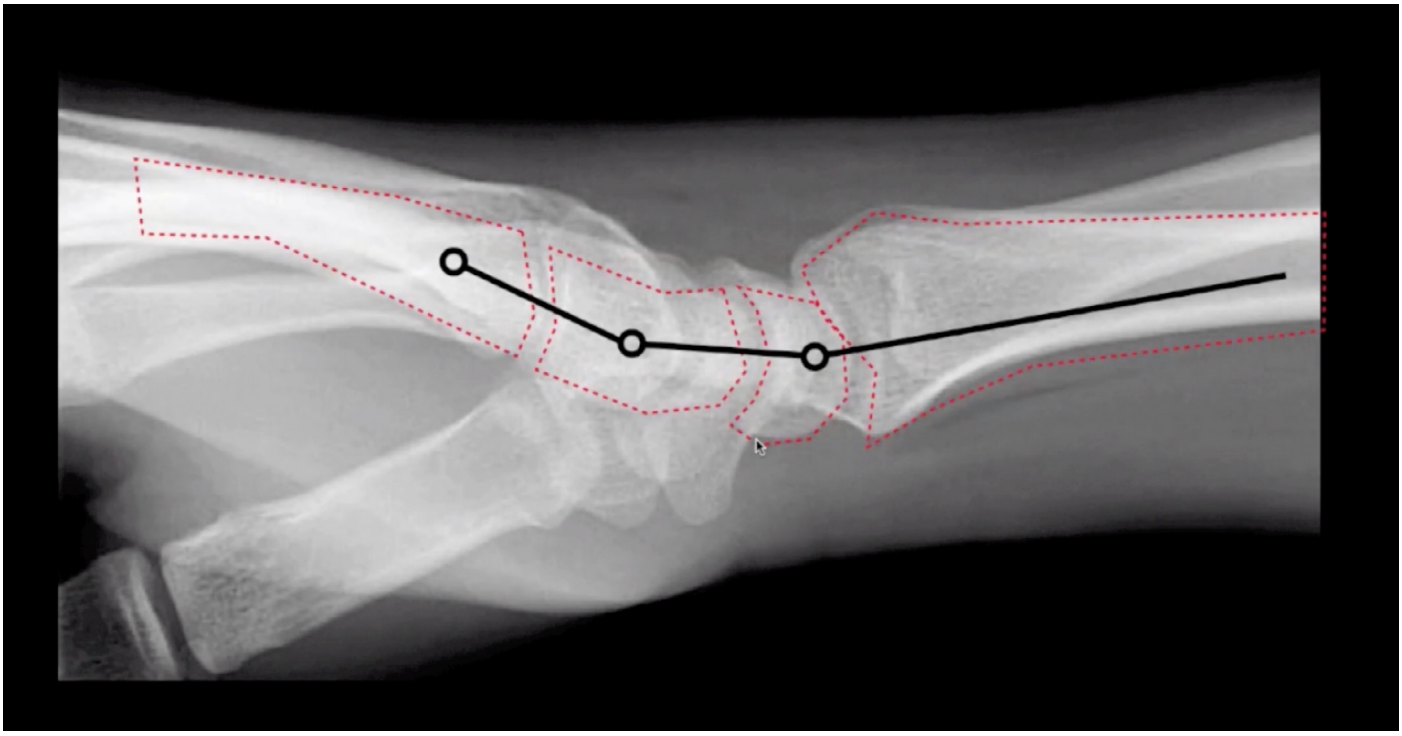
The carpal bones on a normal plain X-ray are evenly spaced. Where there is a scapholunate dissociation there will be a large gap (>3mm) between scaphoid and lunate bones. This is also known as the Terry Thomas sign (named after a famed comedian who had a large gap between his two front teeth).

