Orthopaedics

MBBS Recap: high-yield notes for revision

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Revision notes for the MD/MS entrance: the facts an examiner asks in orthopaedics and trauma, set out for fast revision. Where classic textbook answers differ from current practice, both are given, the exam answer first.

Fractures

Healing and general principles

- Stages and timing: **haematoma and inflammation** (first week), **soft callus** (about week 3; the first radiological sign of healing), **hard (woven-bone) callus** (weeks 4-6; **the stage at which clinical union is first found**), **remodelling** (months to years, by Wolff's law). **Primary (direct) healing** occurs only with absolute stability and anatomical reduction (compression plating): Haversian remodelling across the gap, no visible callus. **Secondary healing** (casts, nails, external fixators, bridging plates) goes through callus.
- **Clinical union**: no pain and no movement on stressing the fracture site. Radiological union (bridging callus on three of four cortices) comes later. Do not judge union by the X-ray alone.
- Delayed union, non-union (hypertrophic: good blood supply, "elephant foot" callus, needs stability; atrophic: poor biology, needs graft and stability), malunion. **Commonest cause of non-union: inadequate immobilisation** (with poor blood supply and infection); **commonest site: the distal third of the tibia**. Other sites prone to non-union: scaphoid, femoral neck, lateral condyle of the humerus, talar neck, fifth metatarsal metadiaphysis (Jones).
- **Tension band wiring** (patella, olecranon, medial malleolus, greater trochanter): a wire on the tension side turns the distracting pull of the quadriceps or triceps into **compression at the articular surface** as the joint flexes, so early movement helps union.
- The endosteum is the most metabolically active surface of a long bone; the periosteum's cambium layer makes callus.

Physeal (growth plate) injuries

- Zones of the plate, from the epiphysis: resting (germinal), proliferative, **hypertrophic (the weakest: large swollen cells, little matrix, so most physeal fractures run through it)**, zone of provisional calcification, then the metaphysis. The germinal cells stay with the epiphysis, so growth is usually preserved in types I and II.
- **Salter-Harris** (mnemonic SALTR): I **S**traight across the physis; II **A**bove (through the physis and out through a metaphyseal corner, the **Thurston Holland fragment**): **the commonest, about 75%**; III **L**ower (through the physis and down through the epiphysis into the joint: intra-articular, needs exact reduction); IV **T**hrough (metaphysis, physis and epiphysis: intra-articular, risk of a growth bar; the lateral condyle of the humerus is the classic); V **R**ammed (crush: worst for growth, often diagnosed late).

Complications

- **Compartment syndrome** (in full under Amputations and compartment syndrome): a child in a cast after a supracondylar or forearm fracture with **pain out of proportion and pain on passive finger extension, even with a palpable radial pulse**, needs the **cast and padding split down to skin at once**, then fasciotomy if it does not settle; never wait for the pulse to go.
- **Fat embolism**: 24-72 hours after a long-bone (femoral) or pelvic fracture, **triad of hypoxaemia, neurological change (confusion) and petechiae** (axillae, conjunctivae, chest), sometimes called Bergmann's triad. Diagnosis by **Gurd and Wilson's criteria**; fat globules in urine or sputum support it. Treatment is supportive (oxygen, ventilation); early fixation of the fracture lowers the risk.
- Volkmann ischaemic contracture (brachial artery injury in a supracondylar fracture or a tight cast: the deep flexors, FDP and FPL, are worst hit); myositis ossificans (elbow, quadriceps); avascular necrosis (femoral head, proximal scaphoid, body of talus, humeral head); complex regional pain syndrome (Sudeck's atrophy); joint stiffness.

Upper limb

- **Clavicle**: the first bone to ossify (5th-6th week in utero); **the commonest fracture at birth** and among the commonest overall; the middle third (junction of middle and outer thirds) is the usual site. Most heal in a sling; fixation for marked shortening or displacement in active adults.
- **Surgical neck of humerus**: axillary nerve most often injured. **Shaft: radial nerve** (spiral groove); Holstein-Lewis fracture (spiral distal-third shaft) traps it. Proximal humerus: Neer classification.
- **Supracondylar fracture of the humerus (children)**: the commonest fracture around a child's elbow; **extension type (about 95%)** from a fall on the outstretched hand; **posteromedial displacement of the distal fragment is the commonest**. Nerves: **anterior interosseous nerve is the commonest injured overall**; a posterolateral displacement endangers the median nerve and brachial artery, a posteromedial one the radial nerve; the flexion type, the ulnar nerve. Complications: brachial artery injury, compartment syndrome, Volkmann contracture, and **cubitus varus (gunstock deformity), the commonest late deformity, from malunion with medial tilt and internal rotation (not growth arrest)**; corrected by a supracondylar (French) osteotomy. Gartland classification: I undisplaced (cast), II hinged posterior cortex intact, III completely displaced; displaced types are treated by closed reduction and percutaneous K-wires.

- **Lateral condyle fracture (child)**: Salter-Harris IV (Milch); unstable and pulled by the extensors, so displaced ones need open reduction and fixation. Commonest sequel a lateral bony spur; the important one, **non-union, gives cubitus valgus and tardy ulnar nerve palsy** years later.
- **Elbow three-point relationship** (the two epicondyles and the olecranon tip: an isosceles triangle at 90 degrees of flexion, a straight line in extension): **disturbed in elbow dislocation and condylar fractures; kept in a supracondylar fracture**.
- **Colles fracture**: distal radius within 2.5 cm of the wrist, from a fall on the outstretched dorsiflexed hand in an osteoporotic woman; displacement of the distal fragment: **dorsal displacement and dorsal tilt, radial displacement and tilt, impaction, supination**, giving the **dinner-fork deformity**. Complications: **stiffness of the fingers, wrist and shoulder (the commonest)**, malunion (the commonest bony one), Sudeck's atrophy, delayed rupture of extensor pollicis longus, median nerve compression. Closed reduction: **disimpaction by traction, then palmar flexion, ulnar deviation and pronation, then a below-elbow cast** in that position. Classified by Frykman or Fernandez. **Smith**: volar displacement (garden-spade; fall on a flexed wrist; "reverse Colles"). **Barton**: intra-articular rim fracture with carpal subluxation (dorsal or volar). **Chauffeur's (Hutchinson, backfire)**: radial styloid.
- Distal radius fractures are commonest in children (with the greenstick forearm fracture, the commonest childhood fracture) and the elderly; in a young adult with the same fall, think **scaphoid**.
- **Monteggia**: **proximal-third ulna fracture with radial head dislocation**. **Bado**: I anterior dislocation of the radial head (commonest), II posterior, III lateral, IV anterior with fracture of both bones. Nerve at risk: **posterior interosseous**. **Galeazzi**: radial shaft fracture at the junction of the middle and distal thirds with **distal radioulnar joint dislocation** (prominent ulnar head, "piano-key" sign); the "fracture of necessity", needing open reduction and fixation in adults. Reverse Galeazzi: ulnar fracture with DRUJ dislocation. **Essex-Lopresti**: radial head fracture with interosseous membrane tear and DRUJ disruption. Nightstick fracture: isolated ulnar shaft.
- **Scaphoid**: the commonest carpal fracture, at the waist in most; anatomical snuffbox tenderness; seen best on scaphoid views (PA in ulnar deviation, obliques). **The proximal pole is prone to avascular necrosis** because its blood enters distally (dorsal branches of the radial artery), so flow is retrograde. Complications: **non-union** and **avascular necrosis** (both examined; non-union is the more frequent), then radiocarpal arthritis (SNAC wrist). Initial X-ray may be normal: exam answer, immobilise and repeat at 10-14 days; current practice: **MRI is the investigation of choice for a suspected occult fracture** (NICE NG38, 2016), CT if MRI is not available. Waist fractures that are undisplaced heal in a cast; proximal pole and displaced fractures need screw fixation. Preiser disease is idiopathic AVN of the scaphoid.
- **Lunate**: the **most commonly dislocated carpal bone**; on the lateral view it tips volarly ("spilled teacup"), and it can compress the median nerve (acute carpal tunnel). **Terry Thomas sign**: a scapholunate gap over about 3 mm on the PA view, a sign of **scapholunate dissociation**. Kienbock disease: AVN of the lunate.
- Hand fractures: **boxer's** (fifth metacarpal neck, the commonest metacarpal fracture), **jersey finger** (FDP avulsion, usually the ring finger), hook of hamate fracture (ulnar nerve). Bennett and Rolando fractures, mallet finger and gamekeeper's thumb (the Stener lesion) are under Hand and wrist.
- **Madelung deformity**: growth arrest of the **volar-ulnar part of the distal radial physis** (often with a tethering Vickers ligament), usually bilateral, in adolescent girls; associated with Leri-Weill dyschondrosteosis (SHOX gene).

Lower limb

- **Femoral neck**: **intracapsular** fractures (**Garden I-IV by displacement**; **Pauwels I-III by the angle of the fracture line from the horizontal: I under 30°, II 30-50°, III over 50°** (often misquoted as 30°, 50° and 70°), the steeper the line the more shear and the less compression across it, so the higher the non-union) tear the retinacular vessels from the **medial circumflex femoral artery** (branch of the profunda femoris; the main supply, its lateral epiphyseal branches feeding most of the head); the artery of the ligamentum teres (obturator) is minor in adults; the intracapsular neck has no cambium layer and synovial fluid dilutes the clot. So **avascular necrosis and non-union are high**. Limb **short and externally rotated**.

	Intracapsular (neck)	Extracapsular (inter-trochanteric)
Pain, walking	Less; an impacted fracture may still walk	Severe; cannot walk
External rotation	Mild (under about 45 degrees)	Marked (near 90 degrees)
Tenderness	Scarpa's triangle	Greater trochanter
Commonest complication	**Non-union and AVN**	**Malunion** (varus, shortening)
Treatment	Screws or arthroplasty (never traction as the plan)	Sliding hip screw or cephalomedullary nail

- Treatment of neck fractures: young patient, displaced: urgent reduction and cannulated screws (or a sliding hip screw). Elderly, displaced: **hemiarthroplasty**, or total hip replacement in the active, cognitively intact patient (NICE CG124, updated 2023). Undisplaced (Garden I-II): screws. Intertrochanteric: **sliding hip screw (DHS) for stable patterns, cephalomedullary nail for unstable, reverse-oblique and subtrochanteric**. Surgery within 36 hours of admission (NICE). Classified by Boyd-Griffin or Evans.
- **Steroids are the commonest cause of non-traumatic femoral head osteonecrosis** (then alcohol); MRI detects AVN earliest; crescent sign (subchondral fracture) on X-ray; Ficat staging.
- Acetabular fractures: classified by **Judet and Letournel** (Judet oblique views: obturator and iliac oblique); five elementary and five associated patterns. Pelvic ring: Young-Burgess and Tile. Femoral head fractures: Pipkin.
- Femoral shaft: **intramedullary interlocking nail**, the standard in adults; blood loss 1-1.5 L; fat embolism; Winquist-Hansen classification of comminution. Children: under 2 years (and under about 12-15 kg) **Gallows (Bryant's) traction**; under about 6, hip spica; older children, flexible (elastic) nails.
- Tibial shaft: open fractures by **Gustilo-Anderson**: I wound under 1 cm, clean; II 1-10 cm, moderate soft-tissue damage; III high energy, extensive soft-tissue damage (IIIA bone still covered by soft tissue, **IIIB periosteal stripping needing a flap**, **IIIC arterial injury needing repair**). Current practice (BOAST 4, British Orthopaedic Association 2017): **antibiotics within 1 hour**, debridement at once for gross contamination

or vascular injury, within 12 hours for high-energy and 24 hours for others, **definitive soft-tissue cover within 72 hours** ("fix and flap"). Compartment syndrome is commonest after tibial fractures. Patellar-tendon-bearing (PTB, Sarmiento) cast for functional treatment.

