Exam Corner

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MCQs – Adult Pathology – Single Best Answer

1. The interaction between cartilage and water is beneficial because:
Answer: d. Water is imbibed by cartilage and has a passive role in resisting compression.

Water shifts in and out of cartilage to allow deformation of cartilage in response to stress. Water makes up 65 to 80% of the wet weight of hyaline cartilage. In osteoarthritis this can rise to 90% but in very severe osteoarthritis the percentage of water can be reduced.[1]

2. The location of Kaplan's cardinal line is:
Answer: b. from the first web space to the hook of the hamate

Kaplan's cardinal line is defined as the transverse line drawn from the apex of the thumb-index web space towards the hook of the hamate, parallel with the proximal palmar crease. It is just proximal to the superficial palmar arterial arch and is an important consideration during hand surgery.[2]

3. What type of afferent peripheral nerve fibre is responsible for transmitting vibration sense to the spinal cord?
Answer: b. A (A beta)[3]

Fibre	Function
Aα	alpha-motorneurons, muscle spindle primary endings, Golgi tendon organs, touch
Aβ	touch, vibration sense, muscle spindle secondary endings
Aγ	touch, pressure, gamma-motorneurons
Aδ	pain, crude touch, pressure, temperature

4. Which of the following investigations best differentiates osteoporosis from osteomalacia?
Answer: e. Tetracycline labelled bone biopsy

Osteoporosis is a state of decreased bone mass with normal bone mineralisation. In osteomalacia, bone mass may be variable but mineralisation is decreased. When undertaking blood tests, serum calcium and phosphate are likely to be normal in osteoporosis and may be low or normal in osteomalacia. However, osteomalacia as a result of hypophosphatasia may cause elevated calcium and phosphate. Urinary calcium may be high or normal in osteoporosis and low or normal in osteomalacia (high in hypophoshatasia). For these reasons the blood and urine tests will not differentiate well. In terms of bone biopsy, tetracycline labelling allows the rate of calcium uptake and turnover to be estimated (mineralisation) and therefore in osteomalacia tetracycline labels are abnormal and they are normal in osteoporosis.[1]

5. The nerve supplying teres minor is a branch of which one of these nerves?
Answer: d. Axillary nerve

Suprascapular nerve (C5,C6) supplies supraspinatus and infraspinatus.
Lower subscapular nerve (C5,C6) supplies subscapularis and teres major
Upper subscapular nerve (C5,C6) supplies subscapularis
Axillary nerve (C5,C6) supplies deltoid and **teres minor**
Medial supraclavicular nerve (C3,C4) is one of several nerves arising from the cervical plexus that supply the skin over the upper medial part of the chest.[4]

Vivas

Adult Pathology

A 58-year-old keen runner presents with a history of hip pain especially after running. This is the radiograph obtained in the clinic (Fig. 1).

Fig. 1

1. Describe the abnormality on the radiograph.
Answer: There is a transcervical fracture of the right neck of femur. This is minimally displaced on the AP view and is on the tension side of the neck.

2. Describe the likely presentation and mechanism of injury of this patient.
Answer: This is likely to be a stress fracture. The radiograph represents a female pelvis and at the age of 58 the patient is very likely to post-menopausal. As the protective effects of oestrogen on bone (promotes bone formation) are diminished post-menopause, patients may develop osteoporosis and are more susceptible to fractures. In this case, the stress fracture has likely resulted from repetitive microtrauma from running. The presentation of stress fracture is normally insidious and slow due to the repetitive microtrauma that occurs. These patients are normally very active and will only seek medical attention when the pain becomes severe.

3. What further investigations should be performed?
Answer: Blood tests should be performed including calcium, phosphate and alkaline phosphatase to rule out causes other than osteoporosis. Urinary calcium should also be measured. A DEXA (Dual energy X-ray absorptiometry) scan should also be undertaken – however this would likely follow the initial management. Additionally pre-emptive pre-operative bloods tests should be undertaken including FBC, U&E and Group and Save.

4. What are the options for management?
Answer: Options for management would depend on the full history and patient co-morbidities and beliefs. As the patient is a keen runner it is likely that the patient would like to return to that level of function, this would be very unlikely without operative intervention.