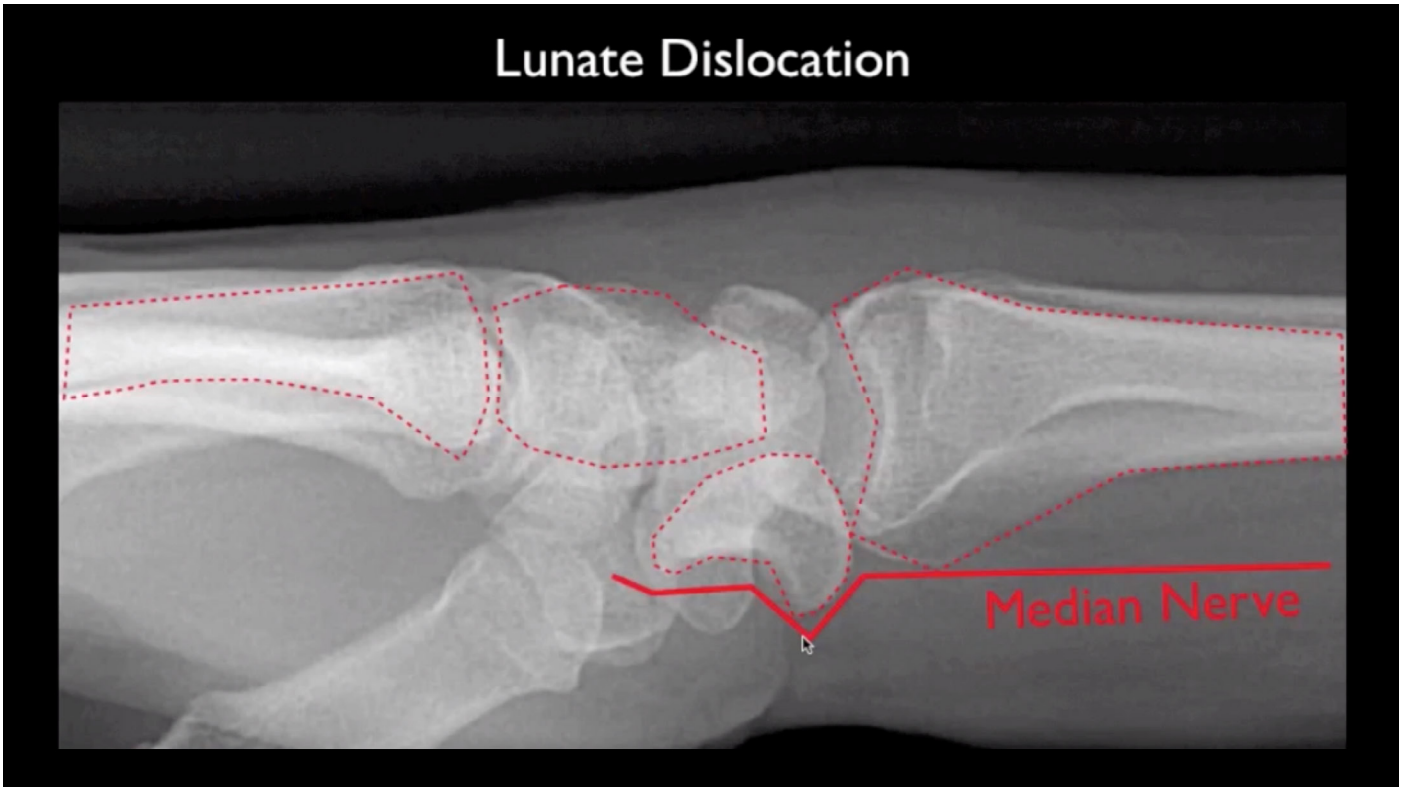


Other ligament bands may tear between carpal bones causing carpal instability. These can lead to the following 4 stages of pathology; perilunate dislocation, perilunate dislocation with triquetrum dislocation and lunate dislocation. Injuries of these ligaments can cause long term damage including chronic pain and arthritis. PA views with help with Terry Thomas sign. Lateral views are most useful in helping to identify any misalignment and potential dislocation of the other carpal bones (mostly lunate and perilunate dislocations).

A lunate dislocation can be a devastating injury. There is loss of articulation between the lunate and radial head and lunate and capitate. This injury would

be excruciatingly painful. However most importantly there is also a high risk of median nerve damage as the dislocated lunate bone causes pressure on the median nerve which would usually run freely through the carpal tunnel. This can cause an acute carpal tunnel syndrome. Due to pain it should be hard to miss but needs urgent management.





