Exam Corner

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MCQs – Adult Pathology – Single Best Answer

1. The following statement is true:

Answer: d. Tendon predominantly contains Type I collagen (95%) and Type III collagen (5%)
The fibroblasts in tendons are arranged in a parallel fashion. The amount of proteoglycan matrix is minimal – collagen accounts for the majority of the extracellular matrix.[1]

2. The 'toe' region in the stress-strain graph is a characteristic feature of the following material:

Answer: d. Tendon
The toe region is at the beginning of the stress-strain curve and is concave and non-linear. During the stretching of a ligament or tendon, an increasing number of fibres are recruited under tension and crimped fibres begin to straighten. Initially there is little resistance to tension as the fibres lengthen, but as elongation progresses an increasing number of collagen fibrils become taut and carry load.[1]

3. Load relaxation can be best defined as:

Answer: c. Time-dependent, non-linear, decrease in load
Stress-relaxation is a decrease in stress as a tendon is subjected to a constant strain over an extended period.[1]

4. As age increases, crimp angle in a tendon:

Answer: b. Decreases
Crimp angle decreases with ageing.

5. Bone cement is strongest in:

Answer: b. Compression
Bone cement has poor tensile and shear strength.[2]

Vivas

Adult Pathology

A 63-year-old lady with longstanding history of rheumatoid arthritis is referred with increasing pain in her right ankle.

1. Describe the clinical photograph (Fig. 1a).

Fig. 1a

Answer: The clinical photograph shows a well-aligned ankle with some swelling of the joint. There is a hallux valgus deformity with over-riding of the second toe.

2. Describe the radiographs (Figs 1b and 1c).

Answer: The radiographs show bone-on-bone changes in the ankle joint with well-preserved alignment. There are no major deformities in the coronal or sagittal planes. There is some loss of joint space within the sub-talar joint.

3. What are the options of treatment?

Answer: The options for treatment are conservative management with analgesia, weight loss, restricted weight-bearing, physiotherapy and bracing. The surgical options are ankle arthrodesis or replacement.

Fig. 1b

Fig. 1c

4. What treatment would you offer her at this stage and why?

Answer: I would take a full history and determine the mobility status of the patient and her functional demands. The presence of symptomatic ipsilateral knee, sub-talar and mid-tarsal arthritis can guide treatment options. I would offer her an ankle replacement as the patient groups that have been shown to benefit from this procedure include rheumatoid patients with multiple joint involvement.

5. What are the advantages of an ankle arthrodesis over an ankle replacement?

Answer: Advantages of an ankle arthrodesis include the fact that it is robust. Once fusion is achieved, the patient is able to return to work and leisure activities. Coronal and sagittal plane deformities of the ankle can be corrected with an arthrodesis. Patients with significant deformities are not suitable for an ankle replacement. The complications of ankle arthrodesis include delayed and non-union, infection, neurovascular damage and wound healing problems. A longer-term complication is the development of degenerative changes in adjacent joints.[3]

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6. If you decided to proceed with a total ankle replacement, what kind of prosthesis would you use?

Answer: I would use a second generation three-component design such as the STAR (Scandanavian Total Ankle Replacement) prosthesis. The three-component design allows greater congruency at all joint positions to minimise wear and deformation of the components.

7. What are the possible complications of this procedure?

Answer: The main complication is aseptic loosening; mal-alignment resulting in abnormal contact stresses can contribute to this. Mal-alignment can also cause medial or lateral impingement pain and may result in fracture of the medial malleolus if incorrectly sited in the coronal plane.

8. What are the long-term results for total ankle replacement?

Answer: The STAR prosthesis has a ten-year survival of 80.3% and is one of the most widely used prostheses available.[4]

Trauma

Fig. 2a

Fig. 2b

A 72-year-old lady fell at home sustaining this fracture (Figs 2a and 2b).

1. Describe the abnormality.

Answer: The radiograph reveals a two-part extra-capsular fracture of the neck of femur.

2. How would you classify this fracture?

Answer: I would classify it according to AO classification as 31-A1 (simple per-trochanteric fracture).

3. How would you treat this patient?

Answer: I would treat this patient with an extra-medullary fixation device such as a dynamic hip screw.