Operative options include closed reduction and internal fixation, open reduction and internal fixation and arthroplasty options. As the patient is 58 years old, bone preservation is preferred to arthroplasty and thus fixation would be the operation of choice. Additionally, as the fracture appears minimally displaced on the AP view, fixation is likely to be possible with a closed reduction, leading to the least disruption of blood supply to the femoral head. Fixation options would include cannulated screws or 2-hole dynamic hip screw with a derotation screw.

The major concern with closed reduction and internal fixation is avascular necrosis to the femoral head

5. Describe the blood supply to the femoral head.
Answer: The blood supply to the femoral head is as follows:

Extracapsular arterial ring at the base of the femoral neck,
- formed posteriorly by large branch of medial femoral circumflex artery
- formed anteriorly by smaller branches of lateral femoral circumflex artery
- superior & inferior gluteal arteries have minor contributions

Ascending cervical branches
- these give rise to retinacular arteries
- gives rise to subsynovial intra articular ring

Artery of ligamentum teres;
- derived from obturator or medial circumflex femoral artery
- forms the medial epiphyseal vessels
- only small amount of the femoral head is nourished this artery

Epiphyseal blood supply:
- arises primarily from lateral epiphyseal vessels that enter head posterosuperiorly
- vessels from medial epiphyseal artery entering through ligamentum teres

Metaphyseal blood supply:
- arises from extracapsular arterial ring
- arise from branches of ascending cervical arteries & subsynovial intra articular ring

Trauma

A 74-year-old female living alone in a warden controlled home, tripped and fell at home injuring her right leg. She was unable to weight-bear and was brought into A&E. This is the radiograph of her pelvis (Fig. 2).

1. Describe the radiograph.
Answer: There is a 4-part subtrochanteric fracture of the right femur. There is medial displacement of the shaft and lesser trochanter and the split through the greater trochanter and involvement of the piriformis fossa extending into the lateral wall down to the fracture site. This is a Seinsheimer type V fracture.

Fig. 2

2. What are the classification systems that are commonly used to describe this fracture and which system allows for recommendation of treatment based on the type of fracture?
Answer: Seinsheimer, Fielding's, AO and Russell-Taylor are classification systems.

Seinsheimer[5]
- I – undisplaced fracture with less than 2cm displacement
- II – 2 part fracture
- IIa – transverse fracture
- IIb - Spiral configuration with the lesser trochanter attached to proximal fragment
- IIc - Spiral configuration with the lesser trochanter attached to distal fragment
- III – 3 part fracture
- IIIa -Three-part spiral configuration with the lesser trochanter a part of the third fragment
- IIIb -Three-part spiral configuration with the third part a butterfly fragment
- IV - Comminuted fracture with four or more fragments
- V - Subtrochanteric-intertrochanteric configuration

Fielding's[6]
- I - fracture is at the level of the lesser trochanter
- II - fracture is 2.5 to 5 cm below the lesser trochanter
- III - fracture is 5 to 7.5 cm below the lesser trochanter

Russell-Taylor[7] (based on piriformis fossa involvement)
- I - fracture does not extend into piriformis fossa
- Ia - comminution and fracture lines extend from below lesser trochanter to femoral isthmus
- Ib - fracture lines and comminution involve area of lesser trochanter to isthmus
- II - fracture extends proximally into greater trochanter and involves piriformis fossa
- IIa - no significant comminution or fracture of lesser trochanter
- IIb - significant comminution of medial femoral cortex and loss of continuity of lesser trochanter

Of these classifications the Russell-Taylor system is most useful as treatment can be tailored specifically for different fracture configurations. If the piriformis fossa is intact then an intramedullary nail can normally be utilised and if the piriformis fossa is fractured then a fixed angle hip screw device may be preferred.

3. What are the principles of management of such an injury?
Answer: Initial management of such an injury in the emergency department would include a full ATLS work up including resuscitation and analgesia. The fracture is best treated with operative intervention, given anaesthetic suitability, to ease nursing care, enable a return to mobility and to reduce future medical complications. Informed consent would then be obtained. Pre-operative optimisation of the patient status would include orthogeriatric and anaesthetic input. Regional anaesthesia (spinal) could be used in the event of significant

cardio-respiratory co-morbidity. Post- operative management would centre on early mobilisation, nutrition, fluid balance and DVT prophlyaxis.

