AAOS-MCQ

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Questions

1. A 32-year-old man has left hip pain that has become more severe over the past year. He also reports popping of the hip during the extension phase of gait. He has limited internal rotation and a positive impingement sign. An AP radiograph of the hip shows a normal head neck configuration but an AP radiograph of the pelvis is most likely to show which of the following?

(1) Normal-appearing radiograph
(2) Increased femoral offset
(3) Acetabular crossover sign
(4) Sacral iliac sclerosis
(5) Valgus hip

2. A study is proposed in which 50 patients with osteonecrosis of the knee are compared with 23 patients without osteonecrosis in terms of their alcohol consumption levels. This is an example of what type of study?

(1) Case–control
(2) Cohort
(3) Cross-sectional
(4) Randomized
(5) Longitudinal

3. Intermittent daily administration of recombinant parathyroid hormone (rhPTH) is a PDA-approved treatment for osteoporosis. Intermittent rhPTH treatment targets which of the following cells in osteoporotic patients?

(1) Osteoclasts
(2) Macrophages
(3) Chondrocytes
(4) Osteoblasts
(5) Endothelial cells

4. A patient falls on his side, impacting the greater trochanter and resulting in a fracture to the femoral neck that initiates on the inferior side of the neck. What type of loading most likely caused the fracture?

(1) Axial compression along the neck
(2) Axial compression along the shaft of the femur
(3) Bending load, resulting in tensile stresses on the inferior aspect of the neck
(4) Torsional loading
(5) Tensile stresses on both the superior and the inferior sides along the neck

5. Which of the following zones of articular cartilage has the highest concentration of proteoglycans?

(1) Superficial
(2) Transitional
(3) Deep
(4) Calcified
(5) Tidemark

6. The nucleus pulposus of the intervertebral disk consists of chondrocyte-like cells that have a limited vascular supply and generate energy through which of the following?

(1) Anaerobic glycolysis
(2) Kreb's cycle
(3) Ketosis
(4) Gluconeogenesis
(5) Lipogenesis

7. Early failure of arthroscopic rotator cuff repair most commonly occurs by which of the following mechanisms?

(1) Anchor pullout
(2) Anchor fracture
(3) Suture rupture
(4) Knot failure
(5) Tissue failure

8. A 20-year-old male tennis player reports the acute onset of ulnar-sided wrist pain after hitting a forehand shot. Examination indicates dorsoulnar tenderness and minimal swelling. The pain is recreated with supination, wrist flexion, and ulnar deviation. Radiographs are normal. What structure is most likely involved?

(1) Ulnar styloid
(2) Flexor carpi radialis tendon
(3) Extensor carpi ulnaris tendon
(4) Scapholunate ligament
(5) Transverse carpal ligament

9. A 16-year-old female gymnast reports a 9-month history of knee pain with activities of daily living and night pain. Management consisting of nonsteroidal anti-inflammatory drugs and physical therapy has failed to provide relief. Examination indicates posterior soft-tissue fullness just proximal to the popliteal fossa, no effusion, 130° of knee motion, no instability, negative meniscus signs, and a normal gait. Radiographs are normal. What is the next best step in management?

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(1) Additional physical therapy
(2) Corticosteroid injection
(3) Sympathetic block
(4) MRI
(5) Bone scan

10. When performing elbow arthroscopy, it is often necessary to evaluate the posterior compartment. When entering the posterior compartment of the elbow, what are the two safest and most commonly used portals?

(1) The posterior portal created 3 cm proximal to the tip of the olecranon and the posterior medial portal created 3 cm from the tip of the olecranon and medial to the triceps
(2) The posterior portal created 3 cm proximal to the tip of the olecranon and the posterior lateral portal created 3 cm proximal from the tip of the olecranon and just lateral to the triceps
(3) The posterior medial portal created 3 cm from the tip of the olecranon and medial to the triceps and the posterior lateral portal created 3 cm from the tip of the olecranon and lateral to the triceps
(4) The posterior medial portal created 3 cm from the tip of the olecranon and the lateral portal made through the anconeus
(5) The posterior portal created at the tip of olecranon and the posterior medial portal just medial to the triceps

11. A 17-year-old pitcher reports pain over the medial aspect of the elbow that occurs during the acceleration phase of throwing, and it prevents him from throwing at the velocity required to be competitive. What structure is most likely injured in this patient?