- **Calcaneum**: the commonest tarsal fracture; fall from a height, so **look for an associated thoracolumbar (L1) fracture**. **Bohler's (tuber-joint) angle: normal about 20-40 degrees** (quoted 25-40 or 24-40 in different books), **reduced (flattened)** in a joint-depression fracture; the critical angle of Gissane increases. Lover's (Don Juan) fracture.
- Talus: aviator's fracture of the neck, with **AVN of the body** (Hawkins sign, subchondral lucency at 6-8 weeks, means the blood supply survives). Talus is the keystone of the medial arch, the cuboid of the lateral.
- Ankle: **Pott's** (bimalleolar), Cotton's (trimalleolar), **Maisonneuve** (an external-rotation injury: a spiral fracture of the **proximal fibula** with the **distal tibiofibular syndesmosis torn** and a medial malleolar fracture or deltoid rupture, so the ankle is unstable; an injured ankle with a tender upper fibula needs the whole fibula imaged), Tillaux (anterolateral distal tibial epiphysis in adolescents), pilon (axial load into the tibial plafond). Weber (A, B, C by level of fibular fracture to the syndesmosis) and Lauge-Hansen classifications.
- Knee region: **Segond fracture** (avulsion of the lateral tibial rim: **a marker of ACL tear**), Hoffa (coronal femoral condyle), toddler's fracture (undisplaced spiral distal tibia).
- Foot: **Lisfranc** (tarsometatarsal fracture-dislocation; fleck sign), Chopart (midtarsal), **Jones** (fifth metatarsal **metaphyseal-diaphyseal junction**, a watershed of poor blood supply: delayed and non-union are common, so a non-weight-bearing cast, or a screw in athletes), pseudo-Jones (avulsion of the tuberosity by peroneus brevis or the lateral band of the plantar fascia: heals in a boot), dancer's fracture (spiral fracture of the distal fifth metatarsal shaft).
- **Stress (fatigue) fractures**: repetitive loading of normal bone. **March fracture: the second metatarsal neck** (the classic exam answer; the third next); in athletes the **tibia** is the commonest site in many series; **upper limb: the olecranon** (throwers); spine: **pars interarticularis of L5** (spondylolysis). X-ray often normal early; **MRI is the most sensitive test** (bone scan the older one).

Classification systems and casts (lookup)

Fracture	Classification
Proximal humerus	Neer
Supracondylar humerus	Gartland (Wilkins modification)
Monteggia	Bado
Distal radius	Frykman, Fernandez, AO
Thoracolumbar spine	Denis (three columns), AO Spine, TLICS
Pelvis	Young-Burgess, Tile
Acetabulum	Judet and Letournel
Femoral head	Pipkin
Femoral neck	Garden, Pauwels
Intertrochanteric	Boyd-Griffin, Evans
Femoral shaft	Winquist-Hansen
Tibial plateau	Schatzker (I lateral split to VI dissociation of metaphysis from diaphysis)
Tibial plafond (pilon)	Rüedi-Allgöwer
Calcaneum	Sanders (CT), Essex-Lopresti
Open fractures	Gustilo-Anderson
Ankle	Weber, Lauge-Hansen
Physis	Salter-Harris

Cast, splint or traction	Used for
Cock-up splint	Radial nerve palsy (wrist drop)
Knuckle-bender splint	Ulnar (and median) palsy, claw hand
Turnbuckle splint	Volkmann contracture
Aeroplane splint	Brachial plexus injury
Figure-of-eight bandage	Clavicle fracture
U-slab, hanging cast	Humeral shaft fracture
Glass-holding (scaphoid) cast	Scaphoid fracture (includes the thumb)
Thomas splint	Femoral shaft fracture (transport and traction)
Bryant's (Gallows) traction	Femoral shaft fracture under 2 years
Russell traction	Intertrochanteric fracture
Dunlop traction	Supracondylar humerus fracture
Toe-raising splint, ankle-foot orthosis	Foot drop
Denis Browne splint	Clubfoot (after correction)
Pavlik harness, von Rosen splint	DDH
Broomstick (Petrie) cast	Perthes disease
Minerva cast, halo	Cervical (and upper thoracic) spine
Milwaukee, Boston brace, Risser cast	Scoliosis
Taylor brace, ASHE	Dorsolumbar spine
SOMI brace	Cervical spine
Cylinder (tube) cast	Patella
PTB cast	Tibial shaft

Crush injury, wounds and the curriculum's emergency fractures

- **Crush injury and crush syndrome**: prolonged compression of muscle (earthquake, collapsed building, 4 or more hours) then release causes **rhabdomyolysis: myoglobinuria (dark urine), hyperkalaemia, acidosis, hypocalcaemia and acute kidney injury. Start intravenous saline (1–1.5 L/h) before extrication where possible, keep urine output above 200–300 mL/h, treat hyperkalaemia, and consider fasciotomy only if compartment syndrome is proven**; amputation as a life-saving step in trapped, unreleasable limbs.
- **Wound toilet, excision and suture**: for a contaminated wound, **irrigate with large volumes of saline, excise (debride) all dead and contaminated tissue and bring in healthy bleeding edges; leave heavily contaminated, old (over 6–8 hours) or bite wounds open for delayed primary closure at 3 to 5 days**; give tetanus prophylaxis and antibiotics (see Fractures: open fractures).
- **Pott's fracture** (the curriculum wants severe, unstable grades referred): **as Pott described it (1768), a fracture of the fibula a few centimetres above the lateral malleolus with rupture**

of the deltoid ligament and lateral shift of the talus; in common and exam usage, **any bimalleolar fracture-dislocation of the ankle** (the lateral malleolus with the medial malleolus or the deltoid ligament); **a trimalleolar (Cotton's) fracture adds the posterior malleolus**. The commonest mechanism is **supination-external rotation** (Lauge-Hansen), giving a **Weber B** spiral fibular fracture at the syndesmosis. **Both sides of the ankle broken (or the deltoid torn), talar shift, a medial clear space over 4–5 mm on the mortise view or a Weber C (above the syndesmosis) fracture mean an unstable mortise: open reduction and internal fixation**; a 1 mm lateral talar shift cuts the tibiotalar contact area by about 40% (Ramsey and Hamilton, 1976), so early arthritis follows a poor reduction. **A Weber A fracture, and an isolated Weber B with an intact medial side (stable on a stress or weight-bearing film), are treated in a cast or boot.**

- **Nerve and vessel injuries with a fracture or dislocation** (complicated cases) need urgent referral; a limb with a vascular injury should be **reduced and splinted first, then explored**; the **tibial plateau fracture** is intra-articular and needs referral.
- **Painful arc (60°–120° of abduction)**: the inflamed **supraspinatus tendon or subacromial bursa is pinched between the greater tuberosity and the coracoacromial arch** (impingement), and the pain eases above and below the arc; pain only at the top of elevation (beyond 120°–150°) comes from the **acromioclavicular joint**; **adhesive capsulitis restricts all movements**, active and passive, external rotation first (see Sports injuries).

Dislocations

Shoulder

- **Anterior dislocation** (about 95%; the shoulder is the commonest major joint to dislocate): abduction, extension and external rotation injury; the arm is held **slightly abducted and externally rotated**, the contour squared (loss of the round deltoid shape), and the head lies subcoracoid. Signs: **Dugas** (cannot touch the opposite shoulder with the elbow at the chest), **Hamilton ruler** (a ruler touches the acromion and lateral epicondyle at once), Callaway (axillary girth increased). Test the **axillary nerve** (regimental-badge sensation) before and after reduction. Reduction methods: Kocher's, Hippocratic, Milch, Stimson, FARES; X-ray after.
- **Bankart lesion**: avulsion of the **anteroinferior glenoid labrum** (with the inferior glenohumeral ligament); bony Bankart when it takes bone. **The essential lesion of recurrent anterior dislocation.**
- **Hill-Sachs lesion**: a compression defect of the **posterolateral humeral head** from impaction against the anterior glenoid rim (the second lesion of recurrence; together with Bankart, the bipolar lesion). Reverse Bankart and reverse Hill-Sachs (anteromedial head) in posterior dislocation.
- Recurrence risk is highest in those under 20 years (up to 70-90%), so primary stabilisation is considered in young athletes. Tests of instability: **apprehension and relocation (Jobe) tests** for anterior instability, jerk test for posterior, **sulcus sign** for inferior (multidirectional).
- Operations for recurrent anterior dislocation (the exam lists): **Bankart repair** (reattaches the labrum and capsule to the glenoid rim; now arthroscopic), **Putti-Platt** (overlap and shortening of subscapularis and capsule), **Bristow and Latarjet** (coracoid transfer to the anterior glenoid), Magnuson-Stack (subscapularis transfer). Current practice: **arthroscopic Bankart repair**, with **Latarjet when glenoid bone loss is large** (classically over 20-25%, "inverted pear"; many now use lower thresholds) and **remplissage** for an engaging ("off-track") Hill-Sachs; Putti-Platt and Magnuson-Stack are historical because they limit external rotation and cause arthritis.
- **Posterior dislocation** (2-4%): classically from **epileptic seizures or electric shock**; the arm is held **adducted and internally rotated** and cannot be externally rotated. The AP film can look almost normal: the **light-bulb sign** (fixed internal rotation makes the head look round), the empty ("vacant") glenoid, the **rim sign** (widened gap between head and anterior glenoid rim), and the **trough line** (reverse Hill-Sachs). Axillary or scapular Y view and CT confirm. **The dislocation most often missed.**
- **Luxatio erecta** (inferior, under 1%): the arm is held up above the head, with axillary nerve and artery at risk.

Hip

- **Posterior dislocation** (about 90%, the commonest): **dashboard injury** (knee strikes the dashboard with the hip flexed), often with a posterior acetabular lip fracture; the same injury tears the PCL. The limb is **flexed, adducted, internally rotated and shortened** (true shortening). **Sciatic nerve (its peroneal division) injury in 10-20%.** Reduce urgently (within 6 hours lowers AVN); Allis or Bigelow method under anaesthesia; CT afterwards for fragments. **AVN of the femoral head is the commonest serious complication** (with sciatic palsy, myositis ossificans and late osteoarthritis). Thompson-Epstein classification; Pipkin for associated femoral head fractures.
- **Anterior dislocation**: the limb is **flexed (obturator type) or extended (pubic type), abducted and externally rotated**, with apparent lengthening. **Femoral vessels and nerve are at risk: vascular injury is commoner than in posterior dislocation**, sciatic injury commoner in posterior.
- Central fracture-dislocation: acetabular fracture with the femoral head driven medially.
- Hip attitudes: **flexion, abduction and external rotation** in anterior dislocation and the early (synovitis) stage of TB hip, septic arthritis and synovitis (the position of maximal capsular volume); **flexion, adduction and internal rotation** in posterior dislocation and the later (arthritic) stages of TB hip; **external rotation with shortening** in neck and intertrochanteric fractures.
- Hip tests: **Thomas test** (flexing the other hip removes the lumbar lordosis and shows a **fixed flexion deformity**); **Trendelenburg test** (on standing on the affected leg the opposite side of the pelvis drops: weak **gluteus medius and minimus**, superior gluteal nerve, or an unstable hip); Ober test (iliotibial band tightness).

