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## MCQs – Adult Pathology – Single Best Answer

1. Two types of metal on polyethylene total hip replacements are being compared. They both use the same polyethylene, the same head material and the same external socket diameter. Type A has a 32 mm head on a 16 mm trunnion and Type B has a 22mm head on a 11 mm trunnion. Which of the following statements is true:

*Answer: c.* Frictional torque is directly proportional to the ratio of head size to socket size.

The larger 32 mm head will cause greater volumetric wear than the smaller 22 mm head since it has a greater arc of motion and therefore generates a higher number of wear particles. The head neck ratio with a 32 mm head and 16 mm neck, compared with a 22 mm head and 11 mm neck are both 2:1 hence the primary arc of motion is identical.

The ratio of the external diameter of head size to the external diameter of the socket is directly proportional to the frictional torque. Charnley applied this principle of low frictional torque to hip arthroplasty aiming for a ratio of head to socket size of 2:1 reducing the incidence of acetabular component loosening with a larger socket and a 22 mm head. With a smaller diameter head, the moment of frictional force is lessened and then if the external diameter of the socket is increased the tendency for the socket to rotate against the bone is reduced. Since the bearing surfaces are the same, the coefficient of friction will be equal but due to greater volumetric wear with a larger head size A would not be expected to last as long as B.<sup>1</sup>

2. Which of the following statements is true? *The endurance limit of a material is:*

*Answer: c.* The stress beneath which a material will not fail through fatigue.

The endurance limit is the maximum stress under which a material will not fail regardless of how many load cycles are applied to it. Ultimate tensile strength is the highest stress observed on the stress-strain curve and represents the highest load/stress before the material fails. The area under the elastic portion of the stress-strain curve is the resilience of the material and is essentially the elastic energy absorbed by the material as it is elastically deformed. The manufacturing process does influence the endurance of materials such as steel.

3. The pattern of inflammation in the peri-prosthetic tissues of loose metal-on-metal articulations is

characterised by:

*Answer: e.* Perivascular infiltration of lymphocytes and accumulation of plasma cells.

Aseptic loosening of metal-on-metal articulations is characterised by a perivascular infiltrate of lymphocytes and an accumulation of plasma cells. The chronic inflammatory infiltrate reveals an abundance of T-lymphocyte cells (and to a lesser extent B lymphocytes and plasma cells) centred on small obliterated blood vessels. Eosinophils are not characteristic but can be present, however histiocytes are often seen.<sup>2,3</sup>

4. Which imaging modality is the most sensitive for diagnosing asymptomatic avascular necrosis of the femoral head:

*Answer: d.* Magnetic resonance imaging.

MRI is sensitive and specific for avascular necrosis of the femoral head and is the investigation of choice since early changes may also be identified as well as information about specific necrotic foci within the femoral head and associated articular degeneration can be obtained. This can help planning of treatment in the form of carefully directed core decompression, which would not be facilitated by the other imaging modalities listed.

5. Which of the following statements concerning a total knee replacement in patients with Pigmented Villonodular Synovitis (PVNS) of the knee is true:

*Answer: d.* Post-operative results are acceptable with good knee and functional scores.

Total knee arthroplasty for PVNS provides satisfactory results with good knee and functional scores. Aseptic loosening in these patients is uncommon and in a study of 18 patients with PVNS receiving a total knee replacement at the Mayo clinic at ten-year follow-up, 14 had well-fixed prostheses with satisfactory function. In addition recurrence of PVNS is similar to that in patients managed with synovectomy alone and in this series there were two recurrences in 14 patients who had extensive disease, one successfully treated with revision and the other required an amputation. Overall recurrence rates are low due to surgical exposure allowing for thorough debridement of the entire synovial membrane. Post-operative stiffness is more common in patients with PVNS undergoing knee arthroplasty possibly a product of having multiple previous procedures as well as the underlying disease process.<sup>4</sup>

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## Vivas

### Adult Pathology

A 17-year-old male presents with pain in his foot and inability to run long distances. He has recently noticed

that he has flat feet. This is his radiograph (Fig. 1).