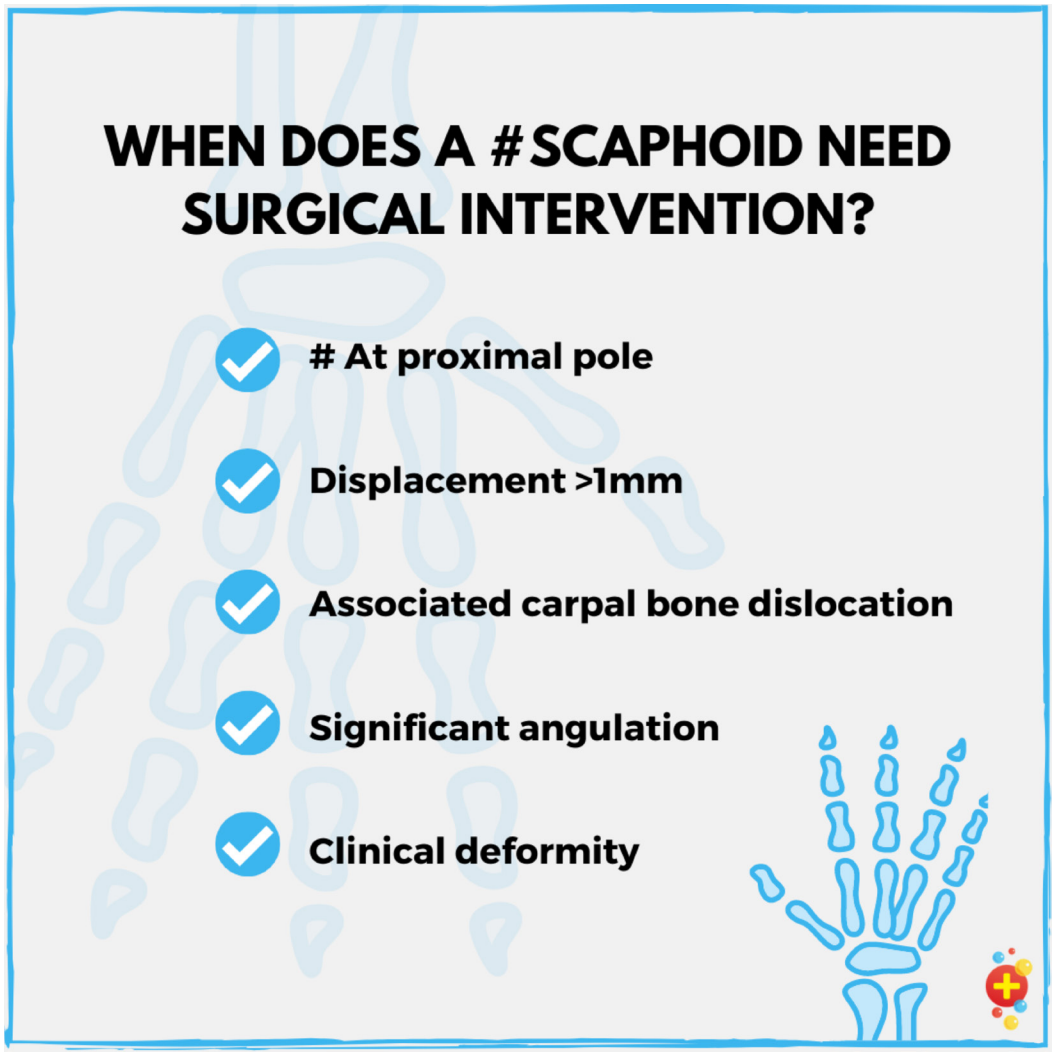
Images from LITFL presentation- originals from radiopedia: normal alignment of radius and carpal bones (lunate, hamate and metacarpal bones highlighted) and dislocation of lunate with risk of median nerve compression highlighted

Scaphoid fractures (from LITFL and pedemmorsels)
A scaphoid fracture is uncommon in 4-11 year olds as ossification centres appear to be protective against scaphoid fractures. However, the scaphoid bone is the most easily broken carpal bone and is easily broken in the adolescent age group. The fracture occurs via transference of force onto the scaphoid following FOOSH where the wrist deviates radially during impact. It is a more common injury following extreme sports. Where a scaphoid fracture has occured X-ray a lucency will be apparent running through the scaphoid bone.