Other joints

- **Elbow**: dislocation is the second commonest major joint dislocation in adults (after the shoulder); posterior or posterolateral is commonest; **ulnar nerve** (and brachial artery) at risk. **Terrible triad of the elbow (Hotchkiss)**: posterior dislocation with **radial head and coronoid fractures**. **Nursemaid's (pulled) elbow**: subluxation of the radial head under the annular ligament in a child under 5 lifted or pulled by the hand with the forearm pronated, **the commonest dislocation (subluxation) of childhood**; the child holds the

arm still and pronated; reduce by supination and flexion, or hyperpronation.

- Knee dislocation: a vascular emergency; **popliteal artery injury in about 20-30%**, so check pulses and the ankle-brachial index (under 0.9 means CT angiography); common peroneal nerve also at risk.
- **Patellar dislocation**: lateral; medial patellofemoral ligament torn; apprehension test; young women with patella alta or a shallow trochlea.
- Acromioclavicular dislocation (Rockwood types I-VI); sternoclavicular posterior dislocation can compress the great vessels.

Nerve injuries

Classification of injury

Seddon	Sunderland	What is damaged	Wallerian degeneration	Recovery
Neurapraxia	I	Conduction block, local demyelination; **axon intact**	**None**	Complete, in days to weeks
Axonotmesis	II	Axon divided, endoneurium intact	Yes	Good; regrowth about 1 mm a day (1 inch a month)
Axonotmesis (mixed)	III	Axon and endoneurium divided, perineurium intact	Yes	Incomplete (misdirected regrowth)
Axonotmesis (mixed)	IV	Perineurium divided too, only epineurium intact (neuroma in continuity)	Yes	Poor without surgery
Neurotmesis	V	Whole nerve divided	Yes	Needs surgical repair

- **Tinel's sign** (tingling on tapping over the nerve) advances distally as the axon regrows. Nerve conduction stays normal distal to a division for about 7-10 days, and denervation potentials (fibrillations) on EMG appear only at about **2-3 weeks**, so electrodiagnosis is done after that. Primary repair for a clean cut; graft (sural nerve) for a gap; nerve transfers are now used for brachial plexus and high injuries.

Upper limb nerves

- **Radial nerve**: fractures of the **humeral shaft** (spiral groove; Holstein-Lewis fracture). **Wrist drop**, with sensory loss over the **first dorsal web space**. **Saturday-night palsy**: compression in the spiral groove of the arm (the arm draped over a chair), a neurapraxia; crutch palsy compresses it in the axilla (triceps weak too). **Posterior interosseous nerve** (Monteggia, radial head fractures, radial tunnel and arcade of Frohse): **finger and thumb drop, no wrist drop** (ECRL spared, so the wrist extends with radial deviation) **and no sensory loss**. Cheiralgia paraesthetica: superficial radial nerve. Most radial palsies with closed shaft fractures recover, so wait about 3 months (cock-up splint) before exploring.
- **Median nerve**: at or above the elbow (supracondylar fracture, **ligament of Struthers from a supracondylar process**, pronator syndrome): loses FDS, the radial half of FDP and FPL, so the index and middle fingers stay straight on making a fist: the **pointing index, or "hand of benediction" on attempted fist**. **Anterior interosseous (Kiloh-Nevin) syndrome**: pure motor, FPL, the index FDP and pronator quadratus; **cannot make the "OK" sign** (the **pinch sign**: the tips of thumb and index cannot flex, so they meet flat, pulp to pulp); no sensory loss. At the wrist (**carpal tunnel**, the commonest entrapment neuropathy): thenar wasting (ape hand), weak **abductor pollicis brevis (the pen test)**, tingling of the lateral three and a half digits with **palm sensation spared** (the palmar cutaneous branch passes above the retinaculum). Tests: Phalen, Tinel, **Durkan's carpal compression (the most sensitive and specific bedside test)**; **nerve conduction study is the investigation of choice**. Splint, steroid injection or carpal tunnel release. **Ochsner's clasping test**: on clasping the hands the index finger of the affected side fails to flex (median nerve).
- **Ulnar nerve**: at the elbow (**cubital tunnel**, the second commonest entrapment; medial epicondyle fracture; elbow dislocation; tardy palsy after lateral condyle non-union) and wrist (**Guyon canal**: handlebar palsy in cyclists, repeated blows with the heel of the hand, a ganglion, a hook of hamate fracture; the little finger and ulnar half of the ring finger are numb and the intrinsics weak, but **the dorsum of the ulnar hand is spared**, because the dorsal cutaneous branch leaves the nerve about 5 cm above the wrist; a cubital tunnel lesion numbs the dorsum too). **Froment's sign tests the adductor pollicis** (the patient holds paper by flexing the thumb IP joint with FPL, median nerve). **Card test** (palmar interossei, adduction); **Egawa test** (dorsal interossei, middle finger side to side); **Wartenberg's sign** (little finger held abducted). **Ulnar claw hand**: MCP hyperextension and IP flexion of the ring and little fingers, present at rest. **Ulnar paradox**: the claw is **worse in a low lesion** than in a high one, because a high lesion also paralyses the ulnar half of FDP, so IP flexion is lost.
- Combined median and ulnar palsy: **total claw hand**.
- **Axillary nerve**: shoulder dislocation and surgical neck fracture (deltoid and the regimental-badge area).
- Brachial plexus: **Erb's palsy (C5-C6, upper trunk; waiter's-tip or policeman's-tip position: arm adducted and internally rotated, elbow extended, forearm pronated, wrist flexed, with the hand's grip preserved; in a newborn after shoulder dystocia, see Paediatric)**, **Klumpke's (C8-T1, lower trunk; claw hand with an ipsilateral Horner syndrome, because the T1 root carries the sympathetic fibres to the eye; from traction on an abducted arm, as in a breech delivery or a fall caught by a branch)**. Preganglionic avulsion (Horner sign, winging, normal sensory action potentials) has a poor outlook.
- **Winging of the scapula**: medial winging from the **long thoracic nerve** (serratus anterior); lateral winging from the **spinal accessory nerve** (trapezius).

Lower limb

- **Common peroneal nerve**: wraps the **neck of the fibula**; injured by a fibular neck fracture, a tight cast or below-knee plaster, lateral knee injury, and in the leg-crossing or squatting position; **foot drop** (loss of dorsiflexion and eversion; deep and superficial branches) with sensory loss over the lateral leg and dorsum of the foot; **high-stepping gait**. Ankle-foot orthosis (toe-raising splint); tendon transfer (tibialis posterior) for a permanent palsy.
- Sciatic nerve (**posterior hip dislocation and acetabular fracture**; the peroneal division is more vulnerable), femoral

nerve (anterior hip dislocation), tibial nerve (tarsal tunnel), superior gluteal nerve (Trendelenburg gait), obturator nerve.

- **Meralgia paraesthetica**: entrapment of the purely sensory **lateral femoral cutaneous nerve of the thigh** (L2-L3) under or through the inguinal ligament just medial to the anterior superior iliac spine (obesity, tight belts, pregnancy): burning numbness of the anterolateral thigh, no weakness, knee jerk normal.

Nerve injured, by injury, and the entrapment syndromes

Injury	Nerve
Shoulder dislocation, surgical neck of humerus	Axillary
Humeral shaft	Radial
Supracondylar humerus (extension type)	Anterior interosseous (commonest), median, radial
Medial epicondyle, elbow dislocation	Ulnar
Monteggia, radial head	Posterior interosseous
Distal radius, lunate dislocation	Median
Hook of hamate	Ulnar
Posterior hip dislocation, acetabulum	Sciatic
Anterior hip dislocation	Femoral
Fibular neck, knee dislocation, lateral tibial plateau	Common peroneal

Syndrome	Nerve and site
Carpal tunnel	Median at the wrist
Pronator syndrome; ligament of Struthers	Median at the elbow
Kiloh-Nevin	Anterior interosseous
Cubital tunnel	Ulnar behind the medial epicondyle (the "arcade of Struthers" is on the ulnar nerve, unlike the ligament)
Guyon canal	Ulnar at the wrist
Radial tunnel	Posterior interosseous
Meralgia paraesthetica	Lateral femoral cutaneous nerve under the inguinal ligament
Piriformis syndrome	Sciatic
Tarsal tunnel	Posterior tibial nerve behind the medial malleolus
Morton's neuroma	Interdigital nerve, usually the third web space

- Spinal shock and the bulbocavernosus reflex are under Spine.

Bone infection and TB spine

Osteomyelitis

- **Acute haematogenous osteomyelitis**: children, the **metaphysis** of long bones (the hairpin capillary loops beneath the physis slow the blood); **lower femur, then upper tibia**; in adults the **vertebrae** are the usual site.
- Organisms: ***Staphylococcus aureus* is the commonest at every age and in most settings**; neonates also Group B Streptococcus and *E. coli*; *Kingella kingae*, a fastidious Gram-negative coccobacillus carried in young children's throats, in children of 6 months to 4 years, now a leading cause there (the commonest in some series) since the Hib vaccine, found by PCR as it grows poorly on ordinary culture; **Salmonella is characteristic in sickle-cell disease** (though S. aureus is still commonest in many series), often diaphyseal and multiple; ***Pseudomonas aeruginosa* after a puncture wound through a rubber-soled shoe and in IV drug users**; *Pasteurella multocida* after cat or dog bites; *Eikenella corrodens* after human bites; fungi after long parenteral therapy.
- Imaging timeline: **MRI is the most sensitive early test** (marrow oedema within a day or so); bone scan positive in 24-48 hours; on X-ray, **soft-tissue swelling and loss of fat planes are the first sign**, and **bony change (lucency, periosteal reaction) appears at 7-14 days**.
- Diagnosis: **culture (or histology) of bone or aspirated pus is the gold standard** (blood cultures positive in about half). ESR and CRP are raised; CRP rises and falls faster and is used to follow treatment.
- Treatment: an anti-staphylococcal antibiotic (flucloxacillin or cloxacillin, or cefazolin; clindamycin or vancomycin where MRSA is common). Exam answer: IV for 2 weeks then oral to a total of about 6 weeks. Current practice in children (ESPID 2017 guidance, from Peltola's trials): **IV for only 2-4 days, then oral once afebrile and CRP falling, for 3-4 weeks in all** in uncomplicated cases. Surgical drainage for an abscess or no response in 48 hours.
- **Chronic osteomyelitis**: **sequestrum** (dead, separated bone), **involucrum** (new periosteal bone around it), **cloaca** (opening in the involucrum through which pus drains). Cierny-Mader classification. Treatment: sequestrectomy and debridement, dead-space management, stabilisation, antibiotics. **Squamous cell carcinoma in a chronic sinus (Marjolin ulcer)** is a late, rare complication.
- **Brodie abscess**: subacute, localised, **well-defined lytic cavity with a sclerotic rim in the metaphysis**, long-standing mild pain, usually the proximal or distal tibia; on MRI a **penumbra sign** (a rim of granulation tissue brighter than the abscess on T1). **Garre's sclerosing osteomyelitis**: non-suppurative, with dense sclerosis, cortical thickening and periosteal new bone and **no abscess, sequestrum or sinus** (often the mandible, also the tibia, in children and young adults).