1. Describe the abnormal findings on the radiograph.

*Answer:* This oblique view of a skeletally mature foot demonstrates a bony bar between the anterior process of the calcaneum and the navicular.



Fig. 1

2. What further history would you obtain?

*Answer:* I would ask the patient whether he has pain from the foot. I would also ask whether he has any pain or stiffness affecting either wrist potentially due to rarely associated carpal coalition.

3. What further investigations would you request if any?

*Answer:* A CT scan of the foot would be useful to determine whether this is a complete/incomplete/fibrous coalition and to investigate for other associated coalitions.

4. What is the likely diagnosis?

*Answer:* Calcaneonavicular coalition.

5. How would you classify this condition?

*Answer:* I would classify this as a complete bony coalition.

6. What are the options for treatment?

*Answer:* Initial conservative treatment in the form of rest or a period of time spent in cast may settle symptoms followed by surgery indicated for pain relief if non-surgical management fails. Surgery would aim to resect the bar but not restore movement.

7. What is the expected prognosis following surgical intervention?

*Answer:* Prognosis is determined by the age of the patient at presentation, the nature and extent of the bar (complete/incomplete, osseous/fibrous) and whether there are any associated complex joint deformities. Movement following excision of the bar does not usually significantly improve but studies have shown that meticulous excision with extensor digitorum brevis interposition can result in significantly improved subtalar movements and planarflexion, 74% and 82% respectively, allowing return to sport and preventing re-ossification.<sup>5</sup>

**Trauma**

A 32-year-old electrician fell off a ladder leading to this injury (Fig. 2a).

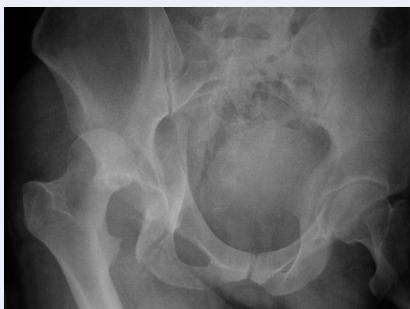


Fig. 2a

1. Describe the abnormality in the radiograph.

*Answer:* The plain radiograph shows a dislocated right hip with an associated acetabular fracture extending to the inferior pubic ramus.

2. What is the likely diagnosis?

*Answer:* The diagnosis is a traumatic right hip anterior fracture dislocation. The mechanism of injury (fall from height) and radiographic appearances with the lesser trochanter in full profile suggest that this is an anterior (superior) dislocation more likely to occur with the leg extended, abducted and externally rotated.

3. How would you manage this injury?

*Answer:* Following a primary survey, this gentleman will require emergent closed reduction of the right hip under conscious sedation in the A&E department followed by application of skin traction. Prompt reduction, with traction, extension and internal rotation is necessary to reduce the risk of osteonecrosis and relieve tension on surrounding neurovascular structures.

4. This is the radiograph following your initial intervention (Fig. 2b). Describe the radiographs and classify the injury.

*Answer:* This is an obturator oblique Judet radiograph of the right hip taken with the patient's right hip rotated 45° anteriorly and the beam directed vertically towards the affected hip. This shows disruption of the iliopectineal line indicative of an anterior column fracture with a transverse extension to the posterior column. I would classify this fracture with the X-rays available as a Letournel I with an anterior wall fracture and posterior hemitransverse fracture.<sup>6</sup>

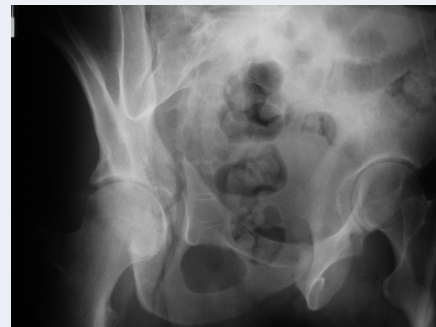


Fig. 2b

5. Would you request any further investigations at this stage? If yes, why and which one?

*Answer:* I would request a CT scan of the pelvis with 3D reconstruction to further characterise the personality of the fracture and allow surgical planning. It is also useful to ensure a congruent reduction, exclude bony fragments retained within the joint and exclude other pelvic fractures.

