ANSWERS AND ADDITIONAL INFORMATION FOR ORTHOPAEDIC CLINICAL QUIZ

Shivdas S, Mansor A, Ahmad TS
Department of Orthopaedic Surgery, University of Malaya, Kuala Lumpur, Malaysia

Answer 1

(Image source- *https://radiopaedia.org/cases/polydactyly-1*)

a) i. Duplication of the thumb.
   ii. Triphalangia of the ulnar thumb.
   iii. Coronal plane angular deformity of both thumbs. (2 marks for any two)
b) Pre-axial polydactyly. (1 mark)
c) Wassel Classification.
   Type 1 - bifid distal phalanx.
   Type 2 - duplicated distal phalanx.
   Type 3 - bifid proximal phalanx.
   Type 4 - duplicated proximal phalanx.
   Type 5 - bifid metacarpal.
   Type 6 - duplicated metacarpal.
   Type 7 - triphalangism. (total 4 marks)
d) Wassel type 7. (1 mark)
e) i. Excision of non-dominant thumb with soft tissue repair/plication.
   ii. Combination procedure with excision or fusion of one joint. (Bilhaut-Cloquet) (2 marks)

Description 1

Presence of extra digits, known as polydactyly, is a congenital deformity involving hands and feet. It has an incidence of 1 in 10,000 live births. It follows an autosomal dominant pattern of genetic inheritance with variable penetrance. While more often being sporadic, polydactyly may be associated with syndromes such as Holt-Oram syndrome and Fanconi's anaemia, which need to be excluded. In the hands, pre-axial polydactyly denotes an extra thumb, whilst an extra little finger is described as a post-axial polydactyly. Polydactyly of the other digits is known as central polydactyly and is rarer. Wassel type 4 is the commonest thumb polydactyly. When involving the thumb, the aim of surgery is to provide a stable and sufficiently long thumb, which is able to oppose against the other digits.

References:

1. Manske MC, Kennedy CD, Huang JI. Classifications in Brief: The Wassel Classification for Radial Polydactyly. *Clin Orthop Relat Res.* 2017; 475(6): 1740-6.
2. Baek GH. Surgical strategy for polydactyly of the thumb. *BMC Proc.* 2015; 9(Suppl 3): A10. doi: 10.1186/1753-6561-9-S3-A10

Answer 2

(Image source- http://www.globusmedical.com/trauma/CAPTIVATE_HeadlessCompressionScrews.html)

a) Headless compression screw. (1 mark)
b) i. Headless.
   ii. Cannulated.
   iii. Differential pitch.
   iv. Self-tapping.
   v. Variable core diameter.
   vi. Variable thread depth. (4 marks for any four)
c) Differential pitch allows interfragmentary compression to be achieved, provided the advancing threads have crossed the fracture site. (2 marks)
d) Rotational stability is not provided. (1 mark)
e) Fracture fixation and arthrodesis. (2 marks)

Description 2

A screw is a surgical device, which converts a torsional force, to a compression force at a fracture site. In orthopaedic surgery, screws are primarily used to achieve inter-fragmentary compression of fracture fragments. They are also commonly used to secure a plate to a bone. Non-locking screws function differently as compared to locking screws. Other screws include rafting screws, position screws, anti-glide screws and poller (blocking) screws. Headless screws are used to achieve inter-fragmentary compression at fracture sites or to achieve fusion at sites of osteotomy. When a good inter-fragmentary compression is achieved, bone heals by primary healing, with little or no callus formation. This is especially useful in intra-articular fractures, where the synovial fluid may wash away the fracture haematoma, thus preventing callus formation and hence, secondary bone healing. The 'headless' design allows the screw head to be buried sub-chondrally, thus protecting articular surfaces. A single screw, whilst being able to provide good compression, does not provide rotational stability. To provide rotational stability, a second screw or an anti-rotation k-wire may be necessary.

References:

1. Adla DN, Kitsis C, Miles AW. Compression forces generated by mini bone screws-a comparative study done on bone model. *Injury.* 2005; 36(1):65-70.
2. Usman Ahmed, Shahbaz Malik, Michael David, Claire Simpson, Simon Tan, Dominic Power. The Headless Compression Screw - Technical challenges in scaphoid fracture fixation. *J Orthop.* 2015;12(Suppl 2): s211-6.

