Fig. 5. Unifacet dislocation of C5/6. All lines disrupted with forward shift (listhesis) and loss of articular facet contact.

Fig. 6. AP X-ray indicating normally aligned spinous processes.

visualised and should there be a sideways shift, a unifacet dislocation with spine rotation suspected.

The open mouth view is to assess the C1 and C2 vertebrae (Figs 7 and 8). Should there be splaying of the C1 articular masses, a C1 ring fracture is suspected. Should the sum of the overhang bilaterally exceed 7 mm, the transverse ligament is disrupted and the fracture unstable, requiring fixation. The odontoid (dens) can also be assessed on this view of fracture.

Fig. 7. Open mouth view with fracture at base of dens.

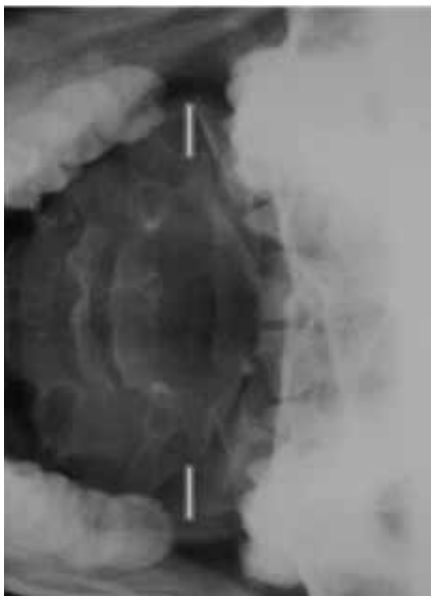

Fig. 8. Open mouth with C1 lateral mass overlap indicating transverse ligament rupture.

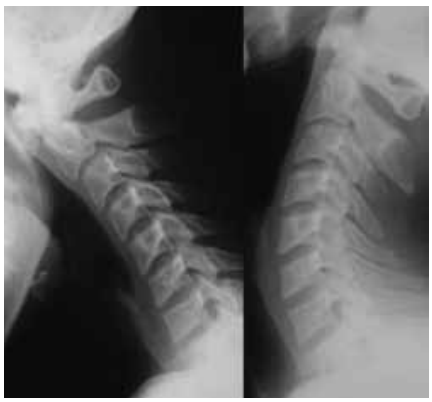

Fig. 9. Normal flexion-extension views demonstrating good range of motion.

Should the initial X-rays be normal but there is clinical concern, dynamic views can be useful (Fig. 9). In the fully awake, cooperative patient flexion-extension views can be done. The patient should perform the motion and not be forced in any way. This may be unsuccessful if painful and the patient has muscle spasm and X-rays need to be assessed for adequate motion. These views may unmask instability not readily visible on the static views.

Computer tomography (CT) is useful in delineating bony structures and pathology. Overseas many protocols are escalating to CT as the primary investigation, but this is probably not appropriate in the South African setting with problems of access and cost. CT is indicated should there be poor visualisation on X-ray such as at the cervico-thoracic junction or a high index of suspicion of an atlanto-axial injury.

Magnetic resonance imaging (MRI) is excellent in assessing the soft tissue, including the ligaments and spinal cord. This is generally reserved for assessment of concomitant spinal cord injury or assessment of occult ligamentous injury.

In summary

- Missed cervical injury is catastrophic.
- At least three X-ray views required – AP, lateral, open mouth.
- Assess lateral with 5 lines.
- If lateral does not show C0-T1, then inadequate.
- Assess AP spinous process alignment.
- Assess open mouth for C1-2 overlap.
- CT when X-rays are inadequate.
- MRI is needed to assess the spinal cord and ligaments.

References available at www.cmej.org.za

Radiological pitfalls in hand injuries

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Fractures around the hand and wrist are common, resulting from work, sport and high-speed collisions. It is vitally important to recognise and treat these injuries promptly to optimise outcomes. Most of the injuries are detected by routine screening radiographs. There are, however, five relatively common injuries around the hand that are consistently missed by radiology staff and clinicians alike.

Figs 1a and b. A relatively benign-looking condyle fracture on the AP view (a) is noted to be substantially displaced on the true lateral view (b).