(1) Radial collateral ligament
(2) Posterior bundle of the ulnar collateral ligament
(3) Anterior bundle of the ulnar collateral ligament
(4) Flexor carpi ulnaris
(5) Pronation teres

12. Which of the following organisms is most often found in a late (> 3 months) infection of a total hip arthroplasty?

(1) *Staphylococcus aureus*
(2) *Staphylococcus epidermidis*
(3) Group B streptococcus
(4) *Escherichia coli*
(5) *Streptococcus viridans*

13. During normal human knee flexion (beginning with the knee fully extended), which of the following statements best describes tibial rotation with respect to the femur?

(1) Rotation is constantly occurring in both directions during the flexion cycle.
(2) The tibia initially externally rotates, and then progressively internally rotates.
(3) The tibia initially internally rotates, and then progressively externally rotates.
(4) The tibia initially internally rotates, and then remains in that rotational position until deep flexion, when further internal rotation occurs.
(5) The tibia initially externally rotates, and then remains in that rotational position until deep flexion, when further external rotation occurs.

14. The anterior approach to the hip (iliofemoral or Smith–Peterson) places which of the following anatomic structures at greatest risk?

(1) Femoral artery
(2) Femoral nerve
(3) Lateral femoral cutaneous nerve
(4) Medial femoral circumflex artery
(5) Obturator artery

15. When compared with total hip arthroplasty, hip resurfacing offers which of the following advantages?

(1) Better patient compliance with precautions
(2) Increased patient activity in sports
(3) Increased mobility of the hip
(4) Improved pain relief
(5) Preservation of proximal femoral bone

16. During total hip arthroplasty, neurologic injury most commonly occurs in which of the following structures?

(1) Inferior gluteal nerve
(2) Obturator nerve
(3) Peroneal branch of the sciatic nerve
(4) Tibial branch of the sciatic nerve
(5) Femoral nerve

17. Post-traumatic physeal arrest is most common at which of the following locations?

(1) Proximal tibia
(2) Proximal humerus
(3) Distal radius
(4) Distal humerus
(5) Distal tibia

18. An 18-month-old girl is brought in by her parents because of concerns of intoeing, bowlegs, and tripping and falling. Prenatal and birth history are otherwise unremarkable. The child's growth and development appear to be normal and she has a normal neurologic exam, a straight spine with no defects, and the hips are stable. Examination indicates hip internal rotation of 40° and hip external rotation of 60°. The thigh-foot angle is internal 30°. The feet are straight and supple. Gait is characterized by intoeing with occasional tripping and falling. On the basis of these findings, what is the most appropriate action?

(1) No treatment because internal tibial torsion slowly resolves on its own
(2) Immediate treatment with a Denis–Browne bar
(3) Distal tibial osteotomies
(4) Proximal femoral derotational osteotomies

(5) Treatment with twister cables

19. What is the most likely reason why open fractures tend to heal more slowly than closed fractures?

(1) Loss of osteoinductive potential from the hematoma that is lost around the fracture
(2) Introduction of foreign material
(3) Subclinical infection
(4) Loss of blood supply at the fracture site
(5) Loss of soft-tissue coverage at the fracture site

20. A patient with Pott's disease, tuberculosis of the spine, is more likely to have which of the following early findings?

(1) Acute-onset back pain and neurologic dysfunction
(2) Preservation of the disk space between two affected adjacent end plates
(3) Involvement of the cervical spine and torticollis
(4) Elevated WBC count and markedly elevated erythrocyte sedimentation rate
(5) Lordotic deformity in late stages of the disease

Answers

1. Preferred response: 3

Discussion: Acetabular retroversion is a cause of anterior femoral neck impingement. In this condition, a standard pelvic radiograph gives the appearance of a figure 8. This image is caused by a crossing over of the anterior rim margin on the posterior rim margin because of the retroversion. The fact that the femoral head and neck configuration appeared normal on the hip radiograph makes coxa valga an unlikely response. The other conditions are not associated with the presenting symptoms and clinical findings in this patient.