Surgical principles would be to obtain indirect reduction and restoration of length, alignment and rotation and stabilisation using principles of relative stability.

4. If you decided to proceed with operative intervention, what kind of implant would you use and why?
Answer: The Russell-Taylor classification would recommend a fixed angle device such as a DCS given that the piriformis fossa is involved and the entry point for a nail is comminuted. The key issue for this fracture is to attempt to restore the anatomy prior to fixation and therefore one should have a low threshold to perform an open reduction with cabling/wiring of the subtrochanteric element. Modern cephalomedullary long intramedullary nails with distal locking can also be used and would be my implant of choice.

5. What drug has been recently implicated in the treatment of these fractures and what are the classical radiological features to suggest its usage?
Answer: Bisphosphonates have been recently associated with subtrochanteric fractures. This is typically a transverse fracture in an area of thickened cortices, following low energy trauma. Before the fracture a conical ridge at the lateral aspect of the femur in the subtrochanteric area can be seen.[8]

Hands

A 34-year-old man sustained a hyperextension injury to his little finger leading to this injury (Fig. 3).

Fig. 3

1. What is your differential diagnosis?
Answer: The clinical picture shows the loss of the normal cascade of the fingers when the hand is in the resting position. Given the acute hyperextension injury, the likely diagnosis is of flexor digitorum proundus (FDP) avulsion of the little finger. Other differentials include a trigger finger. Rupture of the flexor tendons could be secondary to rheumatoid arthritis, cystic degeneration, post-fracture, or calcification of the triangular fibrocartilage complex (TFCC).

2. How would you confirm your diagnosis?
Answer: The diagnosis would be confirmed with a full history to rule out antecedent pathology and a thorough clinical examination. This would include separate testing of the FDP and flexor digitorum superficialis (FDS) tendons. In FDP avulsion the avulsed fragment can be felt as a mass over the proximal phalanx or sometimes in the palm. Radiographs may help localise the position of the retracted tendon. MRI allows for accurate pre-operative assessment of tendon position and degree of retraction, thereby facilitating surgical planning and approach. Some centres advocate the use of ultrasound rather than MRI.

3. Which finger is commonly involved?
Answer: The ring finger is most commonly affected (in 75% of patients). The ring fingertip is usually the most prominent or "longest" during grip in 90% of cases and that it absorbs more force than any other finger during pull-away testing. Secondly the flexor digitorum profundus tendon, as demonstrated in cadaver specimens indicates a significantly weaker insertion of the ring finger compared with the middle finger. These factors contribute to the susceptibility of the ring finger to the profundus avulsion injury.[9]

4. What is the classification system associated with this problem?
Answer: Leddy and Packer[10] have classified profundus avulsions. In type I, the tendon retracts to the palm, held up by the lumbrical origin with disruption of the entire vincular system. Type II avulsion is characterized by retraction of the tendon to the PIP level that spares the vinculum longum, presumably maintaining blood supply. In type III, the profundus tendon avulsion occurs in addition to a fracture of the distal phalanx base.

5. What are the treatment options?
Answer: Treatment can either be operative or non-operative. Return to function is significantly better with surgical intervention. Options include re-attachment to the distal phalanx, tendon grafts, staged reconstruction, tenodesis and arthrodesis.

6. How would you like to treat this patient?
Answer: The factors that influence treatment are
i) the length of time between injury and treatment
ii) tendon retraction
iii) blood supply to the fragment
iv) the presence of bony fragments. My preferred treatment would depend on all of the above. An early diagnosed Type 1 injury would be amenable to delivery of the tendon from the palm and re-attachment to the distal phalanx with a pull-out wire. For three weeks the limb is immobilized in a dorsal splint with the wrist in flexion, MCPJ in 70° of flexion and the IPJs in extension. The wire is then removed and hand therapist completes the rehabilitation. Late injuries can be treated by tendon grafting, tenodesis or arthrodesis. Type 2 and 3 injuries can be repaired at a later date because of preservation of circulation.

Children's Orthopaedics

This child has no complaints but her parents are disappointed about the shape of her left upper limb one year after an elbow injury (Figs 4a and 4b). They want an explanation and a remedy.

