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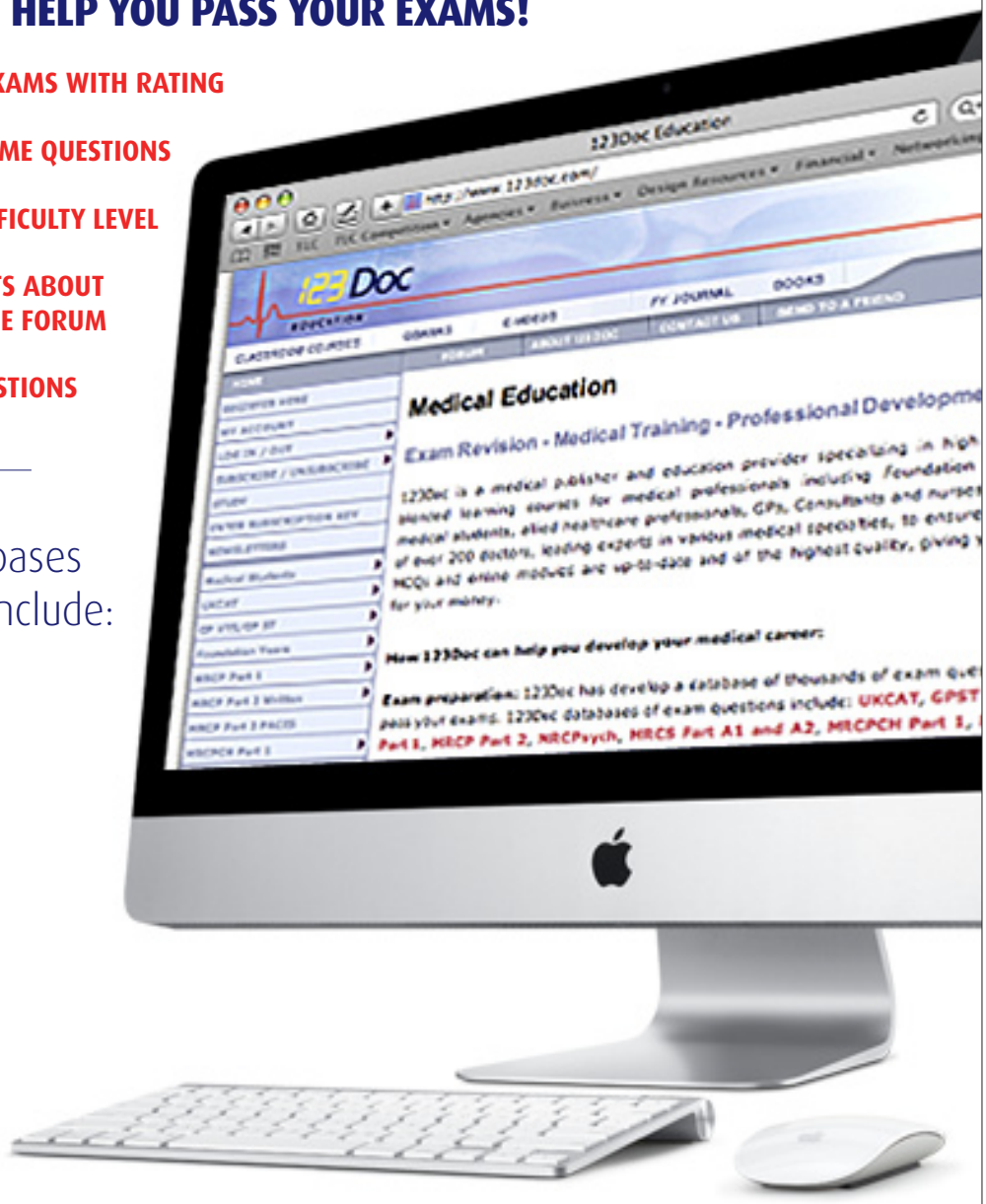

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Volume 10

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LISFRANC INJURIES - OFTEN A DIFFICULT DIAGNOSIS TO MAKE IN A&E

L Wiffen, J Kohis-Gatzoulis

Abstract

The Lisfranc joint or the tarsometatarsal joint was named after a field surgeon in Napoleon's army, Jacques Lisfranc-de-Saint-Martin.(1) Lisfranc described an amputation which he performed through the level of the tarsometatarsal joint as a consequence of gangrene following injury to the forefoot. These injuries typically affected soldiers when they fell from their horse with their foot caught in the stirrup iron. (2)

The incidence of Lisfranc injuries is 1 per 55000 per year, accounting for 0.2% of all fractures (1)(3). Men are 2 to 4 times more likely to sustain this injury. (1)(3) Lisfranc injuries require surgical stabilization as soon as the swelling reduces ideally within the first two weeks following injury.

An alarming 20% of Lisfranc injuries are initially missed or misdiagnosed. It is usually the subtle injuries or those less severe that are often missed. It is therefore important to have a high index of suspicion for these injuries in anyone presenting with pain in the midfoot or an inability to weight bear. Failure to identify this injury can have significant long-term consequences. The purpose of this article will be to highlight the important aspects of history and examination, which alert the foundation doctor in A & E to the severity of the injury.

A Case of Lisfranc Injury

History

Trauma Call: 19 year old lady brought into A&E by ambulance following an RTA, having rolled her car at 80mph. Her car flipped over the central reservation of the motorway with the car landing on its roof. She self-extricated herself and was found sat at the side of the road.

Examination

ATLS was followed from her arrival in A&E. Her spine was immobilised. Airway and breathing were intact and she was haemodynamically stable. She had some mild neck pain, bilateral shoulder pain and pain in her right foot. On examination of her foot it was neurovascularly intact but there was significant bruising and deformity, particularly to the dorsum of the foot, suggestive of fracture dislocation to the mid-foot. In addition there was an associated right hallux toenail avulsion.

Investigations

There were no injuries identified on CT Chest/Abdo/Pelvis and CT C-Spine showed no fractures of dislocation.

XR of the right foot (Figure 1) revealed a Lisfranc injury with dislocation of the medial cuneiform. There was severe disruption of the distal tarsal bones and their articulation. There was also slight malalignment of the talotibial articulation. There was dislocation of the medial cuneiform bone, which was relocated in A&E.

Figure 1: AP radiograph of the right foot showing dislocation of the medial cuneiform and disruption of the distal tarsal bones.

Management

Tetanus and a stat dose of co-amoxiclav were administered as prophylaxis for potential open fractures due to avulsion of the toenail.

Closed reduction of the dislocated medial cuneiform was performed in A&E resus under entonox and morphine. A back slab was applied and the foot was neurovascuarly intact. A post reduction CT scan was performed.

The general alignment was now normal following relocation. A bony fragment was seen related to the lateral aspect of the medial cuneiform and further bony fragments seen related to the lateral aspect of the lateral cuneiform. She was admitted to an orthopaedic ward, kept nil by mouth with strict high elevation overnight.

Due to significant swelling, this patient required strict elevation for a further 7 days before surgery could be performed.

She underwent on ORIF to her right foot. On exploration there was a large fracture blister to the dorsum of the foot. There was found to be disruption of the:

1. *Lisfranc ligament*
2. *Internal cuneiform ligament*
3. *1st TMTJ*

Stabilisation was achieved with an intercuneiform screw and a Lisfranc screw. A Synthes plate was fixed to the TMTJ (Figure 2). The nail was replaced into the fold.

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Figure 2: Intraoperative images showing surgical fixation with a screw and Synthes plate.

Post-OP

She was placed in a backslab and advised to keep her foot elevated for the majority of the time for the first two weeks. She was to be non-weight bearing in the back slab for 6 weeks and would need dalteparin injections subcutaneously once a day for VTE prophylaxis.

At 2 weeks the sutures were removed. The blister was flaccid but intact and the wound was healing well. She was switched into a non-weight bearing full plaster cast. At 6 weeks from her operation she will be placed into an air cast boot and will begin to start mobilising. In 6 months' time the metal work will be removed.

Case Discussion

1. Anatomy of the Lisfranc Ligament and Joint

The Lisfranc joint is a complex structure of bone and ligamentous elements, which form the transverse arch of the midfoot, providing structural stability to the midfoot (Figure 3). Without it the arch of the foot collapses. It is formed proximally by the medial, intermediate and lateral cuneiforms and the cuboid, and distally by the five metatarsals (1)(4). The middle cuneiform is recessed in relation to the medial and lateral cuneiforms, which allows the base of the second metatarsal to be locked into a mortise between the medial and lateral cuneiforms (1)(4-6). The base of the 2nd metatarsal forms a "key stone" to maintain stability of the arch (Figure 4). (4-7)

In addition, the plantar Lisfranc ligament runs from the base of the 2nd metatarsal to the medial cuneiform. It is a thick strong ligament and without it the arch tends to drop. (4)

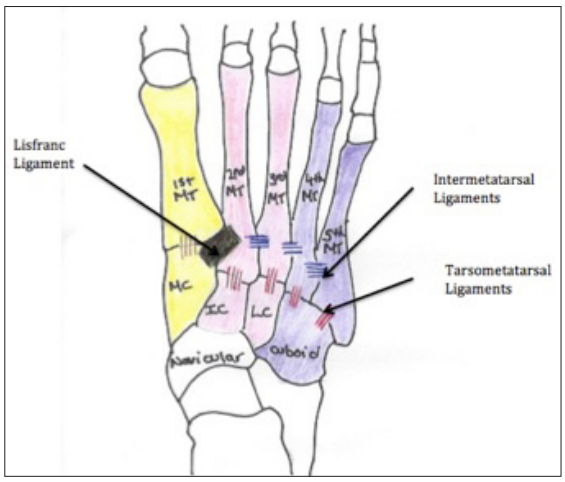

Figure 3: Anatomy of the midfoot and Lisfranc Joint.

The Lisfranc joint is can be divided into 3 columns: the medial column which is formed from the articulations of the medial cuneiform with the 1st metatarsal (Yellow), the Middle column which is formed from the articulations of the intermediate and lateral cuneiform with the 2nd and 3rd metatarsals (Pink) and the Lateral column which is formed from the articulations of the cuboid with the 4th and 5th metatarsals (Purple). (3)(4)

The Lisfranc ligament attaches the 2nd metatarsal base to the lateral aspect of the medial cuneiform. The plantar and dorsal tarsometatarsal ligaments cross all the tarsometatarsal articulations and intermetatarsal ligaments. There is no intermetatarsal ligament between the 1st and 2nd metatarsals. (4)

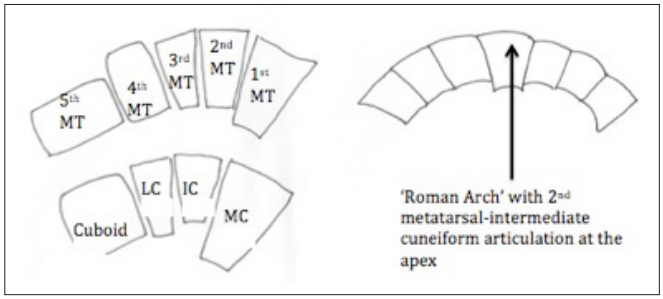

Figure 4: Midfoot Anatomy: Coronal View

The middle cuneiform is recessed in relation to the medial and lateral cuneiforms, which allows the base of the second metatarsal to be locked into a mortise between the medial and lateral cuneiforms. This can be best appreciated when the joint is viewed coronally. The cuneiforms and 1st-3rd metatarsals are trapezoid in shape and are positioned to form a 'Roman Arch' structure with the 2nd metatarsal at the apex, forming the keystone of the entire structure. (4)(5)(6)

LISFRANC INJURIES - OFTEN A DIFFICULT DIAGNOSIS TO MAKE IN A&E

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2. Diagnosis

History - Mechanism of injury

Usually from direct or indirect trauma.

Direct trauma is the most common and is usually to the dorsum of the foot. Injuries typically result from high velocity blunt force trauma or crush injuries. These can result in severe soft tissue injuries with potential compartment syndrome to the foot. Which part of the joint is affected is dependant on the direction of the force. For example, if the force comes from the plantar side this can cause dorsal displacement of the joint, disrupting ligaments leading to a fracture-dislocation.(8)

Indirect trauma usually occurs either from rotational forces applied to the forefoot or when an axial load is applied to a hyper-plantar-flexed foot, most commonly achieved when playing sport, particularly football or rugby (Figure 5). (2)

Common scenarios include:

- *Foot being trapped in dorsiflexion under the pedal in an RTA*
- *Horse riders falling from their horse while their foot is stuck in the stirrup*
- *Fall from height landing on the forefoot*
- *Twisting the plantar-flexed foot during a fall down steps or even off the edge of a pavement*

Patients will present complaining of an injury with swelling of the dorsum of the foot and pain in the midfoot. Patients will also complain of inability to weight bear normally on the foot.

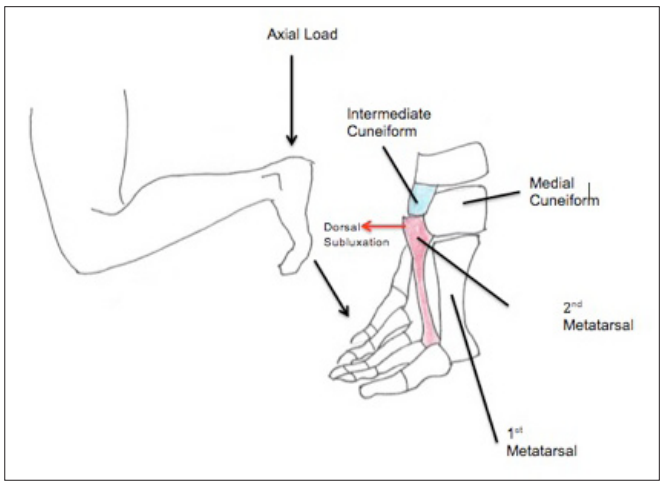

Figure 5: Axial load applied to a hyper-plantar-flexed foot causing dorsal displacement of the 2nd metatarsal.

Examination

Swelling of the midfoot and pain on weight bearing or inability to weight bear signify that the Lisfranc Joint has been injured. A full list of findings include:

- *Deformity of the foot*
- *Swelling throughout the midfoot*
- *Pain and tenderness on palpation over the midfoot*
- *Inability to weight bear*
- *Plantar Ecchymosis (bruising under the arch)*
- *Pain on passive supination, pronation, abduction, and adduction of the midfoot.*
- *Flexing the foot at the Lisfranc joint can reveal instability and dorsal subluxation of metatarsals*

Always check for compartment syndrome, the most reliable sign of which is severe pain with passive extension and flexion of the toes combined with severe swelling of the foot.

Where there has been a less severe injury and the patient has not immediately sought medical attention, they are most likely to report pain or discomfort in the midfoot which is worse when walking on even ground or if trying to stand on tiptoes and tends to limit their daily activities. On examination there is likely to be asymmetry of the foot arches. (1)(8)

Radiographs

Unfortunately it is the inability of the doctor in A & E to interpret the radiographs that lead to many Lisfranc injuries being missed. Even if the radiographs appear to be normal, if the patient has a history and examination compatible with a Lisfranc injury, a fine cut CT scan of the midfoot and referral to the on call T&O is indicated in all cases.

First-line are AP/Lateral/Oblique XRs of the foot. There are four signs to look for (Figure 6 and 7): (1-6)

1. Disruption of the line drawn from the medial aspect of the base of the 2nd metatarsal to the medial aspect of the middle cuneiform (AP view)

2. Widening of the space between the 1st and 2nd metatarsal. This should not exceed 2mm

3. Discontinuation of the line drawn between medial aspect of the base of the 4th metatarsal and medial aspect of the cuboid bone (oblique view)

4. Dorsal subluxation of the metatarsal bases on lateral XR

Other findings consistent with Lisfranc injuries:

1. Fleck Sign: small piece of bone in the 1st metatarsal space which indicates avulsion of the Lisfranc ligament.(7)(8)

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Non-weight bearing X-rays are the easiest to achieve however commonly Lisfranc injuries can be missed with these. Weight bearing XRs are more beneficial but are normally not feasible due to pain. CT has consequently become the gold standard in diagnosing Lisfranc injuries.(4) In purely ligamentous injuries an MRI scan is occasionally required in order to appreciate the extent of injury.

If X-rays are not diagnostic then a CT scan must be performed.

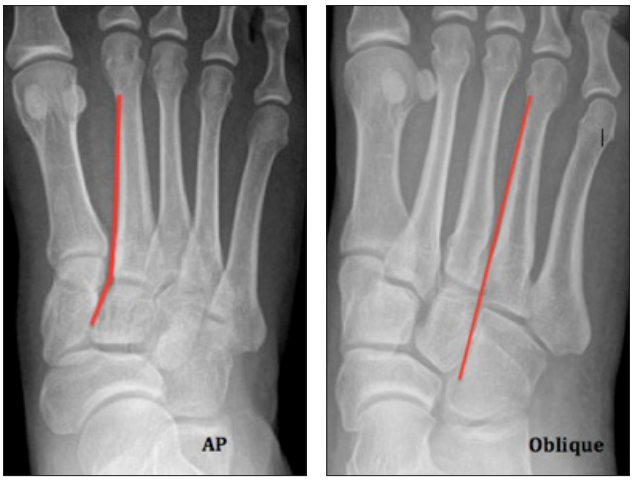

Figure 6: AP and Oblique radiographs of a normal foot to demonstrate key lines of alignment to look for when assessing radiographs for possible Lisfranc injuries.

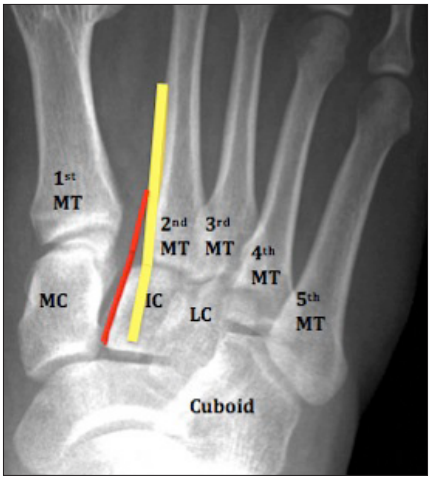

Figure 7: Radiograph to demonstrate a Lisfranc injury where there is widening of the space between the 1st and 2nd metatarsal and disruption of the line drawn between the medial border of the 2nd metatarsal and intermediate cuneiform.

4. Management

Lisfranc injuries can involve just the bones, just the ligaments or both. Early diagnosis is essential to prevent poor outcomes. Initial management is the same for any fracture; resuscitation, reduction, restriction and rehabilitation. (9)

Management depends on the stability of the injury and it is essential that all injuries are assumed to be unstable and that all patients are referred to Orthopaedics. Conservative management is rarely an option but when the injury is undisplaced and stable (for example a partial ligamentous injury) patients will be placed in a non-weight bearing cast for 6-8 weeks.(1)(5) After the cast is removed rehabilitation is vital with a graded return to regular activities. Where pain persists an ankle-foot orthotic device can be worn for a further 4 weeks.

Where there is displacement and instability of the injury, open reduction and internal fixation (ORIF) is necessary in order to restore alignment and stability to the Lisfranc joint. It is usual to delay surgery to allow the swelling to reduce.(8) A good way to assess this is to watch for the wrinkling of the skin, which develops as the swelling reduces. A backslab should be applied to restrict the fracture and provide pain relief until theatre.

The medial and middle columns are comparatively more rigid than the lateral columns. It is for this reason they are usually fixed with a screw or a dorsal plate.(1)(11) The lateral column is usually stabilised with K-wires due to its more mobile nature.(1)(11) These are usually removed at the 6-week mark. Where there is ligament injury the foot can need to be immobilised for up to 4 months in order for them to heal.

Patients will be non-weight bearing post-operatively for 6 weeks in plaster with a progressive return to weight bearing thereafter.

5. Complications of not diagnosing

Delayed or missed diagnosis or mis-management is likely to have significant long-term consequences. Instability, deformity and eventually arthritis can all develop.(1)

6. Key points

- The integrity of the Lisfranc joint is essential to stability of the arch of the foot
- Any patient with an injury and pain to their midfoot and an inability to weight bear has a Lisfranc injury until proven otherwise
- The fleck sign on a plain radiograph is diagnostic of a Lisfranc Injury
- A CT scan must be performed either to make the diagnosis or after diagnosis to allow a thorough assessment of the nature of the injury
- Patients who have had a midfoot injury and are unable to weight bear should not be sent home without crutches and without a referral to T&O from A&E
- Patients need to be informed by T&O that this is a serious injury and that even with early, appropriate treatment that they will require a lengthy recovery.

LISFRANC INJURIES - OFTEN A DIFFICULT DIAGNOSIS TO MAKE IN A&E

L Wiffen, J Kohis-Gatzoulis

MCQS

1. A patient attends A&E having slipped and fallen down the last 2 steps early this morning. She has no other injuries but cannot bear weight on the right foot. The foot is swollen but the radiographs do not show any sign of a Lisfranc injury. The most appropriate thing to do is:

a. Tell the patient she is lucky that the x-rays are normal and discharge her home

b. The patient cannot weight bear so put them in a plaster back slab and tell them they must have a sprain and arrange follow up in fracture clinic

c. Organise at CT scan and ask the on call Orthopaedic Registrar to review the patient

d. Get a senior to look at the x-rays too and provided they also don't see an abnormality then discharge the patient

e. Discharge the patient home but ask the patient to come back in a few days to perform weight-bearing radiographs.

2. Which of the following radiographic signs is not a finding of a Lisfranc Injury on oblique and AP and lateral radiographs of the foot?

a. Disruption of the line drawn from the medial aspect of the base of the 2nd metatarsal to the medial aspect of the middle cuneiform on the AP view

b. Widening of the space between the 1st and 2nd metatarsal

c. Discontinuation of the line drawn between medial aspect of the base of the 5th metatarsal and medial aspect of the cuboid bone on the oblique view

d. Dorsal subluxation of the metatarsal bases on lateral XR

e. The Fleck Sign

3. A patient attends A&E. His car flipped as it left a country lane, he was travelling at 40MPH. He was able to get out the car himself. Lucky for him a friend was following him and has brought him straight to hospital.

The patient is complaining of pain and bleeding from his left foot. You have read this article and you think he must have an open Lisfranc fracture. What do you do now?

a. Call T&O, Ensure the patient's tetanus is up to date, start him on broad spectrum antibiotics, take a photo of the wound, put the patient into plaster and arrange a CT scan of the foot.

b. Send out a trauma call, stabilize the C-spine and let the foot injury wait

c. Send him for urgent x-rays of the foot and call the on call T&O SpR

d. Ask him to wait in the waiting room and call T&O on call to sort out, there is a severe asthma patient expected by ambulance

e. Put a dressing on the foot and ask him to see his GP next week

4. It is 4 hours later in your shift. You have managed the above patient well and on call T&O reg has arranged for the patient to be admitted but the patient is still waiting for a bed (your hospital isn't meeting it's A&E targets) A nurse asks you to assess the patient because he is in a lot of pain. What do you do?

a. Ask the nurse to bleep the on call T&O team to sort the patient out

b. Ask the nurse to bleep the site manager, this patient should have a bed by now

c. Re-assure the nurse that the patient has an open fracture and will soon be going to theatre

d. Write the patient up for more Morphine. You are busy with a young mother with an aneurysm who is going to blue lighted to the neurosurgery centre

e. Go and see the patient to look for possible compartment syndrome

5. You have identified that a patient likely has a midfoot injury based on history of midfoot trauma and inability to weight bear. You want to go on to train as a MSK radiologist and you are quite confident that the plain films and CT scan you have ordered are normal. What do you do now?

a. Tell the patient that the swelling is all soft tissue and that they need to use RICE for a week and then their foot should be fine

b. Tell the patient they are lucky not to have any injury and send them home and tell them to start using there foot immediately

c. Force the patient to do weight bearing radiographs of the foot in A&E now

d. Discuss the case with the orthopaedic Registrar. Ensure that orthopaedics have plans to organise an urgent outpatient MRI with a weeks follow up in fracture clinic

e. Arrange for the patient to have a visit in fracture clinic in 2 weeks and give them crutches and a removable weight bearing splint

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LISFRANC INJURIES - OFTEN A DIFFICULT DIAGNOSIS TO MAKE IN A&E

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Answers

1C

A patient having the history of a midfoot injury and the inability to bear weight has a Lisfranc injury. CT scan and orthopaedic management are both necessary

2C

It is a line between the medial aspect of the base of the 4th metatarsal and the medial aspect of the cuboid bone on the oblique view that must be continuous

3B

This patient has brought himself to the hospital but he has been involved in a high-energy road traffic accident. He must be treated using ATLS principles. 4ePatients with open fractures are more at risk of developing compartment syndrome. Any patient with increasing pain after a fracture needs to be examined for compartment syndrome.

5D

Any patient with a history of trauma to the foot and the inability to weight bear has a Lisfranc injury until proven otherwise. This patient is in too much pain to perform weight-bearing radiographs. This patient will need an MRI and if T &O discharge the patient to have this as an outpatient, they need to be aware of the patient and seeing the patient at regular intervals so that surgery won't be delayed.

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CASE BASED DISCUSSION: AN UNUSUAL PATHOLOGICAL FRACTURE IN FEMUR

FK Ali, SA Ali

Abstract

A 17-year-old boy presented with a left femoral shaft fracture after minor trauma. The fracture pattern raised suspicion of pathological fracture. The patient was treated with intramedullary nailing. Post operatively he developed signs of infection with raised temperature. Ultrasound of the operative site showed haematoma collection. Skeletal survey X-rays showed lucencies in the left and right femur and the skull vault. Differential diagnoses of malignant and non-malignant lesions were considered. Provisional diagnosis of Eosinophilic granuloma was made. The reaming from the femur was sent for histology and it showed necrotic crushed bone with no features suggestive of malignancy. The Haematoma was drained and the patient got better. On discharge his left femur showed signs of healing.

