Exam Corner

Adult Pathology
A 73-year-old man presents with a painful right hip. He has a background history of severe shortening and stiffness of the left hip (Fig. 1), which is pain-free.

1. Describe the radiographic features of the left hip.
   Answer: This AP radiograph of a left hip shows expansile lesions within the proximal femur. These have a narrow zone of transition but are eroding the cortices. They are relatively radiolucent but there are areas of variable radio-opacity. There is an associated shepherd's crook deformity of the proximal femur which implies the changes are chronic.

2. What is the diagnosis?
   Answer: Fibrous dysplasia

3. What is this condition associated with?
   Answer: This condition may be associated with precocious puberty (McCune Albright syndrome) and occasionally may be associated with malignant transformation (4%). It may also be polyostotic. Hormonal imbalance can occur due to the same genetic mutation occurring in the cells of glands throughout the body, for example the thyroid, adrenals, pituitary and parathyroid can be affected leading to over, or underproduction of hormones. Bony deformity can lead to deafness and blindness.

4. The right hip shows primary osteoarthritis with no other pathological involvement. Discuss whether these changes are related to the underlying condition.
   Answer: Primary osteoarthritis has a multifactorial aetiology. There is a likely genetic susceptibility and environmental factors will also play a role. The abnormal mechanical load through the normal femur on the right from the alterations in gait pattern related to the deformity on the left could be expected to have an effect on subsequent degenerative change.

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MCQs and EMQs

1. Which of the following is not a risk factor for quadriceps tendon rupture?
   Answer: d. Sickle cell disease.

   The risk factors are renal failure, diabetes, rheumatoid arthritis, hyperparathyroidism, connective tissue disorders and steroid use.

2. With regards to the operative treatment of talar fracture dislocations which of the following statements is true?
   Answer: d. 91% of Hawkins type III talar neck fractures develop osteonecrosis.

   The major arterial supply is from the posterior tibial artery via the artery of the tarsal canal. Hawkins sign (subchondral lucency) is best seen on mortise view at 6-8 weeks and is a good prognostic sign. Hawkins type 3 fractures have an AVN rate of approximately 90%.

3. Please select the matching vessels and their perforators from the list below which would supply the flaps with the following axes
   a. A flap with an axis along the lateral cutaneous nerve of the forearm, cephalic vein and superficial radial nerve: Radial Artery
   b. A flap with an axis along the saphenous nerve and greater saphenous vein: Posterior Interosseus Artery
   c. A flap with an axis along the lesser saphenous vein and sural nerve: Peroneal Artery

   There is also alteration on the acetabular side which may be a similar in nature or may be cystic degenerative change.

4. Regarding the excision of the supraclavicular part of the first rib, which of the following statements is true?
   Answer: e. Injury of the thoracic duct is a recognised complication.

5. Whilst performing ulnar shortening osteotomy, care should be taken to avoid the dorsal sensory branch of the ulnar nerve. Please select from the following options the direction of this nerve while crossing the wrist joint.
   Answer: a. From volar to dorsal just distal to the ulnar styloid at an angle of 45° to the long axis of the forearm.

   The sensory branch originates on average 5 cm proximal to the ulnar styloid process and 2 cm radial to the subcutaneous border of the ulna. The nerve crossed the subcutaneous border of the ulna from volar to dorsal on average 0.2 + 1.1 cm proximal to the ulnar styloid process.

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Vivas

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Trauma

A 56-year-old lady has presented to the fracture clinic after falling off a horse on to her left side with the following radiographs and subsequent CT scan (Figs 2a to 2c).

1. Describe the radiographs and the CT scan.
   Answer: This is an AP radiograph of both hips showing bilateral displaced intracapsular fractures of the proximal femurs. Radiographs show a displaced fracture of the acromion with multiple fractures of the rib. CT scan confirms the fracture, which is displaced and also shows evidence of haemopneumothorax.

2. How would you further investigate this patient?
   Answer: A plain radiograph of the chest should be performed and it confirmed the haemopneumothorax.

3. How would you manage this patient?
   Answer: I would discuss with the patient regarding operative fixation. This would provide improvements in pain and would reduce subacromial impingment and rotator cuff pathology from the malunion that is likely to occur. I would treat this with open reduction internal fixation with a pre-contoured locking plate via a direct posterior approach.