Septic arthritis

- Organisms: ***S. aureus* overall, in neonates and over 5 years**; **2 months to 5 years: *Haemophilus influenzae* type b, the classic exam answer**, now rare where Hib vaccine is routine, so ***Kingella kingae*** has taken its place in young children; **sexually active young adults: *Neisseria gonorrhoeae***.
- Joint aspiration with Gram stain and culture is the key test. **Kocher criteria** for the child's hip (fever over 38.5 degrees C, non-weight bearing, **ESR over 40 mm/h, WBC over 12,000**; CRP over 20 mg/L added later by Caird): all four make septic arthritis very likely. Emergency arthrotomy or arthroscopic washout, as articular cartilage is destroyed within days; transient synovitis is the main differential.
- **Clutton joints**: painless, symmetrical knee effusions (hydrarthrosis) in late congenital syphilis, at about 8-15 years, with interstitial keratitis and Hutchinson teeth; not septic, and not the neuropathic joint of tabes.

Tuberculosis of bones and joints

- Skeletal TB is haematogenous and paucibacillary; **the spine is the commonest skeletal site** (about half), then hip and knee. Typical features: **marked osteopenia, minimal periosteal reaction, and sequestra uncommon** (except the soft "feathery" sequestra in some spinal lesions), cold abscess. Periosteal reaction is seen only in **spina ventosa** (tuberculous dactylitis of a child's phalanx or metacarpal). **Phemister's**

triad of TB arthritis: juxta-articular osteoporosis, peripheral erosions, gradual joint-space narrowing.

- **TB hip** stages: synovitis (flexion, abduction, external rotation; apparent lengthening), early arthritis (flexion, adduction, internal rotation; apparent shortening), advanced arthritis (the same with true shortening), and in late disease the wandering acetabulum and pathological dislocation. Outcome with healing is fibrous (or bony) ankylosis.
- **Poncet disease** (tuberculous rheumatism): a sterile, reactive polyarthritis in a patient with active tuberculosis elsewhere; no bacilli in the joints, and it settles with antituberculous treatment (a diagnosis of exclusion).

Tuberculosis of the spine (Pott's disease)

- **Commonest region: the lower thoracic and thoracolumbar spine (T12-L1)**. The **paradiscal type is commonest**: infection starts in the metaphyseal (paradiscal) part of two adjacent bodies, the disc is destroyed, pus tracks under the anterior longitudinal ligament, and **collapse of the anterior vertebral bodies** gives an angular **kyphosis (gibbus)**. Other types: central (looks like a tumour, vertebra plana), anterior, appendicular (posterior elements, the least common). Cervical lesions give a retropharyngeal abscess; lumbar, a **psoas abscess** (to the iliac fossa, groin and thigh).
- Features: **back pain is the first symptom**; evening fever, weight loss, night cries in children, a stiff spine with spasm. **First X-ray sign: narrowing of the disc space**, then paradiscal erosion and a paravertebral (fusiform, "bird's nest") shadow. **MRI is the investigation of choice** for early disease, soft tissue and cord involvement; diagnosis confirmed by CT-guided biopsy (smear, culture, **Xpert MTB/RIF Ultra**, histology).
- **Pott's paraplegia** (Hodgson): **early-onset (active disease)** is due to **pressure from abscess, granulation tissue, caseous material or sequestra** (often recovers with ATT and decompression, a good prognosis); **late-onset (healed disease)** is due to a bony ridge (internal gibbus), stretching over the deformity or dural fibrosis (a worse prognosis).
- Treatment: exam answer, **Tuli's "middle path" regimen** (ambulatory antitubercular chemotherapy with rest and bracing, surgery for those who do not respond or have complications). **Duration: WHO's 6-month regimen (2HRZE/4HR) for extrapulmonary TB excludes bone and joint TB, for which longer treatment, 9-12 months, is advised** (WHO consolidated guidelines, Module 4, 2022, 2025 edition); follow Nepal's National TB Programme guideline for the regimen used. Surgery for neurological deficit not improving on ATT, instability, severe or progressive kyphosis, or a doubtful diagnosis: anterior radical debridement and strut grafting ("Hong Kong operation"), now often with posterior instrumentation.
- Cold abscess: no heat or redness; drain only if large or causing pressure. **Rajasekaran's "spine-at-risk" signs** predict progressive kyphosis in children. Adolescent kyphosis is mostly postural; in an adult, an angular kyphosis suggests TB.

Poliomyelitis (the curriculum's acute and paralytic polio)

- **Pathology**: poliovirus (an enterovirus, spread faecal-oral) destroys **anterior horn cells of the spinal cord (and brainstem motor nuclei)**, so the paralysis is a **lower motor neuron lesion: flaccid, asymmetrical (patchy, often a leg), with absent reflexes, wasting later, and no sensory loss** because sensory neurons are spared. Less than 1% of infections paralyse. **Stages: acute (fever, meningism, pain, 1 to 2 weeks), convalescent (recovery up to 2 years), chronic or residual.**
- **Acute management**: bed rest, **splinting in a neutral position and avoiding stretching, analgesia, physiotherapy after the pain settles**; ventilatory support in bulbar disease; **no intramuscular injections** in the acute phase (provocation paralysis). **Notify as acute flaccid paralysis surveillance case (stool for virus)**. Prevention is by **vaccination (OPV and IPV)** under the national immunisation schedule.
- **Residual paralytic polio is a referral problem**: **muscle imbalance gives deformities (equinus, calcaneus, hip flexion contractures, scoliosis)**, a flail limb and shortening; treatment: **orthoses (calipers), tendon transfers, arthrodesis, and limb-lengthening**; **post-polio syndrome** (new weakness decades later) is a late complication.

Bone tumours

Approach

- **Metastases are the commonest malignant lesion of bone** (breast is the commonest source overall; then prostate, lung, kidney, thyroid). **Commonest primary malignant tumour: multiple myeloma** (a marrow tumour), so **osteosarcoma is the commonest primary malignant tumour of bone itself** and the commonest in adolescents. **Osteochondroma (exostosis) is the commonest benign bone tumour** (strictly a developmental outgrowth that stops growing when the physes close); osteoid osteoma is the commonest true benign bone-forming neoplasm. **Lung is the commonest site of metastasis from primary bone sarcomas.**
- Age and site are the first clues. Imaging: **plain X-ray first** (the lesion's nature), **MRI for marrow and soft-tissue extent and skip lesions** (staging the primary), **CT for cortical detail, the osteoid osteoma nidus and the chest**, bone scan for blastic metastases (prostate) but negative in myeloma; **PET-CT is the most sensitive for metastases**. Enneking (MSTS) staging. **Biopsy last, by the surgeon (or team) who will resect, along the line of the planned incision**; it is the most specific test. Treatment of osteosarcoma and Ewing: neoadjuvant chemotherapy, then limb-salvage resection.
- Sites in the long bone: **epiphysis**: chondroblastoma (open physes), giant cell tumour (closed physes), clear-cell chondrosarcoma; **metaphysis**: osteosarcoma, osteochondroma, chondrosarcoma, simple and aneurysmal bone cysts, non-ossifying fibroma, chondromyxoid fibroma, Brodie abscess; **diaphysis**: Ewing sarcoma, myeloma, adamantinoma, fibrous dysplasia, Langerhans histiocytosis, osteoid osteoma (cortex).

Table of key tumours

Tumour	Age and site	Radiograph and pathology	Notes
Osteoid osteoma	10-25 y, males; cortex of femur and tibia	Small lucent **nidus** (under about 1.5-2 cm) with dense surrounding sclerosis; "double density" on bone scan	**Night pain relieved promptly by aspirin or NSAIDs** (the nidus makes prostaglandins); **CT is the investigation of choice for the nidus**; **CT-guided radiofrequency ablation** is the current treatment (excision before); in the spine, a painful scoliosis
Osteoblastoma	Spine, posterior elements	Like a larger osteoid osteoma (over 2 cm)	Pain not relieved by NSAIDs
Osteochondroma	Metaphysis of long bones (around the knee, proximal humerus), pointing away from the joint	Cartilage-capped bony stalk whose **cortex and medulla are continuous with the host bone**	Malignant change to chondrosarcoma about 1% in a solitary lesion, more (about 1-5%) in **hereditary multiple exostoses (diaphyseal aclasis; EXT1/EXT2)**; suspect it if it grows after maturity or the cap is over 2 cm
Enchondroma	Small bones of the hand (phalanges)	Central lucency with stippled ("rings and arcs") calcification	**Ollier disease** (multiple, not inherited) and **Maffucci syndrome** (Ollier's enchondromas plus soft-tissue haemangiomas, with phleboliths) carry a high risk of chondrosarcoma (about a quarter to a half, highest in Maffucci); IDH1/IDH2 mutations
Chondroblastoma (Codman tumour)	10-20 y, **epiphysis with open physis** (proximal humerus, distal femur, proximal tibia)	Lytic, well defined, often a sclerotic rim; polygonal chondroblasts with **"chicken-wire" pericellular calcification**	Not to be confused with the Codman triangle of osteosarcoma
Giant cell tumour (osteoclastoma)	**20-40 y, after physeal closure**, women slightly more; **distal femur, then proximal tibia, then distal radius**	**Eccentric lytic epiphysiometaphyseal lesion reaching the subchondral bone, "soap-bubble"**, thin expanded cortex ("eggshell crackling"); osteoclast-like giant cells and the neoplastic mononuclear stromal cells, which make **RANKL**	Campanacci grade; locally aggressive, recurs; benign lung implants in about 2-3%. **Extended curettage** with adjuvants (phenol, cement); **denosumab (anti-RANKL)** for unresectable or to downstage. Modern marker: **H3F3A (H3.3 G34W) mutation**, shown by immunostaining
Osteosarcoma	**10-25 y; metaphysis of distal femur (commonest) and proximal tibia**; a second peak over 50-60 y in Paget disease or after radiation	Mixed lytic-sclerotic, **sunburst (sunray) periosteal reaction, Codman triangle**; **malignant osteoid made by tumour cells** is the diagnostic feature	Raised alkaline phosphatase (and LDH: prognosis); skip lesions; lung metastases; **RB1** (hereditary retinoblastoma) and **TP53** (Li-Fraumeni); radioresistant; **MAP chemotherapy (high-dose methotrexate, doxorubicin, cisplatin)** before and after resection; over 90% necrosis after induction (Huvos) is a good sign. Parosteal osteosarcoma: posterior distal femur, older patients, better prognosis, MDM2 amplification
Ewing sarcoma	**5-20 y (second decade)**, boys; **diaphysis (or metadiaphysis) of the femur**, and pelvis	**Permeative lytic lesion with lamellated "onion-peel" periosteal reaction** and a large soft-tissue mass; **small round blue cells**, glycogen (PAS positive), **CD99 (MIC2) positive**, NKX2.2	**t(11;22)(q24;q12), EWSR1-FLI1** (about 85%); **fever, raised ESR and leucocytosis mimic osteomyelitis**; biopsy decides; **radiosensitive**; chemotherapy with surgery or radiotherapy. Origin debated: a primitive mesenchymal cell with neuroectodermal features (not an epithelial tumour)
Chondrosarcoma	Over 40 y; pelvis, proximal femur, shoulder girdle	Lytic lesion with ring-and-arc ("popcorn") calcification, **deep endosteal scalloping**, cortical breach	**Resistant to chemotherapy and radiotherapy**: wide surgical excision