References: Reynolds D, Lucas J, Klaue K. Retroversion of the acetabulum. A cause of hip pain. *J Bone Joint Surg Br* 1999; **81**:281–288.

Jamali AA, Mladenov K, Meyer DC, Martinez A, Beck M, Ganz R, Leunig M. Anteroposterior pelvic radiographs to assess acetabular retroversion: high validity of the 'cross-over-sign'. *J Orthop Res* 2007; **25**:758–765.

2. Preferred response: 1

Discussion: In a case–control study, all the participants are selected on the basis of whether they have (cases) or do not have (controls) the disease or outcome of interest. Case–control studies are retrospective as they always look back to see how a certain risk factor may be different between the two groups. The main aspect of a cross-sectional study is that it is designed to look at a representative sample of the entire population of interest at a single point in time. Longitudinal studies follow groups of individuals over a period of time. A cohort study follows a particular group in relation to an event, studying them at intervals in time, and uses objective outcome criteria. In a randomized-controlled study, participants are divided randomly into control and experimental groups to balance both the known and the unknown differences between the groups.

References: Koval KJ, editor. Orthopaedic knowledge update 7. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2002 pp. 79–84.

Einhorn TA, O'Keefe RJ, Buckwalter JA, editors. Orthopaedic basic science: foundations of clinical practice. 3rd ed. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2007 pp. 87–101.

3. Preferred response: 4

Discussion: PTH is an anabolic agent that enhances osteoblastic bone formation on both cortical and cancellous surfaces. It is synthesized in the parathyroid glands as a 115 amino acid precursor and is cleaved into the active 84 amino acid form. The biological activity in the clinically used recombinant PTH is in the 1–34 amino acid sequence at the N-terminus of the molecule. There are PTH receptors expressed by osteoblasts that mediate the anabolic bone response to intermittent PTH administration. Chronic elevation of PTH leads to the stimulation of osteoclasts, producing bone loss.

References: Einhorn TA, O'Keefe RJ, Buckwalter JA, editors. Orthopaedic basic science: foundations of clinical practice. 3rd ed. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2007 pp. 315–330.

Gehrig L, Lane J, O'Connor MI. Osteoporosis: management and treatment strategies for orthopaedic surgeons. *J Bone Joint Surg Am* 2008; **90**:1362–1374.

4. Preferred response: 3

Discussion: In general, an impact load on the side of the hip can be considered a resultant of two forces: one along the axis of the femoral neck and the other perpendicular to the neck. The component that is along the axis will generate compressive stresses; however, the magnitudes of these stresses are smaller than those generated by bending, and bone is stronger in compression than in tension. The component of load that is perpendicular to the femoral neck will bend the neck, generating tensile stresses on the 'concave' side and tensile stresses on the 'convex' side. In this patient, the fracture initiated on the inferior aspect of the neck; therefore, this area was probably subjected to tensile stress. Torsional loads are caused by twisting about the long axis of a bone, which is unlikely in this patient.

References: Smeesters C, Hayes WC, McMahon TA. Determining fall direction and impact location for various disturbances and gait speeds using the articulated total body model. *J Biomech Eng* 2007; **129**:393–399.

Robinovitch SN, Hayes WC, Mcmahon TA. Distribution of contact force during impact to the hip. *Ann Biomed Eng* 1997; **25**:499–508.

5. Preferred response: 3

Discussion: The fundamental structure of normal adult articular cartilage is divided into four different zones: superficial, transitional, deep, and calcified. These layers vary in chondrocyte morphology, size and orientation of

collagen bundles, and water and proteoglycan content. The deep zone has the highest concentration of proteoglycans and the lowest concentration of water. The tidemark is a boundary between the calcified and the uncalcified layers of articular cartilage.

References: Koval KJ, editor Orthopaedic knowledge update 7. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2002 pp. 5–7.

Einhorn TA, O'Keefe RJ, Buckwalter JA, editors. Orthopaedic basic science: foundations of clinical practice. 3rd ed. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2007 pp. 161–174.