Case History

A fit, healthy 17-year-old boy was brought into A & E following an injury to his left leg after a plaster board fell onto his leg, seemingly a minor trauma. He was in pain in the left femur and the X-ray showed a spiral fracture with three or four well-defined lucencies with thin sclerotic margins. The patient underwent IM nailing to fix the fracture 3 days later. During the procedure, due to the lesion found on X-ray, reaming samples from the femur were sent for histological analysis.

Figure 1: X-ray of Left femur on admission.

Figure 2: X-ray of Left femur on post-IM nailing.

Post-surgery, the patient was continually spiking temperature above 38 degrees despite intravenous antibiotics. His bloods showed elevated inflammatory markers. Ultrasound scan from the operation site showed haematoma formation which was drained, the patient then gradually stopped spiking temperature. Further X-rays were taken, X-ray of the right femur showed a well-defined septate lucent lesion in the distal femoral meta-diaphysis and a lucent lesion in the skull vault. The radiologist suggested Langerhans cell histiocytosis/eosinophilic granuloma as differential diagnosis since the clinical and radiological presentation were more in favor of the condition.

Figure 3: X-ray of right femur showing lytic lesion.

Figure 4: X-ray of Skull vault showing lytic lesion.

After drainage of the haematoma, the patient was no longer spiking temperatures and was working well with physiotherapy, he was eventually discharged from the ward with outpatient follow up. The histology results from the reaming sample showed "Irregular spicules of necrotic bone not suitable for definitive diagnosis but no features suggestive of malignancy".

The case was referred to the Regional Orthopaedic-Oncology team at the tertiary referral centre. The X-rays as well as the reaming sample were discussed at their MDT meeting and they concluded that the sample showed sclerotic crushed bone due to bone infarct with no evidence of malignancy. The patient was being followed up in their clinic for further investigation and if required, biopsy of the other lytic lesions.

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CASE BASED DISCUSSION: AN UNUSUAL PATHOLOGICAL FRACTURE IN FEMUR

FK Ali, SA Ali

The patient was also followed in our hospital with regards to the fracture and the subsequent follow up X-rays showed signs of healing of the fracture with callous formation.

Figure 5: X-ray of right femur on follow up showing signs of healing.

Discussion

Bone infarction, otherwise called osteonecrosis is usually found within the metaphysis or diaphysis of long bone. It resembles benign or malignant lesion of the bone and sometimes appear like bone infection or osteomyelitis. The differential diagnosis for benign bone lesion include Eosinophilic granuloma (EG), Non ossifying Fibroma, Osteochondroma and Simple bone cyst. For malignant lesions Osteosarcoma, Ewing's sarcoma and multiple myeloma need to be considered.

Benign Bone Lesions

Eosinophilic Granuloma (EG)1-:

- *Usually occurs as single benign focus in skeleton.*
- *80% of patients are < 20 years of age, more common in males (2:1).*
- *Commonly presents in the skull, flat bones, can also occur in long bones and the pelvis.*
- *Usually asymptomatic but can cause pain.*
- *Pathological fracture possible and systemic symptoms may also be present, including general malaise and occasionally fever with leucocytosis.*
- *Radiologically presents as a well-defined intramedullary lytic or "punched-out" lesion, cortex may be thinned, expanded or destroyed, may have periosteal reaction.*
- *Presence of Langerhans cells on biopsy is diagnostic (also composed of eosinophils and other inflammatory cells).*
- *Good prognosis for solitary lesions – usually spontaneously resolve by fibrosis within 1-2 years; where symptoms persist, treatment include excision and curettage, steroid therapy, intralesional injection, chemotherapy, radiofrequency ablation.*

Figure 6A: Eosinophilic Granuloma.

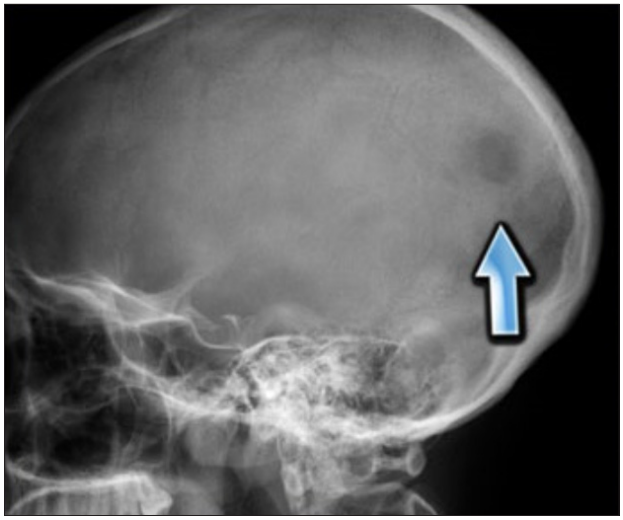

Figure 6B: Eosinophilic Granuloma (EG).

Non Ossifying Fibroma 1, 2, 3, 8:

- *Common in adolescents – 10-15 years old.*
- *Prevalence is estimated 30-40 % of all normal children, more common in males (2:1).*
- *Majority are asymptomatic and larger lesions may be painful, can cause pathological fracture.*
- *Radiologically it presents as sharply demarcated, asymmetrical, cortically based lucencies with a thin sclerotic rim, often multiloculated.*
- *Usually require no treatment but if large (involving more than 50% of the diameter of the bone) prophylactic curettage and bone grafting may be considered to avoid pathological fracture.*

CASE BASED DISCUSSION: AN UNUSUAL PATHOLOGICAL FRACTURE IN FEMUR

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Figure 7A (9) & Figure 7B (10): Non- Ossifying Fibroma.

Osteochondroma (1), (2), (3), (11):

- An outgrowth of the growth plate and is made up of both bone and cartilage.

- Symptoms include:
  - A painless bump near the joints. The knee and shoulder are most often involved.
  - Pain with activity.
  - Numbness or tingling – in the associated limb caused by pressure on a nerve.
  - Changes in blood flow - pressure on a blood vessel may cause changes in blood flow leading to loss of pulse or colour change of the limb.
  - As a child grows an osteochondroma may grow larger as well.
  - Once a child has reached skeletal maturity, the osteochondroma typically stops growing.
  - If the osteochondroma causes pain, excision may be considered.

Figure 8: Osteochondroma (12).

Simple Bone Cyst (3,13):

- It is a common benign fluid containing lesion, mostly found in the metaphysis of long bone.
- Pathological fractures occur with minimal trauma.
- These typically resolve after skeletal maturity and not usually associated with bone tumour.
- Treatment include – watchful waiting with activity modification, curettage and bone grafting, aspiration, steroid injection, bone marrow injection.

Figure 9: Simple Bone Cyst (1).

Malignant Bone Lesions

Osteosarcoma 1, 2, 3:

- Osteosarcomas are bone forming tumours.
- 75% occurring before the age of 20 with slight male predominance.
- Presents as bone pain occasionally accompanied by a soft-tissue mass or swelling.
- Osteosarcomas are bulky tumours that can cause pathologic fracture.
- Common sites: femur - 40% (distal femur), tibia - 16% (proximal tibia), humerus - 15%.
- Serum Alkaline Phosphatase may be raised particularly with advanced disease.
- Radiological appearance includes medullary and cortical bone destruction, wide zone of transition, permeative or moth-eaten appearance.
- Once diagnosed, staging done by MRI.
- Treatment requires aggressive surgical resection, often with amputation, followed by chemotherapy.
- If a limb-salvage procedure is feasible - a course of multi-drug chemotherapy precedes surgery to downstage the tumour, followed by wide resection of the bone with an endoprosthesis.

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CASE BASED DISCUSSION: AN UNUSUAL PATHOLOGICAL FRACTURE IN FEMUR

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Figure 10: Osteosarcoma (1).

Ewing's Sarcoma (1, 2, 3):

- Mainly seen in adolescents between 10 and 20 years of age with Male:Female 1.5:1.
- Non-specific presentation with local pain, occasionally a soft tissue mass palpable.
- Mainly seen in lower limb (45%); Pathological fractures also occur.
- Systemic symptoms including fever, may present with elevated ESR.
- Radiologically presents with Lytic lesion, laminated (onion skin) periosteal reaction, sclerosis.
- Systemic chemotherapy is the mainstay of treatment with surgery and/or radiotherapy playing a role depending of the location and size of the tumour.

Figure 11: Ewing's Sarcoma (1).

Multiple Myleloma (3,14):

- 70% of cases are between 50 -70 years old with Male female ratio is 2:1
- Usual presentation is back pain and pathological fractures, anaemia, neutropenia or thrombocytopenia, bleeding and bacterial infection, renal impairment.
- X-ray findings include lytic, punched out lesions – pepper pot skull, pathological fractures.
- Currently multiple myeloma is controlled with multidrug therapy.

Bone Conditions	Non-ossifying Fibroma	Eosinophilic granuloma	Osteochondroma	Simple Bone Cyst	Ewing's Sarcoma	Osteosarcoma	Multiple Myeloma
Type	Benign	Benign	Benign	Benign	Malignant	Malignant	Malignant
Age	10-15 year olds	80% under 20 years old	Under 20s	Under 20s	95% are 4-25 years old	75% under 20 years old	70% are between 50 -70 years old
Gender	Male (2:1)	Male (2:1)	Male (3:1)	Male (2-3:1)	Male (1.5:1)	Male predominance	Male (2:1)
Presentation	Asymptomatic Larger lesions painful and cause pathological fracture	Asymptomatic Can cause pain Pathological fractures Systemic symptoms (malaise, fever with leucocytosis)	A painless bump near the joints. (Commonly knee and shoulder) Pain with activity Numbness/tingling in the associated limb (pressure on a nerve) Loss of pulse or colour change in limb (pressure on a blood vessel causing changes in blood flow)	Asymptomatic Pain, swelling and stiffness in the adjacent joint Pathological fracture	Local pain Soft tissue mass Pathological fractures Fevers and elevated ESR Lower limb - most common site of presentation	Bone pain Soft tissue mass Pathological fracture Femur is the commonest site followed by tibia and humerus	Back pain Pathological fractures Systemic symptoms (anaemia, neutropenia or thrombocytopenia, bleeding, bacterial infection and renal impairment)
Radiology	Sharply demarcated, asymmetrical, cortical lucencies with thin sclerotic rim Often appear multiloculated	Well defined intramedullary "punched-out" lesion Cortex may be thinned, expanded, or destroyed. May have periosteal reaction	Sessile or pedunculated Seen in the metaphyseal region projecting away from the epiphysis.	Lucent lesions Sclerotic margins	Lytic lesion "Onion skin" periosteal reaction Sclerosis	Medullary and cortical bone destruction Wide zone of transition Permeative or moth-eaten appearance	Lytic, punched out lesions Pepper pot skull Pathological fractures
Prognosis	Good	Good	Good	Good	70% cure rate for children, 56% survival rate for 15-19 year olds	70% survival rate with appropriate treatment for high grade tumours. Higher survival rate for lower grade tumours	Variable, dependant on stage of disease and age. Generally poor
Treatment	No treatment In larger lesions prophylactic curettage and bone grafting to avoid pathological fracture	No treatment (spontaneously resolve by fibrosis) If symptoms persists- excision and curettage, steroid therapy, chemotherapy, radiofrequency ablation	No treatment – usually self-limiting	Watchful waiting with activity modification Curettage and bone grafting, aspiration Steroid injection, bone marrow injection	Systemic chemotherapy Surgery/radiotherapy depending on the size and location of the tumour	Staging followed by aggressive surgical resection (often with amputation) and chemotherapy	Multidrug therapy

Figure 12: Table Summarising the Benign and Malignant bone lesions.

Other condition which needs to be considered is Bone infection or Osteomyelitis.

Bone Infection/Osteomyelitis (3):

- Common tumour mimic, seen in any age group.

- Usually associated with redness, swelling and pain in the affected limbs.

- In acute infection, systemic sign of infection usually present.

- Radiologically present as well or ill-defined osteolytic or sclerotic lesion.

- Treatment include long term antibiotics, surgical drainage, curettage in chronic infection.

CASE BASED DISCUSSION: AN UNUSUAL PATHOLOGICAL FRACTURE IN FEMUR

FK Ali, SA Ali

Summary & Conclusion

In this case study although the fracture was considered pathological, the patient was not investigated with MRI or Bone scan. He did not have his tumour markers checked either. The onset of temperature with detection of haematoma raised the suspicion of bone infection and other differential diagnosis of bone lesion.

Bone infarction is a type of cell death due to irreversible cell injury. It is due to the result of ischaemia causing destruction of bony architecture leading to pain and loss of function. It can be recognised microscopically by alteration in the cytoplasm (eosinophilic) and in the nucleus (swelling, deformation). The lesion is usually seen in metaphysis, in the medulla often symmetrical and / or with multiple infarcts.

General causes of bone infarction include trauma, sickle cell disease, radiotherapy, connective tissue disorder, renal transplantation, corticosteroid use, gout, gauchers disease, pacreatitis, alcohol. Plain X-ray reveals the bone infarct but the diagnosis is confirmed by MRI and bone scan. In the MRI scan, the central signal remains that of normal marrow and in the bone scan the lesion is normally cold. Usually the condition does not require treatment.

Learning points

Appropriate pre surgery investigation with tumor markers and MRI and bone scan would have provided better clue towards the diagnosis.

Questions

1) What is the most salient feature of a pathological fracture?

a) pain

b) deformity

c) high velocity injury

d) low velocity injury

e) loss of function

2) Radiological appearance of 'punched out lesion in the bone' is caused by the following condition:

a) Osteochondroma

b) Osteosarcoma

c) Eosinophilic Granuloma

d) Chondroblastoma

e) Pagets disease

3) The following condition is most likely to resolve after skeletal maturity:

a) Ewing's sarcoma

b) Simple bone cyst

c) Multiple myeloma

d) Osteomyelitis

e) Osteoclastoma

4) MRI scan of the Bone infarction shows the following signal:

a) increased signal

b) decreased signal

c) altered signal

d) normal marrow signal

e) no signal

5) Eosinophilic granuloma occurs in the following age group:

a) under 20 years of age

b) over 50 years of age

c) between 60 to 70 years

d) between 40 to 50 years

e) over 80 years of age

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CASE BASED DISCUSSION: AN UNUSUAL PATHOLOGICAL FRACTURE IN FEMUR

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Answers

1. Answer: d) Low Velocity Injury

Pathological fracture happens after a minor trauma with low velocity injury. The bone being already weak, with its architecture destroyed by the pathology, render it to break after a trivial injury.

2. Answer: c) Eosinophilic Granuloma

Radiologically eosinophilic granuloma present as a well-defined intramedullary lytic or punched out lesion, cortex may be thinned, expanded or destroyed, may have periosteal reaction.

3. Answer: b) Simple Bone Cyst

Simple bone cyst is of unknown origin, commonly found in the metaphysis of long bone. They are not associated with bone tumors and typically resolve after skeletal maturity.

4. Answer: d) Normal Marrow Signal

Central signal of the MRI scan shows normal marrow signal in both T1 & T2 images due to the lesion being not active.

5. Answer: a) Under 20 Years Of Age

Eosinophilic Granuloma is a benign, usually self-limiting condition seen mainly in patients less than 20 years of age, more common in males.

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ACUTE COMPARTMENT SYNDROME: A CASE BASED DISCUSSION

B Smith, R Gregory

Abstract

This article focuses on the presentation, investigation and management of two patients with acute compartment syndrome (ACS). The cases illustrate the importance of having a high degree of suspicion for ACS and the severe consequences that can result from a delayed diagnosis. The purpose of this article is to make junior doctors aware of the non-specific early symptoms of ACS and of key principles in patient management.

Case History 1

A 31 year old male attended the Emergency Department having tripped and fallen down a flight of stairs. His main complaint was of left knee pain and he had a previous history of IV drug use. X-rays identified a left tibial plateau fracture.

Figure 1

The patient was difficult to manage in the Emergency Department, demanding pain relief and behaving aggressively towards staff. This was attributed to his previous IV drug use and high opiate tolerance. In an attempt to control his pain he was given intravenous opiates and entonox. An orthopaedic review was requested with the expectation that the fracture would be immobilised and the patient discharged.

Orthopaedic review revealed that the patient was agitated, using excessive entonox and demanding other forms of analgesia. He had a tense, swollen, tender left calf with altered sensation up to the knee. His dorsal pedis and posterior tibial pulses were present but weaker than on the contralateral side and he had a positive passive calf stretch test.

A diagnosis of acute compartment syndrome was made, the duty consultant called and the patient was taken to theatre for emergency fasciotomy of the lower leg through lateral and medial incisions. At the time of surgery he was found to have bulging, dusky muscle in the posterior compartments. The wound was left open and closed two days later using a split skin graft taken from the right thigh having established muscle viability. The patient ultimately made a full functional and neurological recovery.

Case History 2

A fit 25 year old male sustained a closed transverse fracture of the lower third of the right tibia as a result of a football injury. This was treated on the first post-admission day with locked intra-medullary nailing and post-operatively was initially noted to be comfortable, requiring minimal analgesia administered through a patient controlled analgesia (PCA) device.

Figure 2

During the early hours of the following morning his analgesic demands dramatically increased and he developed signs of swelling and tenderness affecting the calf with pain on passive calf stretching. His pedal pulses turned palpable and he had no sensory deficit.

Figure 3

A diagnosis of acute compartment syndrome was made and again the duty consultant called. The patient was taken to theatre for emergency fasciotomy of the lower leg through lateral and medial incisions.

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ACUTE COMPARTMENT SYNDROME: A CASE BASED DISCUSSION

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Figure 4

The lateral incision was closed at 48 hours and the medial incision covered at four days with a split skin graft taken from the contralateral thigh. The patient made a full functional and neurological recovery.

Figure 5

Background

Acute compartment syndrome is an absolute surgical emergency but an early diagnosis is not invariably made. The condition occurs when increased pressure in a muscle compartment, most commonly a limb, compromises circulation and tissue perfusion. It is most commonly seen as a result of trauma but can also occur secondary to reperfusion injuries, IV drug use, vascular injuries, burns, tourniquet use or following prolonged compartment compression for other reasons. Young males are most commonly affected and the injury with the highest prevalence of ACS is a tibial fracture (1).

A condition that shares some common features with ACS is Chronic Exertional Compartment Syndrome, this often being seen in athletes. Although the patho-physiology is similar - pain occurring as a result of muscle ischaemia - the condition rapidly resolves with rest, is not limb threatening and if necessary, can be treated with compartment decompression through small incisions.

Discussion

The two cases described above emphasise the importance of having a high degree of clinical suspicion for ACS in patients where the pain experienced out of proportion to that expected given their injury. In the first case the diagnosis was missed in the Emergency Department and this could have resulted in irreversible muscle and nerve damage without prompt recognition and treatment. In the second case the warning sign of rapidly increasing analgaesic demands was graphically revealed from the PCA monitor (Figure 3).

The diagnostic challenge lies in the sometimes vague and non-specific early symptoms that can often be overlooked. Classical symptoms such as paraesthesia, paralysis and pulselessness are late signs associated with irreversible muscle and nerve damage (Table 1).

Early Signs/ Symptoms	
Pain out of proportion to injury	Two most reliable early signs
Pain on passive stretch test	
Tense "wood like" feeling	
Altered sensation in the nerve distribution	
Late Signs/ Symptoms	
Numbness	These signs occur when irreversible ischaemic damage has occurred - ACS should be detected before these are present
Muscle weakness	
Loss of pulses	
Cold limb	

Table 1

When ACS was considered as a diagnosis in the patient he was already displaying all of the early signs and starting to show some of the late signs. There was a danger that over-emphasis on the previous history and a failure to consider the significance of the physical signs could have led the inexperienced clinician to overlook the diagnosis and to miss the opportunity to refer the patient for appropriate management.

With each of the two illustrated cases the diagnosis was clinically obvious. Often though, the diagnosis is not clear-cut from the history and examination alone, for example in the unconscious patient. It is in such circumstances that it can be helpful to measure the compartment pressures.

ACUTE COMPARTMENT SYNDROME: A CASE BASED DISCUSSION

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This involves using a manometer or transducer with the tip of the probe measuring the pressure within the muscle compartment. Appropriate placement of the tip is therefore crucial for accurate pressure measurement. Compartment pressures of less than 30mmHg below the diastolic blood pressure are widely accepted as being a good indicator of compromised tissue perfusion. (2,3)

The two cases illustrated above conform with the demographics of the most commonly affected patient group: a young male sustaining a tibial fracture (40% ACS cases)(1). ACS can however occur in any closed compartment including lower leg, hand, arm, buttock, thigh, foot and abdomen and can even be associated with open fractures (Table 2).

Common	Less common
Long bone fracture	Open fractures
Crush Injury	Prolonged surgery
Reperfusion injury	Childbirth
Burns	Tourniquet use

Table 2

The definitive treatment for ACS is fasciotomy of the affected compartment. In the lower leg there are four compartments as shown in Figures 6 and 7.

The fasciotomy incisions need to adequately decompress each of the four compartments to prevent nerve and muscle damage. This can be successfully accomplished with two incisions as show in Figure 4. The incisions must extend from just below the knee to just above the ankle.

The incisions are normally left open and re-inspected at 24-48 hours at which time, after the soft tissue swelling has reduced, if deemed safe, closure can begin. Full wound closure may require a further return to theatre and often requires split skin grafting to prevent closure with excessive tension.

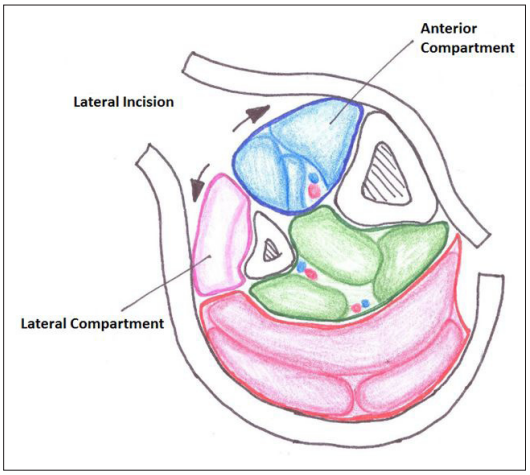

Figure 5

The patients in the cases above went on to make a full recovery with no residual functional deficit but this is invariably not the case. Common sequelae following ACS include muscle contractures, infection, persistent sensory symptoms and paralysis and amputation of the limb is a rare but possible outcome.

Learning Points

- *ACS is an acute surgical emergency.*
- *A high degree of clinical suspicion is required for early identification.*
- *Classical symptoms such as paraesthesia, paralysis and pulselessness are late signs associated with irreversible muscle and nerve damage.*
- *Urgent surgical consultation should be sought if a diagnosis of ACS is suspected.*

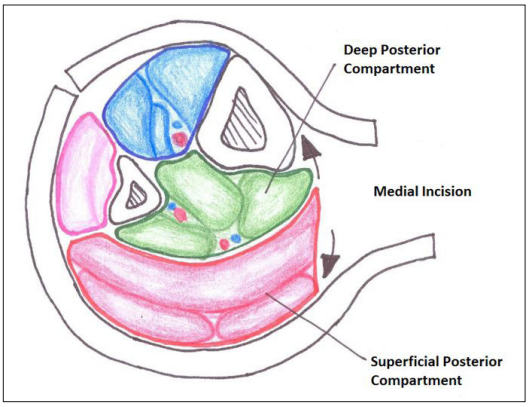

Figure 6

MCQs

1. Which of the following statements is true:

a. A patient with soft calves cannot have acute compartment syndrome (ACS)

b. Muscle weakness is an early symptom

c. Pain with a passive stretch test is a sign of ACS

d. Measurement of compartment pressures is essential for diagnosing ACS

e. If you are uncertain about a diagnosis of ACS you should wait and re-examine later

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ACUTE COMPARTMENT SYNDROME: A CASE BASED DISCUSSION

B Smith, R Gregory

2. Which one of the following symptoms is the earliest indicator of ACS:

a. Pain

b. Contractures

c. Pulselessness

d. Paraesthesia

e. Ischemic skin changes

3. Which of the following injuries is least associated with ACS:

a. Open fracture

b. Long bone fracture

c. Crush Injury

d. Head Injury

e. Burn Injury

4. Which of the following statements in false:

a. Patients with ACS must be nil by mouth for 6 hours before surgery

b. Contractures can be a long term consequence of ACS

c. ACS most commonly occurs in the lower leg

d. ACS is most commonly seen in patients <40 years old

e. ACS can occur in the hand, buttock or abdomen

5. Which of the following accurately describes the compartments of the lower limb:

a. Superficial, deep, lateral, medial

b. Superficial lateral, deep lateral, anterior and posterior

c. Superficial posterior, deep posterior, medial, lateral

d. Superficial posterior, deep posterior, anterior, lateral

e. Superficial lateral, deep lateral, anterior and posterior

Answers

1. c **2. a** **3. d** **4. a** **5. d**

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AN EXAMPLE OF LATERAL THINKING & REFERRED PAIN IN ORTHOPAEDICS

S Sait, R Anwar

Abstract

Common causes of referred pain include knee pain due to an arthritic hip, leg pain due to lumbar disc prolapse, and upper limb pain due to neck problems. This case report highlights the importance of considering non musculoskeletal conditions which cause referred pain.

A 55 year old female presented with worsening pain in her left shoulder. She had not noticed any weakness, pins and needles or any muscle wasting in her arms. She was a long term smoker and otherwise fit and well. The left shoulder and spine of the scapula were tender on palpation. Abduction was significantly reduced, and there were decreased neck movements. Neurological and respiratory examinations were unremarkable.

A shoulder and chest radiograph showed left upper lobe opacity with slight tracheal deviation. CT scan of the thorax demonstrated a soft tissue mass in the left lung apex in keeping with Pancoast tumour. The patient had four cycles of neoadjuvant chemotherapy followed by resection. She responded well to treatment and further follow up CT scan showed no evidence of recurrence of the disease.