Tumour	Age and site	Radiograph and pathology	Notes
Multiple myeloma	Over 50 y; spine, skull, pelvis, ribs	**Punched-out lytic lesions**, "raindrop" skull; **cold on bone scan**	M-protein, Bence Jones protein, CRAB features. Current practice: **whole-body low-dose CT (or PET-CT, MRI) replaces the skeletal survey** (IMWG 2015 and 2019)
Chordoma	Adults; **sacro-coccygeal region** (commonest) and **clivus**, then the mobile spine	Arises from **notochordal remnants**; destructive midline lytic mass; **physali-ferous cells**	Malignant but slow, locally destructive, recurs after incom-plete excision; **brachyury** positive
Adam-antinoma	Anterior tibial diaphysis, young adults	Multiple lucencies, "soap-bubble"	Low-grade malignant

Tumour-like lesions

- **Simple (unicameral) bone cyst**: under 20 years, **proximal humeral metaphysis** (then proximal femur), presents with a pathological fracture; **"fallen fragment" (fallen leaf) sign**. Steroid or marrow injection, curettage.
- **Aneurysmal bone cyst**: eccentric, expansile, blood-filled metaphyseal lesion; **fluid-fluid levels on MRI**; USP6 gene rearrangement in the primary form.
- **Fibrous dysplasia**: **ground-glass** matrix, **shepherd's crook** deformity of the proximal femur, "Chinese letter" woven bone on histology; **GNAS activating mutation (Gs alpha)**; **McCune-Albright syndrome** (polyostotic disease, cafe-au-lait spots with "coast of Maine" borders, precocious puberty).
- Non-ossifying fibroma and fibrous cortical defect: the commonest bone lesions of childhood, eccentric metaphyseal, heal on their own.
- **Langerhans cell histiocytosis (eosinophilic granuloma)**: **vertebra plana** in a child, punched-out skull lesions; Birbeck granules, CD1a, BRAF V600E in many.
- **Glomus tumour** (a benign soft-tissue tumour, asked with bone tumours): from the glomus body, a thermoregulating arteriovenous shunt, usually **subungual**, in adults; the triad of **severe paroxysmal pain, cold sensitivity and pinpoint tenderness** (Love's pin test), a bluish spot under the nail; it may scallop the distal phalanx on X-ray, and MRI shows it; excision cures.
- Vertebral haemangioma: vertical striations ("corduroy" or "jail-bar") on X-ray, "polka-dot" on axial CT.

Signs at a glance

Sign	Lesion
Sunburst, Codman triangle	Osteosarcoma
Onion peel	Ewing sarcoma
Soap bubble	Giant cell tumour (also adamantinoma, ABC)
Ground glass, shepherd's crook	Fibrous dysplasia
Chicken-wire calcification	Chondroblastoma
Popcorn, rings-and-arcs calcifica-tion	Chondroid tumours
Fallen fragment	Simple bone cyst
Fluid-fluid levels	Aneurysmal bone cyst
Double density, nidus	Osteoid osteoma
Physaliferous cells	Chordoma

Metastases

- **Prostate cancer spreads to the lumbar spine and pelvis through the valveless vertebral venous plexus of Batson**, and gives **osteoblastic (sclerotic)** deposits. **Purely lytic: kidney (expansile, "blow-out") and thyroid**; mostly lytic: lung, GI tract; **breast: mostly lytic or mixed** (sclerotic after treatment). Hypercalcaemia is commonest with lytic deposits (breast, myeloma, lung).
- Commonest site of skeletal metastasis: the **spine** (thoracic), then pelvis, ribs, proximal femur; below the elbow and knee metastases are rare (acral ones usually from lung).
- Pathological fracture risk: **Mirels' score** (site, pain, lytic or blastic, size), **9 or more: prophylactic fixation**.
- Spread from bone to bone (skip or multifocal): osteosarcoma, Ewing sarcoma, neuroblastoma.

Paediatric orthopaedics

Developmental dysplasia of the hip (DDH)

- Risk factors: **female sex, breech presentation, first-born, positive family history, oligohydramnios**, tight swaddling with the hips straight; the **left hip** is involved more often.
- Newborn examination: **Ortolani** (a "clunk" as the **dislocated head is reduced into the acetabulum by abduction** and lifting the trochanter) and **Barlow** (the **reduced but unstable head is pushed out** by adduction and backward pressure). After about 3 months: **limited abduction (the most reliable sign then)**, asymmetric thigh creases, apparent shortening (**Galeazzi or Allis sign**: with hips and knees flexed, the knee is lower on the affected side), and in the walking child a Trendelenburg gait (waddling if bilateral) and lumbar lordosis.
- Imaging: **ultrasound (Graf's method; alpha angle under 60 degrees is abnormal) up to 4-6 months**; X-ray after the femoral ossific nucleus appears at about 4-6 months (Hilgenreiner's and Perkin's lines, acetabular index, broken Shenton's line).
- Treatment by age: **under 6 months, Pavlik harness** (avoid forced abduction, which causes AVN; von Rosen splint is an alternative); 6-18 months, closed reduction (with adductor tenotomy) and hip spica; older, open reduction with pelvic (Salter, Pemberton) and femoral osteotomy.

Clubfoot (CTEV)

- One of the commonest congenital musculoskeletal deformities (about 1 in 1,000 births); boys twice as often; bilateral in about half. **Primarily a soft-tissue deformity** with contracted tendo Achillis and tibialis posterior; **the talus is the bone most deformed** (neck turned medially and plantarwards), and the **talonavicular joint is the key joint** (medial displacement of the navicular).
- Deformities: **CAVE**: **C**avus (forefoot pronated relative to the hindfoot), forefoot **A**dductus (at the talonavicular and calcaneocuboid joints), hindfoot **V**arus (subtalar), **E**quinus (ankle). Severity: **Pirani** and Dimeglio scores.
- **Ponseti method** (the current standard, started in the first weeks): weekly serial casts correct the **cavus first (supinate the forefoot and lift the first ray), then adductus and varus**

together (abduct the foot around the head of the talus, with counter-pressure there, never pronating the forefoot), and **equinus last by percutaneous tendo-Achilles tenotomy and a final cast for about 3 weeks**; then a **foot-abduction brace (boots and bar, Denis Browne type)** full time for 3 months and at night to 4-5 years. Success is over 90%; relapse is mostly from not wearing the brace and is treated by recasting and, after about 3 years, **tibialis anterior tendon transfer**. Over-correction by forcing dorsiflexion before the hindfoot is corrected makes a **rocker-bottom foot**.

- Older or neglected feet: soft-tissue release (posteromedial) in young children, bony procedures after about 5 years, **triple arthrodesis (subtalar, talonavicular and calcaneocuboid) only after about 10-12 years**, when the foot bones have grown; Ilizarov frames for complex cases.

Perthes disease (Legg-Calve-Perthes)

- Idiopathic avascular necrosis of the femoral capital epiphysis in a child of **4-8 years** (range 2-12), **boys 4-5 times more**, bilateral in about 10-15% (not at the same stage). A **painless or mildly painful limp**, often **knee pain** (referred along the obturator nerve), limited **abduction and internal rotation**.
- **MRI shows it earliest**; X-ray: a small, dense, flattened, then fragmented head, the **crescent sign** (subchondral fracture). **Waldenstrom stages**: initial (sclerosis), fragmentation, reossification, healed.
- Classifications: **Catterall** (four groups by head involvement; the **"head at risk" signs**: Gage sign, lateral calcification, lateral subluxation, horizontal physis, metaphyseal cysts), **Herring lateral pillar** (A, B, B/C, C: the most used now), Salter-Thompson.
- Prognosis: **age at onset over 8 years is the worst prognostic factor** (with a Herring C head, loss of motion and extrusion). Girls are affected less often but tend to do worse, because they are skeletally older at the same age.
- Treatment is **containment** (keeping the head inside the acetabulum while it remodels): observation and physiotherapy for the young with mild disease; abduction (Petrie broomstick) cast or brace; femoral varus or Salter innominate osteotomy in older children. The disease is self-limiting.

Slipped capital femoral epiphysis (SCFE)

- **Obese adolescent boy, 10-16 years**, hip or knee pain and a limp; **obligatory external rotation as the hip is flexed (Drehmann sign)**; limited internal rotation. The femoral neck displaces forwards and upwards, so the epiphysis lies **posterior and inferior** on the neck. Bilateral in about 20-40%. Endocrine causes in the atypical, young or thin (hypothyroidism, growth hormone treatment, renal osteodystrophy).
- **Klein's line** along the superior femoral neck fails to cut the epiphysis (**Trethowan sign**); the **lateral (frog-leg) view shows a slip best**; Southwick angle measures it.
- Loder: **stable** (can bear weight) or **unstable** (cannot; high AVN risk, up to about half). **Treatment: in situ fixation with a single cannulated screw, without manipulation**; forced reduction risks AVN; chondrolysis is the other complication. Prophylactic pinning of the other hip in the young or those with endocrine disease.

Other

- **Blount disease (tibia vara)**: a growth disturbance of the **posteromedial part of the proximal tibial physis**, giving progressive **genu varum** with internal tibial torsion; infantile (under 3, early walkers, obese) and adolescent forms; a medial metaphyseal **beak**; Langenskiold stages I-VI; metaphyseal-diaphyseal (Drennan) angle over about 11-16 degrees separates it from physiological bowing.
- Normal alignment: physiological **bow legs until about 2 years**, then knock knees maximal at 3-4 years, adult alignment by about 7. **Genu varum: in children rickets (and Blount), in adults osteoarthritis. Genu valgum: in children idiopathic then rickets; in adults rheumatoid arthritis (the classic exam answer) and lateral-compartment osteoarthritis.** Windswept deformity (one knee varus, the other valgus): rickets in children, rheumatoid arthritis in adults.
- Congenital pseudarthrosis of the tibia: about half have neurofibromatosis type 1. **Osteogenesis imperfecta**: COL1A1/COL1A2, blue sclerae, wormian bones, deafness, fractures; bisphosphonates. **Achondroplasia: an activating (gain-of-function) FGFR3 mutation**, which slows endochondral growth at the physis (autosomal dominant, about 80% new mutations, linked to older fathers; rhizomelic short limbs with a normal trunk length and intelligence, frontal bossing, trident hand, interpedicular distance narrowing down the lumbar spine); vosoritide (2021) for growth. Rickets: see Metabolic bone disease.
- **Osteochondroses** (eponyms): **Perthes** (femoral head), **Kienbock** (lunate), **Preiser** (scaphoid), **Panner** (capitulum), **Osgood-Schlatter** (tibial tubercle; a traction apophysitis in active adolescents), Sinding-Larsen-Johansson (lower pole of patella), **Sever** (calcaneal apophysis), **Kohler** (navicular), **Freiberg** (second metatarsal head), **Scheuermann** (vertebral ring apophyses: thoracic kyphosis with wedging of three or more vertebrae), Calve (vertebral body: vertebra plana).
- Childhood fractures: **greenstick fracture of the forearm (radius more than ulna) is the commonest fracture of childhood**; the supracondylar humerus, the commonest around the elbow; non-accidental injury suggested by metaphyseal corner fractures, posterior rib fractures and fractures of different ages.
- **Adolescent idiopathic scoliosis**: girls, **right thoracic curve commonest** (a left thoracic curve needs MRI for a cord lesion); Adams forward-bend test; Cobb angle; Risser sign of skeletal maturity; **bracing at 25-40 degrees in the growing child, surgery above about 45-50 degrees**.
- **Growth plate injuries** (in full under Fractures): the **hypertrophic zone is the weakest**, so physeal fractures run through it; **Salter-Harris type II (with the Thurston Holland metaphyseal fragment) is the commonest, about 75%**; type V (crush) has the worst outlook for growth; III and IV are intra-articular.
- **Klippel-Feil syndrome**: congenital fusion of cervical vertebrae; the classic triad of a **short neck, low posterior hairline and limited neck movement** is complete in under half; associated Sprengel shoulder, scoliosis, renal anomalies, deafness and heart defects, so screen for them.
- Flexible flatfoot needs no treatment; cerebral palsy deformities (equinus, hip adduction and subluxation, crouch).