6. Preferred response: 1

Discussion: The intervertebral disk is an avascular structure in the adult. Nucleus pulposus cells have a critical need for glucose because they obtain their energy primarily by glycolysis, even in the absence of oxygen. Disk cells do not require oxygen to remain alive, but they die at low glucose levels or acidic pH. Nutrients are supplied from the blood vessels at the margins of the disk and have to traverse the cartilaginous end plate to reach the disk cells. The loss of the nutrient supply through the vertebral body will starve the cells in the disk center and may be a major factor in disk degeneration.

References: Andersson GBJ, An HS, Oegema TR Jr, Setton LA. Intervertebral disc degeneration: Summary of an AAOS/NIH/ORS Workshop, September 2005. *J Bone Joint Surg Am* 2006; **88**:895–899.

Roberts S, Evans H, Trivedi J, Menage J. Histology and pathology of the human intervertebral disc. *J Bone Joint Surg Am* 2006; **88** (Suppl 2):10–14.

7. Preferred response: 5

Discussion: Arthroscopic repair of the rotator cuff is becoming increasingly popular. Unfortunately, recent objective evaluations have indicated high failure rates even in patients who are clinically improved. Early failure can occur by failure of the suture anchor, suture, or knot. However, the most common cause of failure is when the suture pulls through the tendon. This results in 'stretching' of the repair that can lead to gap formation between the repaired tendon and the osseous insertion, and subsequently, poor tendon-to-bone healing.

References: Gerber C, Schneeberger AG, Beck M, Schlegel U. Mechanical strength of repairs of the rotator cuff. *J Bone Joint Surg Br* 1994; **76**:371–380.

Cummins CA, Murrell GAC. Mode of failure for rotator cuff repair with suture anchors identified at revision surgery. *J Shoulder Elbow Surg* 2003; **12**:128–133.

Ma CB, MacGillivray JD, Clabeaux J, Lee S, Otis JC. Biomechanical evaluation of arthroscopic rotator cuff stitches. *J Bone Joint Surg Am* 2004; **86**:1211–1216.

8. Preferred response: 3

Discussion: Extensor carpi ulnaris (ECU) lesions produce pain at the dorsoulnar aspect of the wrist, particularly during wrist supination, wrist flexion, and ulnar deviation. It has been described frequently in tennis players. Most ECU tenosynovitis can be successfully treated nonsurgically using immobilization techniques. Surgical treatment is generally indicated for ECU tenosynovitis or tendinopathy that does not respond to rest. Anatomically, the ECU retinaculum can rupture and the tendon can leave its sheath. With supination, the tendon can leave the sheath and then return to its position during pronation.

References: Montalvan B, Parier J, Brasseur JL, Le Viet D, Drape JL. Extensor carpi ulnaris injuries in tennis players: a study of 28 cases. *Br J Sports Med* 2006; **40**:424–429.

Allende C, Le Viet D. Extensor carpi ulnaris problems at the wrist-classification, surgical treatment and results. *J Hand Surg* 2005; **30**:265–272.

9. Preferred response: 4

Discussion: The phenomenon of tumors misdiagnosed as athletic injuries has been termed 'sports tumors' by Lewis and Reilly. These authors presented a series of 36 patients who were initially believed to have a sports-related injury, but were ultimately diagnosed with a primary bone tumor, soft-tissue tumor, or a tumor-like condition. Muscolo and associates presented a series of 25 tumors that had been treated previously with an intra-articular procedure as a result of a misdiagnosis of an athletic injury. Initial diagnoses included 21 meniscal lesions, one traumatic synovial cyst, one patellofemoral subluxation, one anterior cruciate ligament tear, and one case of nonspecific synovitis. The final diagnoses were a malignant tumor in 14 patients and a benign tumor in 11 patients. The authors observed that oncologic surgical treatment was affected in 15 of the 25 patients. The most frequent causes of erroneous diagnosis were initial poor-quality radiographs and an unquestioned original diagnosis despite persistent symptoms. Persistent symptoms warrant further diagnostic studies, not additional treatment such as physical therapy, corticosteroid injection, or sympathetic block. Although a bone scan may be useful, the possibility of a soft-tissue mass makes MRI the preferred initial imaging modality in this patient.