Pancoast tumour is characterized by a malignant mass in the superior sulcus of the lung. It accounts for less than 5% of all lung cancers. This case highlights the importance of a thorough assessment when patients present in a clinical setting. In an outpatient clinic of any specialty the importance of good history taking, a thorough clinical examination and awareness of referred pain cannot be overemphasised.

Introduction

Pain is the commonest presenting complaint in orthopaedic patients. Pain can arise from the local area or be referred from elsewhere. A common cause of referred pain is knee pain due to an arthritic hip.

Shoulder pain has wide range of aetiologies. The common causes are rotator cuff disorders, glenohumeral disorders and acromioclavicular joint disease (1).

In some cases shoulder pain may be due referred pain from a serious underlying pathology. The process of determining the cause can be challenging, and therefore a thorough history and careful examination are crucial in making the appropriate diagnosis. This case report highlights the importance of considering non musculoskeletal conditions which cause referred pain.

Case History

A 55 year old female presented with an eight month history of progressively worsening constant pain in her left shoulder. She had not noticed any weakness, pins and needles or any muscle wasting in her arms. She did not have any chest pain or shortness of breath. Her weight was steady; however she did mention that she had a reduced appetite and sleep disturbance due to the pain. She was a long term smoker of 10 cigarettes a day and was otherwise fit and well.

On physical examination the patient had a normal left shoulder on inspection with no muscle wasting. The left shoulder and spine of the scapula were tender on palpation. Abduction was significantly reduced, and there were decreased neck movements. Neurological and respiratory examinations were unremarkable and there was no cervical lymphadenopathy.

A shoulder and chest radiograph showed non homogenous left upper lobe opacity with slight tracheal deviation.

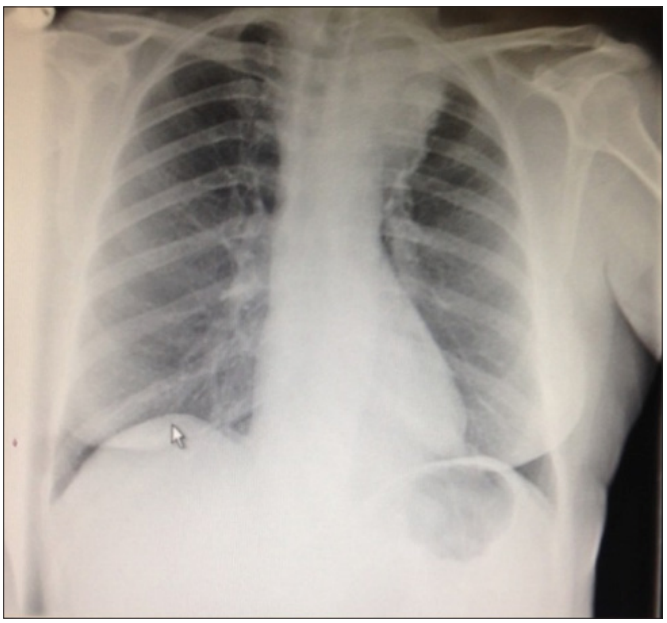

Figure 1: Chest xray - non homogenous left upper lobe opacity with slight tracheal deviation.

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AN EXAMPLE OF LATERAL THINKING & REFERRED PAIN IN ORTHOPAEDICS

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The history and radiological findings were highly suggestive of a left apical lung lesion. An urgent CT scan of the thorax and abdomen was requested. CT scan of the thorax demonstrated a soft tissue mass in the left lung apex in keeping with Pancoast tumour.

Figure 2: CT thorax - Soft tissue mass in the left lung apex in keeping with Pancoast Tumour.

No metastases were identified in the thorax or the abdomen and the tumour was staged by using a PET scan at T3/4 N1 M0. An ultrasound biopsy was done which confirmed an adenocarcinoma. A full body bone scan was arranged which was showed no bony metastases.

The case was discussed at the respiratory multi-disciplinary meeting. The patient had four cycles of neoadjuvant chemotherapy comprising of Cisplatin and Taxotere followed by resection of the superior sulcus lung cancer. This was followed by adjuvant radiotherapy to prevent the recurrence of the tumour. She responded well to treatment and further follow up CT scan showed no evidence of recurrence of the disease.

Discussion

Pancoast tumour is characterized by a malignant mass in the superior sulcus of the lung. It accounts for less than 5% of all lung cancers. The tumour can cause compression of various structures in the thoracic inlet2. Most commonly it presents with severe shoulder pain radiating to the axilla, signs of Horner's syndrome and atrophy of the muscles in the hand and arm3, 4. Urgent treatment is vital as the tumour can rapidly spread to the surrounding structures. Shoulder and chest radiographs were key in spotting the apical lung mass. As the diagnosis was picked up in the initial consultation, treatment was commenced urgently and the patient responded well.

This case highlights the importance of a thorough assessment when patients present in a clinical setting. In an outpatient clinic of any specialty the importance of good history taking, a thorough clinical examination and awareness of referred pain cannot be overemphasised.

Referred pain from the cervical spine can occur in upper limb disorders and leg pain can be the presenting symptom of a lumbar disc prolapse with nerve root compression. One of the great misses in orthopaedics is a child presenting with knee pain and the doctor failing to examine the hip joint.

Learning Points

- *A detailed assessment and careful evaluation of the patient are essential in making the appropriate diagnosis.*

- *Always consider referred pain.*

- *Lateral thinking helps in making an early diagnosis of malignancy as in this case.*

MCQs

1. A 15 year old obese child presents with knee pain. Clinical examination of the hip reveals external rotation when the hip is flexed with restricted internal rotation. X rays carried out show:

a) Congenital dislocation of the hip

b) Osteoarthritis

c) Perthe's disease

d) Slipped upper femoral epiphysis SUFE

e) Transient synovitis

AN EXAMPLE OF LATERAL THINKING & REFERRED PAIN IN ORTHOPAEDICS

S Sait, R Anwar

Slipped upper femoral epiphysis is a condition that occurs in late childhood where the epiphysis (the growth center) of the femoral head displaces or slips out of alignment from the rest of the femur. It is commonly associated with obesity, and pain can be referred to the knee. The principle of initial treatment is to prevent continued progression of the deformity and this is done by placing a screw across the weakened growth plate.

2. One would suspect Cauda Equina syndrome:

a) if the patient presented with vomiting

b) if the patient had constant pain

c) if the patient has lost bladder control

d) if the patient had loss of appetite

e) if the patient had numbness in their fingers

Cauda equina syndrome is a surgical emergency where there is compression of the lower spinal nerve roots. The most common causes are a severe ruptured disk or a malignant tumour. Common symptoms including severe back pain, numbness and loss of sensation in one or both of the legs, groin area and buttocks. Loss of bowel or bladder control are other red flag signs which point to cauda equina syndrome.

3. An elderly gentleman with knee pain and an antalgic gait must undergo the following:

a) A proper examination of the lumber spine, hip and knee

b) An MRI scan of the Knee

c) Blood tests to rule out septic arthritis

d) Referral to the pain clinic

e) Knee replacement surgery

Osteoarthritis of the hip is a common condition in the elderly population. Patients may present with referred pain to the knee. This is due to the common nerve supply of the knee and the hip. Always remember when examining any orthopaedic joint to thoroughly examine the joint above and below.

4. Which one of the following is not a clinical sign of Horner's syndrome?

a) Enophthalmos

b) Ipsilateral loss of sensation of the face

c) Ipsilateral impaired sweating of the face.

d) Miosis

e) Ptosis

As mentioned in the case report Horner's syndrome is a common presentation of Pancoast tumour and is due to an interruption of sympathetic nerve supply.

It is characterised by the classic triad of miosis (constricted pupil), ptosis (drooping of the eyelid), loss of hemifacial sweating. It can also cause enophthalmos (posterior displacement of the eye). Ipsilateral loss of sensation of the face is not usually associated with Horner's syndrome.

5. A 17-year-old boy presents with severe left shoulder pain following a tackle during a rugby match. On examination, the contour of the left shoulder is flattened and the humeral head is palpable just under the clavicle. There is also sensory loss at the upper lateral aspect of the arm. Which nerve has most likely been affected?

a) Accessory nerve

b) Axillary nerve

c) Long thoracic nerve

d) Median nerve

e) Radial nerve

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Anterior shoulder dislocation is by far the commonest type of dislocation. The axillary nerve which supplies the deltoid muscle can be damaged. When examining the shoulder it is always important to test the function of the axillary nerve (both sensory and motor).

This is done by testing sensation over the lateral aspect of the humerus and abduction of the shoulder. Shoulder dislocations are usually managed with closed reduction however may require surgical repair if there is shoulder instability, Bankart or a Hill – Sachs lesion (posterolateral humeral head compression fracture).

Answers

1. D

2. C

3. A

4. B

5. B

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WHAT DOES A JUNIOR DOCTOR NEED TO KNOW TO MANAGE JOINT ARTHROPLASTY PATIENT?

G Verma, S Shah

Abstract

According to National joint registry (NJR) website report for 2015 there were total of 66,802 total hip replacements (THR) and 68,268 total knee replacement (TKR) procedures were performed in National Health Service (NHS) hospitals. In 2016 so far 26,199 THR and 26,955 TKR have been performed in NHS hospitals (1).

A foundation training doctor is very likely to come across patients with one of these common procedures on the wards at some stage during your training. THR and TKR are highly successful operations though small number of patients can suffer disastrous complications. This article is aimed to provide sufficient knowledge and understanding about these procedures to arm foundation doctor to be able to provide the best quality of care for these patients safely.

Introduction

Osteoarthritis affects approximately 7.3 million in England, with higher prevalence in women than in men (2). It causes painful joints which interferes with performance of activities of daily living. Thus affecting quality of life and fulfilments of demands of life for every affected individual. Rising levels of obesity and ageing populations will increase number of individuals with osteoarthritis. Arthritis Research UK report projected an increase of 3.8% per year in the number of people with osteoarthritis of knee between 2010 and 2020 (from 4.7 to 6.5million.) (2).

Clinic Assessment

Assess of severity of osteoarthritis by determining patient's capability of performance of activities of daily routine and their ability to meet the demands of life. How osteoarthritis interferes with their quality of life? Adequate non operative treatment for at least 3 months should be exhausted before surgical interventions are considered (2). Obtain adequate weight bearing x-rays of relevant joint and associated joints. Some centres collect Patient Reported Outcome Measures (PROMS) like Oxford hip and knee scores (OHS and OKS) to see whether joint arthroplasty surgery has been successful from patient's perspective (3).

Once patient is listed for joint replacement surgery they will have preoperative assessment. Some centres perform preoperative assessment on the same day while some centres offer an appointment date in few weeks. For patients with multiple co-morbidities obtain an anaesthetic opinion before surgery to prevent any unnecessary delays or cancellation on the day of surgery. Once patients are deemed fit for surgery, they are invited to attend joint replacement information school.

Preoperative Assessment

Do Full blood count and Urea and electrolytes. Electrocardiogram (ECG) is required for patients older than 45 years old. Echocardiography is indicated if patient has heart murmur or any cardiac symptoms including breathlessness, pre-syncope, syncope or chest pain or symptoms of heart failure.

Clotting profile is required if patient has chronic liver disease or patient is on anticoagulant medication (4). Chest x-ray is indicated for more than 65years old. Chronic obstructive respiratory disorders or suspected respiratory diseases will need chest x-ray and pulmonary function test. HbA1c test should be performed for known diabetics if they have not been tested in last 3 months (4).

Asprin, Clopidogrel and warfarin should be stopped for 5 days before surgery (5). Oral anticoagulants viz, Dabigatran, Rivaroxaban, Apixaban and Edoxaban should be stopped for 48 to 72 hours before surgery. For renal impairment patients consider stopping them for 3 – 5 days before surgery (6).

International Normalized Ratio (INR) should be determined one day before surgery. If the INR is ≥ 1.5 than administer vitamin K as per trust guidelines to correct the INR. In patients who are receiving pre-operative bridging with Low molecular weight heparin (LMWH) the last dose should be at least 24 h before surgery (5).

Patients known to carry Methicillin-resistant Staphylococcus aureus (MRSA) and positive on MRSA swabs should have a course of eradication therapy before surgery as per the hospital guidelines. Stroke and other neurological issues may influence post operative rehabilitation. These patients may need special physiotherapy and occupational therapy assessment.

Patients will need to consent to the surgery. Consent is a process of multiple discussions starting in clinics where patients are informed about the surgical procedure, post-operative management, prognosis, and all associated risk and complications. An information leaflet for joint arthroplasty surgery is usually given in the clinic. It is best practice to complete the consent form in the clinic and give a copy to the patient (7, 8).

On The Day Of Surgery

The majority of hip and knee arthroplasty patients are admitted on the day of surgery unless there are multiple comorbidities which make it necessary for the patients to be admitted a day before surgery. Routinely group and save is enough for joint arthroplasty procedure.

Crossmatch is required for complex cases or where high blood loss is anticipated or patients known to have low haemoglobin. Complete venous thromboprophylaxis assessment. If relevant joint preoperative x-rays are more than six months old than new x-rays needs to be repeated to assess the current state of osteoarthritis in the joint.

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Intraoperative Management

In theatre at the time of induction Tranexamic acid and the prophylactic dose of antibiotics are given intravenously as per hospital guidelines. If excessive bleeding occurs during surgery than Tranexamic acid infusion may be given intraoperatively to control bleeding.

Blood loss may be up to 984ml for total hip replacement and 789mls for total knee replacement (9). Intraoperative blood salvage via cell saver technique is very useful for patients with rare blood group or multiple red blood cell alloantibodies and to some Jehovah's witnesses (10).

Intraoperative infiltration of local anaesthetic in the soft tissue is routinely done to achieve postoperative pain relief and reduce the need for opioid analgesia. Avoid routine use of morphine to reduce the incidence of nausea, vomiting and drowsiness. Amount and combination of local anaesthetic is as per agreed departmental or hospital guidelines. Infiltration is done in posterior soft tissues before implantation followed by anterior soft tissue after implantation. Remaining infiltration is done into the subcutaneous tissue before skin closure.

Bone cement implantation syndrome: Characterised by hypoxia, hypotension (fall in systolic blood pressure >20%), cardiac arrhythmias, increased pulmonary vascular resistance and cardiac arrest. Incidence of hypotension during polymethylmethacrylate (PMMA) insertion is less than 5% (11). Multimodal potential mechanisms are involved in bone cement implantation syndrome viz, embolization of fat and marrow debris, cement monomer toxicity, histamine release, complement activation.

The main cause is believed to be embolization of fat and marrow debris which occurs as high pressure develops during cementation and prosthesis insertion. Cement undergoes an exothermic reaction and expands in the closed space between prosthesis and bone. The trapped air, fat and bone marrow contents under pressure are propelled into circulation causing multiple small emboli also known as 'snow flurry' (12).

The risk of fracture during THR is 0.1% – 1% for cemented components and 3% – 18% for uncemented components. Femur fractures are most common during stem insertion. Other intraoperative complications during THR like nerve injury is 0% – 3%. Injury to sciatic nerve is most common with peroneal division more susceptible than tibial division. Vascular injury is rare from 0.2% - 0.3% (11).

Post Operative Management

Monitor pulse, blood pressure, respiratory, oxygen saturation, urine output and level of consciousness. Post operative hypotension is very common due to blood loss. This would manifest as tachycardia, tachypnoea, low blood pressure, decreased urine output and altered level of consciousness. Watch for wound haematoma or soakage of the wound dressing. Assess circulation, sensations and movements of the operated extremity. Elevate operated total knee replacement to reduce swelling. Watch for acute urinary retention in patients with spinal or epidural anaesthesia.

Mechanical prophylaxis like flowtron pumps over calfs and foot pump may be used to prevent deep vein thrombosis. Administer Low molecular weight heparin within 8 hours after the operation and two doses of antibiotics postoperatively as per Enhance recovery protocol.

Patients should have recovered normal sensations and motor function in both lower limbs before mobilisations after spinal or epidural anaesthesia. Persistence of numbness and motor weakness in the operated lower limb could be due to nerve palsy. The Common peroneal nerve is most commonly affected after total knee replacement and sciatic nerve after total hip replacement. Common peroneal nerve palsy is identified by presence of hypoaesthesia on the dorsum of the foot and inability to dorsiflex the foot. In sciatic nerve palsy, there is an inability to flex the knee and all the findings of common nerve palsy.

The common peroneal nerve is a branch of sciatic nerve. If suspected than immediately remove dressings and flex the knee to relieve pressure on the nerve. Patient will need foot drop splint during nerve recovery (13). Physiotherapy for the operated limb is started as soon as possible. During patient assessment it is important to look at the alignment of the operated lower limb. Dislocation of hip joint will present with internal rotation attitude of lower limb for posterior dislocation and external rotation for anterior dislocation along with shortening of the operated lower extremity.

Calf swelling is expected postoperatively after total knee replacement in the operated leg. It needs to be carefully differentiated from deep vein thrombosis. If in doubt than discuss with seniors before starting full treatment dose of low molecular weight heparin for suspected thromboembolism. Consider Doppler ultrasound to confirm DVT if there is strong clinical suspicion. Unnecessary treatment will lead to further blood loss and ooze from the wound, causing haematoma formation. Haematoma is a perfect medium for bacteria to colonise and cause infection.

Postoperative high fever spikes are quite common in first 48 – 72 hours. Similarly, postoperative wounds are inflamed and erythematous for initial few days. It needs to be carefully observed. Please do not start antibiotics without prior agreement from seniors. Patient controlled anaesthesia is no longer used as part of Enhance recovery programme.

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Haemoglobin, Urea and electrolyte assessment is done on the next postoperative day. Obtain postoperative arthroplasty x-rays to assess the alignment of implants and rule out any fractures. THR will need pelvis with both hips anteroposterior (AP) and lateral views whilst TKR will need AP and lateral views.

Discharge & Follow up

Venous thromboembolism (VTE) prophylaxis needs to be prescribed as per the trust policy. Usually it is continued for 14 days for total knee replacement patients and between 28 – 35 days for total hip replacement patients (14). Wound review and suture removal are usually done by practice nurse at 2 weeks post surgery.

Patients are reviewed in follow-up an orthopaedic clinic at 6 weeks, 3 months, 6 months, 1 year and yearly thereafter for the life time of replaced joint. On each follow-up visit enquire for symptoms of pain or discomfort. X-rays of the relevant joints are done on each yearly follow-up visit and compared with previous x-rays to rule out any loosening or deterioration in alignment.

Discussion

NHS constitution gives legal right to patients to have their elective treatment started within 18 weeks of referral from their general practitioner to the hospital (15). After the initial trial of non-operative treatment and lifestyle changes operative treatments are considered. This may mean the x-rays done in the clinic may be more than six months old on the day of surgery.

The National Joint Registry (NJR) collects information on joint replacement surgery and monitors the performance of joint replacement implants. Since 2003, the median age for THR is 69years and TKR is 70 years. Preoperative Oxford hip and knee scores in isolation have no predictive accuracy in relation to postoperative patient satisfaction (16). Though Hamilton et al demonstrated that high levels of patient satisfaction were primarily based on achieving preoperative expectation in a pain-free joint and overall patient's hospital experience (17).

Excessive and unnecessary preoperative testing does not help but add to the cost and wasted resources. According to Hospital episode statistics, 2012 – 2013, the NHS in England completed 10.6million operations compared with 6.61 million in 2002 – 2003, an increase of 60% (4). Diabetes affects 4 – 5% of UK population. As people live longer, the cost of management of diabetes and its complications intrudes into a larger share of limited NHS budget.

In 2012 approximately £9.8 billion was spent with an expected increase to £16.9 billion in next 25 years. (Approximately 17% of total NHS budget.) (18). Good preoperative glycaemic control in diabetics, as determined by HbA1c concentrations, is associated with a lower incidence of systemic and surgical complications, decreased mortality, and shorter duration of hospital stay. Delaying elective major surgery while glycaemic control is improved is predicted to decrease mortality and serious morbidity (19).

Joint replacement school is an integral part of Enhance recovery programme. It is a unique and exciting opportunity for patients to learn and understand their journey of having joint replacement surgery. A multidisciplinary group of professional viz, physiotherapist, occupational therapist, anaesthetist, surgeon, pain specialist nurse and enhanced recovery nurse explain patients in details about the specific aspect of care and how patient's can actively participate in their own recovery.

It is an opportunity for patients to meet other patients having similar surgery and develop a support network. It is recommended for a member of family or friend to accompany patients for this meeting, who will act as a support during the recovery process.

Pregnant patients who had THR in past can undergo normal vaginal delivery and there is no necessity for caesarean section unless indicated for obstetric reasons. (20). Intraoperative fractures can occur during the reaming process while preparing the bone before implantation. It most commonly occurs when surgeon tries to achieve a fine balance of tight fit in the bone in order to achieve stability of components.

Condition's which weakens the bone like osteopenia, osteoporosis and rheumatoid arthritis increases the risk of fracture. Female sex is more prone to intraoperative fractures (11). Nerve injury could be due to trauma during retraction, transaction, excessive limb lengthening of more than 5cm during THR, thermal injury due to diathermy or cement, acetabular screw insertion, haematoma formation and dislocation (11, 21). Higuchi observed that sciatic nerve injury occurred in lower limb that was lengthened by a percentage of lower limb (LL) / Body height (BH) of ≥ 3.5 (21).

Nerve recovery is variable with the possibility of residual nerve deficit. Usually, nerve recovers in 6 to 12 months but can take up to 1.5 - 2 years for full recovery (22). Vascular injury though rare can be life threatening due to blood loss from external iliac vessels in the anterosuperior quadrant and iliac vessels in anteroinferior quadrant during acetabular screw insertion (11). Enhanced recovery programme empowers patients to become partners in their care. It focuses on optimising every aspect of patient's joint replacement journey. It is aimed to ensure that patients are in optimal condition for treatment, receive innovative care during surgery and experience optimal postsurgical rehabilitation.

Programme involve patient education and involvement in preoperative planning processes, preoperative oral carbohydrates, improved anaesthetic and postoperative analgesic techniques to reduce the physical stress of the operation, early oral feeding and mobilisation. The success of enhanced recovery programme is usually measured through reduced length of stay in the hospital, reduced complications after surgery and reduced number of readmissions to the hospital (23, 24).

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WHAT DOES A JUNIOR DOCTOR NEED TO KNOW TO MANAGE JOINT ARTHROPLASTY PATIENT?

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Novel Oral Anticoagulants offer ease of administration and increases patient compliance. There are certain cautions and avoidances which need to be observed for certain patient groups. It is recommended that the reader follows British National Formulary. Monitor platelet counts weekly for patients on LMWH to identify Heparin Induced Thrombocytopenia. Half dose to be used in patients with reduced kidney functions. Aspirin is not recommended along with it (14).

Test yourself section:

1) 72 year old man has returned an hour ago to the ward after having right total hip replacement operation. He is confused, pale with the pulse of 110 / minute, blood pressure of 80/60 mmHg, respiratory rate of 25/minute, no urine output so far. He does not complaint of chest pain. There is no swelling of his legs. The patient had general anaesthesia for surgery. The staff nurse is worried and has bleeped you to review this patient. What is the cause and how will you manage? Multiple choice answers:

1) Postoperative hypotension

2) Deep vein thrombosis

3) Myocardial infarction

4) Overdose of opiod analgesia

5) Postoperative confusion

2) 65 year lady was trying to get out the bed during her when she felt a give in her operated right total hip replacement. She was unable to stand on her right leg. Staff nurse has put the patient back in the bed. Her right leg is shortened and internally rotated. You are asked to review her. What is the cause and how will you manage? Multiple choice answers:

1) Postoperative pain

2) Deep vein thrombosis

3) Posterior hip dislocation

4) Anterior hip dislocation

5) Sciatic nerve palsy

3) 75 year old female 3 days post total knee replacement is mobilising with zimmer frame with the help of a physiotherapist. She notices pain in her chest with shortness of breath. She describes it as heaviness in the middle of her chest with radiation of pain to her neck and jaw. There is associated dizziness and perspiration.

She is cold and clammy. Physiotherapist and nurses have put her back in her bed. Her blood pressure is 150/100 with the pulse of 104/ minute. Her respiratory rate is 28/min. ECG shows ST elevation in lead II, III aVF Staff nurse has fast bleeped the oncall doctor. What is your diagnosis and how will you manage?

1) Pulmonary embolism

2) Anterior myocardial infarction

3) Inferior myocardial infarction

4) Reflux oesophagitis

5) Lateral myocardial infarction

4) 69 years old female 3 days post right total hip replacement complains of sudden onset of difficulty in breathing, pleuritic chest pain, pain in her right leg. She is cold and clammy. Her right lower limb is swollen and painful.

ECG shows S1, Q3, T3 (S wave in lead I, Q wave in lead III and T wave inversion in lead III). You have been asked to review the patient. What is your diagnosis and how will you manage?

1) Anterior myocardial infarction

2) Inferior myocardial infarction

3) Pulmonary embolism

4) Chest infection

5) Lateral myocardial infarction

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WHAT DOES A JUNIOR DOCTOR NEED TO KNOW TO MANAGE JOINT ARTHROPLASTY PATIENT?

G Verma, S Shah

5) A 75 year old gentle man had his left total knee replacement done 2 days ago. He had spinal anaesthesia during surgery. Post surgery he went into urinary retention and needed urinary catheter insertion. His urine output has gradually decreased over last 8hours. It is <0.5mls for the last 6 hours. Staff nurse bleeped the oncall night junior doctor to prescribe some intravenous fluids but as the doctor was very busy with on call he could not prescribe it.

Staff nurse sent routine urea and electrolyte which has shown the increase in creatinine to >30micromol/litre since yesterday. You see the patient on your morning ward rounds. The patient is talking. His blood pressure is 110/70mmHg, pulse 80/min, respiratory rate 20/min, temperature 37.5. What is your diagnosis and how will you manage?