The scaphoid is positioned beneath the anatomical snuff box.
On examination it is important to check for pain here.Tenderness of the Scaphoid Tubercle (on the volar aspect), pain with radial deviation, pain on axial loading to the thumb and pain with active wrist range of motion may also point to this diagnosis.
It is important not to miss scaphoid fractures. The reason being is that the scaphoid bone is at high risk of non union and avascular necrosis if fractured and left untreated.

Although simplistic to attribute all blood supply to the scaphoid from the radial artery a fracture especially at the distal end of the scaphoid has been associated with compromise in the blood supply to the rest of the scaphoid. Complications of missed scaphoid fractures can be bone growth arrest and chronic pain.

Controversy is however present as to whether surgical treatment is preferential to conservative management. A recent systematic review of randomised controlled trials surrounding this question in 2018 by Al-Ajmi et al suggested that surgical management of minimally or non-displaced scaphoid fractures resulted in better functional outcomes than conservative management. However, the findings were not significantly strong enough to make concrete conclusions.
It is however generally accepted that scaphoid fractures which are unstable due to being at the proximal pole, having displacement > 1 mm, those with associated carpal bone dislocation and those with significant angulation or clinical deformity will need referral to orthopaedics and surgical intervention.



Scaphoid fractures in children are generally believed to heal well.
Casting of non-displaced, acute fractures leads to high rates of scaphoid union.
Where there is clinical suspicion of a scaphoid fracture but uncertain or negative X-Ray findings generally early immobilisation is initiated by application of a thumb spica splint or cast with follow-up imaging 2 weeks later.
Casting may however need to be applied for 3 months or more.
The videos on thumb splints and hard cast spica's from Don't forget the bubbles and orthofilms can be used for demonstration and to assist in practical sessions. (Please see the simulation section for full details).

Conversely porter et al suggested that symptomatic treatment is sufficient with those who have normal X-rays. This paper advocated using a removable splint with follow-up only arranged if symptoms do not improve. This was however a single centre study and advocated for a larger multicentered prospective clinical trial on this matter.
If in doubt and there is high clinical suspicion of a scaphoid fracture it is not unreasonable to consider application of a thumb spica cast with a plan to bring back the child for review in 2 weeks.

ADVANCED CASE SCENARIO 2

A 13 year old girl is brought to ED following a fall from a tree she has significant pain, swelling and deformity of the distal shaft of the radius.
Analgesia is given and she is taken to X-ray... Galeazzi fracture-dislocation

From Radiopedia

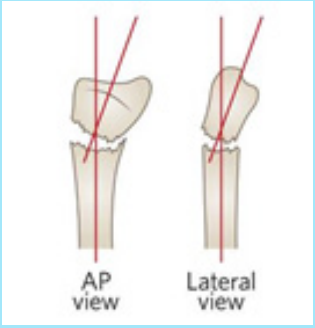
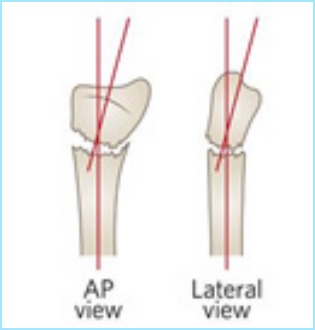
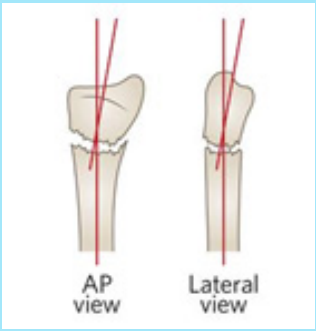
Questions:
What type of fracture has occurred?
How would you manage this fracture?

Discussion:(from the Royal Children's Hospital Melbourne)
Distal radius fractures can be classified according to:

- Presence of displacement (whether they are displaced or nondisplaced)
- Bone involvement (an isolated radius fracture only or if both radius and ulna are involved)
- Fracture type:
- Buckle and Greenstick fractures: - see previous sections for further information
- Complete fractures: These fractures extend through both cortices of the radius. Most complete metaphyseal fractures of the distal radius also involve the ulna with either an associated complete fracture, greenstick fracture, or bowing deformity.