Fig. 4a

Fig. 4b

1. How would you manage the case?
Answer: The diagnosis is cubitus varus following a supracondylar fracture. A full explanation is necessary. Regardless of the initial treatment, there is a significant number of malunions after this injury. It is also important to explain that, although the deformity would be permanent, there is usually no functional disability and correction of the deformity by valgus supracondylar osteotomy is for appearance. As with all cosmetic operations, the patient has to want the appearance improved and their expectations may not be realised because it may not be possible to correct the deformity completely and there will be a scar. Therefore, do not offer supracondylar osteotomy unless all these points are understood and the child herself finds the deformity unsightly.

Fig. 5

Here is a radiograph (Fig. 5) showing a recent fracture of the upper tibial metaphysis in a three-year-old boy.

2. Whose name is associated with the injury, how might it cause a problem and how should it be managed?
Answer: The radiograph shows a Cozen's fracture of the proximal tibial metaphysis. This fracture can lead to a valgus angular deformity, even if the fracture appears to be undisplaced. I would manage this patient by taking a full history and performing a thorough clinical examination. I would warn the parents about the risk of later deformity. This may result from asymmetrical growth stimulation of the proximal tibial physis following the injury. It would be best managed in a long-leg straight cast with varus moulding. Regular radiographs should be taken for the first three weeks and the cast wedged appropriately. If a suitable reduction was not possible and the fracture became further displaced, open reduction and removal of periosteum or even the pes anserinus from the fracture site, followed by fixation may be necessary to allow for suitable reduction and stabilisation.

Basic Science

1. What are the types of bone graft that you are aware of?
Answer: Bone grafts may be autografts or allografts and may consist of cancellous or cortical bone.

Autografts involve utilising bone obtained from the same individual receiving the graft. Bone can be harvested from a myriad of sites. An additional surgical site is often required, in effect adding another potential location for post-operative pain and complications. Autografts are osteoinductive (able to recruit host mesenchymal cells to differentiate into osteoblasts to make new bone), osteoconductive (form a scaffold enabling blood vessel ingrowth and new bone formation) and osteogenic (the ability of cellular elements within the graft to make new bone).

Allograft is harvested from an individual other than the one receiving the graft. Allograft bone is taken from cadavers. There are three types of bone allograft available, fresh or fresh-frozen bone, freeze-dried bone allograft and demineralized freeze-dried bone allograft. Allografts are osteoconductive and may be osteoinductive.

Cancellous bone graft is used for osteogenesis. It is commonly used for treating non-unions and cavitary defects as it is quickly remodelled and incorporated.

Cortical bone graft is used for structural support and is slowly incorporated.

Heterogenous bone from another species was trialled but with poor results thus resulting in its withdrawal.

2. What are the different types of synthetic grafts that you are aware of?
Answer: Synthetic bone grafts or graft substitutes are commercially available. The main constituents of these are either calcium triphosphate, hydroxyapatite, calcium carbonate and calcium sulphate. These often contain bone morphogenic proteins (BMPs) and demineralised bone matrix. The composition varies between commercial products.

3. Compare and contrast the properties of synthetic bone grafts.
Answer: Osteoconductive grafts include calcium sulphate, hydroxyapatite, ceramics, calcium phosphate, collagen and other polymers. Osteoinductive grafts include demineralised bone matrix, bone morphogenic proteins and growth factors. Composite grafts may combine these properties.

4. Explain the term *creeping substitution*.
Answer: Creeping substitution is the process by which cancellous bone graft is incorporated. It refers to osteoblasts laying down new bone over the old grafted bone, which is subsequently resorbed.

5. Explain the process of collection and storage of donor femoral heads to be used as bone graft in future.
Answer: A femoral head from a living donor undergoing a total hip replacement is packaged and frozen within 24 hours of donation. Chips from the bone taken by the retrieving surgeon are placed into aerobic and anaerobic broths for culture. The product is only used if free from microbial growth. The sample is quarantined for 180 days to retest the donor for serological markers or tested at time of donation by PCR technology for Hepatitis and HIV in addition to the routine serology. It is stored at less than -40°. This product is stored in two sterile plastic containers within an outer bag. Delivery is in a disposable transport box containing dry ice (solid carbon dioxide) validated to keep the graft frozen until the date and time provided on the box. It is delivered direct to the point of use e.g. theatre.[11,12]

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