6. How would you manage this patient?

*Answer:* I would now manage the patient with open reduction internal fixation of the right acetabulum with an ilioinguinal approach and plan to do this 3-5 days following admission allowing for adequate pre-operative optimisation. The ilioinguinal approach allows excellent visualisation of the anterior column for reconstruction with contoured plates in addition to lag screws.

7. What other structures are likely to be involved as a result of this injury?

*Answer:* The surrounding neurovascular structures are likely to be at risk following this anterior-superior fracture dislocation of the right hip. The femoral artery and nerve are most at risk and must be clinically assessed before and after reduction.

8. What is the expected prognosis?

Answer: The prognosis is affected by the fracture type, congruity of reduction, presence of local complications and heterotopic ossification. In a retrospective review of 424 acute acetabular fractures the clinical outcome was worse where a non-anatomical reduction was achieved, which is more likely in older patients. Other poor prognostic indicators identified were complicating factors recognisable at initial presentation including significant impaction, articular abrasion, a femoral head or neck fracture or obesity.<sup>7,8</sup>

Hands

A 7-year-old boy presents with pain in his wrist following a fall. Examination reveals minimal tenderness over the distal ulna and no other abnormality. These are his radiographs (Fig. 3).

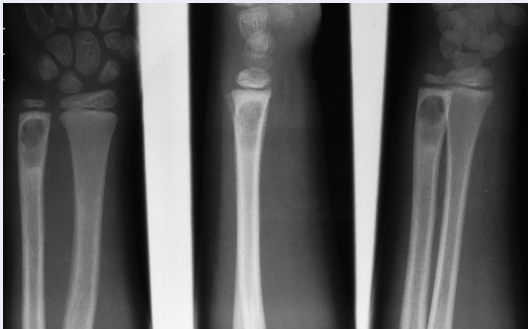


Fig. 3

1. Describe the abnormality.

Answer: Figure 3a illustrates a lytic lesion in the distal ulna metaphysis not extending up to the physis. The lesion is well-defined with a narrow zone of transition and a sclerotic rim. There is no expansion of the cortex or any periosteal reaction.

2. What is the differential diagnosis?

Answer: The differential diagnosis includes infection, leukaemia, unicameral bone cyst, non-ossifying fibroma and eosinophilic granuloma.

3. What other investigations would you request, if any?

Answer: I would request screening blood tests to exclude the first two conditions on my list of differential diagnoses. Full blood count (including blood film) and inflammatory markers.

4. How would you treat him at this stage?

Answer: If the results of the blood tests were normal, I would treat the patient conservatively with observation only. The appearances of the lesion are benign and the patient's main risk is a pathological fracture through the lesion. More extensive investigations are not required.

5. What is the prognosis?

Answer: The prognosis is good. As the child grows, I would expect the lesion to resolve without treatment.

Children's Orthopaedics

Please examine this radiograph (Fig. 4).

1. What is this condition?

Answer: Multiple Enchondromatosis (Ollier's Disease).

2. What are the orthopaedic problems and how can they be addressed?

Answer: Limb deformity and shortening, which can generally be treated successfully by established limb reconstruction techniques.

3. What is the associated condition and its significance?

Answer: Maffucci syndrome, which is multiple enchondromas associated with multiple haemangiomas and possibly lymphangiomas. There is a 100% risk of malignant change into



Fig. 4

chondrosarcoma and an increased risk of visceral malignancy.<sup>9</sup>

This is the radiograph of a six-year-old boy (Fig. 5), who is active but with a limp and intermittent pain in the left thigh.