Birth palsies and other newborn musculoskeletal conditions

- **Erb's palsy (Erb-Duchenne, C5–C6, the upper trunk of the brachial plexus)**: an obstetric injury after **shoulder dystocia, a big baby, breech or traction on the head**; the arm hangs in **adduction and internal rotation with the elbow extended and the forearm pronated, the 'waiter's tip' position**; **Moro reflex is absent on the affected side, the grip is preserved**. **Klumpke's (C8–T1)**: claw hand and Horner's syndrome. Most recover within 3 months by observation and physiotherapy; **no recovery of elbow flexion by 3 to 6 months is the indication for nerve grafting or transfer**. **Phrenic nerve injury (C3–C5)** may cause diaphragm paralysis.
- **Congenital muscular torticollis**: a fibrotic swelling of the sternocleidomastoid, felt at 2-4 weeks; the **head tilts towards the affected side and the chin turns away**; most resolve with **passive stretching** by the parents; surgical release if still restricted after about a year; untreated, plagiocephaly and facial asymmetry follow.
- **Spina bifida**: failure of fusion of the neural arch. **Spina bifida occulta** (bone defect only, often L5–S1, a hairy patch or dimple) is asymptomatic; **meningocele** (meninges only) and **myelomeningocele** (cord and nerves in the sac: legs paralysed, neurogenic bladder, hydrocephalus and Arnold–Chiari malformation); **prevention by periconceptional folic acid (400 µg a day; 4 mg a day with a previous affected child, 5 mg in UK practice)**; **alpha-fetoprotein raised in the mother's serum and amniotic fluid**; surgery within 48 to 72 hours to close the sac (**prenatal repair before 26 weeks** improves mobility and cuts the need for a shunt: MOMS trial, 2011); **tethered cord** appears later.
- **Syndactyly**: failure of separation of the digits (webbed fingers or toes, commonest between the middle and ring fingers); **simple** (skin only) versus **complex** (bone fusion); surgical separation with skin grafts at about 1 to 2 years (earlier for the border digits that tether growth). **Polydactyly** (extra digit; the commonest congenital hand anomaly in African ancestry) is removed in the first year.
- **Gallows (Bryant's) traction**: both legs suspended vertically from an overhead beam, the **buttocks just clear of the bed**, for a **femoral shaft fracture in a child under about 2 years (up to 12–15 kg)**; heavier children risk vascular compromise of the legs. That is the exam answer; current practice (AAOS 2015) is a **Pavlik harness under 6 months and an early hip spica cast from 6 months to 5 years**.
- **Developmental dysplasia of the hip (CDH)** and **clubfoot** are covered above; newborn screening is by the **Ortolani and Barlow tests** and **ultrasound** in the first 6 weeks.

Metabolic bone disease

Biochemistry at a glance

Disease	Calcium	Phosphate	Alkaline phosphatase	PTH
Osteoporosis	**Normal**	**Normal**	**Normal**	**Normal**
Osteomalacia, nutritional rickets	Low or normal	Low	**High**	High
Primary hyperparathyroidism	**High**	Low	High (or normal)	**High**
X-linked hypophosphataemic rickets	Normal	**Low** (phosphate wasting)	High	Normal
Chronic kidney disease (renal osteodystrophy)	Low	**High**	High	High
Paget disease	Normal	Normal	**Markedly high**	Normal

- Confusion corner: osteoporosis is **less bone of normal mineralisation**; rickets and osteomalacia are **poorly mineralised osteoid**; scurvy is **poor osteoid formation** (collagen); hyperparathyroidism is **increased resorption**.

Scurvy and rheumatoid arthritis, ankylosing spondylitis and osteoarthritis treatment

- **Scurvy (vitamin C deficiency)**: needed for hydroxylation of proline and lysine, so **collagen synthesis is defective**; in infants aged **6 to 24 months** fed on boiled milk without fruit: irritability, the **'frog-leg' posture with pseudoparalysis from painful subperiosteal haemorrhage**, **swollen bleeding gums** (if teeth present), petechiae, **scorbutic rosary (sharp, tender)**, anaemia. **X-ray: the dense white line of Frankel at the metaphysis, Trümmerfeld zone below it, a Wimberger ring (sclerotic ring around the osteopenic epiphysis), Pelkan spurs and subperiosteal haemorrhage that calcifies on healing; the 'pencil-thin' cortex**. **Treatment: vitamin C 100–300 mg daily orally for 1 to 3 months; the response is dramatic within days**; it differs from rickets by the dense (not frayed) metaphysis.
- **Rheumatoid arthritis**: diagnose by the **2010 ACR/EULAR criteria** (joint involvement, serology RF and anti-CCP, acute-phase reactants, duration); **a DMARD is started early (methotrexate first, with folic acid), then added biologics or JAK inhibitors for failure; NSAIDs and short low-dose steroids give relief of pain; splints and exercise**; surgery (synovectomy, arthroplasty) later. **Osteoarthritis**: weight loss and exercise first; **topical NSAIDs (knee, hand) then oral NSAIDs**; paracetamol (the classic first drug) is no longer advised routinely on its own (NICE NG226, 2022); intra-articular steroid for flares, **total joint replacement** for end-stage disease; **no DMARDs**. **Ankylosing spondylitis**: **NSAIDs (continuous) and exercise first; anti-TNF or IL-17 inhibitors if inadequate; DMARDs such as methotrexate do not help the spine**.

Osteoporosis

- Reduced bone mass with microarchitectural deterioration and normal mineralisation. **DEXA T-score -2.5 or below is osteoporosis, -1 to -2.5 osteopenia, above -1 normal** (WHO; measured at the hip and lumbar spine); the Z-score (against age-matched people) is for premenopausal women, men under 50 and children.
- **Commonest osteoporotic fracture: vertebral (dorsolumbar)**; then distal radius (Colles) and hip. Fish-mouth (biconcave, "codfish") vertebrae occur in osteoporosis and osteomalacia (choose osteomalacia when both are offered, as the classic answer).
- **FRAX (WHO)** gives the **10-year probability of a major osteoporotic fracture and of a hip fracture**, for people aged 40-90: age, sex, BMI, previous fragility fracture, parental hip fracture, current smoking, glucocorticoids, rheumatoid

arthritis, secondary osteoporosis, alcohol 3 or more units a day, with or without femoral neck BMD. It does **not** include falls, vitamin D, physical activity or spine BMD. Treatment can start at a FRAX threshold without a T-score of -2.5.

- Secondary causes: **glucocorticoids (the commonest)**, hyperparathyroidism, hyperthyroidism, hypogonadism, malabsorption, myeloma, heparin.
- Treatment: calcium, vitamin D, weight-bearing exercise, falls prevention, and **bisphosphonates (alendronate, risedronate, zoledronate) as the first line** (they inhibit osteoclasts; rare **atypical femoral fractures and osteonecrosis of the jaw** with long use, hence "drug holidays"). Anti-resorptives: **denosumab** (anti-RANKL antibody; stopping it without a follow-on bisphosphonate causes rebound vertebral fractures), raloxifene (SERM: vertebral, not hip, protection), HRT, calcitonin (little used). Anabolics: **teriparatide** and abaloparatide (PTH analogues), **romosozumab** (anti-sclerostin, both anabolic and anti-resorptive). Strontium ranelate (dual action) is largely withdrawn. Current practice for **very high fracture risk** (for example a recent vertebral fracture): **an anabolic agent first, then an anti-resorptive** (Endocrine Society 2019/2020; AACE 2020).

Osteomalacia and rickets

- Defective mineralisation of osteoid (vitamin D deficiency; renal tubular disease; phosphate wasting). **Osteomalacia**: bone pain, proximal myopathy (waddling gait); **Looser's zones (pseudofractures; Milkman fractures)**: symmetrical lucent bands perpendicular to the cortex in the pubic rami, femoral neck, axillary border of the scapula and ribs.
- **Rickets**: **earliest radiological sign: loss of the zone of provisional calcification** (blurred, widened physis), then **cupping, splaying and fraying** of the metaphysis; earliest clinical sign in infants: **craniotabes**; **rachitic rosary** (enlarged costochondral junctions: **rounded and non-tender**, whereas the **scorbutic rosary is sharp, angular and tender**), Harrison's sulcus, wrist widening, bowing. Treatment: vitamin D and calcium; **stoss therapy** is a single large oral dose of vitamin D (for example 300,000-600,000 IU) for poor adherence.
- **X-linked hypophosphataemic rickets** (PHEX mutation, high FGF23): low phosphate, normal calcium and PTH, high ALP; exam treatment phosphate with calcitriol; current practice **burosumab (anti-FGF23 antibody)**, approved 2018.
- Renal osteodystrophy: **rugger-jersey spine** (sclerotic upper and lower endplates; also osteopetrosis), subperiosteal resorption.

Paget disease of bone (osteitis deformans)

- Excessive, disordered osteoclastic resorption followed by chaotic formation: big, weak, vascular bone. The **elderly** (over 50), the **pelvis (commonest)**, spine, skull, femur and tibia; linked to SQSTM1 mutations and a suspected paramyxovirus.
- **Serum alkaline phosphatase markedly raised** with normal calcium and phosphate; urinary hydroxyproline and other resorption markers raised.
- X-ray: **"blade of grass" (flame-shaped, V-shaped) advancing lytic front** in a long bone; **osteoporosis circumscripta** and **"cotton wool" skull**; thickened skull (Tam o'Shanter); **picture-frame vertebra**, ivory vertebra; brim sign of the pelvis; anterolateral bowing of femur and tibia (the "sabre tibia" proper is of congenital syphilis); "banana" (transverse, chalk-stick) fractures; bone scan intensely hot ("Mickey Mouse" vertebra). **Mosaic (jigsaw) pattern of cement lines** on histology.
- Complications: **deafness** (the commonest neurological one), nerve and cord compression, high-output cardiac failure, fractures, secondary osteoarthritis, and **osteosarcoma (the most important malignant complication, under 1%)**.
- Treatment: **bisphosphonates, a single zoledronate infusion the most effective**; calcitonin is the older second line.