Answer 3

a) 2-point discriminator (1 mark).
b) The 2-point discrimination (2 PD), which measures the innervation density for light touch. (1 mark).
c) Following a demonstration of 1 and 2 points with the eyes open, the patient is asked to close their eyes. With the patient's eyes closed, the pins on the device are gently pressed on the skin, where the 2PD is to be assessed. With each touch from the pins, the patient is advised to inform the examiner if they feel 'one' or 'two' pins. This is done sequentially from the nearest pins to the furthest pins until the patient can distinctly feel both pins. The shortest distance at which both pins can be distinctly felt is the 2PD for that location. The lower the 2PD reading, the higher is the innervation density. (4 marks)
d) The normal 2PD at fingertips of hand is 1-5mm. (1 mark)
e) i. Diabetic neuropathy.
   ii. Peripheral nerve injury.
   iii. Compression neuropathy. (3 marks)

Description 3

2-Point discrimination (2 PD) is a measure of 'Density of innervation'. It indirectly measures the number of nerve fibres recruited to a unit area of skin. The patient's ability to discriminate closer points indicates a good density of innervation. There are two types of 2 PD testing- Static & Dynamic. The 2 PD assessment is useful in studying the severity of nerve damage as well as in assessing the neurological recovery following nerve repair/decompression/neurolysis. In contrast, the Semmes-Weinstein monofilament test is designed to test the 'threshold of innervation', which is tested to study protective sensations. The 2 PD, as well as the innervation threshold, are affected in conditions such as compression neuropathies, nerve injuries, and systemic disease related demyelinating neuropathies.

References:

1. Klein LJ. Fundamentals of Hand Therapy. 2nd ed. Arizona: Mosby; 2014. Chapter 5, Evaluation of the Hand and Upper Extremity; p. 67-86.
2. Won SY, Kim HK, Kim ME, Kim KS. Two-point discrimination values vary depending on test site, sex and test modality in the orofacial region: a preliminary study. *J Appl Oral Sci.* 2017; 25(4): 427-35.

Answer 4

(Image source- *https://www.cureus.com/articles/5573-giant-cell-tumour-of-proximal-phalanx-of-ring-finger-case-report-and-review-of-literature)*

a) i. An expansile bony lesion, arising from the metaphysis of the left ulna.
   ii. Extending into the epiphysis and subchondral bone.
   iii. Cortical thinning.
   iv. No sclerosis.
   v. No periosteal reaction.
   vi. Narrow zone of transition.
   vii. No calcifications.
   viii. Septate lesion.
   ix. Adjacent radius looks intact. (4 marks for any four)
b) Giant cell tumour (GCT) of bone. (1 mark)
c) Hematoxylin and eosin (H&E) stain. (1 mark)
d) i. Multinucleated giant cells.
   ii. Nucleus of the giant cells is the same size as the surrounding stromal cells. (2 marks)
e) Magnetic Resonance Imaging (MRI). (1 mark)
f) Campanacci grading. (1 mark)

Description 4

A locally aggressive benign tumour of bone, the giant cell tumour (GCT) represents about 5% of all primary bone tumours. Metastases can occur in up to 9% of patients. Up to 90% are epiphyseal in location, often extending into subchondral bone. Histologically, the GCT demonstrates multinucleated giant cells, with nuclei resembling those of the surrounding stromal cells. This is in stark contrast to the multinucleated giant cells in tuberculosis, wherein, the nuclei are arranged

eccentrically in a 'horseshoe' pattern. Recent studies have shown some response of the GCTs to chemotherapy, bisphosphonates and anti-RANKL therapy. However, the mainstay of treatment remains surgical excision. Following excision and simple curettage, they often have a high rate of recurrence. Hence, 'extended' curettage is often advised. Due to the juxta-articular involvement in GCTs, joint destruction is often present, and following excision of the lesion, complex surgical procedures are often needed to restore joint function.

References:

1. Sobti A, Agrawal P, Agarwala S, Agarwal M. Giant Cell Tumor of Bone - An Overview. *Arch Bone Jt Surg.* 2016; 4(1): 2-9.
2. Chakarun CJ, Forrester DM, Gottsegen CJ, Patel DB, White EA, Matcuk CRJ. Giant Cell Tumor of Bone: Review, Mimics, and New Developments in Treatment. *Radiographics.* 2013; 22(1):197-211.