Fig. 5

4. What are the likely findings on examination?

Answer: Preservation of hip flexion but restriction of abduction and rotation.

5. What is the likely diagnosis?

Answer: Legg-Calve-Perthes disease, early stage. There is loss of epiphyseal height.

6. What is the natural history?

Answer: Depending on extent of necrosis, progressive partial or total collapse of the epiphysis to the fragmentation stage, followed by healing and remodelling. The whole process takes three to four years.

7. What are the goals of treatment and what results would you hope to achieve after treatment?

Answer:

- a) maintain movement, avoid adduction contracture
- b) achieve either spherical or aspherical congruity. The former may not be possible in more severe cases but both are compatible with good long-term outcomes. I would expect the child to have a reduced range of motion with abduction and internal rotation deficits.<sup>10</sup>

Basic Science

1. What do you understand by the terms friction and lubrication?

Answer: Friction is defined as the resistance to sliding motion

between two bodies in contact. Lubrication reduces friction and wear in joints. There are two main types, fluid film and boundary lubrication.<sup>11</sup>

## 2. Describe the different types of lubrication.

**Answer:** During fluid film lubrication surfaces are separated by a thin film of fluid with a minimum thickness that exceeds the surface roughness of the bearing surface which therefore prevents asperity contact. During boundary lubrication the bearing surfaces are separated by a boundary lubricant, which prevents excessive friction and wear. There are many different types of fluid film lubrication:

- a) *Hydrodynamic lubrication* – a thin layer of fluid that is sufficient to support the applied load, which prevents contact between the bearing surfaces.
- b) *Elastohydrodynamic lubrication* – deformation of the bearing surface traps pressurised fluid and increases the surface area. The increased area decreases the shear rate and increases the viscosity of the fluid, which increases the ability of the fluid to bear load.
- c) *Micro-elastohydrodynamic lubrication* – the asperities of articular cartilage are deformed under high loads which smooths out the surface and creates a fluid thickness that is sufficient for fluid-film lubrication.
- d) *Squeeze film lubrication* – viscous fluid that cannot be squeezed out between two bearing surfaces is temporarily able to support load by the pressure it exerts on the bearing surfaces.
- e) *Weeping lubrication* – lubricant fluid is extruded by the cartilage as the bearing surfaces are forced together, which increases the fluid film.
- f) *Boosted lubrication* – under squeeze film conditions the water content of synovial fluid is pressurised into the cartilage leaving a concentrated pool of hyaluronic acid-protein complex to lubricate the surfaces.<sup>11</sup>

Boundary lubrication occurs when the fluid film dissipates with lack of joint motion.

## 3. What is the mechanism of lubrication in the normal hip joint?

**Answer:** It is thought that different types of lubrication are predominant within the hip joint at different stages of the gait cycle. At heel strike it is squeeze film. During stance it is elastohydrodynamic and micro-elastohydrodynamic. During toe-off it is a combination of boundary, elastohydrodynamic, micro-elastohydrodynamic and weeping lubrication. During the swing

phase of gait it is hydrodynamic lubrication and during prolonged stance it is boundary and boosted lubrication.<sup>11</sup>

## 4. Describe the mechanisms in which articular cartilage contributes to lubrication in a normal synovial joint.

**Answer:** A hydrophobic glycoprotein and phospholipid layer coats the cartilage surface and prevents the bearing surfaces from coming into contact.<sup>12</sup>

## 5. Describe the mechanism of lubrication in a metal-on-metal total hip replacement.

**Answer:** Metal-on-metal articulations have a low surface roughness and are able to be manufactured with a high radius of articulation (large head and large cup) and polar bearing articulations. This increases the contact area and theoretically allows fluid-film lubrication to take place.<sup>11</sup> However, this is only during the swing phase of gait when the bearing surfaces are moving rapidly. During the stance phase of gait, only boundary lubrication occurs.

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