Articular fractures in the fingers

Fractures extending into the joints occur commonly in the hand. These can be the result of many different injuries. These fractures are usually associated with an extreme angular force such as hyperextension, flexion or radial or ulnar deviation. It is critical to assess the intra-articular displacement, as this will affect the long-term outcome. To this end, it is imperative that the radiographs be taken as true anteroposterior (AP) and lateral views. If there is any doubt about the integrity of the joint, the clinician should not hesitate to send the patient back for further radiographs until a true lateral view has been achieved. Examples of these intra-articular fractures would include the mallet fracture injuries of the terminal phalanx, as well as various condylar fractures of the proximal middle and distal phalanges. A true lateral radiograph of the proximal interphalangeal (PIP) joint will confirm a concentric reduction after a fracture dislocation of this joint (Figs 1a and 1b).

Fig. 2. In this serires of radiographs documenting a dorsal dislocation of the index finger MP joint, one can see how subtle the radiological signs are. Joint widening on the AP view is the give-away. The lateral radiograph is difficult to interpret due to 'stacking' of the fingers.

MP joint dislocations

A true dorsal dislocation of the metacarpophalangeal joint (MPJ) can be a surprisingly easy finding to miss on radiographs. On the AP view, there is very little to see except for a slight widening of the joint. It is only on the lateral view that the astute clinician will see the dorsally displaced proximal phalanx on the metacarpal head. The fact that the lateral radiograph shows four overlapping MP joints explains why this injury is commonly missed. Clinically, the patient has a well-aligned finger with the MP joint in hyperextension. Patients are able to easily flex and extend the PIP and distal interphalangeal (DIP) joints. MPJ flexion or movement is both painful and impossible (Fig. 2).

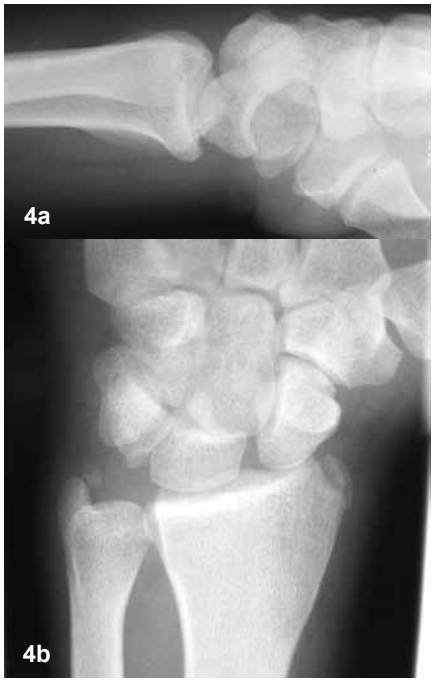
Carpometacarpal (CMC) joint dislocation

This uncommon injury is often missed and is often associated with concomitant life-threatening injuries. The hand is often overlooked and it is only once the patient's condition stabilises that the swollen hand is reassessed. Due to the variable three-dimensional anatomy of the CMC joints, this injury is commonly missed on the AP view. Only a true lateral view will show the dorsal displacement of the metacarpals relative to the carpal bones. This injury needs to be specifically looked for in the multi-trauma patient with an extremely swollen hand where no obvious radiological cause for injury can be identified (Fig. 3).

Fig. 3. Dorsal dislocation of the 4th and 5th CMC joints can be seen on this lateral radiograph.

Peri-lunate and volar lunate dislocations

It is estimated that up to 50% of these injuries are initially missed. Early treatment can include a direct repair of the torn scapholunate ligament. Any delay beyond 4 weeks makes closed reduction extremely difficult and direct repair almost impossible. These patients will then require a scapholunate reconstruction. Any patient who presents after high-energy trauma to the wrist with marked swelling should be repeatedly examined to exclude this devastating injury. The true AP view can be confusing. One needs to look for a disruption of the normal lines of the wrist on the AP view. The lateral view is normally the give-away. The distal radius articular surface creates a cup-like structure into which the lunate fits. The lunate itself creates a cup-like form to which the head of the capitate should fit. If any of these bones are not aligned, one must suspect a peri-lunate dislocation. If the lunate is sitting in a volar flexed and dislocated position, one gets an empty tea-cup sign with the cup of the lunate void of the head of the capitate (Figs 4a and 4b).