References: Muscolo DL, Ayerza MA, Makino A, Costa-Paz M, Aponte-Tinao LA. Tumors about the knee misdiagnosed as athletic injuries. *J Bone Joint Surg Am* 2003; **85**:1209–1214.

Lewis MM, Reilly JF. Sports tumors. *Am J Sports Med* 1987; **15**:362–365.

10. Preferred response: 2

Discussion: The posterior portal created 3 cm proximal to the tip of the olecranon and the posterior lateral portal created 3 cm proximal from the tip of the olecranon and just lateral to the triceps are the 'workhorse' portals of the posterior compartment and although relatively safe, risks exist. The radial nerve proximity averages 4.8 mm (3–8 mm) from the posterolateral portal. The central posterior portal is close to 20 mm from the ulnar nerve.

References: Steinmann SP. Elbow arthroscopy. *J Am Soc Surg Hand* 2003; **3**:199–207.

Dodson CC, Nho SJ, Williams RJ III, Altchek DW. Elbow arthroscopy. *J Am Acad Orthop Surg* 2008; **16**:574–585.

11. Preferred response: 3

Discussion: The anterior bundle of the ulnar collateral ligament of the elbow is the primary constraint to valgus force of the elbow. In pitchers and in overhead athletes, injury to this portion of the ligament results in valgus instability. Reconstruction of the anterior band of the ulnar collateral ligament is necessary in many elite athletic throwers to allow them to return to this competitive activity.

References: Azar FM, Andrews JR, Wilk KE, Groh D. Operative treatment of ulnar collateral ligament injuries of the elbow in athletes. *Am J Sports Med* 2000; **28**:16–23.

Cain EL Jr, Dugas JR, Wolf RS, Andrews JR. Elbow injuries in throwing athletes: a current concepts review. *Am J Sports Med* 2003; **31**:621–635.

Rettig AC, Sherrill C, Snead DS, Mendler JC, Mieling P. Nonoperative treatment of ulnar collateral ligament injuries in throwing athletes. *Am J Sports Med* 2001; **29**:15–17.

12. Preferred response: 2

Discussion: *Staphylococcus epidermidis* is the most common organism found in an infected total hip arthroplasty greater than 3 months from the original surgery. *Staphylococcus aureus* is more common in acute postoperative infections, and *E. coli* is associated with infections of the urinary tract. Streptococcus species are less common.

Reference: Barrack RL, Booth RE Jr, Lonner JH, McCarthy JC, Mont MA, Rubash HE. Orthopaedic knowledge update: hip and knee reconstruction 3. Rosemont, IL: American Academy of Orthopedic Surgeons; 2006 pp. 475–503.

13. Preferred response: 4

Discussion: During knee flexion, the tibia initially rotates internally in approximately the first 20° and generally maintains this rotational position until flexion past 90°, when significantly more internal rotation occurs.

Reference: Coughlin KM, Incavo SJ, Churchill DL, Beynnon BD. Tibial axis and patellar position relative to the femoral epicondylar axis during squatting. *J Arthroplasty* 2003; **18**:1048-1055.

14. Preferred response: 3

Discussion: The anterior approach to the hip involves a dissection between the sartorius and the tensor fascia lata (TFL) superficially, followed by a deep dissection between the rectus femoris and the gluteus medius. The lateral femoral cutaneous nerve generally enters the top of the thigh overlying the sartorius, and then usually crosses the interval between the sartorius muscle and the tensor fascia lata more distally. As the fascia between the sartorius and the TFL is incised, the nerve is at risk. The ascending branch of the lateral femoral circumflex artery is also at risk during this approach. The femoral nerve should not be in the plane of dissection as it lies medial to the sartorius.

Reference: Hoppenfeld S, DeBoer P. Surgical exposures in orthopaedics: the anatomic approach. Philadelphia, PA: JB Lippincott; 1984 pp. 301–315.