Arthritis in the examinations

- **Osteoarthritis**: **Heberden nodes (DIP)** and **Bouchard nodes (PIP)**; involves the DIP (the commonest joint in the hand), PIP and the **first carpometacarpal** joints, and **spares the MCP joints and wrist**. Knee: the **medial compartment** most often (varus), with patellofemoral disease. X-ray: **asymmetric narrowing of the joint space is the first sign**, then osteophytes, subchondral sclerosis and cysts.
- **Rheumatoid arthritis**: symmetrical MCP, PIP and wrist synovitis, **sparing the DIP**; morning stiffness over an hour; ulnar drift, **swan-neck (PIP hyperextension, DIP flexion)**, **boutonniere (PIP flexion, DIP hyperextension)**, Z-thumb. **First X-ray sign: periarticular osteopenia** (with soft-tissue swelling), then marginal erosions. **Anti-CCP is the most specific test**; rheumatoid factor (IgM against the Fc of IgG) is sensitive but not specific, a high titre means a worse prognosis. HLA-DR4; CD4 T cells. Felty syndrome (RA, splenomegaly, neutropenia); Caplan syndrome (RA with pneumoconiosis). Atlantoaxial subluxation is the spinal danger. Jaccoud arthropathy (SLE): reducible deformities without erosions.
- **Pseudogout (CPPD)**: older adult, acutely hot **knee** (the commonest joint), often **after surgery or an illness**; **rhomboid crystals with weak positive birefringence (blue when parallel to the compensator, yellow when perpendicular)**; **chondrocalcinosis** (linear calcification of the menisci and articular cartilage). Associations: **haemochromatosis**, hyperparathyroidism, hypomagnesaemia, hypophosphatasia, ochronosis.
- **Gout**: monoarthritis, **first MTP joint (podagra) the commonest**; mimics cellulitis. **Needle-shaped, strongly negatively birefringent crystals (yellow when parallel)**; the **diagnosis is by aspirate of joint fluid or a tophus**; serum urate may be normal during an attack. **Underexcretion is the commonest mechanism.** X-ray: **punched-out erosions with overhanging edges (Martel or "rat-bite" sign)**; tophi in the helix of the ear and around joints. Acute attack: **NSAIDs (indomethacin, the classic exam answer), colchicine or steroids** (steroids when NSAIDs are unsafe, as in renal failure); exam answer (older teaching): do not start allopurinol during an attack, but continue it if already taken; **current practice, ACR 2020 (conditional): urate-lowering therapy may be started during a flare, under colchicine, NSAID or steroid cover** (BSR 2017 prefers starting once the flare has settled, about 2 weeks on, but allows it during frequent flares). **Why cover is needed: falling serum urate loosens and mobilises crystal deposits, which provokes flares in the first months; give low-dose colchicine or an NSAID prophylaxis for 3 to 6 months** (allopurinol is a xanthine oxidase inhibitor and does not itself raise urate or cause the flare by its own action), treating to a **target urate under 6 mg/dL**; allopurinol first line (start low), **HLA-B*58:01 screening** before allopurinol in high-risk groups (Han Chinese, Thai, Korean, African ancestry); febuxostat the alternative.

- **Charcot (neuropathic) joint**: painless disorganisation of a joint that has lost pain and position sense. Sites by cause: **diabetes, the midfoot (tarsometatarsal and tarsal joints), now the commonest cause**; **tabes dorsalis, the knee**; **syringomyelia, the shoulder and elbow**; leprosy, the foot and hand. **Acute Charcot foot** (warm, swollen, pulses present, little pain; the X-ray may be normal early, MRI shows it): **offload and immobilise in a total contact cast** until the skin-temperature difference settles, then a protective boot (IWGDF Charcot guideline, 2023); surgery for unstable deformity. Not infection: antibiotics are for an ulcer with osteomyelitis.
- **Skeletal fluorosis**: endemic where drinking water carries fluoride above about 1.5 mg/L (WHO's guideline value) for years; **osteosclerosis with calcification of ligaments and the interosseous membranes** of the forearm and leg, spinal stiffness and cord compression, genu valgum in children, and mottled teeth.
- Hyperparathyroidism: **subperiosteal resorption on the radial side of the middle phalanges**, brown tumours, "salt and pepper" skull.

Joints (anatomy asked here)

- Synovial joint types: **ball and socket** (shoulder, **hip**, incudostapedial), hinge (elbow, interphalangeal; the knee is a modified hinge and compound joint), pivot (proximal radioulnar, median atlantoaxial), ellipsoid (wrist, MCP, atlanto-occipital), **saddle** (first carpometacarpal, sternoclavicular), plane (acromioclavicular, intercarpal, lateral atlantoaxial). **Primary cartilaginous** (synchondrosis: hyaline, the growth plate, first costosternal joint) and **secondary cartilaginous** (symphysis: fibrocartilage, pubic symphysis, intervertebral discs).
- The **joint capsule is the most pain-sensitive** structure; articular cartilage has no nerves.

Sports injuries

Anterior cruciate ligament (ACL)

- **The commonest knee ligament injured.** Mechanism: non-contact pivoting or landing on a planted foot with a twist; a "pop", **swelling within hours (haemarthrosis: the ACL is the commonest cause of acute traumatic haemarthrosis of the knee)**, then instability ("giving way").
- Tests: **Lachman (20-30 degrees of flexion) is the most sensitive**, because at this angle the hamstrings cannot hold the tibia back and the posterior horn of the medial meniscus does not wedge against the condyle; the **anterior drawer** at 90 degrees is less reliable acutely; **pivot shift is the most specific** (often only under anaesthesia). Sensitivity: Lachman > anterior drawer > pivot shift. **MRI confirms** and shows associated injuries (bone bruises of the lateral femoral condyle and posterolateral tibia). **Segond fracture** on X-ray is a marker of ACL rupture.
- Anatomy: from the **posteromedial (inner) surface of the lateral femoral condyle** to the anterior intercondylar area of the tibia; stops anterior tibial translation and controls rotation. Two bundles: **anteromedial (tight in flexion)** and **posterolateral (tight in extension)**. Blood supply from the **middle genicular artery**. The PCL is the stronger and runs the opposite way.
- Treatment: arthroscopic reconstruction with a hamstring or bone-patellar tendon-bone autograft for the active and the unstable; rehabilitation for the low-demand.
- **O'Donoghue's unhappy triad**: ACL, **medial collateral ligament** and **medial meniscus** (the original description). Later MRI series show the **lateral meniscus tears more often with an acute ACL tear**, the medial meniscus with chronic ACL deficiency, but the exam answer for the triad is the medial structures.

Other knee injuries

- **PCL**: **dashboard injury** or a fall on a flexed knee; **posterior sag (Godfrey) sign** and **posterior drawer**, quadriceps active test, reverse pivot shift; isolated tears are usually managed without surgery.
- **Menisci**: the **medial meniscus is torn more often overall** (it is fixed to the MCL, so less mobile); bucket-handle (a longitudinal tear displaced into the notch) causes **locking**. Tests: **joint-line tenderness (the most sensitive sign)**, McMurray, **Apley's grinding**, Thessaly, Ege's (squatting); **Lachman is not a meniscal test**. Tears in the vascular outer third (red-red zone) can be repaired; inner (white) zone tears are trimmed. Arthroscopic partial meniscectomy for degenerative tears in middle age is no better than exercise therapy (trials 2013-2016; BMJ Rapid Recommendation 2017).
- Collaterals: **valgus stress at 30 degrees for the MCL**, varus stress for the LCL. The MCL is treated in a brace. **Pellegrini-Stieda lesion**: post-traumatic ossification at the femoral origin of the MCL, a streak beside the **medial femoral condyle** on X-ray.
- **Patellar height**: the **Insall-Salvati ratio** (patellar tendon length divided by the patella's length on a lateral X-ray), **normal 0.8-1.2**; **over 1.2 patella alta** (it engages the trochlea late: recurrent lateral dislocation; also after a patellar tendon rupture), **under 0.8 patella baja** (after knee surgery, a quadriceps tendon rupture, polio).
- **Bursitis** names: **prepatellar: housemaid's knee** (kneeling forwards); **infrapatellar (superficial): clergyman's knee** (kneeling upright); olecranon: student's elbow (or miner's elbow); ischial: weaver's bottom; pes anserine bursitis (medial below the knee); a **Baker (popliteal) cyst** is the semimembranosus-gastrocnemius bursa distended behind the knee. The subacromial (subdeltoid) is the largest bursa.
- Other: **Wilson test** (osteochondritis dissecans, the lateral part of the medial femoral condyle), jumper's knee (patellar tendinopathy), runner's knee, iliotibial band syndrome (Ober test).

Shoulder, elbow, wrist and ankle

- **Rotator cuff**: supraspinatus (the commonest torn), infraspinatus, teres minor, subscapularis. **Supraspinatus starts abduction (0-15 degrees)**, the deltoid continues to 90, trapezius and serratus anterior rotate the scapula beyond. **Painful arc 60-120 degrees** (impingement); **drop-arm test (Codman)** for a full-thickness supraspinatus tear; **Jobe's empty-can test** (supraspinatus); **lift-off (Gerber) and belly-press tests** (subscapularis); external rotation lag (infraspinatus); hornblower (teres minor); Neer and Hawkins (impingement). Investigation: **ultrasound first** (cheap, dynamic), **MRI the investigation of choice** (MR arthrogram for the labrum), **arthroscopy the gold standard**. Acute traumatic tears in the young: early repair (now arthroscopic); massive

irreparable tears in the elderly with arthritis: **reverse shoulder arthroplasty**.

- **Frozen shoulder (adhesive capsulitis)**: middle-aged, **diabetics**; painful then stiff then thawing; **loss of both active and passive movement, external rotation the first and most lost**.
- **Tennis elbow (lateral epicondylitis)**: origin of **extensor carpi radialis brevis**; **Cozen's** (resisted wrist extension), **Mill's** (passive wrist flexion with the elbow extended) and Maudsley's tests. Golfer's elbow: medial epicondyle, flexor-pronator origin.
- De Quervain tenosynovitis and trigger finger are under Hand and wrist; thoracic outlet syndrome under Spine.
- Ankle: **lateral ligament sprain, the anterior talofibular ligament first and most often**; the **Ottawa ankle rules** decide on X-ray; squeeze test for the syndesmosis. **Achilles rupture: Thompson (Simmonds) calf-squeeze test**, Matles test; exam answer: repair in the active; current practice: **functional (early weight-bearing) non-operative treatment gives similar re-rupture rates** (UKSTAR trial, Lancet 2020), so surgery is no longer routine.
- **Heel pain**: **plantar fasciitis**, the commonest cause in adults: degeneration at the fascia's origin on the **medial calcaneal tuberosity**, pain with the **first steps in the morning** that eases with walking; a calcaneal spur may coexist but is not the cause. Fascia and calf stretching, heel cups, NSAIDs (most settle within a year); steroid injection or shock-wave therapy for persistent pain. Others: calcaneal stress fracture (pain on squeezing the heel), tarsal tunnel syndrome, retrocalcaneal bursitis (behind the heel).
- Soft-tissue injury: the old RICE; current advice **"PEACE and LOVE"** (Dubois and Esculier, British Journal of Sports Medicine 2019), avoiding prolonged rest and anti-inflammatories in the first days.

Rotator cuff and tendon ruptures

- **Rotator cuff tear** (the tests and imaging are above): the supraspinatus tears in its **critical zone, a poorly perfused area about 1 cm from its insertion into the greater tuberosity**; a chronic massive tear lets the humeral head ride up (**acromiohumeral interval under 7 mm** on X-ray); **partial and small degenerative tears: physiotherapy and subacromial injection; acute large tears in the young, and tears still disabling after 3–6 months of physiotherapy: repair**.
- **Rupture of the long head of the biceps** (at the shoulder, in the older patient): a sudden snap and the **'Popeye' bulge** of the muscle belly in the lower arm, with surprisingly little loss of function; treated non-operatively in the elderly. **Distal biceps rupture** in the young needs repair.
- **Rupture of the quadriceps tendon or patellar tendon**: the **inability to extend the knee against gravity (extensor lag)**, a palpable gap, a **low (quadriceps rupture) or high (patellar tendon rupture) patella** on lateral X-ray; usually in older people (quadriceps, with diabetes, steroids, renal disease) and young athletes (patellar tendon); **operative repair promptly**. The **Achilles tendon** ruptures in middle-aged people (**Simmonds-Thompson test positive: squeezing the calf does not plantarflex the foot**).