4. What do you understand by the term tip apex distance (TAD)?

Answer: The sum of the distance between the tip of the lag screw and the apex of the femoral head on antero-posterior and lateral views, adjusting for magnification.[5]

5. What is the ideal position of the screw when you are trying to fix this fracture? Why?

Answer: Central in the head on both the antero-posterior and lateral views. This position helps minimise the tip-apex distance. A TAD of less than 25mm is recommended to reduce the probability of cut-out of the screw.

6. What is the expected outcome?

Answer: Satisfactory union would be expected within three and six months.

7. Six months following fixation the patient is referred back to you with pain in her hip and a limp. Describe the radiograph (Fig. 2c).

Fig. 2c

Answer: The implant has failed and the screw has cut out of the femoral head. The fracture has displaced into varus and there are no signs of union. There is some evidence of callus, which would suggest a hypertrophic nonunion.

7. What are the management options at this stage?

Answer: The options of management are operative at this stage. Removal of metalwork in the first instance and revising the fixation with an alternative implant. This could be in the form of a fixed-angle device such as a blade-plate or locking plate. An intra-medullary femoral nail could be used and lastly, a total hip replacement should be considered.

Hands

A 14-year-old boy fell while skateboarding. This is the radiograph taken in A & E (Fig. 3).

Fig. 3

1. Describe the abnormality.

Answer: The radiograph demonstrates a Type 3 (osseous) D'Arienzo undisplaced fracture of the waist of the scaphoid.[6] Fractures account for approximately one quarter of overall paediatric scaphoid fractures, with distal pole fractures being most prevalent.[7]

2. What is the blood supply to the scaphoid?
Answer: The major blood supply of the scaphoid bone is distally based derived from branches of the radial artery entering the dorsal ridge. Between 70% and 80% of the intraosseous vascularity and the blood supply to the entire proximal pole enters this way with no blood vessels penetrating the cortex of the proximal pole separately, explaining the higher rate of avascular necrosis with proximal pole fractures.[8,9]

3. How would you like to treat him?
Answer: I would manage this patient conservatively in a scaphoid cast for between six and eight weeks at which point I would remove the plaster to further examine the wrist and take further radiographs to assess union.

4. What is the expected outcome?
Answer: I would expect this fracture to unite. In a historical series of eight patients aged between 9 and 14 years and managed for scaphoid nonunion, four patients had no treatment after the initial injury, but one had presented initially with an undisplaced fracture of the waist of the scaphoid and went onto nonunion.[10] Essentially nonunion of this fracture pattern is rare in children and generally relates to neglected cases following initial injury, supported by a series of 108 children with scaphoid fractures, including 13 waist fractures, with a 100% union rate.[11]

5. What are the indications for internal fixation of the scaphoid?
Answer: The indications for internal fixation of the scaphoid remain debatable. A systematic review and meta-analysis performed in 2010 concluded that there is currently insufficient evidence to make definitive conclusions on the indications for, or effectiveness of operative versus nonoperative management of acute scaphoid fractures.[12] Some evidence does, however, suggest acute fixation of minimally displaced or undisplaced fractures in high level athletes and manual workers and fractures with over 1mm displacement.[13,14]

6. If the fracture fails to unite and goes into nonunion, what are the surgical options?
Answer: The surgical options for nonunion depend on the blood supply to the proximal pole and the presence or absence of osteoarthritis. Open reduction internal fixation with a headless compression screw using cortico-cancellous bone graft can be used in the absence of avascular necrosis (AVN) and higher success rates are seen in more distal fractures.[15]
Where AVN is present a vascularised bone graft can be considered. There are various options available for re-vascularising the proximal pole including a vascularised pedicled bone graft or potentially a vascularised periosteal patch onlay graft, though this technique has demonstrated disappointing union rates.[16]

Children's Orthopaedics

1. This is the photograph and radiographs of a 3-year-old boy, who is asymptomatic and has had no treatment (Figs 4a and 4b). This is a radiograph 18 months earlier (Fig. 4c). Describe the abnormality.

Fig. 4a

Fig. 4b

Fig. 4c

Answer: The radiographs demonstrate thickening and widening of the physis with marked metaphyseal cupping and bowing of the femur and symmetrical tibia on both sides. The findings have not resolved in the radiograph taken 18 months later since the child has not had treatment.