15. Preferred response: 5

Discussion: When compared with the outcomes of conventional hip arthroplasty with large-diameter femoral heads, hip resurfacing does not result in better outcomes in terms of compliance with hip precautions, increased hip mobility, pain relief, or improved patient activity. The advantage of hip resurfacing is in preserving proximal femoral bone stock that may be advantageous in revision surgery, should that become necessary.

Reference: Mont MA, Ragland PS, Etienne G, Seyler TM, Schmalzried TP. Hip resurfacing arthroplasty. *J Am Acad Orthop Surg* 2006; **14**:454–463.

16. Preferred response: 3

Discussion: The incidence of nerve injury with total hip arthroplasty is ~1%. The sciatic nerve is involved roughly 80% of the time, with the peroneal branch being almost always involved. Isolated tibial branch involvement is reported to occur in only 1% of neurologic injuries related to hip arthroplasty. The superior gluteal nerve may be injured in direct lateral approaches.

References: Barrack RL. Neurovascular injury: avoiding catastrophe. *J Arthroplasty* 2004; **19** (Suppl 1):104–107.

Lewallen DG. Neurovascular injury associated with hip arthroplasty. *Instr Course Lect* 1998; **47**:275–283.

Schmalzried TP, Noordin S, Amstutz HC. Update on nerve palsy associated with total hip replacement. *Clin Orthop Relat Res* 1997; **344**:188–206.

17. Preferred response: 5

Discussion: Post-traumatic physeal arrest occurs most commonly in the distal medial tibia. Using MRI, Ecklund and Jaramillo confirmed this finding. Arrest of the distal radius and proximal humerus is rare after trauma. Traumatic injuries of the distal femoral and the distal ulnar physis also have a high incidence of growth arrest.

References: Ecklund K and Jaramillo D. Patterns of premature physeal arrest: MR imaging of 111 children. *Am J Roentgenol* 2002; **178**:967–972.

Khoshhal KI, Kiefer GN. Physeal bridge resection. *J Am Acad Orthop Surg* 2005; **13**:47–58.

18. Preferred response: 1

Discussion: The child has classic internal tibial torsion that is very commonly seen in younger children who are just beginning to walk. The normal outcome is for the slow resolution of this problem and it seldom requires any treatment. Treatment with a Denis–Browne bar or with twister cables has not been proven to be effective. Surgical treatment at this point is premature and clearly not indicated.

References: Lincoln TL and Suen PW. Common rotational variations in children. *J Am Acad Orthop Surg* 2003; **11**:312–320.

Staheli LT, Corbett M, Wyss C, King H. Lower-extremity rotational problems in children. Normal values to guide management. *J Bone Joint Surg Am* 1985; **67**:39–47.

19. Preferred response: 1

Discussion: In open fractures, the hematoma that forms beneath the periosteum and around the ends of the fracture site is lost from the open wound. In addition, the irrigation process washes out the hematoma that contains growth factors and cytokines from the platelets. Although loss of blood supply at the fracture site and soft-tissue coverage are important factors, loss of the factors that initiate the inflammatory phase of fracture healing is the most important. Infection may also delay healing, but is less common in this population.

References: Buckwalter JA, Einhorn TA, Simon SR, editors. Orthopaedic basic science: biology and biomechanics of the musculoskeletal system. 2nd ed. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2000 pp. 377–381.

Green NE and Swiontkowski MF, editors. Skeletal trauma in children. 3rd ed. Philadelphia, PA: WB Saunders; 2003 pp. 1–14.

20. Preferred response: 2

Discussion: Tuberculosis of the spine typically has an indolent presentation. Unlike pyogenic infections of the spine, the disk space is usually preserved. Most commonly, the thoracic and the lumbar spine are affected. Laboratory studies may be nonspecific. Delayed presentation usually results in neurologic compromise and a kyphotic deformity. Treatment includes a multidrug regimen. Surgery is indicated for deformity correction or failure of medical treatment.

References: Rajasekaran S. Buckling collapse of the spine in childhood spinal tuberculosis. *Clin Orthop Relat Res* 2007; **460**:86–92.

Tay BK, Deckey J, Hu SS. Spinal infections. *J Am Acad Orthop Surg* 2002; **10**:188–197.