1) Acute kidney injury

2) Urinary tract infection

3) Post operative hypotension

4) Chest infection

5) Post operative confusion

Answer

1. Answer: It is postoperative hypotension.

Explanation: Management would follow advanced life support approach. Assess airway, breathing, circulation, consciousness level and operated wound site for any soakage or haematoma formation. The average blood loss during total hip replacement surgery is approximately 1 litre. Administer 100% oxygen. Make sure intravenous access is working. Send blood sample for haemoglobin and urea and electrolytes assessment.

Consider electrocardiogram to rule out other cause of post operative hypotension such as silent myocardial infraction. Review total amount of intravenous fluids given so far from the anaesthetic chart and total blood loss during surgery. Start intravenous fluid challenge. Review patient analgesia. Consider inserting urinary catheter to monitor hourly urine output. If haemoglobin is <8 g/dl then transfuse blood. Inform seniors and discuss your treatment plan. Review patient at regular intervals. Hand over this patient to your colleague at the end of your shift.

2. Answer: It is the posterior hip dislocation.

Explanation: Patient will not be able to stand on her leg if the hip is dislocated. Posterior hip dislocation will present with shortening and internal rotation alignment of the affected lower limb. This patient needs an x-ray of right hip to confirm your diagnosis and to rule out any periprosthetic fractures. The patient will need to return to the theatre for manipulation and reduction of right hip under anaesthetic.

3. Answer: Inferior wall myocardial infarction.

Explanation: On arrival follow Advance life support approach. Start 100%oxygen (unless history of chronic obstructive respiratory disease (COPD)). Achieve intravenous access and send blood samples for troponin, FBC, CRP, UE, glucose, liver function test, lipids, coagulation screen and chest x-ray. Follow trust guidelines for managing acute myocardial infarction. Contact medical registrar for further advice and treatment. Inform you seniors. Consider transferring the patient to a coronary care unit.

4. Answer: Pulmonary embolism.

Explanation: On arrival follow Advance life support approach. Start 100% oxygen. Achieve intravenous access and send blood samples for routine blood, arterial blood gases. Start intravenous fluids. Follow trust guidelines for managing pulmonary embolism. Get urgent computed tomography pulmonary angiography (CTPA) to confirm the diagnosis. Will need to treat with therapeutic low molecular weight heparin. Contact medical registrar for further advice and treatment. Inform you seniors.

5. Answer: Acute kidney injury.

Explanation: Review patient's vital parameters trend since his surgery, intake and output fluid chart in last 24 hours, urea and creatinine levels and medications on drug chart. Assess other comorbidities. Rule out any blockage in the urinary catheter. Start intravenous fluids. Follow trust guidelines for acute kidney injury management. Discuss with nephrology registrar with regards to further management. Inform your seniors.

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LEARNING POINTS: COMPARTMENT SYNDROME

W Groom, A Saini, OM Lahoti

Abstract

Compartment syndrome is an orthopaedic emergency with potentially devastating consequences. It is a clinical diagnosis and, once identified, requires urgent surgery to decompress the affected compartments in order to preserve function in the affected limb. Adjuncts exist to help with the diagnosis but should not be relied upon over experienced clinical judgment. In this paper we discuss the causes and how to diagnose the condition as well as present an illustrative case study.

Case Study

Mr P, a 54 year old man, presented to King's College Hospital having fallen 6 feet, landing on his left leg. He took medication for anxiety but had no other past medical history. He was managed according to the ATLS protocol in the emergency department and was noted to have a deformity to the left leg with no other significant injury.

Imaging confirmed a closed mid-shaft fracture of his left tibia and fibula. He was noted to have normal sensation distally with good dorsalis pedis and posterior tibial pulses. However, the overlying skin was threatened due to the underlying deformity of the fracture.

Figure 1: AP and lateral radiographs of mid-shaft tibia and fibula fractures.

The anterior compartment was firm to the touch when compared with his lateral and posterior compartments. However, he had good function of tibialis anterior and his extensor digitorum muscles as well as normal sensation in the deep peroneal distribution. Passive stretching of his extensor compartment was uncomfortable but tolerable.

Figure 2: AP and lateral radiographs of fractures after reduction.

The fracture was reduced in the emergency department under ketamine sedation and an above knee back slab was applied (not a complete cast which may have caused further compression of the leg). Intra-medullary nail fixation was planned for the following day.

He continued to be monitored for the development of compartment syndrome; 2 hours after admission his compartment pressures were measured using an arterial line transducer system and found to be 8mmHg. This was reassuring, especially when compared to the diastolic pressure of 73mmHg. Despite this, the treating team maintained a high level of suspicion for the development of compartment syndrome.

4 hours after admission he was developing increasing pain in his left leg which was not responding to analgesia and he had developed paraesthesia in the deep peroneal nerve distribution. Pedal pulses were intact. His anterior compartment remained firm to the touch. He was transferred to theatre as soon as possible and underwent fasciotomies of all 4 compartments in the leg via medial and lateral incisions (Figure 3).

An external fixator was then applied to stabilise the fracture. During the operation the muscle of the anterior compartment was noted to be contused. Vacuum assisted closure (VAC) dressings were applied to both fasciotomy wounds.

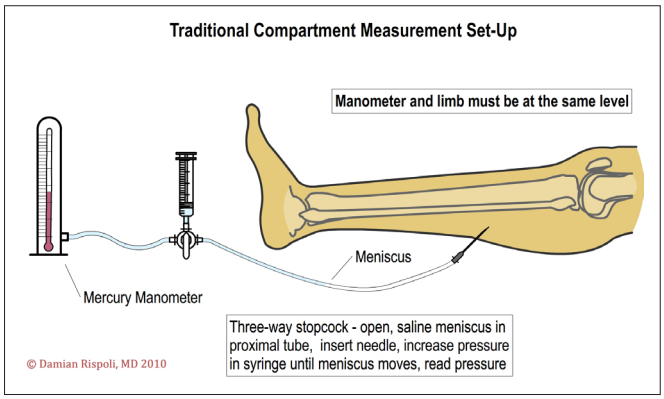

Figure 3A: Compartment pressure monitoring with transducer.

Figure 3B: Site of fasciotomy wound following skin grafting.

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Two days later Mr P returned to theatre for removal of the external fixator and intra-medullary nail fixation of the fracture. Soft tissue swelling had settled enough to allow the medial fasciotomy wound to be closed primarily with skin grafting required for the lateral wound. Mr P was discharged 2 weeks post-operatively.

Pathophysiology of Compartment Syndrome

Muscles of the extremities are contained in defined compartments, bound by dense connective tissue called fascia. The compartments have a limited capacity for expansion and so any increase in volume from within, or external compression from outside can result in a pathological increase in pressure within the compartment.

A significant increase in intra-compartmental pressure will restrict blood flow into that compartment, resulting in hypoxia, ischaemia and necrosis of the tissues within. This subsequently results in increased oedema, pressure and a self-perpetuating cycle of muscle necrosis, fibrosis and, if left untreated, Volkmann's ischaemic contracture. Fascial compartments also contain nerves, which will also be exposed to potentially irreversible ischaemic injury. (1)

Diagnosis

Compartment syndrome is a clinical diagnosis. In the context of trauma all patients should be initially assessed and resuscitated according to Advanced Trauma Life Support (ATLS®) principles (2). Thereafter focus should be turned to injured extremities. Along with the evaluation of neurological and vascular status, assessment must be made for evidence of compartment syndrome.

Suspicion for compartment syndrome should be particularly high after high energy trauma or crush injuries, but it may occur at other times, as illustrated in our case study. The signs and symptoms of compartment syndrome are often remembered as the '5 Ps'. However, the cardinal symptom is that of pain inconsistent within the context of the injury, and resistant to analgesia. Pain is also increased with passive stretch of muscles contained within the effected compartment.

Symptoms resulting from nerve ischaemia within a compartment include altered sensation in that nerve's distribution, weakness or complete paralysis of any muscles supplied by it. This may be irreversible. Pulses are usually present and their absence is usually due to arterial occlusion, vascular injury or systemic hypotension. (3)

The '5 Ps' of Compartment Syndrome

- *Pain*
- *Pallor*
- *Pulselessness*
- *Paralysis*
- *Paraesthesia*
- *(and pain on passive stretch of the muscles in the affected compartment)*

Increasing demand for analgesia should raise serious concern. In those that are unconscious or if clinical uncertainty exists, the measurement of compartment pressures may serve as a diagnostic adjunct. The pressure within each compartment of concern is assessed using an invasive probe and measured in mmHg.

The result must be considered in isolation and in relation to the systemic blood pressure. A Δ(pronounced 'Delta') P value is calculated by subtracting the intra-compartment pressure from the diastolic blood pressure. All values are in mmHg. A ΔP value of less than 30mmHg is highly suggestive of compartment syndrome in the correct clinical context, as is an absolute intra-compartment pressure above 40mmHg. (4)

Management

Compartment syndrome is a surgical emergency. Any patient considered at risk of developing compartment syndrome should be nursed with the at-risk limb elevated, in a neutral position. They should be closely monitored for development of the signs and symptoms of compartment syndrome. Once a diagnosis has been made, any encircling bandages must be released prior to transfer to theatre for urgent decompression of all affected compartments via surgical fascial release.

Percutaneous or minimally invasive techniques are not recommended in acute traumatic compartment decompression. Surgery is only delayed if other life-threatening conditions take priority. The approach used is dependent on the site of the compartment syndrome and the number of compartments in the region. For example, compartment syndrome is most commonly found in association with a diaphyseal tibial fracture, and this would require decompression of the four compartments of the leg. These are the superficial and deep posterior, the anterior, and the lateral compartments (Figure 4). (5)

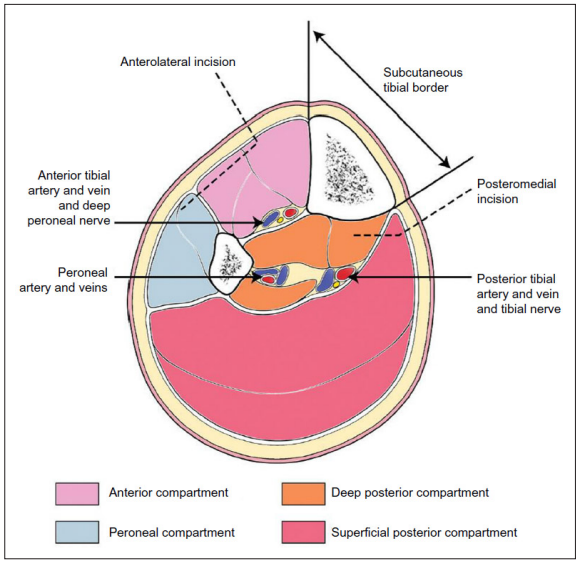

Figure 4

LEARNING POINTS: COMPARTMENT SYNDROME

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Post-decompression, the ankle should be splinted in neutral to avoid an equinus deformity; a common complication of compartment syndrome. Physiotherapy should begin to preserve function distally in the effected limb and prevent clawing due to flexor contracture. Fasciotomy wounds need to be carefully monitored due to the risk of infection. Several techniques for wound closure are described in the literature, each with its own advantages and disadvantages. Split skin grafting is the most commonly used and has the benefit of being tension free although it prolongs hospital stays and creates a second unsightly wound. (6)

Conclusions

Compartment syndrome is an uncommon but potentially devastating condition. The diagnosis in made clinically. Compartment pressure monitoring may provide a diagnostic adjunct if there is clinical uncertainty and in the unconscious patient. The management of compartment syndrome is immediate surgery, with open fascial decompression of all affected compartments.

MCQ's

1. Causes of compartment syndrome include:

a. Crush injuries

b. Fractures

c. Reperfusion of ischaemic limbs

d. Burns

e. All of the above

2. The cardinal symptom of compartment syndrome is:

a. Paraesthesia

b. Pulselessness

c. Pain

d. Pallor

e. Paralysis

3. Compartment syndrome is most commonly encountered in clinical practice after:

a. Knife injuries to the thigh

b. Gunshot wounds to the forearm

c. Fractures of the leg

d. Vascular surgery

e. Crush injuries to the hand

4. The management of compartment syndrome once a diagnosis has been made requires:

a. Decompression of all involved compartments on the next trauma list

b. Observation

c. Elevation

d. Immediate open fascial decompression of all involved compartments

e. Invasive compartment pressure monitoring

5. A Δ P value is calculated by:

a. Adding the intra-compartment pressure to the diastolic blood pressure

b. Adding the intra-compartment pressure to the systolic blood pressure

c. Subtracting the intra-compartment pressure from the diastolic blood pressure

d. Subtracting the intra-compartment pressure from the systolic blood pressure

e. None of the above

Answers

1. e. All of the above.

Whilst trauma is the most common cause of compartment syndrome, multiple other mechanisms have been described. These include reperfusion of ischaemic limbs after both emergency and elective surgery, prolonged immobilisation, burns, extreme exercise, extravasation of intra-venous infusions and intra-compartmental bleeding secondary to coagulopathy.

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LEARNING POINTS: COMPARTMENT SYNDROME

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2. c. Pain.

Pain is the cardinal symptom of compartment syndrome and is out of proportion of the associated injury. Pain is also increased on passive stretch of muscles within the effected compartment. Pulses are usually present and their absence is usually due to arterial occlusion, vascular injury or systemic hypotension (5). Altered sensation in the distribution of nerves contained in the effected compartment may occur, with complete paralysis being a late feature.

3. c. Fractures of the leg.

Fractures of the tibial diaphysis account for 36% of cases of compartment syndrome (1). It should be noted that the leg is considered the area from the knee to the ankle, and the thigh from the hip to the knee.

4. d. Immediate open fascial decompression of all involved compartments.

Compartment syndrome is a surgical emergency and surgery should only be delayed if there are other life-threatening conditions which take priority.

5. c. Subtracting the intra-compartment pressure from the diastolic blood pressure.

The diagnosis of compartment syndrome is based on clinical assessment. However in cases of clinical uncertainty and in the unconscious patient measurement of intra-compartment pressures may serve as a diagnostic adjunct. The Delta P value is calculated by subtracting the intra-compartment pressure from the diastolic blood pressure. All values are in mmHg. A Δ P value of less than 30mmHg is suggestive of compartment syndrome in the correct clinical context.

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THE UN-DODGED BULLET: SPINAL CORD INJURY SECONDARY TO A GUNSHOT WOUND

S Foster, AR Michaels

Abstract

A 45-year-old male presented to a major trauma centre (MTC) with a complete spinal cord injury (SCI), secondary to an intrathecal bullet at T3 level. He underwent urgent decompressive spinal surgery although no neurological improvement was noted during subsequent rehabilitation within a specialist SCI centre (SCIC). The management of this case will be critically appraised based upon current guidelines in terms of his immediate and subsequent care. Additionally, the role of human factors within a trauma setting will be considered, alongside the difficulties of balancing a doctor's duties towards their patient versus the forensic priorities of the police.

Case history

A 45-year-old male was admitted to a MTC under armed police custody after sustaining a gunshot wound to the left shoulder. It was noted during the primary survey (1) that the patient had a GCS of 15, he was haemodynamically stable with a circular left anterolateral shoulder entry wound (see image 1) and there was minimal external blood loss. His cervical spine had been immbolised (2) and the patient stated he was unable to move or feel his lower limbs. A neurological examination demonstrated no distal sensation or motor function in the lower limbs with a sensory level at T3 dermatomal level. A rectal examination after log roll3 confirmed a Frankel Grade A (complete) SCI2, (4).

Image 1: Bullet entry wound.

A trauma CT series (reported by a senior radiologist 5) showed a small left haemothorax with lower lobe contusion and a fracture of the left transverse process of T3 with a foreign body (consistent with a bullet) in the spinal canal (see images 2 and 3 below). The shoulder girdle appeared to be intact, there was gas within the left sub-clavicular tissues and no major vessel trauma or colonic involvement was noted.

Image 2: Lateral reconstruction of trauma CT demonstrating a foreign object at T3 level.

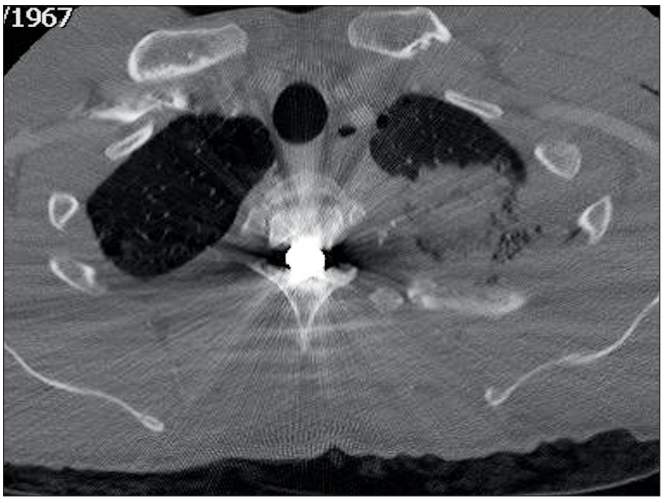

Image 3: Transverse reconstruction of trauma CT demonstrating a metallic foreign body at T3 level with significant artefact.

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The on call spinal surgery and spinal injuries consultants reviewed the case and patient within the emergency department after initial fluid resuscitation and investigations. Urgent surgery was planned to reduce future complications including a post-traumatic syrinx or chronic neuropathic pain. He was taken to theatre for a posterior decompression of T3 with removal of foreign body from the spinal canal (see intraoperative microscope images 4 and 5), repair of dura, insertion of a left sided chest drain and washout of the left shoulder wound. The bullet was removed and confiscated by the police as forensic evidence.

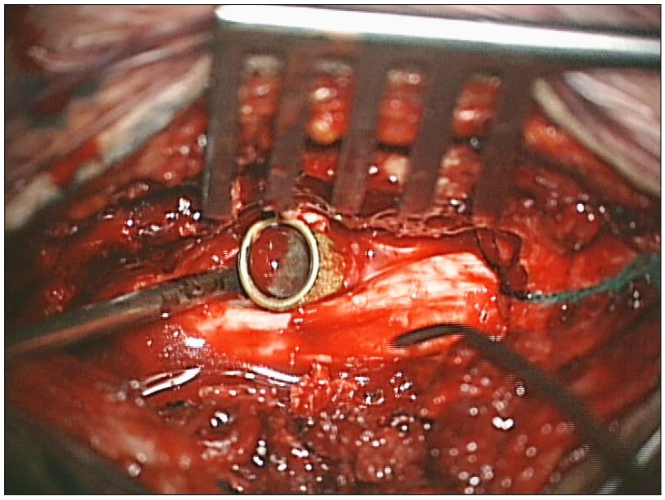

Image 4: Demonstration of bullet within the Dural space.

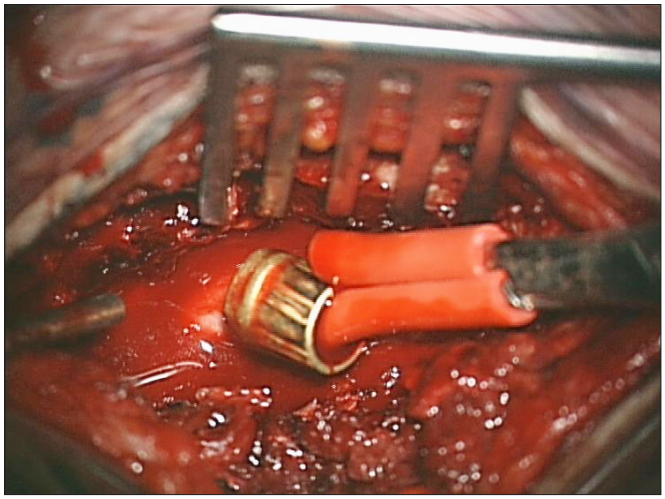

Image 5: Removal of bullet with forceps.

Post operatively, the patient remained paralysed below T3 level and was monitored in level two care due to ongoing pain with an armed police escort. Three days later after removal of his chest drain, he was transferred to the local SCIC for ongoing rehabilitation where he remained an inpatient for four months. He remains under neuro-rehabilitative follow up for complex neuropathic bladder and bowel issues and is semi-independent within his home after significant adaptations three years after his injury.

Discussion

This patient initially self-presented at a Children's Hospital who, although inexperienced with managing adult patients, appropriately ensured he was both haemodynamically stable and had intravenous access with opioid analgesia. The ambulance service immobilised his cervical spine before urgent transfer to the local adult Accident and Emergency department within a MTC.

The MTC was informed of his imminent arrival 15 minutes before he was brought to the resuscitation suite and a full trauma team were on standby. He arrived at 05.58am and the necessary initial biochemical investigations (including samples for cross matching) were collected within 15 minutes of presentation.

His head-to-thigh CT series (the gold standard definitive imaging technique for trauma patients 2,5,6) was at 06.30am after an adequate primary survey and subsequent peripheral neurological examination by the orthopaedic registar (1). The on call consultant spinal surgeon was informed of the patient at 06.35am and reviewed him within the department at 07.45am. A frank conversation about the likely neurological outcome was documented between the surgeon and the patient with the indication and potential risks clearly identified. After discussion with his partner, the patient consented for surgery; he was anaesthetised at 8.40am and surgery commenced at 09.10am.

Cervical spine clearance was completed after his CT series and subsequent clinical examination – modern guidance suggests that cervical spine immobilisation is itself not without risks including pressure sores; no obvious indication for immobilisation could be identified within this case (7). According to the literature, urgent surgical decompression is indicated for new onset or a progressive deterioration in neurological function, regardless of the injury level.

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However, the optimum time for surgery post-injury remains controversial (8) – it was felt by the trauma consultant surgeon and SCI consultant that urgent surgery would offer the best neurological outcome in this case. Post-operative antibiotics in the case of gunshot wounds have been shown to reduce infection rates within numerous studies (9). This patient did receive 7 days of intravenous antibiotic therapy alongside methylprednisolone; the latter has not been shown to improve neurological outcome and can result in systemic complications, thus would not be routinely recommended10.

Following his initial post-operative recovery, the patient was promptly transferred to the local SCIC with specialist access to rehabilitative and psychological services (11). He rejected follow up by the latter; after case note review it is apparent that the SCIC team have offered him psychological follow up regularly since discharge which he continues to decline despite concerns of the multidisciplinary team (MDT).

It is paramount to advocate for the best interests of your patient and offer them access to medical, holistic and social services. However, healthcare professionals must ensure that they respect their patients' autonomy and right to make subjective unwise decisions to ensure maintenance of a bilateral therapeutic relationship (12).

Although under armed police guard for the patient's own protection, there was no documentation to suggest that medical or law enforcement teams were obstructive to one another. This case does however raise the question of medical care and if this contradicts judicial priorities. The patient did not disclose details of how he had sustained his injuries throughout his hospitalisation; it could be argued that the immediate priority of the trauma team was to assess for life threatening injuries, not to ascertain how these occurred.

Additionally, confidentiality is central to a doctor-patient relationship but despite this, disclosure of information to relevant sister services, such as the police, can be essential to safe care provision for both an individual patient and the wider community (13). The General Medical Council (GMC) advise that presentations of gunshot and knife wounds to healthcare professionals should be reported quickly to the police, with the aim of preventing further incidents and protecting other patients and staff (14).

Staff at the Children's Hospital had alerted the local police service and this patient remained under armed police guard within the MTC, operative theatres and whilst nursed on the high dependency unit post-operatively for his own safety. There could be tension when considering if the initial focus should be to treat injuries or to gather forensic evidence.

Within this situation, urgent medical care took clear precedence over forensic assessment. Forensic evidence can degrade with time and therefore physicians, alongside the police, must weigh up the priorities of medical care and gathering evidence, making an assessment of what is in the best interests of their patient and potentially, public safety (14).

The culture of a trauma team, in terms of human factors or non-technical skills, can affect both the performance and morale of the group regardless of individual experience (15). Contemporary literature supports that leadership, inter-professional relationships and the physical environment can each play a significant role in affecting the behaviour of trauma team members (16).

Thus, poor communication or conflicting priorities between the police and medical teams could allow errors to perpetuate, permitting patient harm to occur. Indeed, a police presence itself on the peripheries of a high pressure trauma situation could unduly influence the behaviour of medical staff through causing additional environmental stress.

Teamwork is a vital aspect of professional development allowing collaboration and reduction of systematic errors through an integrated approach to individual skills, organisational structure, teamwork and communication (15). Within the MTC in question, a 'hands off' approach is utilised during the ambulance staff handover to the trauma team, to ensure key aspects of the case are not neglected due to the fast pace of a trauma situation.

Conclusion

Overall, initial examination, investigation and management of this patient seems appropriate and timely, with clear documentation of all stages of assessment and discussion (2). The clinical significance of his injuries was recognised early through adherence to trauma guidelines (1-7), access to specialist advice including prompt reporting of trauma CT scans (5) and clear inter-professional communication between the trauma team, the police (13,14) trauma surgeon and SCI specialists (11).

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THE UN-DODGED BULLET: SPINAL CORD INJURY SECONDARY TO A GUNSHOT WOUND

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It appears, as far as can be ascertained retrospectively from medical records, that all staff remained professional and acted within the best interests of this patient. In future, similar cases of SCI, the indications of post-operative methylprednisolone could be considered by the MDT in terms of current guidelines and the risk of non-neurological poor outcomes (10).

Additionally, pre-hospital management of potential cervical spine injuries could be revisited by the local ambulance service to ensure unnecessary patient harm is minimised where there is no clinical indication for immobilisation (7).

Test yourself Questions

1. An 85-year-old lady had a haemorrhagic stroke several months ago. Which feature would you not expect on neurological examination?

A. Spastic paraplegia

B. Positive Babinski reflex

C. Fasciculations

D. Hypertonia

E. Absent abdominal reflexes

2. A 32-year-old male patient presents to A&E after falling of a horse. Although his GCS is 15/15, he states he cannot move his arms or his legs. Which feature would not be characteristic of neurogenic shock?

A. Bradycardia

B. Warm peripheries

C. Failure to respond to intravenous fluid resuscitation

D. Narrowed pulse pressure

E. All features above are characteristic

3. A 45-year-old female patient presents unable to move their legs after a high speed road traffic collision. On examination they have preserved sensation in the lower limbs but no motor function below L1 level. Which Frankel grade classification is represented here?