4. What are the pitfalls of non-operative management of this fracture?
   Answer: The main problems will be due to weakness of the abductor pollicis brevis and opponens with difficulty in opposing the thumb to the other fingers due to a combination of supination of the thumb and weakness of the opponens pollicis brevis.

Hands

A 70-year-old retired seamstress presents with severe weakness of her thumb with wasting of the small muscles of her thenar eminence (Fig. 3). She has a long-standing history of tingling and numbness affecting the radial digits which used to cause discomfort at night and wake her up on a regular basis.

1. What is the likely diagnosis?
   Answer: Chronic low median nerve compression, most likely carpal tunnel syndrome.

2. What are the difficulties a patient with the above problem is likely to have?
   Answer: The main problems will be due to weakness of the abductor pollicis brevis and opponens with difficulty in opposing the thumb to the other fingers due to a combination of supination of the thumb and weakness of the opponens pollicis brevis.

3. How would you treat the above patient?
   Answer: I would take a full history and perform a complete neurological assessment. I would also examine specifically for a palmaris longus. Assuming the patient required and desired surgical intervention and had any function of the median nerve I would offer carpal tunnel decompression in order to preserve whatever median nerve function she still has.

   The Camitz transfer is a technically reproduceable procedure, which requires a sensate thumb and a functioning FPL in a patient with weakness of abduction and opposition secondary to longstanding carpal tunnel syndrome.

4. What is the expected prognosis?
   Answer: Although laser ablation and sclerotherapy have been described in the management of glomus tumours, surgery is the gold standard and a meticulous dissection and excision is inevitably associated with an excellent clinical result. The prognosis for the neuropathy is poor, however the expected prognosis is reasonable with good improvement of thumb opposition. She will however likely remain weak. A third of the patients with severe wasting of the thenar muscle require no treatment. The rest can be treated with an opponensplasty.

Children’s Orthopaedics

A 15-month-old girl presents with a two-day history of fevers and refusing to weight bear on the left lower limb. She has had coryzal symptoms for the last five days. On examination she has a temperature of 38.8°C. Her hip is held flexed at 15°, and has restriction of movement in all directions. Examination of the rest of the lower limb is normal. Her white cell count is 21, C-reactive protein (CRP) is 70 and Erythrocyte Sedimentation Rate (ESR) is 70.

1. What is your differential diagnosis for this case?
   Answer: The main differentials in this case would be transient synovitis, osteomyelitis (of femur or acetabulum) and septic arthritis of the hip. Other differentials would include Oligoarticular Juvenile Idiopathic Arthritis of the hip. Malignancy must always be considered in patients with non-specific musculoskeletal symptoms.

2. Fig. 4 shows the plain radiograph of her pelvis; what are the relevant findings?
   Answer: There is widening of the joint space of the left hip, suggestive of an effusion. No osseous abnormalities are seen.
3. What further imaging investigations, if any, would you request in this case, and why?
Answer: Ultrasound imaging of the hip would help confirm the presence of an effusion, allowing the planning of surgical management. It may also demonstrate a subperiosteal collection in cases of acute osteomyelitis. Magnetic resonance imaging (MRI) is useful for the investigation of suspected osteomyelitis or pyomyositis.

4. What prediction algorithms to differentiate reactive arthritis from septic arthritis can help guide management in this case?
Answer: Kocher's criteria. Four independent multivariate clinical predictors were identified to differentiate between septic arthritis and transient synovitis: history of fever, non-weight-bearing, erythrocyte sedimentation rate of at least forty millimetres per hour, and serum white blood cell count of more than 12,000 cells per cubic millimetre (12.0 x 10^9 cells per litre). The predicted probability of septic arthritis was determined for all 16 combinations of these four predictors and is summarized as less than 0.2 percent for zero predictors, 3.0 percent for one predictor, 40.0 percent for two predictors, 93.1 percent for three predictors, and 99.6 percent for four predictors. CRP greater than 20 was later added.

5. What will your management be in this case? If this includes antibiotic therapy, which antibiotic will you choose, how will it be administered and for how long?
Answer: I would arrange for the patient to be given a general anaesthetic and perform open washout of the hip joint via an anterior approach. Ideally the patient could be given a general anaesthetic, undergo MRI scanning and then proceed directly to theatre. In theatre I would approach the hip anteriorly I would aspirate the hip prior to my capsulotomy and send the fluid for microbiological analysis. I would also excise a small window of the capsule and take an intra-articular culture swab. Subsequently I would wash the hip thoroughly with 9L of pre-warmed normal saline. I would utilise a paediatric catheter to ensure that I was able to lavage around the femoral neck. I would then close the wound and commence the wound and commence cefotaxime intravenously and then adjust according to sensitivities from cultures. If the child didn’t improve clinically within 48 hours I would consider further washout. I would have the child on intravenous antibiotics via a tunnelled line for 1-2 weeks depending on the patient’s response (monitored by CRP). I would then convert to a suitable oral alternative to allow a total course of 4 weeks.