With complete fractures generally if there is clear deformity on examination, reduction is likely to be indicated. Acceptable angulations of the distal radius fracture are dependent on the age of the child. Coronal plane angulation (seen on AP view) has a poorer prognosis

Adapted from Table 1: Acceptable angulations for distal radius metaphyseal fractures. From Distal radius and or ulna metaphyseal fractures - Emergency Department guideline at the Royal Children's Hospital Melbourne

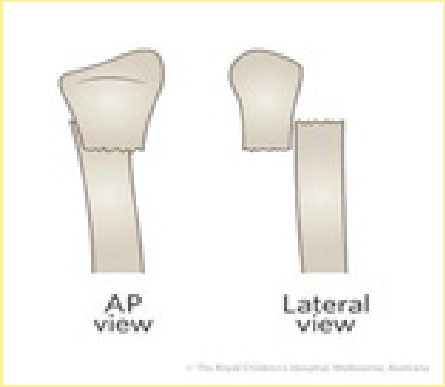
Age	Acceptable angulation	Complete fracture maximal acceptable angulations
0-5 years	< 20 degrees	
5-10 years	< 15 degrees	
10-15 years As girls mature earlier, acceptable angulations may be less	< 10 degrees	

Bayonet Apposition:

This refers to a complete fracture where the two bone fragments are aligned side-by-side rather than end-to-end.
If the degree of angulation is acceptable for age as described above the following applies

6-10 years: may be able to leave in place (check with orthopaedic teams first)

11 years +: these children need to have apposition at the fracture site



Where no reduction is required for a complete distal radius fracture a below elbow plaster of paris back slab should be applied, fracture clinic follow-up arranged within a week and a cast may be required for up to 6 weeks.

Those needing closed reduction may be able to be undertaken in the emergency department using local anesthetic or procedural sedation.
However this should only be attempted with adequate supervision or clinical competence. These children will also need a hard cast applied but with extra moulding in the opposite direction to any angulation.

Following any reduction of a fracture X-rays should be taken.
Angles of the fracture should be within the same parameters for acceptable angulation. An orthopaedics referral should be made for any child presenting with an open fracture, signs of neurovascular compromise or if there is over 10 degrees of angulation of the fractured segments. In children where there has been difficulty in reduction (be that due to ED team inexperience or difficulty in procedure) and those with an associated fracture in the same or opposite limb an orthopaedics referral must also be made.

Galeazzi Fracture-dislocation
A Galeazzi fracture-dislocation is one such instance where an urgent orthopaedic team referral should be made. Galeazzi fracture-dislocations are often missed and may be difficult to recognise. It is however really important that a Galeazzi fracture is identified as it must be repositioned prior to casting.
If there is an isolated radius fracture, always examine the distal radioulnar joint (also known as DRUJ) on x-ray.

A Galeazzi fracture-dislocation is a fracture of the distal third of the shaft of the radius with a disruption to the distal radioulnar joint. This by ulnar displacement which can occur in the volar or dorsal direction. True Galeazzi fractures are very uncommon in children but can occur after a FOOSH with forearm rotation.
However, the Galeazzi equivalent is more common and is when there is a distal radius fracture with an associated distal ulna physeal fracture. There is however no disruption of the Distal radioulnar joint.

Most Galeazzi-equivalent fractures can often be managed with closed reduction in children. However, in some adolescents especially where there is a true Galeazzi fracture-dislocation then open or percutaneous fixation to stabilise the distal radioulnar joint after reduction may be required. Children with Galeazzi-type fractures should be placed in an above elbow cast following any manipulation.

The majority of these fractures will do well.
However outcomes can be poor if there is a delay in diagnosis and or the fracture of radius has been immobilised without correct alignment of the ulnar dislocation or inadequate support such as a below-elbow cast. Nerve injury is uncommon but there have been some case reports of ulnar nerve injury.
Neurovascular status must therefore be carefully examined and assessed.
This however does usually resolve with observation.