A. A

B. B

C. C

D. D

E. E

4. 8 months after a road traffic collision, a patient who sustained a T3 level spinal cord injury presents with chronic pain, loss of temperature sensation in her legs and thoracic spine stiffness. What diagnosis should be considered?

A. Post traumatic syringomyelia

B. Autonomic dysreflexia

C. Neuropathic pain

D. Depression

E. Meningioma

5. A 17-year-old male presents with a stab wound on the left side of his neck. He has a left hemiparesis with complete loss of joint position and vibratory sense below C6 level on the left. An MRI of the cervical spine would show?

A. Lesion of the left posterior cord

B. Complete cord transection

C. Left sided hemi-section

D. Right sided hemi-section

E. Right C6 dorsal root damage

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MCQs

1 – C (fasciculations)

A stroke or cerebrovascular accident represents an upper motor neuron (UMN) lesion, above the anterior horn cells within the spinal cord, where a patient would demonstrate hypertonia, hyperreflexia, pyramidal weakness and spasticity.

Conversely, in a lower motor neuron (LMN) lesion, either within or distal to the anterior horn cell, you could elicit hypotonia, hyporeflexia, muscular atrophy and fasciculations. The latter represents involuntary muscular contractions due to spontaneous lower motor neuron depolarisation; this would not be seen in an UMN lesion (17).

2 – D (narrowed pulse pressure)

Neurogenic shock is characterised by bradycardia, hypotension and peripheral vasodilatation. The underlying cause is due to loss of sympathetic vascular tone occurring after significant nervous system damage, typically due to lesions above T6 level.

Therefore, the incorrect answer is narrowed pulse pressure, as a wide pulse pressure would be observed due to vasodilatation. Conversely, spinal shock is not a true form of shock as it describes flaccid areflexia after spinal cord injury; you could think of this as a concussion of the spinal cord, where resolution of soft tissue swelling can lead to neurological improvement (2).

3 – B (Frankel Grade B)

The Frankel grade classification is used to assess spinal cord injury as follows:

1. Grade A: complete neurological injury with no motor or sensory function below the level of the lesion.

2. Grade B (correct answer): preserved sensation only. Some preservation of sensation with no motor function below the level of the lesion.

3. Grade C: non-functional motor preservation; voluntary motor function is too weak to serve a useful purpose below the lesion.

4. Grade D: functional motor preservation below the level of the lesion.

5. Grade E: normal motor function below the level of the lesion; abnormal reflexes may be present (4).

4 – A (syringomyelia)

Syringomyelia refers to cyst formation within the spinal cord which may be due to an anatomic nervous system abnormality or secondary to a neurological insult including trauma.

A cyst forms within the damaged cord and can expand over months or years leading to sensory impairment at the level of the injury, weakness and pain. Although many patients who have sustained a spinal cord injury will develop a cyst at the original injury site, treatment, including surgery, is only warranted if this expands or causes symptoms (18).

5 - C (left sided hemi-section)

This case represents an incomplete spinal cord lesion, or hemi-section of the cord; the eponymous Brown-Séquard Syndrome. Patients present with ipsilateral upper motor neuron paralysis with loss of proprioception or vibration sense, alongside loss of the spinothalamic tract (conveying the sensory modalities of pain and temperature) on the contralateral side. This can be explained by decussation of the dorsal columns within the medulla whereas spinothalamic fibres cross over at the level of the spinal cord (19).

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ASSESSMENT OF THE SHOULDER IN A&E

MS Bhamra, N Shah, A Akinyooye, T Bochmann

Abstract

Background

The shoulder is a commonly injured joint and will be seen in A&E by the Foundation doctor. They require a system of evaluating the shoulder within the time constraints of the 4 hours.

Aetiology

This is dependent on 2 main factors, age and trauma mechanism. This can effect the type of injury sustained from a soft tissue problem to a neurovascularly compromised fracture dislocation.

Diagnosis & Management

Assessment is made through history, and an examination is key. Imaging with X-Rays (with minimum 2 views) is usually required along with bloods on some occasions. Once the evaluation is complete a plan can be formulated, either to commence management or refer onto Orthopaedics.

Summary

An acute shoulder complaint can be managed competently by a Foundation doctor who knows the symptoms and signs, corresponding to each injury. Senior help should always be sought if any urgent signs are identified.

Introduction

The shoulder joint complex, consisting of 5 joints, is the most mobile joint in the body. As a consequence, it is also one of the most frequently injured. Knowledge of key anatomy, diagnoses and presentation are essential for FY doctors' in making appropriate referrals and knowing when to seek senior help.

The aim of this article is to highlight, through a case scenario and 5 case-based MCQ's, the importance of the basic understanding of differential diagnoses and allow the reader to become comfortable in commencing management for an acute shoulder complaint.

Key points in the anatomy and aetiology of pathology in the shoulder is included. History, examination, investigations and management strategy have been highlighted for the different causes and will help in recognition of related features, specific to their shoulder complaint.

Anatomy

The shoulder joint comprises of articulation between bones (clavicle, scapula and humerus), ligaments and muscles (rotator cuff). The scapula has different articulating parts essential to the workings of the shoulder. The glenoid has a labrum on its circumference, deepening it, but may be prone to injury during a dislocation.

Two joints that are often involved in shoulder pathology are:

The acromio-clavicular joint (ACJ) – Clavicle articulating with the acromion and the gleno-humeral joint (GHJ) – Humerus articulating with the glenoid.

There are various ligaments within the shoulder joint which is beyond the scope of this article. Rotator cuff muscles are essential to the working of the shoulder (see table 1).

Muscle	Action
Deltoid	flex, extend, ABduct humerus
Supraspinatus	ABduct humerus
Infraspinatus	external rotation humerus
Teres minor	external rotation humerus
Teres major	ADDuct, extend, internal rotation humerus
Subscapularis	internal rotation humerus

Table 1: Action of rotator cuff muscles.

Aetiology of Pain and/or Stiffness

Young patient (< 40yrs) Think! Instability.

Middle aged patient (40-60yrs) Think! Frozen shoulder (adhesive capsulitis), calcific tendonitis or rotator cuff tear.

Senior patient (>60yrs) Think! Osteoarthritis (OA)/sepsis or cuff pathology.

Case Study

You are the FY1 in A&E and have been asked to see a usually fit and well 45 year old female with a painful left shoulder.

History

The history surrounding the injury should allude to the diagnosis. When considering the history of a shoulder injury the essential areas in beginning to identify your working diagnoses are:

Is it a traumatic or non-traumatic injury

The age of the patient

Traumatic

The injuries may result from a fall, road traffic collision or playing sport. Trauma may be as the result of a high energy or a low energy injury.

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High energy trauma

Think! Fracture +/- shoulder dislocation (anterior vs posterior), proximal humeral fracture, clavicle fracture or disruption of surrounding soft tissues (e.g. massive rotator cuff tear.)

Image 1: X-ray of anterior shoulder dislocation.

Image 2: 3D CT scan of posterior fracture dislocation.

Low energy trauma

Think! Soft tissue injury (e.g. rotator cuff tear.)

Think! Epileptic seizure classically will lead to posterior shoulder dislocation (see Image 2).

Non-traumatic

Diagnoses commonly include septic arthritis, gout, calcific tendonitis, OA and rotator cuff tear from repetitive trauma, heavy lifting or degeneration.

Close attention to the following can help distinguish non-traumatic injuries:

- *onset and intensity of pain e.g. gout vs septic arthritis*
- *whether the patient has been unwell recently with temperatures and decreased range of movement e.g. septic arthritis vs OA*
- *experiencing night pain or are having difficulty lifting objects e.g. OA vs rotator cuff tear*

Past medical history

- *Connective tissue disorders*
- *Diabetes or other metabolic/ endocrine disorders*
- *Previous dislocations (mechanism, age of onset, subsequent rehabilitation and function)*
- *Previous surgery (including details of metalwork in-situ)*

History

She gives a history of falling off her horse an hour ago. She is in significant pain requiring morphine. and Entonox.

Shoulder Examination

Think! LOOK, FEEL and MOVE.

• LOOK

- *Dislocation*
- *Asymmetry (squaring-off), 'Sulcus sign' (indicative of joint laxity), arm held straight in extension*
- *Gout & Septic Arthritis*
- *Erythema, swelling*
- *Fracture*
- *Bruising and swelling*

• FEEL

- *Dislocation & Proximal Humerus Fracture*
- *Check 'Regimental Patch'- Axillary nerve*
- *Check Median, Radial and Ulna nerve neurological status*
- *Check distal pulse*
- *Gout/Septic Arthritis*
- *Is the joint hot and/or tender*
- *Clavicle Fracture*
- *Palpate deformity along length of clavicle*

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• MOVE

- *Dislocation and Proximal Humerus Fracture*
- *Lack of external rotation is likely to a posterior dislocation*
- *Lack of internal rotation is likely to be an anterior dislocation*
- *Movements not tolerated*
- *Gout, Septic Arthritis and Clavicle Fractures*
- *Decreased range of movement*
- *Rotator cuff tear*
- *Unable to hold arm abducted after passive abduction*
- *Weakness of internal and external rotation +/- resistance*

Examination

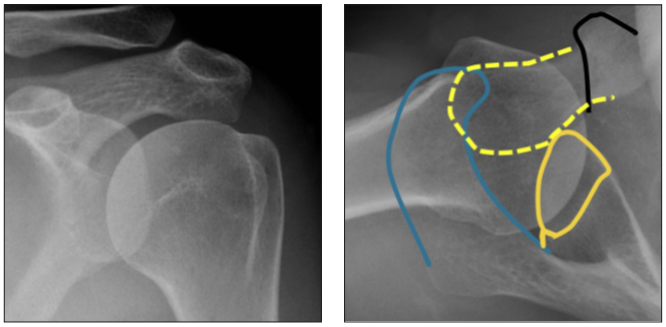
On examination she has an obvious deformity, with 'squaring off' of the shoulder. There are no wounds, some bruising is evident and she is neurovascularly intact. Painful on even gentle palpation with some crepitus and very little movement possible.

Investigations

The following investigations are followed by their relevant diagnoses; however, it is important to remember that the first line investigation for any shoulder problem should be an X-ray showing two or more views.

Shoulder X-ray

Dislocations require AP and axillary views (as a minimum)



Images 3 and 4: AP and an axillary view X-rays of a normal shoulder Calcific Tendonitis - Be aware of Calcific deposits above the greater or lesser tuberosity.

KEY

Blue = acromion

Yellow = clavicle

Orange = glenoid

Black = coracoid

Calcific Tendonitis

Be aware of Calcific deposits above the greater or lesser tuberosity

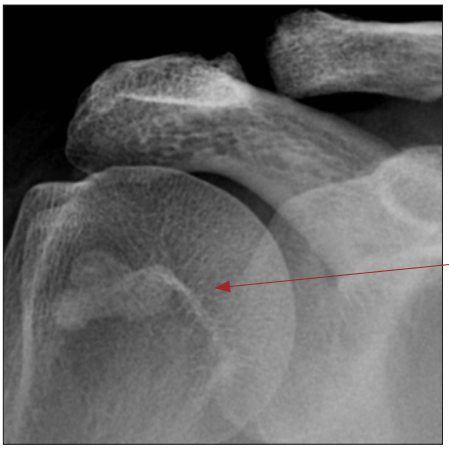


Image 5: X-ray showing calcific tendonitis in subscapularis muscle.

Proximal humerus, septic arthritis and gout require simple AP and lateral views.

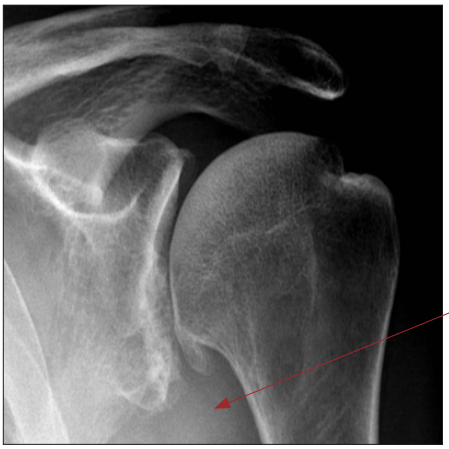


Image 6: X-ray showing OA.

Bloods

In all cases that infection is suspected: FBC, CRP, ESR, Blood cultures, serum Urate, before commencing any antibiotic therapy is essential.

Investigation

Left shoulder X-rays are requested, AP and lateral views as risk of fracture due to high energy. This confirmed a fracture dislocation of the shoulder.

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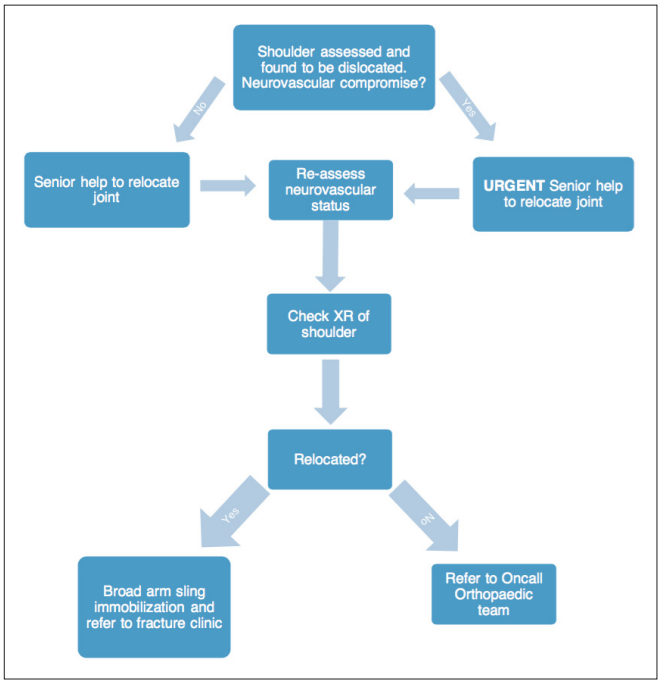
Management

As a FY doctor managing a shoulder injury will require you to first assess symptoms followed by further management e.g. seeking senior help or referral to Orthopaedics.

As part of the assessment and examination, check and record the axillary nerve sensation prior to and after any intervention.

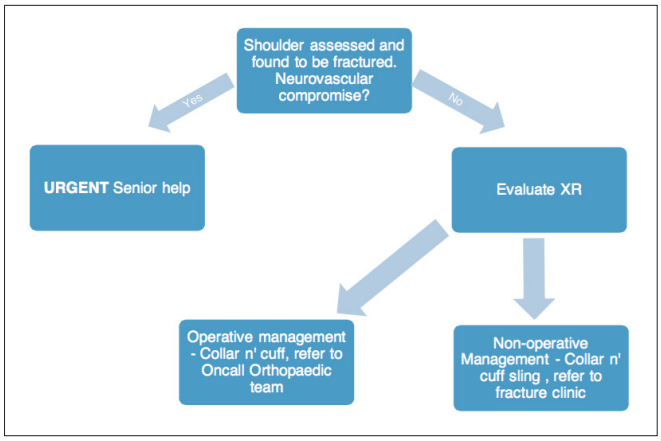
Guidelines for managing a shoulder dislocation.



Proximal Humeral Fracture

Image 7: X-ray showing proximal humeral fracture.

Guidelines For Managing A Proximal Humeral Fracture



ACJ dislocation

· Broad arm sling and refer to Fracture clinic

Image 8: X-ray showing ACJ dislocation.

Clavicle Fracture

Image 9: X-ray showing a clavicle fracture.

Remember to take 2 views (this is the same fracture!)
Neurovascular or respiratory problem ➔ Urgent senior help

ASSESSMENT OF THE SHOULDER IN A&E

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No complicating factors

Evaluate x-ray

Conservative management

Sling & fracture clinic follow-up
Septic Arthritis
Requires admission if investigations raise suspicion of infection
Analgesia & sling for comfort
Refer to Orthopaedics urgently
Do not start antibiotics prior, unless patient septic

Rotator cuff tear/Calcific tendonitis

Does not require admission (Unless social reasons do not permit safe discharge)
Analgesia and NSAIDs (If able to tolerate)
Book Physiotherapy & fracture clinic appointment

Management

This is a complex injury requiring referral to the Orthopaedic team for review to relocate in theatre emergently.

Conclusion

FY doctors will often be called to assess shoulder joint problems in A&E. Knowledge of anatomy and basic history/assessment can provide efficient management of these patients. One must be methodical in approach, working through using the steps highlighted. At any point where the limb may be threatened by either neurovascular injury or dislocation discuss with a senior urgently and refer to Orthopaedics. If further follow-up is required after initial management in A&E, then they may be referred to fracture clinic.

MCQ's (Best of five)

1. How many joints are there in the shoulder joint complex?

a. one

b. two

c. three

d. four

e. five

2. Proximal humerus fracture - Loss of sensation over the deltoid (regimental badge region) is associated with damage to which nerve?

a. median

b. axillary

c. accessory

d. radial

e. musculocutaneous

3. Clavicle fractures - Which of the following is not a commonly recognised complication of clavicle fixation?

a. pneumothorax

b. infection

c. haemothorax

d. compartment syndrome

e. non-union

4. Septic Arthritis- Which investigation is most reliable in the diagnosis of septic arthritis?

a. CRP

b. ESR

c. Joint Aspirate

d. USS

e. X-ray

5. Rotator Cuff Tear- which four muscles constitute the rotator cuff?

a. Supraspinatus, Infraspinatus, Teres Major, Subscapularis

b. Supraspinatus, Infraspinatus, Teres Minor, Subscapularis

c. Supraspinatus, Deltoid, Teres Major, Subscapularis

d. Deltoid, Infraspinatus, Teres Minor, Subscapularis

e. Supraspinatus, Infraspinatus, Teres Major, Teres Minor

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Answers

1. e.

There are five joints in the shoulder joint complex – they being: sternoclavicular; acromioclavicular; subacromial; gleno-humeral and scapulothoracic joints.

2. b.

The axillary nerve is responsible for motor function to the deltoid and sensation of the overlying skin. The course of the nerve around the proximal humerus makes it particularly vulnerable to injury.

3. d.

The clavicles lie in close proximity to the lungs and subclavian vessels; this makes an attempt at fixation potentially hazardous. Infection and non-union are important risks associated with any form of fracture fixation.

4. c.

Joint aspirate allows for microscopy and sensitivity of fluid indicating if the fluid contains pus cells, crystals or organisms.

5. b.

The rotator cuff is made up of these four muscles and any tear will compromise the overall function of the cuff and lead to weakness of the shoulder joint.

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METASTATIC SPINAL CORD COMPRESSION

Z Borton, D Farooq, N Rossiter

Abstract

Metastatic spinal cord compression is an orthopaedic emergency and an important source of morbidity for patients who have a diagnosis of cancer. It occurs when an epidural metastasis causes displacement of the cord. Resulting symptoms can include bladder dysfunction, paralysis and the commonly overlooked symptom of back pain. This case report refers to a 53-year-old patient with a history of breast malignancy who presented to orthopaedics, having been referred by the emergency department.

She described a 2-3 month history of progressive back pain, radiating to her chest. She had been managed in the community for a suspected osteoporotic collapse, a diagnosis reinforced by a nuclear bone scan. However, neurological symptoms developed and quickly progressed from isolated sensory change to paraplegia with urinary retention. Further imaging demonstrated an infiltrating metastatic lesion and critical cord compression, which at the time of presentation was no longer amenable to function-restoring treatment.

This case highlights the severe adverse outcomes associated with metastatic spinal cord compression and hence the importance of early diagnosis and management. To this end, NICE has produced evidence-based guidelines which recommend rapid magnetic resonance imaging in cases of spine pain and a history of malignancy - especially when there is associated neurology - in order to avoid these delayed presentations. Absence of a history of malignancy does not preclude the diagnosis of metastatic spinal cord compression.

Case History

A 53 year old female presented to the breast clinic with a breast lump. Following full investigations, invasive ductal carcinoma was diagnosed. The cancer was staged as T2N1 and graded as 3 – i.e. was poorly histologically differentiated, 2-5cm in size, and with contained spread to the axillary lymph nodes.

Due to the high grade and lymph node involvement it was treated with neoadjuvent chemotherapy, wide local excision with axillary clearance, adjuvant radiotherapy and establishment of hormone therapy. The patient was enrolled onto a surveillance programme and six months later her first screening mammogram was clear and there was no sign of recurrence or metastatic disease.

Shortly afterwards, the patient started to experience back pain radiating into her chest. This slowly progressed over the course of a month before a sudden exacerbation prompted attendance to ED. She denied any neurological symptoms. X-rays of the thoracic spine demonstrated collapse of the body of T8 (figure 1).

Figure 1: AP and lateral radiographs of the thoracic spine. Vertebral collapse of T8 is best appreciated on the lateral view.

Initial management was of gentle mobilisation and physiotherapy as the clinical suspicion at this time was of an osteoporotic fracture. Given the history of malignancy but lack of neurological symptoms, the patient was referred for a nuclear medicine (NM) bone scan as an outpatient. This demonstrated an isolated uptake at the level of T8 (figure 2), felt to be more in keeping with osteoporotic collapse rather than metastasis.

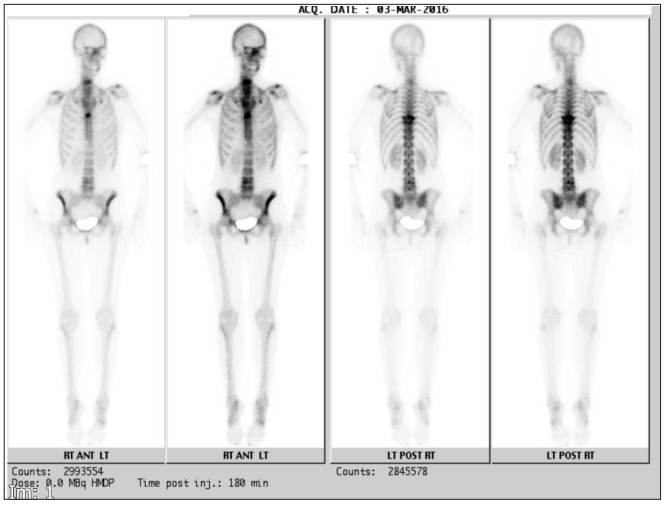

Figure 2: Nuclear medicine bone scan highlighting abnormal uptake at the vertebral level T8. There is local increased uptake at the manubrium and the body of the sternum, which can often be normal secondary to stress-related change at the manubriosternal joint.

Five days after the scan, the patient started to experience altered sensation running from the upper part of her abdomen into both legs. This was followed at day 7 with difficulty walking, with the legs sporadically 'giving way'. On day 10 the patient noted decreased urge to pass urine. She presented to the emergency department unable to walk on day 11 and was admitted under the orthopaedic team. On examination, she had a T8 sensory level, flexor power in lower limbs of 2/5 with minimal power in remaining lower limb muscle groups. She went into urinary retention overnight.

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Discussion

Metastatic spinal cord compression (MSSC) is an emergency, with more favourable outcomes secured by early treatment (<48hours) (1). Breast cancer is responsible for the highest incidence of MSSC, followed by lung and prostate cancer (2-3). In the later stages of breast cancer, bone metastasis has been shown to be as prevalent as 69% and in previously cleared, relapsing patients - as in the case presented here - bone is the most common first distal relapse site (4).

Estimates of lifetime prevalence of metastatic spinal cord compression amongst cancer sufferers vary wildly, from 2.5% to as high as 14% (1, 5-6). Patients who go on to present with cord compression often present with or experience back pain for several weeks prior to the development of neurological symptoms (5).

This can be unilateral or bilateral, commonly radiating to the abdominal or chest walls. Prognosis corresponds with the degree of neurological symptoms at the time of presentation and full recovery after the onset of motor symptoms is rare (7-8). Almost half of patients diagnosed with metastatic spinal cord compression are already unable to walk (9).

The onset of neurology is a concerning development necessitating emergency attention. Patients may complain of "stiff" or "weak" legs, or allude to this indirectly by describing difficulty balancing or falling (6). Any patient admitted with a fall and preceding back pain should be carefully examined to rule out cord compression. Sensory disturbances can occur in dermatomes below the level of the lesion.

Autonomic neuropathy with bowel, bladder and sexual dysfunction is common and may also be the presenting complaint (6,9). These symptoms are especially worrying if noted in conjunction with any red flag symptoms: patients aged over 50, pain unchanged by lying supine, sleep disturbance (night pain), past medical history of cancer or systemic symptoms (fevers, rigors, night sweats or weight loss).

Careful history in the example case elicited many of these features. On examination there was a T8 sensory level bilaterally. She was unable to walk or bear weight, with 2/5 power in the flexor groups of the lower limb, and 0-1/5 elsewhere in the legs. Urgent computed tomography (CT), followed by urgent magnetic resonance imaging (MRI) were performed (figure 3).

These demonstrated a large lesion with extension into both pedicles, the right transverse process, and the spinous process resulting in marked cord compression. The findings were discussed with the regional tertiary spinal service, though due to the delay in presentation and in definitive imaging it was not felt that this would be amenable to surgery. The patient was started on dexamethasone and referred to the regional spinal rehabilitation centre. The prognosis remains uncertain.

Figure 3: Detailed imaging of the lesion. 1 & 2: Coronal and sagittal sections from computed tomography (CT) scanning respectively. 3 & 4: sagittal views from T1 and T2 weighted (respectively) magnetic resonance imaging (MRI).

Due to the poor outcomes often associated with spinal cord compression, a NICE guideline has been commissioned based on evidence comparing the relative sensitivities and specificities of MRI, CT and NM bone scanning. Their conclusion mirrors the prevailing consensus in the literature, and support MRI as gold standard (3,7,9).

They recommend that if spinal metastasis is suspected, whole spine magnetic resonance imaging (MRI) scan should be performed within 1 week; if cord compression is suspected, the MRI should occur within 24 hours (10). Though NM bone scanning has acceptable sensitivity with the added advantage of looking for lesions elsewhere in the skeleton, the images produced are less anatomically detailed.