2. What is the condition and its likely cause?
Answer: Dietary rickets due to prolonged breast-feeding without vitamin D supplementation.

3. This is the radiograph of a child who is doubly incontinent (Fig. 5). What is the diagnosis?
Answer: Sacral agenesis.

Fig. 5

4. What is the typical appearance of the lower limbs in this condition?
Answer: The feet are usually stiff and deformed (typically equino-varus) and the calves are very thin (pipe-stem legs).

5. What is likely to be the child's walking ability?
Answer: The children can usually walk unaided. The foot deformities do not prevent walking and there is good hip and knee control.

6. This is the whole-body and lower-limb radiograph of a child with skeletal dysplasia (Figs 6a and 6b). What is the diagnosis?

Fig. 6a

Fig. 6b

Answer: Spondylo-epiphyseal dysplasia congenita (Conradi). The limbs are short, the epiphyses are stippled and there is an early scoliosis. A description of the areas affected and the appearance of the bones therein often goes a long way to an accurate diagnosis.

7. What is the natural history of this condition?
Answer: The spinal and limb deformities are progressive and severe.

Basic Science

1. Describe the structure of a tendon.

Answer: Tendons have a hierarchical structure where highly orientated fibres of dense collagen together with the tendon fibroblasts are organised into fascicles, and fascicles are bound together by connective tissue sheaths to form a tendon.[17-20]

2. Describe the structure of a molecule of collagen.

Answer: The amino acid sequence for the triple helical region of the collagen molecule is represented by (Gly-Xaa-Yaa)n, where Xaa and Yaa can be any amino acid other than glycine though most frequently these are proline and hydroxyproline. It is a sterical requirement that glycine occupies every third position since a functional group of glycine occupies the interior of the triple helix. The presence of hydroxyproline provides stability through the formation of multiple hydrogen bonds along the length of the molecule while hydroxylysine forms covalent cross-links stabilising the fibrillar assemblies.[21]

3. How does a tendon receive its blood supply?

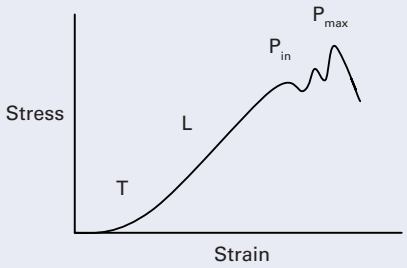
Answer: The blood supply of a tendon depends on whether it is covered by paratenon or avascular and within a sheath. The former receive blood from a small number of small arterioles running longitudinally from the adjacent muscular tissues and surrounding alveolar connective tissue. The sheathed avascular tendons receive blood supply from the mesotenon carrying a blood vessel to one tendon segment with adjacent avascular areas obtaining nutrition via diffusion.[1]

4. What are the functions of a tendon?

Answer: The function of a tendon is to transmit tensile forces from a muscle to bone across diathrodial joints. They also allow the muscle belly to be an optimal distance from the joint and act as an energy store and they also act as stabilisers of the joints.[1]

5. Illustrate the stress-strain curve for a tendon.

Answer: The stress-strain curve for a tendon is shown below[1]:



T = toe region
L = linear region
P_{in} = linear yield point
P_{max} = ultimate tensile strength

6. What do you understand by the term viscoelasticity in relation to the tendon?

Answer: A tendon exhibits time- and rate-dependent visco-elastic properties exhibiting both viscous and elastic responses depending on the load applied. At low loads viscous behaviour predominates with elastic behaviour at higher loads.

7. Describe the process of tendon healing.

Answer: Tendon healing can be divided into three phases[1]:
1- Haemorrhagic / inflammatory: haematoma forms within the damaged area triggering an inflammatory response with a polymorphonuclear infiltrate and activation of a cytokine cascade.
2 - Proliferative: neovascularisation occurs, fibroblast recruitment leads to formation of new matrix material (collagen) with increased elasticity over a period of several weeks.
3 - Remodelling: Progressive maturation and conversion of type 3 to type 1 collagen and reorganisation of the matrix with realignment of fibres according to load for a period of up to several years.

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