Figs 4a and b. Dorsal perilunate dislocation. Despite a relatively normal looking AP view (a), the empty lunate can be seen on the lateral view (b).

Scaphoid fractures

An established scaphoid non-union is an extremely difficult problem to deal with and is associated with high complication rates. Like many orthopaedic conditions, the correct primary management results in the best and optimal outcome. Scaphoid fractures are unfortunately commonly missed. The patient often considers the initial injury relatively trivial, and 2 or 3 days after the injury the wrist seems to be improved and the patient does not seek further attention. The second scenario is that the initial treating clinician sees the patient for radiographs. The original radiographs might fail to reveal the scaphoid fracture and the patient is discharged. The correct management will be discussed. Pointers to a suspected scaphoid fracture are extreme tenderness over the anatomical snuffbox. Tenderness in this area points to a scaphoid waist fracture. A more distal fracture of the scaphoid towards the tubercle will result in tenderness over the scaphoid tubercle. Firm thumb pressure flexion should be applied to the scaphoid tubercle of the volar aspect of the wrist and thumb base. Proximal pole fractures are difficult to diagnose clinically. A high index of suspicion should be maintained. If, after clinical suspicion of a scaphoid fracture is aroused, the radiographs are negative, the clinician has two options. The first would be to place the arm in a scaphoid plaster for 2 weeks and then X-ray again when the arm is out of plaster. This is a reasonable option and will have to be discussed with the patient regarding time off work and financial implications. A more sensitive and timeous way of confirming or denying a scaphoid fracture would be with an MRI scan. Almost immediately the MRI scan will show some evidence of bone oedema in the scaphoid and the radiologist will be able to comment on the likelihood of a fracture based on the type of MRI sequence performed (Figs 5a and 5b).

Figs 5a and b. Crack fracture of the scaphoid (a) develops into a difficult-to-treat non-union (b) if not recognised and immobilised.

Hand immobilisation and rehabilitation

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The hand is a beautifully designed sensate and extremely mobile structure, which if compromised leads to marked morbidity and disability. Therefore, all clinicians should have a clear understanding of the techniques and strategies used to minimise hand swelling.

Injury to the hand can vary widely from a clean incision to a dirty crush injury, from burns to the damage caused by infection.

All causes of tissue injury result in the predictable response of inflammation, which is characterised by pain, swelling and loss of function.

The swelling results in a large amount of exudative fluid being deposited into the interstitial tissues. It is therefore both pain and mechanical obstruction that limit movement. Inflammation heals by fibrosis, with resultant stiffness and loss of function.

The two mainstays of avoiding or limiting the amount of swelling that will affect the hand are elevation and early motion. Starting immediately after an injury, the hand should be above the level of the heart 24 hours a day. Therefore, elevation should be maintained while walking, standing, sitting and lying. Over and above elevation, early motion has been shown to be a major determinant of the amount of swelling. It has been shown that opening and closing the fist a single time is equivalent to 6 hours of elevation in terms of oedema control. Most hand injuries are extremely painful and the use of analgesics to control pain will facilitate early active motion. In addition, immediate referral to a physiotherapist will help with the early mobilisation programme.

Despite an understanding of the need for early motion, the degree of trauma and accompanying pain to the hand is sometimes severe and may restrict the ability to mobilise early. Extreme swelling and resultant fibrosis is therefore unavoidable. It is up to the treating clinician to then 'allow' the development of stiffness, but in a physiological chosen position. It is recognised that the traumatised hand will immediately adopt the 'wounded paw position' (Fig. 1). In this position, the intrinsic muscles of the hand are completely relaxed. The metacarpophalangeal (MP) joints are held in full extension, and the interphalangeal (IP) joints of the fingers are flexed. This is the exact opposite of the 'safe position' of the hand (Fig. 2). In this position, the MP joints are flexed 90°, the wrist is extended 30° and the IP joints are fully extended. The thumb may be placed in any position as long as it is away from the palm. Allowing the thumb to become stiff against the palm results in a contracted first web space, which is a difficult condition to overcome. It might take a substantial analgesic dosage and/or regional or general anaesthesia to manipulate the hand into the safe position and thereafter apply a dorsal plaster of Paris slab or thermoplastic splint to maintain this position.

Fig. 1. 'Wounded paw' hand after sepsis. Note the MP joints in extension and the proximal IP joints in flexion.