The scans can confirm the presence of a lesion in the spine, but cannot definitively identify compression of the spinal cord as a result of the lesion and may not inform on the aetiology of the lesion. The use of NM scanning in our case demonstrated these disadvantages, as the scan was felt to be compatible with the then-suspected osteoporotic collapse. CT has an adjunctive role in addition to MR, better defining the bony anatomy (7).

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There are a number of other learning points to be gained from critical reflection upon this case:

1: Any patient presenting with back pain and a history of malignancy- particularly breast, lung or prostate - should be considered at high risk of metastatic bone disease. The presence of neurology or findings on imaging inconsistent with the history (e.g. no trauma) amplifies this suspicion. Careful evaluation of the patient, including specialist review if there is any doubt, should be undertaken in these patients. The lack of definite history does not preclude the diagnosis: more than a fifth of MSSC presentations do not have a prior history of cancer (6).

2: When considering a diagnosis of osteoporotic fracture - even in the face of radiographic suspicion as in this case - attention must be given to the likelihood of the diagnosis. The patient represented by the case described was young for a porotic fracture, and did not describe a history of trauma. Equally, although there was an acute exacerbation in symptoms, there had been a preceding history of progressive back pain. It is imperative to elicit any history of malignancy in these patients. Had the summation of these factors been critically considered, it may have been prompted referral for urgent spinal MRI rather than an NM bone scan in the first instance, opening the window for urgent intervention with radiotherapy and/or surgical management.

3: The case demonstrates the importance of emphasising 'red flag' symptoms when discharging patients or referring for outpatient treatment. Motor disturbance, paraesthesia, and urinary symptoms should prompt emergency presentation. Thorough patient education might have encouraged earlier presentation in this case, potentially within a treatment window.

4: A final learning point to be borne in mind in this case is the importance of questioning preceding diagnoses and radiological results. Particularly amongst junior doctors, it is often easy to be reassured by specialist imaging or previous diagnoses, often made by more senior clinicians. As always, thorough and comprehensive history and physical examination is mandatory. A clinician should always question diagnoses that have come before. Where there is doubt, the case should be discussed with a specialist.

Questions

1: Which region of the spine is metastatic spinal cord compression most likely to occur?

A: Cervical
B: Thoracic
C: Lumbar
D: Sacral
E: All regions are equally likely

2: Bone is a frequent site of metastasis. Which sites more commonly experience metastasis than bone?

A: Brain, Lung, Liver
B: Lung only
C: Lung, Liver
D: Liver, Lung, Skin
E: Liver, Ovary

3: The effects of metastatic spinal cord compression upon the autonomic supply of the bladder cause...

A: Painful urinary retention
B: Painless urinary retention
C: Urinary incontinence
D: Urinary hesitancy
E: All of the above

4: Which of the following signs is inconsistent in a patient presenting with neurology from a metastatic process in the spine?

A: Hyporeflexia
B: Hyperreflexia
C: Clonus
D: Normal or indeterminate plantar reflex
E: None of the above

5: Compression affecting only one side of the spinal cord may give rise to the Brown-Sequard constellation of symptoms. Which of the following signs are consistent with Brown-Sequard?

A: Upper-track signs on the contralateral side to the lesion
B: Hyperreflexia on the affected side
C: Dorsiflexion of the hallux in response to plantar stimulation on the opposite side
D: Loss of pain sensation on the side of the lesion
E: Loss of pain sensation at the level of the lesion on the contralateral side.

Answers

1. Answer: B

The most common site is the thoracic spine, followed by the lumbar spine. This is a clinically important fact: mechanical low back pain is a very common and often benign clinical entity. Thoracic spinal pain is not, and should act as a 'red flag' to the clinician (1).

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2. Answer: C

The lungs and liver are the most common sites of metastasis, followed by the skeletal system amongst which the spine is the most common site (2).

3. Answer: E

Autonomic effects are usually a late feature of MSSC. This is often incorrectly thought of as urinary incontinence: though overflow incontinence can occur, painless retention and urinary hesitancy are more common. Other autonomic effects include faecal incontinence, constipation, and sexual dysfunction (6).

4. Answer: E

Although a process compressing only the spinal cord may be expected to produce more myelopathic (therefore upper motor neurone) signs, it is important to recognise that the lower motor neurone in the anterior horn, or along its course through the intervertebral foramina as the nerve roots can also be compressed by tumour. Therefore in practice, spinal metastases often present with a mixed UMN/LMN picture. Compression of the cauda equina, by definition, gives rise to lower motor neurone signs (1).

5. Answer B

The Brown-Sequard syndrome describes spastic paralysis (upper motor neurone) and proprioception loss on the ipsilateral side of the lesion, and loss of pain and temperature on the opposite side. Signs associated with upper motor neurone lesions include hyperreflexia. Answer E is almost correct: however, the pain fibres from the periphery cross the midline a couple of segments higher than they enter, running in the tract of Lissauer. Answer C describes a positive plantar reflex, which may be present on the ipsilateral side.

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SPINAL TUBERCULOSIS THE MODERN STATE OF MANAGEMENT

S Russo, E McGhee, J Lucas

Abstract

The incidence of tuberculosis (TB) is increasing in affluent countries. TB spondylitis is one of the most common manifestations of extra-pulmonary TB. Spinal TB is also known as Pott's disease, named after Sir Percival Pott, the British surgeon at St. Bartholomew's Hospital who firstly described the condition in 1779.

Here we discuss the case of a woman with TB spondylitis presenting with progressive disabling back pain, kypho-scoliosis and impending cord compression treated with antimicrobial chemotherapy, surgical debridement and stabilisation.

The clinical presentation of spinal TB can be insidious; the outcome is variable and can lead to permanent disability. The aim of this report is to highlight the increasing incidence of spinal TB in Western industrialised countries and to emphasise the importance of early diagnosis and prompt treatment. We also would like to report the controversies on the duration of the antimicrobial chemotherapy, the goals of treatment and the indications for surgery.

Case History

A 53 year old nurse from the Philippines presented to the Emergency Medicine Department with 8 months history of progressive back pain and bilateral leg dysaesthesia. She moved to the UK 9 years prior to her clinical presentation. Clinical examination demonstrated reduced sensation bilaterally in the T12 and L1 dermatomes. An x-ray revealed an L1 vertebral body compression fracture with end plate changes and kypho-scoliotic deformity (Figure 1 and 2). Inflammatory markers were within physiological range.

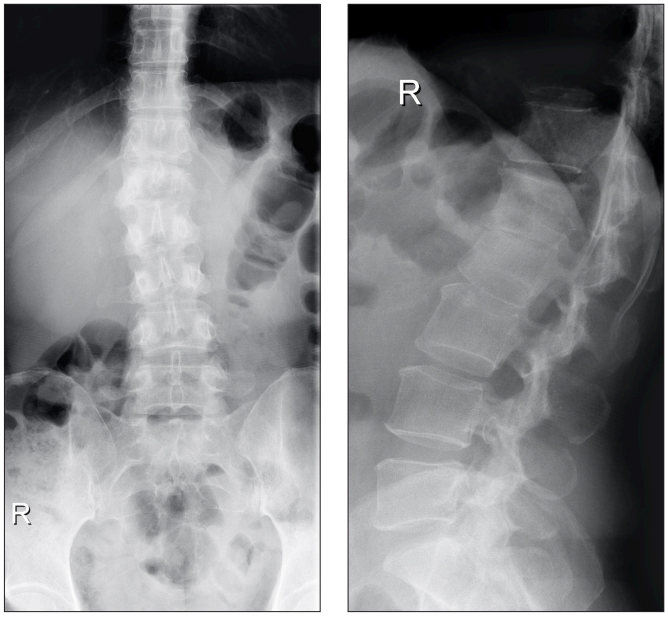

Figure 1 and 2: Antero-posterior and lateral x-rays of the lumbar spine showing kypho-scoliotic deformity and L1 vertebral body collapse.

An MRI was immediately performed and showed an L1 osteomyelitis with an epidural abscess formation compressing the spinal cord (figure 3 and 4). The MRI morphology of the osteomyelitis was consistent with spinal TB and a subsequent fluoroscopic guided biopsy confirmed the diagnosis by means of microscopy (Ziehl-Neelsen staining) and culture. She was immediately started on TB antimicrobial quadruple chemotherapy (rifampicin, isoniazid, pyrazinamide and ethambutol).

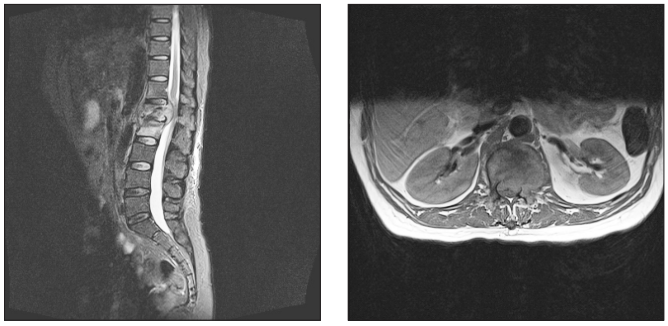

Figure 3 and 4: Sagittal T2 and axial T1 MRI imagining demonstrating epidural and vertebral body abscess formation with spinal cord compression. The anterior involvement of the adjacent segments with spread of the infection below the anterior longitudinal ligament is characteristic of spinal TB.

Surgical debridement and stabilization was performed on an urgent basis to achieve spinal cord decompression and correction of the spinal deformity. An L1 partial vertebrectomy was performed and a titanium mesh interbody cage was inserted to support the anterior column. Posterior stabilisation was achieved with pedicle screw instrumentation at the level above and below the pathological fracture (figure 5 and 6).

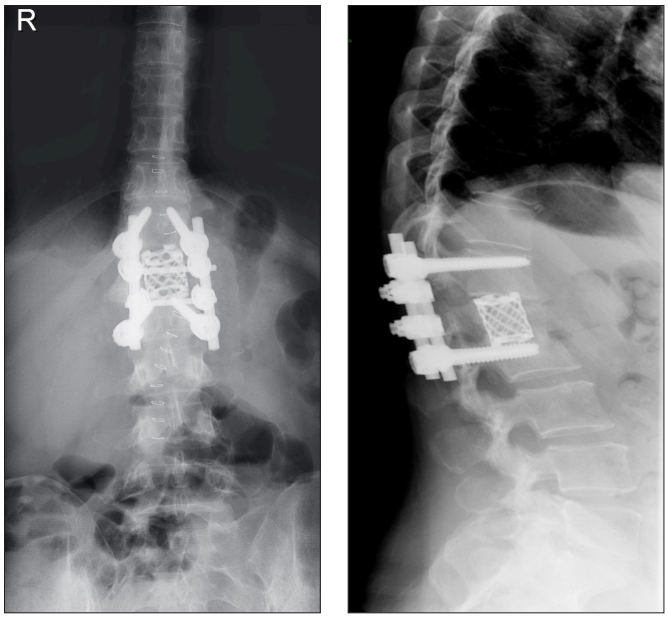

Figure 5 and 6: Post-operative antero-posterior and lateral x-ray of lumbar spine showing the anterior mesh interbody cage and the posterior stabilisation of the L1 vertebra.

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She was discharged to the community with a thoracolumbar sacral orthosis brace. 6 months post discharge she had fully recovered with complete resolution of her initial symptoms. CT confirmed bony union of the instrumented spinal segments (figure 7 and 8). The antimicrobial treatment was extended for a further 3 months.

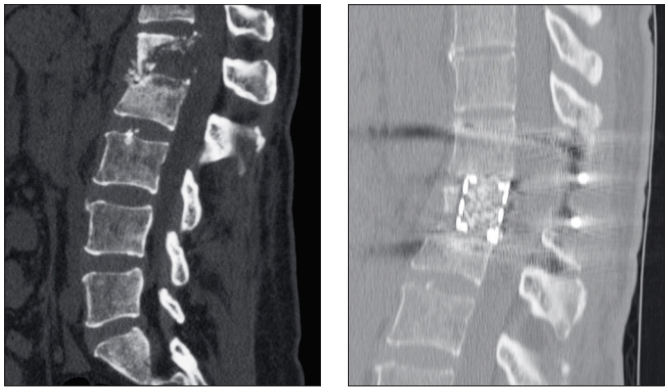

Figure 7 and 8: Pre - and post-operative CT sagittal views demonstrating bone destruction before surgical fixation and bony union at 6 months after surgery.

Discussion: Epidemiology

Tuberculosis (TB) is an infectious disease caused by Mycobacterium tuberculosis, affecting 9 million individuals per year (1). In affluent countries the incidence of TB is increasing and affects primarily immigrants from TB-endemic countries and immunocompromised HIV-positive patients.

The incidence of TB in London is 41.3/100,000 people and has doubled in the past 15 years. 75% of TB cases occur in patients born outside the UK, most commonly of African and South East Asian ethnicity, who have lived in the UK for less than 5 years (2). In endemic countries spinal tuberculosis is more common in children and younger adults, while in the western world the disease primarily affects the adult population.

Bone and joint involvement develops in approximately 10% of patients with TB and half of these affected patients have TB of the spine (3). A neurological deficit will develop in 10 to 40% of those with TB spondylitis. In developing countries with TB-endemic countries, immunocompromised and HIV-positive patients, the disease is still a significant source of morbidity and mortality and remains the most common cause of non-traumatic paraplegia (4-5-6).

Discussion: Diagnosis

Spinal TB causes destruction of the vertebrae and intervertebral discs. It may cause vertebral collapse, abscess formation, spinal cord compression and kyphosis. Multiple vertebrae are often affected, most commonly in the upper lumbar and lower thoracic region of the spine (4-5).

The diagnosis of spinal TB is challenging as the symptoms are often non-specific and there is a wide variability in presentation. Back pain is the most common presenting complaint of spinal TB. Other common symptoms are systemic and include night sweats, fever, weight loss, and malaise. Neurological deficits are caused primarily by spinal cord and nerve root compression by abscess formation and kyphosis and require prompt treatment (4-5-6).

Spinal deformity is a hallmark feature of spinal tuberculosis. Kyphosis is the most common spinal deformity and occurs with lesions involving thoracic vertebrae (see table 1 for a summary of the clinical presentation.) The duration of symptoms before a definitive diagnosis is made varies from few months to 2 years, demonstrating the insidious presentation and the slow progression of TB spondylitis (6).

Clinical Presentation
1. Back pain 95%
2. Systemic symptoms (Fever, malaise, night sweats, weight loss) 45%
3. Neurological Deficit 30%
4. Spinal deformity (kyphosis) 10%

Table 1

The diagnosis of spinal TB relies on the isolation of the mycobacterium from a tissue specimen and MRI imaging demonstrating spondylitis (4-5). The MRI findings in TB spondylitis may be indistinguishable from pyogenic infections, but there are some differences that are characteristic of the disease. The intervertebral disc may have a normal signal on MRI, reflecting the resistance of the disc to TB infection.

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The involvement of the anterior aspect of several contiguous vertebral bodies suggests a diagnosis of TB spondylitis. Vertebral involvement tends to lead to collapse and is likely to produce a significant spinal deformity. Enhanced scans are used to distinguish abscesses from granulation tissue (4-7). Other common MRI findings suggestive of spinal TB are illustrated in table 2. Screening of the whole spine should be performed to look for non-contiguous vertebral lesions.

MRI Findings
1. Vertebral involvement sparing the disc space
2. Anterior vertebral involvement
3. Para-spinal soft-tissue masses with elevation of either the anterior or posterior longitudinal ligament
4. Vertebral destruction and collapse
5. Epidural abscess
6. Posterior element involvement
7. Intraosseous abscess and granulomas on contrast enhancement

Table 2

Neuro-imaging guided spinal needle-biopsy or drainage of para-spinal collections can provide specimens for microbiological confirmation of spinal TB. The conventional microbiological methods of Ziehl–Neelsen staining for acid-fast bacilli have a relatively low sensitivity and specificity. Culturing Mycobacterium tuberculosis is time consuming, taking 6 to 8 weeks for the growth to appear.

The initial diagnosis of tuberculosis, therefore, often depends on histological evidence. DNA amplification from skeletal tissue samples (polymerase chain reaction) are highly sensitive and specific, can be performed at a greater speed and require smaller samples. This modality of microbiological investigation is expected to become an additional routine diagnostic tool. Table 3 summarises the essential diagnostic workup (8).

Diagnostic Workup
1. Chest x-ray to evaluate pulmonary involvement (occasionally normal in extra-pulmonary TB)
2. Peripheral blood inflammatory markers (ESR –CRP; occasionally normal in extra-pulmonary TB)
3. X-ray and whole spine MRI for the morphological diagnosis of spondylitis and to look for non-contiguous vertebral lesion
4. Image guided needle biopsy or paraspinal abscess aspirate for microbiological diagnosis
5. Specimens for microscopy, histology, culture, sensitivity, PCR
6. Consider tuberculin skin test (TST) and Interferon-gamma release assays (IGRA)

Table 3

Discussion: Treatment

The treatment modalities for spinal TB include conservative antimicrobial chemotherapy and surgery. The general objectives of treatment are illustrated in table 4.

General Objective Of Treatment
1. Eradicate infection
2. Prevent recurrence
3. Relieve pain
4. Prevent or reverse neurological deficit
5. Restore spinal stability
6. Correct spinal deformity

Table 4

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The optimal duration of treatment and the role of surgery has been subject to controversy. The World Health Organisation recommends 9 months of treatment for tuberculosis of bones or joints (9) due to the serious risk of disability and the difficulties of assessing treatment response. The American Thoracic Society recommends 6 months of chemotherapy for adult spinal TB and 12 months in children (10).

The British Thoracic Society, based upon the findings of some hallmark studies and trials of British Medical Research Council (MRC), recommends for uncomplicated spinal TB (HIV negative and fully sensitive bacteria) 6 months of daily treatment with rifampicin and isoniazid, supplemented in the initial 2 months with pyrazinamide and either ethambutol or streptomycin (the 6 month four drug regime.) (11-12-13-14).

The MRC trials included patients with only one or two affected vertebrae. More severe cases of spinal TB may require longer treatment regimes. Furthermore in the MRC trial, the treatment response was monitor by means of plain radiographs (12-13-14).

Since the MRC trials, MRI has superseded plain film radiography and has become the 'gold standard' imaging technique used to diagnose spinal TB lesions and to monitor disease progression (100% sensitivity, 88% specificity) (7). Many experts prefer a duration of 12 to 24 months or until radiological evidence of disease regression.

Regarding the role of surgery, the MRC had shown that antituberculous treatment alone can be as effective as surgery, can prevent substantial progression of kyphosis and can achieve resolution of neurological deficit (12-13-14). The Royal College of Physicians published in 2006 their guidelines for the treatment of TB 15.

They reported no additional advantage in routinely carrying out anterior spinal fusion over standard chemotherapy (15). A Cochrane Database review evaluated the role of routine surgery in addition to chemotherapy in spinal TB. They concluded that there was insufficient evidence to support the routine use of surgery (16).

While most patients should respond to medical treatment, a surgical approach needs to be considered (15). Indications for surgical treatment include progressive neurological deficit, severe deformity, instability, incapacitating pain, drainage of abscesses, open biopsy and lack of response to medical treatment (see table 5). The most conventional approaches include radical or focal debridement and posterior instrumented stabilisation.

Indications For Surgery
1. Disease progression despite adequate antibiotic treatment
2. Progressive spinal deformity or instability
3. Neurological compromise
4. Incapacitating pain

Table 5

Conclusions

This report highlights the importance of awareness of the increasing incidence of TB spondylitis in affluent counties. The clinician should be able to recognise the red flags that raise the suspicion of spinal TB. Back pain in the presence of systemic symptoms such as fever, loss of weight and general malaise in immunocompromised patients or those migrating from TB endemic countries should be investigated for spinal TB.

The diagnosis is confirmed by means of MRI and isolation of the mycobacterium tuberculosis. Most patients can be treated primarily with conservative antimicrobial chemotherapy for 6 to 24 months depending of the severity of the presentation and the treatment response. The role of surgery is limited and should be consider mainly in severe deformity, neurological deficit and instability.

Questions Best Of Five

1) Which of the following symptoms is the most common presenting complain in spinal TB?

1. Spinal deformity

2. Paraperesis

3. Back pain

4. Weight loss

5. Pyrexia

SPINAL TUBERCULOSIS THE MODERN STATE OF MANAGEMENT

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2) Which of the following antibiotics is NOT part of the standard quadruple anti-TB chemotherapy?

1. Rifampicin

2. Isoniazid

3. Ethambutol

4. Pyrazinamide

5. Clarithromycin

3) Which image modality represents the gold standard to diagnose spinal TB?

1. Weight bearing spinal x-ray

2. CT with contrast

3. MRI

4. 3D ultrasound

5. 18F-FDG PET/CT

4) What is the duration of antimicrobial chemotherapy recommended by the British Thoracic Society (BTS) in spinal TB?

1. 4 months

2. 6 months

3. 9 months

4. 12 months

5. 16 months

5) Which of the following is NOT an indication for surgery?

1. To obtain a specimen for interferon-gamma release assays (IGRA)

2. To achieve spinal stability

3. To treat incapacitating pain

4. To prevent or reverse a neurological deficit

5. To correct spinal deformity.

Answers

1. Answer C

Back pain is the most common symptoms of TB spondylitis. It is present in 95 % of patients. The triad of Pott includes gibbus (spinal deformity), spinal abscess and paraparesis.

2. Answer E

The standard quadruple anti-TB treatment include rifampicin and isoniazid for 6 months and pyrazinamide and ethambutol or streptomycin (an aminoglycoside) for the initial 2 months. Clarithromycin, although sharing the same suffix with the aminoglycosides, is a synthetic macrolide.

3. Answer C

MRI has superseded plain film radiography and has become the 'gold standard' imaging technique used to diagnose spinal TB lesions and to monitor disease progression (100% sensitivity, 88% specificity).

4. Answer B

Based on the hallmark studies of the British MRC, the BTS advises a 6 months antibiotic treatment in TB spondylitis. Most experts prefer longer treatment regimes (9 to 24 months) or until MRI evidence of disease regression.

5. Answer A

An open biopsy to obtain a specimen for etiological diagnosis is an indication for surgical intervention in spinal TB. The IGRA is a test that quantifies the interferon gamma released by the patient's lymphocytes obtained from peripheral blood. Similarly to the well known Tuberculin Skin Test, the IGRA can confirm latent infection but no active disease.

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SPINAL TUBERCULOSIS THE MODERN STATE OF MANAGEMENT

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PAEDIATRIC SEPTIC ARTHRITIS OF THE HIP

R Sehjal, Z Haider

Abstract

Septic arthritis can cause serious morbidity and even mortality in affected children. Thus a high index of suspicion is required to aid early diagnosis, appropriate escalation and prompt treatment of the condition. This article discusses septic arthritis of the hip, along with salient points in history, examination, controversies in diagnosis and management.

Case History

A 3 year old girl presents to the accident and emergency department with a 1 day history of progressive pain in the left hip. She had initially been limping and is now non-weight bearing on the left leg.

Parents deny any history of trauma or falls. In the last week, she has had a mild upper respiratory tract infection. She is otherwise fit and well with immunisations up to date. There have been no concerns in her development however, she was born premature at 32 weeks by vaginal delivery without any complications.

Clinically the patient has a mild fever of 38 degrees Celsius, blood pressure, respiratory rate and heart rate are normal. On examination, the patient is mildly flushed and warm. The left hip is held in flexion, abducted and externally rotated (Image 1).

The patient refuses to move the affected hip due to severe pain and is non-weight bearing. On palpation, the left hip is tender and feels warmer compared to the other side. Knee examination appears normal. The on-call orthopaedic registrar is contacted to review the patient and to rule out septic arthritis.

Image 1

Antero-posterior and frog leg lateral radiographs of the pelvis appear normal with no other pathology. Blood cultures are taken and blood tests reveal a white cell count of 13.8 x10^9/L, CRP 61 mg/L and ESR 9 mm/h.

An urgent ultrasound of the left hip is requested which reveals a moderate effusion compared to the contralateral side.

The patient is taken to theatre, the same day, for emergent arthrotomy and lavage of pus in the hip joint. Empirical antibiotics are subsequently started in line with the hospital antimicrobial policy (Flucloxacillin) for septic arthritis. Microscopy results later revealed Staphylococcus aureus as the causative pathogen. The patient made a good recovery and was discharged home with a course of oral antibiotics to be taken for 3 weeks. The patient is being regularly reviewed in clinic and thus far showing no long-term sequelae of septic arthritis.

Discussion

Septic arthritis is a bacterial infection of the joint. It commonly presents in children younger than 2 years and most frequently affects the hip. The condition is a surgical emergency which requires prompt diagnosis and treatment. Intra-articular infection causes chondrolysis, leading to early osteoarthritis. In severe cases it can lead to complete destruction of the femoral head.(1,2) An example of this can be seen in Image 2. (3) Early recognition and treatment significantly improves clinical outcomes.(4)

Image 2

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Septic arthritis needs to be ruled out as a diagnosis usually from the more common and benign condition of transient synovitis of the hip. Irritability of a joint is considered to be an infection until proven otherwise.

Haematogenous seeding is the most common source of contamination but can also occur from direct inoculation from trauma or extension of adjacent osteomyelitis. The most common causative pathogen is Staphlococcus aureus, followed by Group A streptococcus and enterobacter.(5)

Diagnosis is often difficult as it may not be possible to elicit a history from a young child and there may be a lack of clinical signs. Symptoms are progressive and may be referred to the thigh or knee. Any recent trauma or surgery to the limb should be identified. There may be a history of a recent or concurrent infection from which the pathogen has seeded, e.g. Staph aureus from impetigo, tonsillitis or respiratory tract infection. A family history of rheumatological disease may suggest a first presentation of juvenile inflammatory arthropathy.