SIMULATION (30 MINUTES)

Depending on the experience of the learners in your group please choose and adapt the following practical elements

1. Role play hand examinations in pairs. Identifying techniques to follow and signs to exclude. Can be done in OSCE format.

2. Removable casts - demonstration by facilitator of rigid casts and soft bandages available in your department alternatively videos from below could be used prior to a learner practice session:

- Thumb splint application: https://www.youtube.com/watch?v=oOOFMvcPC8c

3. Plaster of Paris hard cast application- demonstration by facilitators or alternatively videos from below be used prior to a learner practice session:

- Below Elbow Backslab: https://www.youtube.com/watch?v=8YzhHlle93k
- Above Elbow Backslab: https://www.youtube.com/watch?v=e1TL7u2xjjU
- Thumb spica POP cast: https://www.youtube.com/watch?v=8YzhHlle93k

QUIZ (5 MINUTES)

Question 1.

Which of the following is false?

A: A buckle fracture occurs due to longitudinal force along long bone

B: Greenstick fractures do not have any breach in the bone cortex

C: A buckle fracture will have an intact cortex

D: A torus fracture is always circumferential

Answer:

Greenstick, torus and buckle fractures occur due to longitudinal forces exerted along a long bone. Whilst generally used interchangeably with a buckle fracture; a torus fracture actually involves both sides of the bone whereas a buckle fracture generally involves on side. What differentiates a torus or buckle fracture from a greenstick fracture is that there is a breech in the cortex of the bone in greenstick fractures. The cortex itself remains intact in buckle and torus fractures.

Question 2.

Which nerve is most likely to be affected by a lunate dislocation?

A: Radial nerve

B: Ulnar nerve

C: Median nerve

D: All of the above

Answer:

The ulnar, median, and radial nerves innervate the hand. The course of these nerves all traverse the wrist. They therefore have the potential to be damaged following wrist injuries. It is important to assess neurovascular status in wrist and hand injuries. However, the median nerve runs through the middle of the palmar side of the hand through the carpal tunnel. This can cause an acute carpal tunnel syndrome. Radial nerve damage may be associated with supracondylar and humeral shaft fractures, whilst Ulnar nerve damage although rare may be seen supracondylar and galeazzi-type fractures.

Question 3.

Which statement is true?

A: A Galeazzi fracture-dislocation is one in which the radius is fractured and also dislocated from the radioulnar joint.

B: Scaphoid fractures always require surgical intervention

C: The ulnar nerve may be affected following a Galeazzi fracture-dislocation

D: Bayonet apposition is when the two portions of a fracture are aligned end to end with some angulation

Answer:

A Galeazzi fracture-dislocation is where the distal third of the shaft of the radius is fractured. There is also a disruption to the distal radioulnar joint.
The ulna (not radius) bone is displaced. This can occur in the volar or dorsal direction.
The Galeazzi equivalent fracture-dislocation is more common and is when there is a distal radius fracture with an associated distal ulna physeal fracture.
The ulnar nerve may be affected in a Galeazzi fracture dislocation as it is entrapped by the ulna displacement. Bayonet apposition is a terminology used to describe fractured bone portions which are aligned side by side and not end to end.
Depending on the patient's age and degree of angulation it may be acceptable to leave a fracture in the Bayonet position to heal. Scaphoid fractures may be managed conservatively, however unstable fractures (due to being at the proximal pole, those having displacement >1mm, those with associated carpal bone dislocation and those with significant angulation or clinical deformity will need referral to orthopaedics and are more likely to need surgical intervention.

Finish – Infographic of take home tips (5 minutes)

1. Varius wrist fractures are unique to the paediatric population including buckle, Torus and greenstick fractures. Clinical examination determines the appropriate imaging (a wrist or a scaphoid series).

2. Start examinations with the unaffected side. This not only acts as a comparison but also to minimise fear and establish rapport.

3. Rock paper scissors, ok sign and turn the key always helps its fun and quickly assesses function and neurovasculature

4. Plain radiographs miss up to 25% of scaphoid fractures across all age groups. If the scaphoid views appear normal it is mandatory that the patient is followed up.