Basic Science

1. Describe the process and stages of fracture healing.
Answer: Fracture healing in common with most tissue healing in the body may be divided into three phases: inflammation, repair and remodelling. In the initial phase haematoma forms and provides haemopoietic cells which secrete cytokines and growth factors. Macrophages are the key cell type and both platelets and neutrophils also play a role. The key inflammatory cytokines are PDGF, TNF-a, TGF-B, IL-6, IL-1. Subsequently fibroblasts migrate into the mature haematoma and granulation tissue is formed. The Repair phase involves soft callus formation which then provides a bridging role and the mechanical environment governs whether osteoblastic differentiation or chondroblastic differentiation (see strain theory below). Inhibition of COX-2 (ie NSAIDs) causes repression of runx-2/osterix, which are critical for differentiation of osteoblastic cells. The soft callus is converted to woven bone (hard callus) via a process of enchondral ossification. As this progresses the main collagen changes from type II to type I. The final remodelling phase involves the conversion of woven bone to lamellar bone via cutting cones and governed by Wolff's law. It may also be governed by piezoelectric charges: bone remodels in response to electric charges: compression side is electronegative and stimulates osteoblast formation, tension side is electropositive and simulates osteoclasts. Fractures also heal to a lesser degree by periosteal bony callus whereby new bone is formed directly without a cartilaginous precedent. This occurs due to the direct differentiation of osteoprogenitor cells in the periostium and forms early peripheral hard callus at the fracture site.

2. What do you understand by Primary and Secondary fracture healing?
Answer: Primary bone healing occurs in a situation whereby there is absolute stability and compression. It essentially allows fracture healing via the natural remodelling process of bone involving cutting cones. For primary bone healing to occur there must be no significant gap at the fracture site (50 micrometres) although small defects may heal by gap healing via direct angiogenesis.

3. What do you understand by Perren's strain theory?
Answer: Perren's strain theory suggests that the mechanical environment governs the type of tissue that is laid down in fracture healing. Strain is defined as change in length over original length and may be therefore expressed as a ratio or percentage. Granulation tissue can tolerate 100% strain, fibrous tissue up to 17%, fibrocartilage up to 10% and lamellar bone 2%. Each of these tissues is stiffer than the previous one and therefore as the tissue type progresses the fracture site becomes stiffer and thus the strain is reduced for a given stress allowing the process to continue.

4. Describe the factors that influence fracture healing.
Answer: The two key factors that influence healing of fractures are the mechanical environment and the biological environment. The mechanical environment is important, as explained by Perren, and may also be influenced by the fracture pattern and degree of bone loss. The biology crucially depends on the blood supply and thus any factors which interrupt or alter the blood supply would affect fracture healing. Pre-fracture factors such as medical comorbidities (peripheral vascular disease, diabetes) are important non-modifiable issues as are factors related to the trauma itself such as open injuries, degree of periosteal stripping or concomitant
vascular injuries. Modifiable factors include avoidance of infection, choice of appropriate device for fixation (i.e. assessing whether primary bone healing or secondary bone healing is the goal and using an appropriate mechanical device to assist it), minimising further damage to periosteum and meticulous tissue handling. Post-operatively nutrition should be optimised, NSAIDs should be avoided and a smoking cessation programme should be commenced.

5. What is the role of BMPs in nonunion? What is the evidence for their use?

Answer: Nonunions are broadly due to either biological issues or mechanical ones (or more commonly a combination). BMPs are a group of cytokines which are powerfully osteogenic but have no structural element. They are thus used to alter the biological environment in favour of bone formation. Both BMP-2 and BMP-7 have evidence for their use in fracture nonunions. However studies are generally small numbers, and a Cochrane review in 2010 suggests that there is limited evidence to suggest that BMP may be more effective than controls for acute tibial fracture healing. However, the use of BMP for treating nonunion remains unclear. The limited available economic evidence indicates that BMP treatment for acute open tibial fractures may be more favourable economically when used in patients with the most severe fractures.

References