A child with septic arthritis will usually look unwell. Occasionally one may observe localised hip swelling or erythema on inspection. There will be a reluctance to bear weight and any movement of the joint will cause severe pain. Often the affected limb will lack spontaneous movement (pseudo-paralysis). The hip is held in Flexion, ABduction and External Rotation, mnemonic: FABER. This position permits maximum volume within the hip capsule and in effect reduces intra-articular pressure and pain. The child may later progress to become systemically unwell with pyrexia, signs of septic shock and generalised swelling of the leg or cellulitis/abscesses.

Initial management in the emergency department should consist of prompt intravenous access with blood sent for white blood count (WBC), erythrocyte sedimentation rate (ESR), C-reactive protein (CRP) and blood cultures. Radiographs including an AP pelvis and frog leg lateral should be obtained. An elevated CRP has the highest predictive value for septic arthritis and a result of <10mg/ml makes the diagnosis extremely unlikely. (6–8) The white blood count may be elevated in only a third of children. (9) The CRP and ESR are used to monitor the response to treatment. Blood cultures are positive in up to 40% of cases. (10)

Kocher's criteria are a useful tool in differentiating between the more common transient synovitis and septic arthritis (See Tables 1 and 2). A score of 3 or more predicts a probability of septic arthritis greater than 93%. (11)

Kocher's Criteria
Fever
Non weight-bearing on affected side
WBC >12,000mm3
ESR > 40mm/hr

Table 1

Number Of Criteria Met	Likelihood Of Septic Arthritis
0 of 4	0.2%
1 of 4	3%
2 of 4	40%
3 of 4	93%
4 of 4	99%

Table 2

Radiographs are usually normal in the early stages of the disease but widening of the joint space may be seen due to an effusion. Ultrasound has been shown to have 87% sensitivity and 90% specificity in identifying an effusion.(12) Image 3a shows an ultrasound of a normal paediatric hip. The arrows show the hip capsule adjacent to the anterior femoral neck. Image 3b demonstrates a joint effusion in which the anterior and posterior layers of the hip capsule become separated.(13)

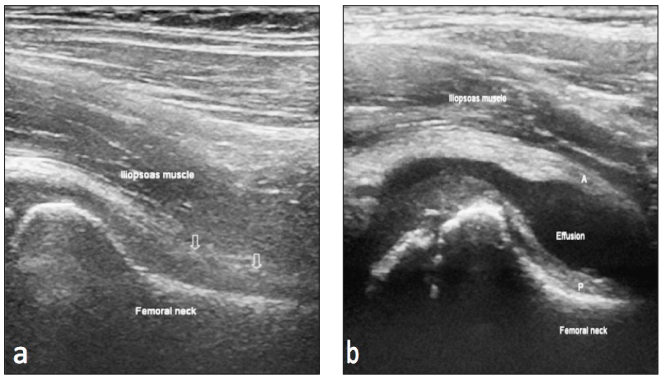

Image 3a & 3b

After initial management the child should be kept fasting and referred to the orthopaedic team for urgent review.

Treatment for septic arthritis involves urgent surgical drainage and lavage of the joint under general anaesthetic via an open anterior approach, followed by targeted antibiotic treatment. Fluid obtained during surgery is sent for cell count, gram staining and microscopy, culture and sensitivities (MCS). In the presence of infection the WCC typically shows >50,000cell/mm^3 and >75% polymorphonuclear leukocytes.(14)

During the surgical washout of the joint a synovial biopsy should be taken and sent for MCS and histology to exclude inflammatory conditions of the hip that may mimic septic arthritis and increases the rate of positive cultures in pyogenic septic arthritis. Specimens should also be sent for AFB (acid fast bacillus) and tuberculosis culture. Though rare, TB needs to be considered and excluded. Joint fluid should also be either sent or stored for PCR (polymerase chain reaction) as this will greatly increase the identification of organisms and is becoming standard practice.(15,16)

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Staphlococcus aureus should be targeted empirically and adjusted according to microbiology results. The synovial fluid yields positive results in 30-55% of patients.(17,18)

For uncomplicated cases of septic arthritis, with signs of clinical improvement, intravenous antibiotics may only be required for 48hours and converted to oral preparation for a subsequent three weeks. Children are then followed up long-term to observe for sequelae of joint infection which include osteomyelitis, growth arrest and avascular necrosis of the femoral head.

Test Yourself

Q1. What is the most common radiological abnormality seen on plain radiographs of the hip in a child presenting with septic arthritis?

a) widening of the joint space

b) periosteal elevation

c) no abnormal findings

d) flattening of the femoral head

e) secondary arthritis

2. According to Kocher's criteria the likelihood of this child having septic arthritis was:

a) 0%

b) 3%

c) 40%

d) 93%

e) 99%

3. What is the most common causative pathogen:

a) Staphlococcus aureus

b) Haemophilus influenza

c) Neisseria gonorrhoeae

d) Group B streptococcus

e) Salmonella

4. A 2-year-old child presents to Accident and Emergency with a 3 day history of pain in the right hip. The parents deny any recent trauma but mentions the child has just recovered from a cough and coryzal symptoms. On examination the child limps and has a discomfort throughout a full range of movement. He is apyrexial with a WBC of 13,000 and CRP <10. Radiographs of the hip show no abnormalities and an ultrasound scan of the hip shows an effusion. What is the most likely diagnosis?

a) osteomyeltis

b) septic arthritis

c) Perthes disease

d) normal findings

e) transient synovitis

5. Which single factor is the most important predictor of septic arthritis over transient synovitis of the hip?

a) fever

b) non weight-bearing

c) flexion abduction and external rotation position of the hip

d) raised CRP

e) effusion on ultrasound imaging of the hip

Answers

1C

Radiographs of the hip do not usually show any abnormality. Widening of the joint space may indicate an effusion in the joint. Options b and e are seqeulae of an infected hip.

2D

The child met 3 of Kocher's 4 criteria (See Tables 1 and 2).

3A

Staphlococcus aureus is the most common pathogen in children over 2 years old. Streptoccal sp. affects neonates. Neisseria gonorrhoeaeis is more common in adolescents. Since the introduction of the Haemophilusi Influenza vaccine in the 1980s its incidence has dramatically fallen.

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4E

The ultrasound scan demonstrates fluid within the hip joint consistent with answers b or e. The CRP value of <10 makes an infective cause very unlikely and hence the child is likely to have a transient synovitis of the hip. The child can be discharged home with advice to the parents of the warning signs of septic arthritis. The child should be reviewed by a senior orthopaedic surgeon or paediatrician in 2-3days.

5A

A fever is the single most important predictor of septic arthritis over transient synovitis of the hip.(8) Fluid in the hip on imaging and a FABER position of the hip indicates an effusion only. Non-weight-bearing may be caused by a large variety of pathologies affecting the lower limb. Of the laboratory investigations a CRP has the highest positive predictive for septic arthritis.

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NECROTISING FASCIITIS IN A DISTRICT GENERAL HOSPITAL - A RETROSPECTIVE CASE SERIES

F Vasarhelyi, L Arany, Z Kiraly, K Naik, A Bott, S Deo

Abstract

Introduction

Necrotising is fasciitis is the most feared soft tissue infection in surgery, due to rapid progression and high mortality. Diagnosis can be challenging in the initial phase; early recognition, radical surgical intervention and multidisciplinary management will determine the prognosis. The LRINEC (Laboratory Risk Indicator for Necrotising Fasciitis) scoring system can be helpful in uncertain situations to differentiate necrotising fasciitis from other musculoskeletal infections and conditions.

Patients and methods: This is a retrospective, case series. We obtained all intensive care unit (ICU) admissions from our ICU & hospital coding databases. We reviewed all patients with a diagnosis of necrotising fasciitis in a 12 year period, 2003 to 2015. We went on to review case notes, serology, microbiology and radiology results.

Aims

Our aims were to define the populations most at risk of developing necrotising fasciitis, detect epidemiologic trends, assess our performance with published series and validate the use of the LRINEC score.

Results

Our series comprises 32 patients, with 19 (60%) occurring in a 3 year time period. The mean age of patients was 55, median 59 (range 20 to 83), with almost equal male to female ratio. Almost 2/3 (62%) were admitted under surgical disciplines. Twenty nine (91%) underwent surgery and the overall mortality rate was 56%, within a mean of 3 days.

No patients treated non-operatively survived. We applied the LRINEC criteria to the patients to assess its sensitivity and predictive value. We noted an increasing number of monomicrobial cases were found, mostly due to virulent, rapidly progressing Group A ß-hemolytic Streptococcal infection.

Conclusion

A high index of suspicion and the use of the LRINEC score can help to diagnose necrotising fasciitis in its early stages. However decisions in terms of definitive management are led by clinical findings and must be achieved as rapidly as possible. Early aggressive surgical debridement, high dose antibiotics & multidisciplinary management is crucial for patient-survival. The prognosis is highly influenced by the age and medical co-morbidities, therefore the mortality remains high.

Introduction

The term necrotising fasciitis (NF) or necrotising soft tissue infection (NSTI) refers to `severe inflammation of the muscle sheath that leads to necrosis of the subcutaneous tissue and adjacent fascia`. (1) It is associated with rapid progression and a high risk of mortality despite advances in antibiotics, surgery, intensive care and interdisciplinary management.

Rapid progression and necrosis leads to a severe systemic inflammatory response syndrome (SIRS), multi-system organ failure and death. (2). The condition is frequent enough that almost every hospital physician will at some point be involved in the care of a patient suffering with NF. However, due to its relative rarity familiarity of the condition and management cannot be always guaranteed. The incidence is estimated at 0.04 cases per 1000 person-years in the United States. (3)

NF`s first description comes from Hippocrates from around 500 BC, as complication of erysipelas. (4) Claude Colles described a condition very similar to the modern definition of NF in 1783, but the first modern description of NF comes from the American Civil war, when J. Jones army surgeon reported more than 2000 gas gangrene cases with high mortality rate 46%. (5, 6) Jean Alfred Fournier described a syndrome with necrosis of the perineum in 1883, this type of NF is known as Fournier's gangrene. (7)

In 1952, the term "necrotising fasciitis" was proposed by Wilson, as a more accurate description of this disease.8 The disease was popularized by the media as "flesh-eating bacteria syndrome". (9)

Epidemiology

The prevalence of NF reported to be around 0.24-0.4 cases per 100,000 population and a male-to-female ratio of 3:1.10 The disease can affect all age groups. The median mortality is around 34%. (11) However, its range in the literature is extensive, varying from 9 to 76%. (1) In regard to NF of the extremities, the mortality rate is slightly lower than that recorded for abdominal and perineal infections. (12,13) As a general rule: without treatment, the mortality rate approaches 100%.

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Microbiology

There is wide spectrum of bacteria that can cause NF, these can be broadly classified into two groups (bear in mind that there are classifications mentioning 4 groups). (2)

Type I NF (synergistic NF)

Type I NF is a polymicrobial infection caused by aerobic, anaerobic and facultatively anaerobic bacteria (gram-negative and positive). Most of the bacteria are part of the bowel flora (E.coli, Bacteriodes, Pseudomonas species). Recent surgery, abdominal malignancy and immune compromise are the most common risk factors. (2,14)

Type II NF (monomicrobial)

Type II NF is usually caused by gram-positive organisms. The most common pathogen is Group A ß-haemolytic streptococcus (GAS) alone or in combination with other species such as Staphylococcus aureus. Risk factors in this group includes injuries that can cause breach to the dermis, recent surgery, varicella infection, intravenous drug use (IVDU) or haematogenous spread. This type of NF has the highest mortality rate approaching 50-70%.

Pathophysiology

Infection begins in the hypodermis and superficial fascia and spreads along the muscle fascia and the overlying dermis can appear normal. (15) This makes NF very difficult to diagnose in early stage. The overall pathophysiology is an exotoxin driven toxic shock syndrome with massive cytokine release (cytokine storm) and T cell proliferation due to the M protein of Group A Ð-hemolytic Streptococcal GAS.

This protein acts as a virulence factor and also produces pyogenic exotoxins, well known as super-antigens. This combination leads to SIRS, which can progress to multi organ failure and death. It is the prevalence of this cascade occurring with Type II NF that generates the very high mortality rate of 40-67%. (2) Thrombosis of the nutrient arterioles in the hypodermis leads to necrosis. This can then affect nerve branches; causing pain which is usually described as out of proportion.

Risk Factors

As already mentioned above, recent surgery, immune compromise, malignancy, trauma can increase the risk of developing necrotising fasciitis. Age over 50 years, IVDU, obesity, peripherial vascular disease and diabetes are general risk factors. (1)

Non-steroidal anti-inflammatory drugs (NSAIDs) are thought to mask early signs of NF, but they can also inhibit neutrophil function and facilitate cytokine release. (2,14)

Clinical Diagnosis

Diagnosis of NF is often very difficult due to the lack of specific signs. High index of suspicion and the presenting pain, which is out of proportion, should guide the management. Clues and risk factors from the history (recent surgery, IVDU, diabetes, trauma) can help us to get closer to the diagnosis. Most common symptoms are pain, fever, tachycardia. (2)

Skin changes early on may look like a rapidly progressing, florid cellulitis. Generalised cutaneous and sub-cutaneous oedema, haemorrhagic bullae and skin necrosis are late presentation of the infection and usually accompanied by symptoms of multi-organ failure (haemodynamic instability, low urine output, etc.). (1) Crepitus (gas formation) can be found in some cases.

Differential diagnosis include cellulitis, deep vein thrombosis, myonecrosis, allergic reaction, auto-immune vasculitis, or sunburn.

Necrotising fasciitis is a surgical diagnosis in that the true definitive diagnosis is the visualisation of "dishwater fluid" in fascial planes and necrotic subcutaneous tissues. The diagnosis can however be accurately confirmed prior to this by appropriate ultrasound or MRI imaging.

Imaging such as X-ray, computed tomography (CT), magnetic resonance imaging (MRI) should never delay surgical intervention, but those can be useful in diagnosing NF if there is subcutaneous gas present and the patient is stable.

Treatment

Definitive treatment of NF generally surgical debridement of all necrotic tissue, coupled with broad spectrum antibiotics and haemodynamic support. In our series no surviving patient avoided surgery. These treatments should be delivered promptly as a team involving intensive care physicians, surgeons and microbiologists.

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Radical surgical debridement or occasionally amputation is necessary. Without surgery the mortality rate approaches 100%. This means NF is a surgical emergency. Patients will require further re-assessment in theatre after the first debridement, usually 12-24 hrs later. Any deterioration in the patient`s condition should facilitate prompt further, sooner surgical intervention as clinical deterioration indicates infective progression through remaining tissue planes, with escalating risk of SIRS & multi organ failure if left untreated.

High dose, intravenous antibiotics are essential in NF, and should be given as soon as the diagnosis is entertained. They may prevent progression of septic shock when commenced early. It is well known that early administration of antibiotics within the first hour of documented hypotension is associated with increased survival in patients with septic shock. Also the delay in administering antibiotics was associated with decrease in survival. (17) Appropriate broad spectrum antibiotics should be used to cover against gram positive, negative and anaerobic organisms:

There are some pitfalls when we try to choose:

1. Penicillin sounds a good choice, but high concentration of GAS in the tissue results in most bacteria being in stationary growth phase where there is no cell wall synthesis – which is the target of penicillins. (2)

2. It would be more useful to switch off the exotoxin synthesis as this will derive SIRS (2)

3. Should have cover for the synergistic gram negative and positive bacteria .

4. Ideally should have cover for methicillin-resistant Staphylococcal (MRSA) infections until proven otherwise (22).

Most hospitals now have published antibiotic guidelines for possible NF and other severe infections, which are regularly reviewed by local microbiology to account for local antibiotic prevalence, sub-types and resistance patterns. Common combinations include: the use of combinations of Clindamycin/Meropenem/ Linezolid. Clindamycin can switch off exotoxin production even in the stationary growth phase. (2) Meropenem will cover for the synergistic gram negative and positive bacteria. Linezolid can be used if MRSA present. (22)

After administering intravenous antibiotics and urgent surgical referral, every patient with the suspicion of possible NF should be transferred to intensive care unit for general supportive treatment, eg ventilation, inotropic, renal support and close monitoring are available. The use of intravenous immunoglobulins (IVIG) and hyperbaric oxygen are newer treatment options under evaluation. IVIG thought to be useful in GAS infection as they contain neutralising antibodies that act against streptococcal antigens. (23) Hyperbaric oxygen thought to increase the bactericidal effects of neutrophils, but the access to hyperbaric oxygen units are very limited worldwide. (2)

Our Case Series

We describe a single institution, retrospective, case series. We reviewed all patients with a diagnosis of necrotising fasciitis or necrotising soft tissue infection, over a 12 year period from 2003 to 2015. We went on to review case notes, serology, microbiology and radiology results.

Our hospital is a 600 bed multi-specialty district general hospital, serving a population of approximately 350,000 patients. Based on the past 3 years data, we estimate that in the 12 year study period we had over 850,000 Emergency Department attendances, 450,000 emergency (non-elective) admissions and there were 8,607 ICU admissions. We did not include neonates in this study. We obtained all intensive care unit (ICU) admissions from our ICU and hospital coding databases.

In March 2015 we introduced the LRINEC (Laboratory Risk Indicator for Necrotising Fasciitis) scoring system to help distinguish from other types of soft tissue infections. This scoring system was first introduced in 2004 by Wong et al. and is based on laboratory investigations such as white cell count, CRP, haemoglobin, sodium, creatinine and glucose as these were found to be most statistically significant indicators for NF (Figure 1.).

The original study by Wong et al. included that a score of six or above should raise suspicion of NF. In this article, the positive predictive value of the LRINEC score was reported as 92% with a negative predictive value of 96%. We went on to apply this scoring system to our patients. (16)

Variable	Value	Score
CRP (mg/l)	<150	0
	>150	4
White cells (/mm3)	<15	0
	15-25	1
	>25	2
Haemoglobin (g/dl)	>13.5	0
	11-13.5	1
	<11	2
Sodium (mmol/l)	>135	0
	<135	2
Creatinine (µmol/l)	<141	0
	>141	2
Glucose (mmol/l)	<10	0
	>10	2

Figure 1: LRINEC scoring criteria.

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The key study aims were:

1. to define the populations most at risk of developing necrotising fasciitis.

2. to assess our performance with published series.

3. to validate the use of the LRINEC score.

Results

Following data received from our databases, our series comprises 32 patients, with 19 (60%) occurring in a 3 year period from 2012 to 14. According to the literature and the population of GWH Swindon the predicted number of cases per year is around 2.6.

However, between 2012 and 2014 we admitted almost three times more patients with the diagnosis of necrotising fasciitis than predicted. Interestingly thus far in 2016 and 2015, we have seen only 2 NF cases, as shown in Fig 2. The mean age of patients was 56, median 59, with age range 20 to 83. The age distribution is shown in Figure 3. There was an almost equal male to female ratio, 54% male.

One may observe varying incidences of NF, as seen in our case series – we observed a high incidence of NF in 2012 and 2013. There appears to be no causal link to this, but it highlights the fact that sporadic "runs" of such cases can and do occur. However, one should therefore maintain a high index of suspicion of NF, particularly in patients with the above mentioned risk factors.

Almost 2/3 of our patients (62%) were admitted initially under surgical disciplines and 29 patients (91%) underwent surgery and the overall mortality rate was 56% within an average time to death of 3 days. This mortality rate is slightly higher than the overall average in the literature although we found articles reporting mortality rate with 76% (1).

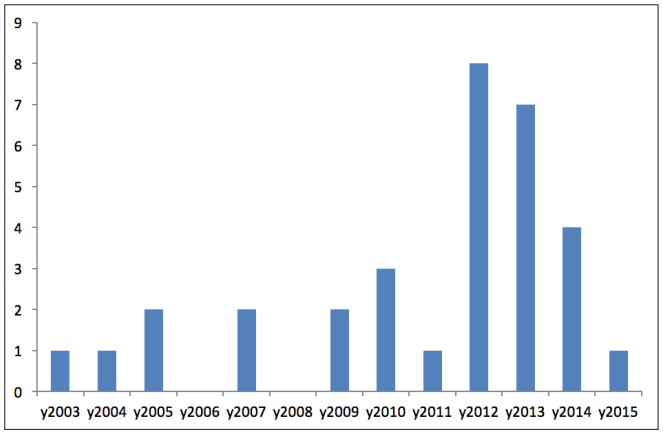

Figure 2: NF cases presenting over study time period.

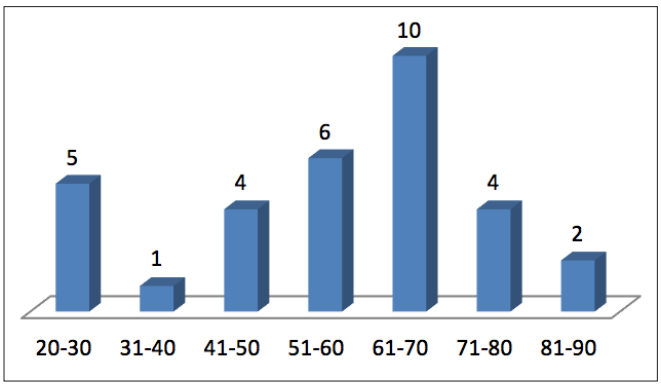

Figure 3: Age distribution of necrotising fasciitis cases in GWH 2003-2015.

In our study period increasing number of monomicrobial cases were found, mostly representing as rapidly progressing Group A ß-hemolytic Streptococcal (GAS) infection. 62% of all cases were found as Type I NF and 38% of cases presented as monomicrobial NF and affected the upper or lower extremities. The mortality rate in Type II group reached 75%. All cases admitted under orthopaedics were Type II NF.

Upper extremity	9 (6 GAS)
Lower extremity	9 (2 GAS)
Chest wall	2
Abdominal wall	7
Perineal area	5

Figure 4: The presentation of NF cases compared to anatomical regions with the presence of Group A ß-haemolytic Streptococcus infection, in our study period 2003-2015.

In our Hospital, every patient will be assessed following the "Sepsis 6 pathway" with a clinical suspicion of infection on presentation or any unwell or deteriorating patient.

The Sepsis Six is an initial resuscitation bundle designed to offer basic intervention within the first hour. This pathway is developed to facilitate early diagnosis of sepsis and commencement of early aggressive treatment and referral to subspecialties and intensive care. (17,18,19,20,21) To complete this pathway accurate recording of vital observations and basic urgent laboratory investigations are needed (Figure 5).

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We went on to apply the LRINEC criteria (see Figure 3) to the patients in our study period to assess its sensitivity. We were able to calculate LRINEC score for 26 patients out of total 32 (81% of our cohort). We had 3 patients with a false negative LRINEC score (score <6 and proven diagnosis of necrotising fasciitis). Therefore in our series the sensitivity and positive predictive value of LRINEC was 88% compared to 92% reported by Wong et. al.

Departmental Policy Change

After valuation of the LRINEC scoring system, we introduced new guidance (Figure 5), to be used in the Accident and Emergency Department (A&E) in suspicious cases, as we think there is a role for the LRINEC criteria in diagnosing NF in its early stage.

Great Western Hospitals NHS
NHS Foundation Trust

LRINEC Score

Laboratory Risk Indicator for **Necrotizing Fasciitis**

Use cases:

Patient with a concerning history or physical exam (pain out of proportion to exam, rapidly progressive cellulitis, for example)
Patient with an unconcerning story (can provide some reassurance if score is very low)

Why use it:

The score may be helpful in providing an overall clinical picture of a patient with a potential necrotizing soft tissue infection -- but it cannot rule out this infection.

Advice:

All patients with a high clinical suspicion for necrotizing fasciitis should receive immediate surgical consultation for potential operative debridement.
Consider calculating a LRINEC score to distinguish patients with severe cellulitis/ abscess vs necrotizing fasciitis

Guidance:

A LRINEC score ≥ 6 is a reasonable cut-off to rule in necrotizing fasciitis, but a LRINEC < 6 does not rule out the diagnosis.

Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC) score

Variable	Score
C-reactive protein (mg/l)	
<150	0
≥150	4
Total white cell count (per mm³)	
<15	0
15-25	1
>25	2
Hemoglobin (g/dl)	
>13.5	0
11-13.5	1
<11	2
Sodium (mmol/l)	
≥135	0
<135	2
Creatinine (µmol/l)	
≤141	0
>41	2
Glucose (mmol/l)	
≤10	0
>10	1

Reference:
Wong CH et al.
Crit Care Med. 2004; 32 (7):1535-41

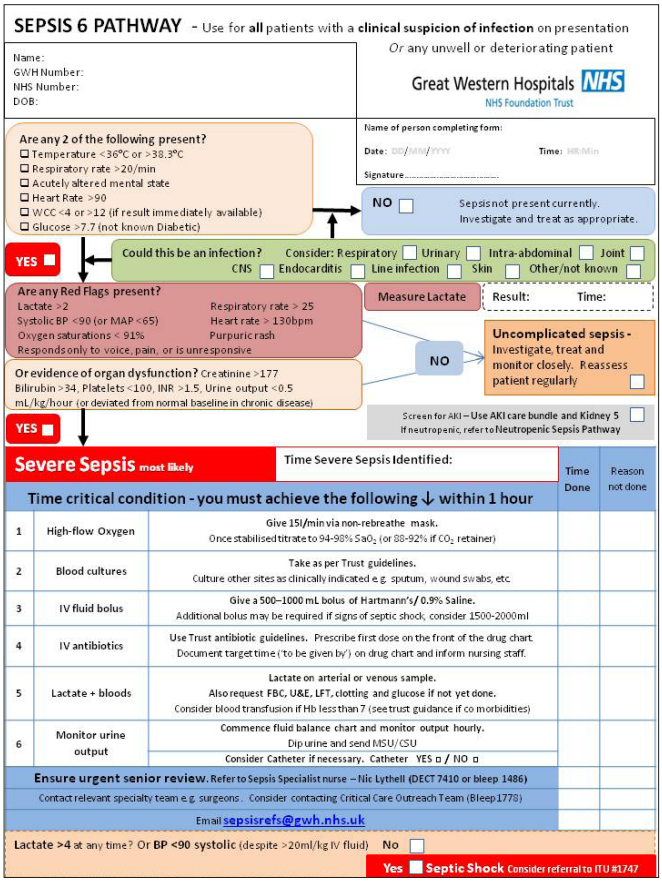

Figure 5: The newly introduced guidance to be used in GWH A&E Department in addition to the "Sepsis 6 Pathway".