5. Urgently refer to ortho when:

- open fracture
- signs of neurovascular compromise
- over 10 degrees of angulation of the fractured segments
- Any difficulty in reduction
- Associated fractures in the same or opposite limb

REFERENCES

1. https://litfl.com/bscc/clinical-anatomy/hand-anatomy/ video series on hand and wrist injuries

2. https://teachmeanatomy.info/upper-limb/joints/wrist-joint/

3. https://teachmeanatomy.info/upper-limb/vessels/arteries/

4. https://www.nysora.com/techniques/upper-extremity/wrist/wrist-block/

5. https://geekymedics.com/hand-examination/

6. https://radiopaedia.org/cases/buckle-fracture

7. Slaar A, Walenkamp MM, Bentohami A, et al. A clinical decision rule for the use of plain radiography in children after acute wrist injury: development and external validation of the Amsterdam Pediatric Wrist Rules. Pediatr Radiol. 2016;46(1):50-60. doi:10.1007/s00247-015-3436-3

8. Davidson AW. Rock-paper-scissors. Injury. 2003;34(1):61-63. doi:10.1016/s0020-1383(02)00102-x

9. https://www.peminfographics.com/infographics/rock-paper-scissors-ok

10. https://force.octru.ox.ac.uk/

11. https://www.rch.org.au/fracture-education/growth_plate_injuries/Physeal_growth_plate_injuries/

12. https://www.rch.org.au/clinicalguide/guideline_index/fractures/Distal_radius_and_or_ulna_metaphyseal_fractures_Emergency_Department_setting/

13. https://first10em.com/ebm-lecture-handout-6-salter-harris-1-injuries/

14. https://www.researchgate.net/figure/Salter-Harris-type-III-fracture-in-a-15-year-old-male-patient-Frontal-radiograph-of-the_fig11_260716406

15. Elvey M, Patel S, Avisar E, White WJ, Sorene E. Defining occult injuries of the distal forearm and wrist in children. J Child Orthop. 2016;10(3):227-233. doi:10.1007/s11832-016-0735-7

16. http://gppaedstips.blogspot.com/search/label/Injury
17. https://www.rospa.com/leisure-safety/Advice/Trampoline

18. Little, Jason & Klionsky, Nina & Chaturvedi, Abhishek & Soral, Aditya & Chaturvedi, Apeksha. (2014). Pediatric Distal Forearm and Wrist Injury: An Imaging Review. Radiographics : a review publication of the Radiological Society of North America, Inc. 34. 472-90. 10.1148/rg.342135073.

19. https://litfl.com/bscc/clinical-anatomy/hand-and-wrist-injuries/

20. https://pedemmorsels.com/scaphoid-fracture/

21. Shaterian A1, Santos PJF1, Lee CJ1, Evans GRD1, Leis A1. Management Modalities and Outcomes Following Acute Scaphoid Fractures in Children: A Quantitative Review and Meta-Analysis. Hand (N Y). 2019 May;14(3):305-310. PMID: 29078712.

22. Porter J, Porter R, Chan KJ. Scaphoid Fractures in Children: Do We Need to X-ray? A Retrospective Chart Review of 144 Wrists. Pediatr Emerg Care. 2018 Mar 12. PMID: 29538268.

23. https://www.orthobullets.com/hand/6034/scaphoid-fracture

24. Al-Ajmi TA, Al-Faryan KH, Al-Kanaan NF, et al. A Systematic Review and Meta-analysis of Randomized Controlled Trials Comparing Surgical versus Conservative Treatments for Acute Undisplaced or Minimally-Displaced Scaphoid Fractures. Clin Orthop Surg. 2018;10(1):64-73. doi:10.4055/cios.2018.10.1.64

25. https://www.rch.org.au/clinicalguide/guideline_index/fractures/Galeazzi_fracturedislocations_Emergency_Department_setting/

26. https://www.paediatricpearls.co.uk/wp-content/uploads/minor-injuries-series-wrist.pdf

27. Clinical Anatomy –hand, wrist (palmar aspect/flexors) Armando Husudungan https://www.youtube.com/watch?v=3aIHxXqKzcU

28. http://www.emdocs.net/hand-expedited-examination-key-points-regarding-ed-diagnoses/

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