Answer 5

a) Tension band wiring of the olecranon. (1 mark)
b) Principle of TBW: when a tension band wire is applied to the tension side of an eccentrically loading bone, the tension band wire absorbs this tension force and converts it into an inter fragmentary compression force at the compression side of the bone, upon loading of the bone. (2 marks)
c) Comminuted fractures or segmental fractures. (1 mark)
d) i. Choosing a cerclage (tension) wire of appropriate size. (1 mark)
   ii. Ideal location of the drill hole for passing the cerclage wire is about four centimetres distal to the fracture. (1 mark)
   iii. Aim the Kirschner wires anteriorly, to ensure purchase of the anterior cortex of proximal ulna. (1 mark)
   iv. Placement of the Kirschner wires to be perpendicular to the fracture plane and parallel to each other. (1 mark)
e) i. Tension band wire fixation with intramedullary screw. (1 mark)
   ii. Tension band plating. (1 mark)

Description 5

Tension band wiring (TBW) is a principle of fixation, wherein, inter-fragmentary compression is achieved at a fracture site on an eccentrically loading bone. It provides a form of dynamic compression, and it is most often applied at intra-articular fractures in eccentrically loaded bones such as olecranon and patella. It is contraindicated in fractures where there is comminution at the compression side. Following an adequate fixation, early mobilization is recommended, as appropriate motion facilitates inter-fragmentary compression, which often results in primary bone healing. However, TBW may be technically challenging and may fail, especially when the relevant basic surgical principles are not adhered to.

References:

1. Wilson J, Bajwa A, Kamath V, Rangan A. Biomechanical comparison of interfragmentary compression in transverse fractures of the olecranon. *J Bone Joint Surg Br.* 2011; 93(2): 245-50
2. Schneider MM, Nowak TE, Bastian L, Katthagen JC, Isenberg J, Rommens PM, et al. Tension band wiring in olecranon fractures: the myth of technical simplicity and osteosynthetical perfection. *Int Orthop.* 2014; 38(4): 847-55.

Answer 6

(Image source- *http://tech.snmjournals.org/content/46/2/147/F1.expansion.html*)

a) Bone scan / Bone scintigraphy. (1 mark)
b) A nuclear medicine imaging technique which detects abnormalities in bone metabolism. A radioactive dye is used, which is absorbed into the hydroxyapatite matrix, which occurs at areas of excessive osteoblast activity. Hence, areas of excessive osteoblastic activity, light up on the scan. (2 marks)
c) The Triphasic Bone Scan has 3 phases: the Flow phase, the Pool phase and the Delayed (bone) phase. (3 marks)
d) 99mTechnetium-MDP. (1 mark)
e) i. Bone forming tumours.
   ii. Osteomyelitis.
   iii. Fracture healing. (3 marks)

Description 6

A metabolic bone scan is a modality of imaging abnormalities in bone. However, unlike the computed tomography (CT) scans and magnetic resolution imaging (MRI) which study anatomical abnormalities in structure, the bone scan studies abnormalities in metabolism and turnover of bone. The triphasic bone scan employs a tracer such as methylene diphosphonate (MDP), which is labelled with radioactive 99mtechnetium (99mTc). The MDP is absorbed into the matrix of newly forming bones. As the MDP is labelled with technetium, the scan will reveal increased radioactivity at areas of increased bone formation. As bone formation is seen in conditions such as fracture healing, osteomyelitis and bone-forming tumours, such lesions will appear as a 'hot spots' on the delayed (bone) phase of the bone scan. For this reason, the bone scan is a sensitive modality of investigation for bone abnormalities but lacks specificity. Specificity can be enhanced by the use of gallium-67 or indium-111 labelled white cell scans. Bone scans are often 'false-negative' on tumours such as multiple myeloma, due to lack of osteoblastic activity. Hence, in non-bone forming tumours, a bone scan is often not useful.

References:

1. Beheshti M, Langsteger W, Logelman I. Prostate cancer: role of SPECT and PET in imaging bone metastases. *Semin Nuci Med.* 2019; 39(6): 396-407. doi: 10.1053/j.semnuclmed.2009.05.003
2. Lee YJ, Sadigh S, Mankad K, Kapse N, Rajeswaran G. The imaging of osteomyelitis. *Quant Imaging Med Surg.* 2016; 6(2): 184-98.