Summary

Necrotising fasciitis

1. Can kill, and delay to diagnosis and treatment is a key factor
2. Is not common, but is not rare either
3. Disease progression is often rapid
4. Early identification or suspicion of this problem is essential
5. Use of pathways such as sepsis 6 and criteria such as lrinec are useful
6. Early broad spectrum high-dose iv antibiotics as recommended locally are mandatory
7. Early surgery either in terms of radical debridement or high amputation may be necessary and can be life saving.
8. Will occur sporadically and clusters of patients do occur

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Multiple Choice Questions (best of five)

1. You're on call for acute medicine, and are asked to review a patient at 2 am, admitted onto the acute medical unit via ED during the day shift. He is a 23 year old type 2 diabetic with learning difficulties, with his mum. He presented with a 2 day history of worsening generalised malaise and high fevers.

He has started to complain of new left elbow pain, and not much else on direct questioning. He has been anuric since admission and is hypotensive and tachycardic. His CRP is 325mg/L, white cell count 18/mm3. He has a mild new patch of erythema over his left olecranon. Plain X-rays show no bony injury or abnormality at the elbow. The most appropriate next step in his treatment would be:

A. MRI

B. Urgent discussion with on call orthopaedic team

C. Ultrasound

D. CT

E. Discuss antibiotic treatment with a microbiologist

2. The most common organism associated with necrotizing fasciitis is:

A. E. coli

B. Group A beta-hemolytic streptococci

C. Pseudomonas aeruginosa

D. Proteus mirabilis

E. Staphylococcus aureus

3. What test is considered the "gold standard" for diagnosis of necrotizing fasciitis?

A. MRI

B. CT scan

C. Deep tissue biopsy

D. Blood cultures

E. Plain radiographs

4. Treatment of necrotising fasciitis includes:

A. Emergent incision of all involved tissues and immediate empiric antibiotics covering aerobic, anaerobic, gram positive and gram negative bacteria.

B. Immediate high dose antibiotics covering virulent Strep species and consideration of compartment decompressions.

C. Emergent limited operation to obtain deep tissue samples, withholding antibiotics until deep tissue samples are taken.

D. Emergent aggressive excision (debridement) of all involved tissues and immediate empiric antibiotics covering aerobic, anaerobic, gram positive and gram negative bacteria.

E. Immediate transfer to an intensive care unit for multi-system supportive monitoring and care.

5. The surgical treatment of necrotising fasciitis:

A. Must be delayed until the patient is fully stabilised

B. Is an adjuvant to high dose antibiotics, and should be deferred until serum antibiotic levels are at their peak

C. Amputation may be required

D. Amputation is never indicated

E. Compartment decompressions often suffice

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Answers

1. Answer: B

This patient is sick, and one must always be mindful of aggressive and potentially life threatening infections, such as necrotising fasciitis. MRI and CT scan are useful adjuncts to demonstrate edema around the soft tissues, with MRI being more sensitive to soft tissue changes, however this patient may require a rapid surgical intervention prior to this.

2. Answer: B

Necrotizing fasciitis is most commonly a polymicrobial infection, with group A ß-hemolytic streptococci the most common bacteria reported.

3. Answer is D

All tissue must be excised and layed open, in conjunction with high dose IV antibiotics. Neither should be delayed, but clearly additional physiologic support, monitoring and investigations must also be undertaken. It doesn't really matter which is commenced 1st, and in general and pragmatically, following Sepsis 6 principles, IV antibiotics will be given before the surgery in most cases.

4. Answer is D

All tissue must be excised and layed open, in conjunction with high dose IV antibiotics. Neither should be delayed, but clearly additional physiologic support, monitoring and investigations must also be undertaken. It doesn't really matter which is commenced 1st, and in general and pragmatically, following Sepsis 6 principles, IV antibiotics will be given before the surgery in most cases.

5. C is correct

In the case of severely necrotic penetrating infection, of necrosis involving multiple tissue planes including blood vessels amputation may be indicated.

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Authors' contributions

All authors participated in the design of the paper, conceived the paper, and participated in drafting and critical revision for important intellectual content. All authors read and approved the final form of this manuscript.

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MANAGEMENT OF OPEN TIBIAL FRACTURES & COMPARTMENT SYNDROME

N Campion, A Bucknor, M Pearse

Abstract

Open tibial fractures are common, high-energy injuries, with a risk of a poor functional outcome if not managed appropriately. Compartment syndrome represents a limb-threatening complication of open tibial fractures. We present the case of a 20 year-old man who sustained an open tibial fracture complicated by compartment syndrome.

The management of this case followed the recently introduced NICE guidelines as well as the guidelines set by BOA and BAPRAS Standards for Trauma (BOAST). This case illustrates the importance of early surgical intervention in patients with compartment syndrome. We discuss the emergency management of open tibial fractures, how to recognise and treat compartment syndrome, and how to definitively management these injuries.

Case History

A 20 year-old man with a past medical history of asthma was knocked off his motorbike at 30mph while attempting to undertake a car. He was brought into the emergency department of his local major trauma centre and seen by the trauma team and was seen by the multi disciplinary trauma team which included Orthopaedics. On arrival, he was alert and complaining of severe pain in his deformed, right leg.

What would be your initial management?

Assess and resuscitate the patient according to Advanced Trauma and Life Support (ATLS) principles. It is important to remember the ABCDE approach despite the obviously injured leg, so as not to miss any life-threatening injuries. The patient was talking and his cervical-spine was triple-immobilised. His observations were as follows: respiratory rate of 12 breaths/min, SpO_2 99% on 15L oxygen, BP 137/88 mmHg, HR 60bpm and regular. His GCS was 15 throughout. Bedside focused assessment with sonography in trauma (FAST) scan, looking for intra-abdominal free fluid, was negative.

What are the important points to elicit in your examination of the right lower limb?

The limb examination is performed during the primary survey. A careful limb inspection assesses limb alignment, swelling, hardness of muscle compartments and other cutaneous signs of trauma. Common patterns of limb deformity may be observed, such as the shortened and externally rotated lower limb in a fractured neck of femur. When wounds are present it is important to describe the wound in terms of size, depth, degree of contamination and visibility of underlying structures. Any injured limb must be assessed for neurovascular compromise. Here, limb perfusion is assessed by palpating the dorsalis pedis and posterior tibial pulses.

Absent pulses require further assessment by Doppler examination. Capillary refill should be checked but it is not a reliable sign of peripheral perfusion. If there is vascular compromise the foot will have no pulses and it will be discoloured and cold.

Active extension and flexion of the toes confirms functioning common peroneal and tibial nerves respectively. An inability to actively move the toes combined with increased pain on passive toe stretch strongly suggests a compartment syndrome. Altered sensation should be recorded diagrammatically. Reduced sensation is a 'soft sign' and may not indicate a severed nerve. The common peroneal nerve supplies the dorsum of the foot and the tibial nerve innervates the sole.

Our limb examination revealed an isolated right lower limb deformity, with a 3cm wound over the anteromedial aspect of the tibial at the level of the fracture. The limb was swollen, particularly in the calf but the foot was warm and well perfused, with good pulses and no neurological deficit or pain on passive stretching.

What investigations would you order at this stage?

Routine blood tests for trauma include, full blood count, renal profile, group and save with a request for a cross match and a venous blood gas. Plain radiographs of the patient's chest and pelvis should be obtained. Given the concerning mechanism of injury, a CT is indicated to exclude any serious injuries. Stabilisation of the patient prior to transport to a CT scanner is paramount; the term the 'doughnut of death' is a reminder to trauma teams to tightly adhere to the ATLS principles.

The results for our case were as follows:

- *CT head, cervical spine, thorax abdomen and pelvis showed no abnormalities.*
- *Haematological investigations – white cell count 16.6 10^9/L, haemoglobin 157g/L, renal profile and venous gas were normal.*

Following his CT, the patient underwent plain radiographs of his right lower limb (see figure 1).

Figure 1: Injury radiographs showing displaced fractures at the junction of the middle and distal thirds of the tibial and fibular shafts.

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What are the main radiograph findings?

Use a consistent system when interpreting radiographs, starting by checking the patient details, date and radiograph details:

This is an anterior-posterior lateral film of the patient's right ankle, extending from the mid tibia/fibula to the metatarso-phalangeal joints of the right foot. Comment on any obvious abnormality, which for fractures can be further subdivided into fracture type, location and any displacement. Long bones are divided into thirds for descriptive purposes. Displacement is described according to the relation of the distal fragment to the proximal fragment.

This is a high-energy fracture, with transverse fractures of the distal third of the tibia and fibula shafts, with lateral displacement and shortening.

A minimum of two views (commonly AP and lateral) must be obtained for all fractures in order to fully assess the injury. Additionally, any force significant enough to break a bone may have damaged other structures, so it is vital to both examine and image the joint above and below the affected one. In this case, it is prudent to image the pelvis, hip and knee.

This patient is found to have an isolated open tibia and fibula fracture of the right lower limb.

How do you classify open tibial fractures?

The most commonly used classification system for open fractures is the 'Gustilo Anderson Open Fracture Classification' (see table). This takes into account the soft tissue injury, amount of energy transferred through the limb and degree of tissue contamination to grade the severity of an open fracture. Higher grades correlate to more severe injuries requiring more advanced repair and there is a greater potential for complications. Classification is best undertaken after primary debridement, when the extent of the damage is known.

How do you manage an open tibial fracture?

The British Orthopaedic Association (BOA) and the British Association of Plastic, Reconstructive and Aesthetic Surgeons (BAPRAS) have published evidence-based guidance on the management of traumatic injuries known as BOA and BAPRAS Standards for Trauma (BOAST).

The BOAST 4 guideline deals with the management of severe open lower limb fractures. In addition to this the National Institute for Clinical Excellence (NICE) have released their guidance on open fractures.

The crucial points from both NICE and BOAST 4 are as follows:

1. IV antibiotics should be administered within three hours of injury.

2. Adequate morphine based analgesia should be given.

3. Regular neurovascular assessment should be undertaken, with any deterioration prompting intervention, specifically looking for evidence of vascular compromise or compartment syndrome.

4. The wound should only be handled to remove gross contamination and to allow photographs, then should be covered with saline-soaked gauze. Routine irrigation should not occur in the emergency department.

5. The fractured limb should be reduced and splinted appropriately.

6. The patient should be kept nil by mouth and appropriate intravenous fluids prescribed pending surgical intervention.

7. The patient should be managed jointly by Plastic and Orthopaedic Surgeons in a major trauma center (transferred as necessary).

8. Primary debridement should occur:

- *Immediately for highly contaminated open fractures, polytraumatic patients or those with devascularised limbs.*
- *Within 12 hours for Gustilo Anderson type IIIA and above.*
- *Within 24 hours for all other open fractures.*

9. IV antibiotics should be administered at primary debridement and continued either until definitive wound closure or 72 hours, whichever is sooner.

10. Definitive skeletal stabilisation and wound cover should be achieved within 72 hours if not possible at the same time as primary debridement but should not exceed seven days.

Clinical progress

After the investigations, the patient underwent fracture reduction and plaster cast application under sedation. Photographs of the wound were taken. He was commenced on IV co-amoxiclav 1.2g three times daily as per BOAST 4 guidelines. He was prescribed fluids and kept nil by mouth awaiting definitive surgery. He was admitted under the orthopaedic team. Regular neurovascular assessment was undertaken and the leg was elevated. Regular and breakthrough analgesia was prescribed.

Approximately six hours after presentation, the patient complained of increasing pain in the right leg, uncontrolled despite Morphine, Fentanyl and Ketamine.

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MANAGEMENT OF OPEN TIBIAL FRACTURES & COMPARTMENT SYNDROME

N Campion, A Bucknor, M Pearse

What is the next appropriate step?

It is important to go and assess the patient. Severe pain in the presence of a tibial fracture is extremely concerning for compartment syndrome. Assuming airway, breathing, circulation and GCS are all stable, the first step is to remove the cast and check the neurovascular status of the limb. Pain from swelling within the cast is common and often subsides quickly once the cast is split.

On examination of the limb, pulses were present, but there was sensory disturbance, with loss of two-point discrimination in the tibial nerve distribution. The severe pain persisted, increasing on passive dorsiflexion of his foot. His calf felt very tight and wooden.

What is the immediate management?

These findings in the context of his injury confirm acute compartment syndrome, which is a surgical emergency and requires urgent decompression. Compartment syndrome describes a pathological process where swelling and increased tissue pressure within a closed muscle compartment exceeds the vascular perfusion pressure, leading to muscle and nerve ischaemia. The most important feature is significant pain, worse on stretching of the muscles. Other features include paraesthesia, pallor, pulselessness and paralysis (the latter two are late signs).

The diagnosis of compartment syndrome is clinical and measurement of compartment pressures should only be undertaken if the patient is obtunded and, therefore, the presence or absence of pain is unknown. Normal tissue pressure ranges from 0-10mmhg. The cut-off pressure for a diagnosis of compartment syndrome is controversial but most texts quote pressures over 30mmhg as an indication for urgent compartmental decompression.

The definitive management of compartment syndrome is urgent fasciotomy – two incisions are made, which decompress all four muscle compartments in the leg (see figure). This should be performed within four hours of onset, as irreversible damage is likely after six hours.

Primary surgery

Our patient was consented for fasciotomy and fracture fixation. The orthopaedic and plastic on call consultants were contacted and surgery was performed within an hour of the diagnosis.

At surgery the 3cm open medial wound was debrided and lavaged. Once the open tibial fracture had been debrided, the fracture was stabilised by a bridging external fixator involving two half pins in the proximal fragment and two half pins in the distal fragment.

Medial and lateral fasciotomy incisions were then made and the four muscle compartments were decompressed (Figure 2). The anterior, lateral and superficial posterior compartments were swollen but contained viable muscle.

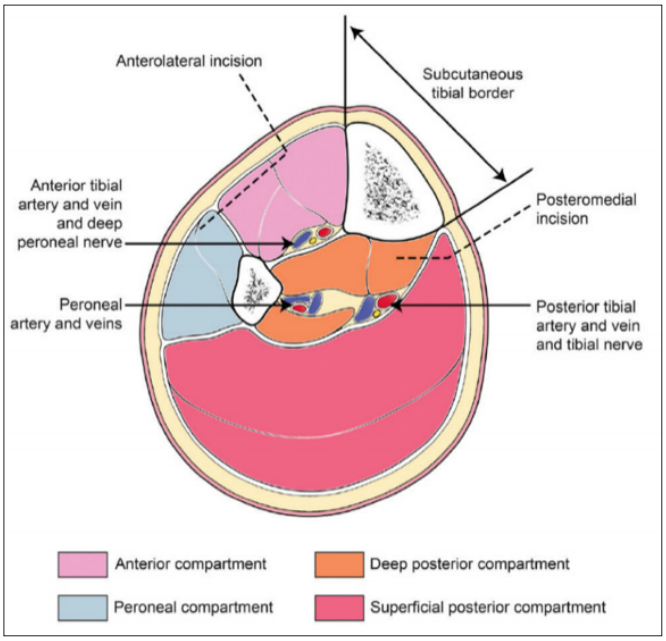

Figure 2: Limb cross-section illustrating decompression of the four muscular compartments via two fasciotomy incisions (from BMJ 2002;325:557).

The deep posterior compartment was very tense with contused muscle around the fracture site. The devitalized muscle was debrided and the remaining muscle was viable and contracting. The faciotomy wounds were covered with a negative pressure dressing. An external-fixator was applied to temporarily stabilise the fracture.

Our patient remained comfortable and he was returned to the operating room at 48 hours for a further soft-tissue inspection and possible definitive fracture fixation. There was a small amount of dead muscle in the deep posterior compartment which was debrided.

The external fixator was removed and a locked intramedullary nail (IMN) was used to provide definitive stability. The medial fasciotomy wound was then closed without tension. The lateral fasciotomy wound was partially closed and a skin graft was harvested from the thigh and applied to the remaining open section of the lateral wound.

How are open fractures fixed?

The urgency of surgical treatment is determined by factors previously outlined by the NICE and BOAST guidance previously stated in this article.

The aim of surgery is the prevention of infection by a thorough wound debridement and lavage performed by senior orthopaedic and plastic surgeons. All foreign material and dead or devitalized tissue is removed. The fracture is then reduced and stabilised by either external or internal fixation.

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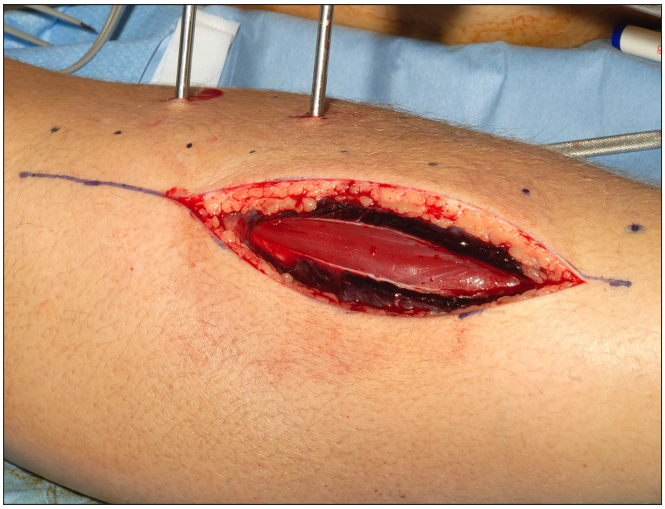
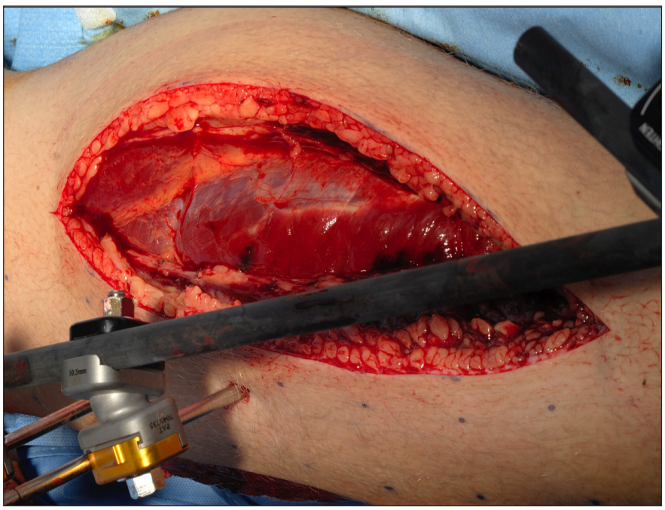
Highly contaminated wounds or injuries associated with bone loss are usually stabilised by external fixation. In external fixation, metal pins are inserted away from the zone of injury and long rods are used to bridge the fracture, providing external stability. It is a temporary measure and may be converted to an intramedullary nail.





Figures 3 & 4: Intra-operative photographs taken after application of a bridging external fixator. Muscle of the lateral compartment is seen to bulge through the lateral fasciotomy wound in Figure 3. The superficial posterior compartment has been decompressed and the muscle appears healthy in Figure 4.

However, if there is significant bone or soft tissue loss, where shortening in the acute setting allows closure of the defect, then the external fixator may be converted to a definitive circular frame. The frame enables distraction of the bone fragments (distraction osteogenesis), facilitating subsequent bone lengthening or bone transport.

Tibial shaft fractures with clean wounds, which can be primarily closed or covered by a local flap may be internally fixed usually with intramedullary nailing. Severe injuries may require a second or third debridement, before the wound can be covered by a local or free tissue flap.

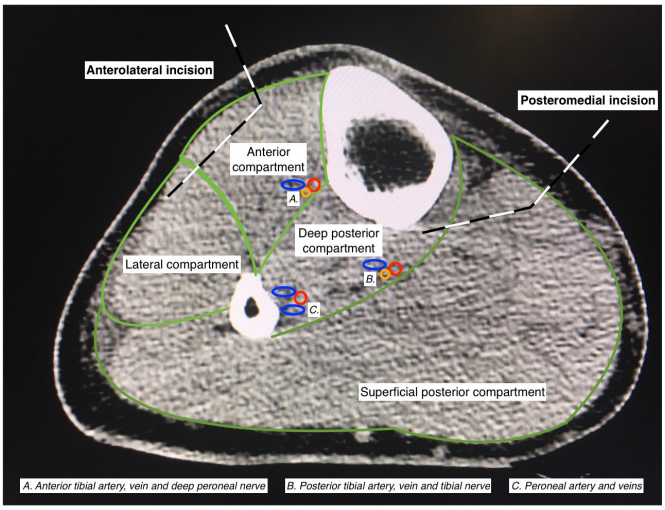


Figure 5: AP radiograph showing stable tibial fracture fixation with a locked intramedullary nail.

Case conclusion

With clinical monitoring, early recognition and prompt decompression of the compartment syndrome, this patient avoided a limb-threatening complication of his high-energy injury. Prompt administration of IV antibiotics reduced the likelihood of later infection. Combined orthopaedic and plastic surgical intervention ensured rigid internal fixation and viable soft-tissue cover of the open fracture, which went onto uneventful aseptic union.

Type	Details of injury
I	Wound <1cm Clean Simple fracture pattern
II	Wound >1cm Moderate soft tissue injury Simple fracture pattern
IIIA	Extensive soft tissue damage (wound >10cm), but adequate coverage of bone
IIIB	Extensive soft tissue injury with periosteal stripping and bone exposure requiring rotational or free flap coverage; or major wound contamination
IIIC	Open fracture with arterial injury requiring revascularisation

Table 1: Gustilo and Anderson classification of open tibial fractures.

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Multiple choice questions

1. Which of the following is true of open tibial fractures?

a. Gross contaminants should be removed and the wound should be irrigated thoroughly in A&E prior to splinting

b. The wound should not be photographed, as this breaches patient confidentiality

c. Compartment syndrome rarely occurs in open fractures

d. IV clindamycin should be administered to penicillin-allergic patients within an hour of injury

2. Classification of open fractures:

a. Is best performed in the emergency department

b. Is by calculating a MESS score

c. Is best undertaken after debridement

d. Determines whether a local or free tissue flap is required

3. Which of the following is true of compartment syndrome:

a. Compartment syndrome can be excluded in the presence of distal pulses

b. Compartment pressures should only be measured in the obtunded patient

c. Urgent decompression of the four muscle compartments in the leg must be undertaken via four carefully-placed incisions

d. The deep peroneal nerve is at risk with a posteromedial fasciotomy

4. Which of the following is true regarding skeletal stabilisation of open fractures:

a. Commonly undertaken with an external fixator or an intramedullary nail

b. Should be undertaken within 48 hours of injury

c. Internal fixation is only performed at the time of definitive wound closure or flap cover

d. Plate fixation is commonly used for shaft fractures

5. Which of the following lower limb anatomy statements are true:

a. The motor supply is largely from the sciatic, femoral and radial nerves

b. The deep peroneal nerve provides motor supply to the anterior compartment of the leg

c. The superficial peroneal supplies the first webspace on the dorsum of the foot

d. The deep peroneal nerve wraps around the head of the tibia

MCQ Answers

Answer 1: d

IV clindamycin should be administered to penicillin-allergic patients within one hour of injury (co-amoxiclav or cefuroxime if no penicillin allergy).

The wound should be handled only to remove gross contaminants or to apply traction, but should not be irrigated. In addition, the wound should be photographed, as this obviates the need to take the dressings down for repeated viewing. A backslab should then be applied, to allow for swelling in the acute setting)

Answer 2: c

The Gustilo and Anderson open fracture classification is based on the extent of the soft-tissue and skeletal injury. The extent of limb damage is best judged after radiographs have been obtained and the wound has been explored and debrided at the first operation. Open fractures requiring local or free flap cover are grade IIIB. See table 1 for further details of the classification.

Answer 3: b

Compartment syndrome in an alert patient is a clinical diagnosis and compartment pressures should only be measured in the obtunded patient; valuable time may be wasted attempting to obtain compartment pressures. Loss of distal pulses is a late sign and the presence of distal pulses does not exclude compartment syndrome.

Severe pain uncontrolled by opiate analgesia is the most important feature. Once the clinical diagnosis is made, the patient should be urgently taken to theatre to have all four compartments decompressed via a two fasciotomy technique: anterolateral and posteromedial (see figure 2). The tibial nerve is at risk with the posteromedial incision and the deep peroneal peroneal nerve is at risk during the anterolateral decompression.

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Answer 4: a

Surgical fracture fixation is achieved at the first operation by either external or internal fixation depending on the extent of the soft-tissue injury and degree of contamination and should be performed within 24 hours of injury. Internal fixation of shaft fractures is usually by IMN but is only performed if the wound can be closed or covered by flap surgery at the same operation. A temporary "brigdging.

Primary fixation should be within 24 hours; an external fixator may be used temporarily, but this should be exchanged for definitive fixation in the form of a circular frame or intramedullary nail.

Answer 5: b

The lower limb is principally supplied by the sciatic, femoral and obturator nerves; the radial nerve supplies the upper limb. Within the thigh, the sciatic nerve supplies the posterior compartment of the thigh, the femoral nerve supplies the anterior compartment and the obturator nerve supplies the medial (adductor) compartment of the thigh.

The sciatic nerve divides into the tibial and common peroneal nerves: the tibial nerve goes on to supply the posterior compartment of the leg, while the common peroneal wraps around the head of the fibula and splits into deep and superficial divisions.

The deep peroneal nerve provides motor supply to the anterior compartment of the leg, while the superficial peroneal nerve provides motor supply to the lateral compartment of the leg. The superficial peroneal nerve supplies the dorsum of the foot EXCEPT the first webspace, which is supplied by the deep peroneal nerve.

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