Spine

Cervical and thoracolumbar injuries

- **Jefferson fracture**: burst fracture of the **ring of the atlas (C1)**, the commonest atlas fracture, from axial loading (diving); on the open-mouth view the lateral masses overhang C2; a total overhang over about 7 mm (Spence's rule) suggests a torn **transverse ligament** (now seen directly on MRI). **Hangman's fracture**: bilateral fractures of the **C2 pars interarticularis** (traumatic spondylolisthesis of C2), from hyperextension. Odontoid fractures: Anderson and D'Alonzo, **type II (base of the dens) the commonest and most prone to non-union**. **Clay-shoveller's fracture**: avulsion of the **C7** (C6 or T1) spinous process by a sudden pull of trapezius and rhomboids; stable, treated in a collar. Flexion teardrop fracture: unstable, with anterior cord syndrome. Whiplash: hyperextension then flexion. **SCIWORA**: spinal cord injury without radiographic abnormality, in children. Jumper's (suicidal jumper's) fracture: H-shaped sacral fracture. **"Undertaker's fracture"**: a tear through the C6-C7 disc space, made after death when a body's head falls back (a forensic artefact).
- **Flexion injuries are the commonest spinal injuries**; the thoracolumbar junction (T12-L1) the commonest level in the thoracolumbar spine.
- **Chance fracture (flexion-distraction)**: a horizontal split through the vertebral body, pedicles and posterior elements, **involving all three columns**, classically from a **lap seat belt** in a car crash, at the thoracolumbar junction; associated **intra-abdominal injury** (bowel, mesentery, pancreas, duodenum).
- **Burst fracture**: axial compression (fall from a height), with retropulsion of fragments into the canal.
- **Denis's three-column model**: **anterior** (anterior longitudinal ligament and the anterior two-thirds of the body and disc), **middle** (posterior third of the body and disc and the posterior longitudinal ligament), **posterior** (pedicles, arches, facets and the posterior ligament complex). **Instability means the failure of two columns or more.** A **burst fracture is failure of the anterior and middle columns** (the posterior column is spared in the classic description); a **wedge compression fracture is the anterior column only**. Current frameworks: **AO Spine thoracolumbar classification and TLICS**.

Spinal cord injury

- **ASIA impairment scale** (International Standards, ISNCSCI 2019): A complete (no motor or sensory function in S4-S5), B sensory incomplete, C and D motor incomplete, E normal.
- **Spinal shock**: areflexia and flaccid paralysis below the lesion; its end is signalled by **the return of the bulbocavernosus reflex** (a sacral reflex, usually within 24-48 hours; the delayed plantar response returns first), not by the knee jerk. A lesion still complete after spinal shock ends has little chance of recovery. **Neurogenic shock**: hypotension with **bradycardia** (loss of sympathetic tone, lesions above T6).
- Methylprednisolone: exam answer (NASCIS trials) high-dose infusion within 8 hours; current practice: **not routinely recommended** (AANS/CNS 2013 advises against it; AO Spine 2017 allows a 24-hour course started within 8 hours to be considered).
- Incomplete syndromes: **central cord (the commonest; upper limbs weaker than lower; hyperextension in an elderly neck with spondylosis)**, **Brown-Sequard** (ipsilateral motor loss and loss of proprioception, contralateral loss of pain and

temperature; **the best prognosis**), **anterior cord** (motor, pain and temperature lost, dorsal columns spared; **the worst prognosis**), posterior cord (rare), conus medullaris and cauda equina.

Disc and degenerative disease

- **Lumbar disc prolapse**: **L4-L5 the commonest level** (with L5-S1 a close second); cervical **C5-C6**. A posterolateral prolapse at L4-L5 compresses the **L5** root (the traversing root). **Straight leg raising** (positive at 30-70 degrees; **crossed SLR is the most specific**; **Bragard sign**: dorsiflexing the ankle at the limit of SLR increases the pain, showing root tension rather than hamstring tightness); femoral stretch test for L2-L4.

Root	Weakness	Reflex	Sensory loss
L4	Tibialis anterior (ankle dorsiflexion), knee extension	**Knee jerk**	Medial leg
L5	**Extensor hallucis longus** (big-toe extension), hip abduction	None reliable	Dorsum of foot, first web space
S1	Plantar flexion, eversion	**Ankle jerk**	Lateral foot, sole

- Most prolapses settle within 6 weeks without surgery; MRI and surgery for persisting radicular pain or deficit.
- **Cauda equina syndrome**: bilateral sciatica, **saddle anaesthesia**, urinary retention (then overflow), reduced anal tone: **urgent MRI and surgical decompression** (as soon as possible, ideally within 24-48 hours).
- **Lumbar canal stenosis**: **neurogenic claudication**: bilateral leg pain, heaviness and numbness on standing and walking, a variable distance, **worse downhill and on extension, relieved by sitting or bending forward** ("shopping-trolley" sign, cycling is easy), with **normal pulses**. **Vascular claudication**: calf cramp at a **fixed distance**, **worse uphill and on climbing stairs, relieved by standing still**, with weak pulses and no numbness.
- **Spondylolysis**: a defect (stress fracture) of the **pars interarticularis**, commonest at **L5**; on the oblique view the "Scottie dog" wears a **collar**. **Spondylolisthesis**: forward slip of a vertebra; **isthmic, at L5-S1, the commonest** (the "beheaded Scottie dog"); **degenerative at L4-L5** (older women, intact pars). **Meyerding grades I-IV** by the percentage slip (25% steps), **grade V spondyloptosis** (complete). Spondylosis means degeneration; spondylitis, inflammation.
- **Ankylosing spondylitis**: young men, **HLA-B27** (about 90%), inflammatory back pain (morning stiffness that eases with exercise); **bilateral sacroiliitis is the earliest X-ray sign**, the **MRI (STIR) bone-marrow oedema earlier still**; vertebral **squaring**, Romanus lesions (shiny corners), **bamboo spine** (marginal syndesmophytes), **dagger sign** (ossified interspinous ligaments), trolley-track sign; **modified Schober test**; FABER (Patrick) and Gaenslen tests stress the sacroiliac joints. **Anterior uveitis is the commonest extra-articular feature**; aortic regurgitation, apical fibrosis. Classified by **ASAS 2009 criteria** for axial spondyloarthritis. Treatment: exercise and **NSAIDs first**, then **TNF inhibitors or IL-17 inhibitors (secukinumab)**, and **JAK inhibitors (tofacitinib, upadacitinib)** (ASAS-EULAR 2022). DISH differs: flowing ossification of the anterior longitudinal ligament over four or more levels in the elderly, sacroiliac joints spared.
- Scoliosis: adolescent idiopathic (see Paediatric); congenital types need MRI for cord anomalies (diastematomyelia, tethered cord).
- **Cervical rib and thoracic outlet syndrome**: a rib from C7 in under 1% of people, most never symptomatic. When it causes symptoms, **neurological features from lower trunk (C8-T1) compression are far commoner** than vascular ones: ulnar-sided paraesthesia and wasting of the hand, most marked in the thenar muscles (Gilliatt-Sumner hand); subclavian artery compression (Raynaud phenomenon, emboli, a post-stenotic aneurysm) and venous thrombosis are rarer and need surgery. **Adson test**; physiotherapy first, excision of the rib for persisting or vascular symptoms.

Amputations and compartment syndrome

Amputations

- **Syme's amputation**: disarticulation through the **ankle joint**, the malleoli trimmed flush with the joint surface and the **heel pad kept** to cover the end of the tibia, so the stump can bear weight. Others: **Lisfranc** (tarsometatarsal), **Chopart** (midtarsal: talonavicular and calcaneocuboid), **Pirogoff** (part of the calcaneum turned up and fused to the tibia), Boyd (talectomy with calcaneotibial fusion), transtibial (below-knee: **Burgess long posterior myocutaneous flap**; ideal bone length about 12-15 cm below the knee joint line), through-knee (Gritti-Stokes), transfemoral (ideal about 10-12 cm above the knee joint), hip disarticulation. Syme's suits foot trauma, gangrene or deformity when the heel pad is healthy.
- Indications ("the three Ds and one more"): **dead** (gangrene from vascular disease, the commonest indication in adults; diabetes), **dangerous or deadly** (malignancy, uncontrolled infection such as gas gangrene), **damaged** beyond repair (trauma), and **a damn nuisance** (a useless, painful or deformed limb).
- **Mangled Extremity Severity Score (MESS)**: scores skeletal and soft-tissue injury, limb ischaemia (doubled after 6 hours), shock and age; **7 or more predicted amputation** in the original series (Johansen, 1990), but later studies show it is not reliable alone, so a senior team decides.
- Principles: preserve the knee (energy cost of walking with a below-knee prosthesis is far lower than above-knee); choose the level by blood supply; myodesis and myoplasty; nerves cut cleanly under tension so the neuroma retracts; early prosthetic fitting. **Phantom limb pain**: most amputees get phantom sensations; treat pain with gabapentinoids or amitriptyline, mirror therapy.

Replantation of an amputated part

- Transport: the part wrapped in **saline-moistened gauze, in a sealed plastic bag, placed in ice-cold water** (never directly on ice or in water). Cold ischaemia tolerance: a digit about 12-24 hours, a muscle-bearing limb part about 6 hours warm and 12 hours cold.
- **Order of repair: bone first (shortening and fixation), then extensor and flexor tendons, then arteries, nerves and veins, then skin.** The artery is repaired before the vein so the part reperfuses; the exam answer "bone, artery, nerve, vein" follows this order (some surgeons repair veins before nerves).

Compartment syndrome (acute)

- Raised pressure within a closed osteofascial compartment reduces perfusion of muscle and nerve. Causes: fractures

(**tibia, the commonest; forearm; supracondylar humerus**), a crush injury, a tight cast or dressing, burns, reperfusion after arterial repair. **Commonest site: the anterior compartment of the leg** (the deep posterior compartment is the one most often missed or incompletely released); in children, the **volar (deep flexor) compartment of the forearm**.

- **First and most important symptom: pain out of proportion to the injury; the earliest sign is pain on passive stretch of the muscles in the compartment** (passive finger or toe extension). The Ps: pain, paraesthesia, pallor, paralysis, poikilothermia, pulselessness: **all but pain are late**. **Distal pulses are usually still palpable**, since the compartment pressure rises above capillary perfusion pressure but stays below arterial pressure; a normal pulse and capillary refill do not exclude it.
- Diagnosis is clinical; measure the pressure when the patient cannot report pain (unconscious, sedated, a child, a nerve block). Normal compartment pressure is about 0-8 mmHg; **fasciotomy when the delta pressure (diastolic pressure minus compartment pressure) is under 30 mmHg** (the current criterion; the older one, an absolute pressure over 30 mmHg).
- Treatment: **split the cast and padding to skin**, keep the limb at heart level (**elevation helps prevent swelling, but once the syndrome is established it lowers perfusion**), oxygen, correct hypotension; if not settled at once, **urgent fasciotomy** (four compartments of the leg through two incisions; volar and dorsal in the forearm). After arterial embolectomy or repair of a long-ischaemic limb, a prophylactic fasciotomy. Late results: **Volkmann ischaemic contracture** (fibrosis of the deep forearm flexors, FDP and FPL; an established contracture is treated by a muscle slide, Max Page operation, or tendon lengthening), rhabdomyolysis, renal failure.
- Chronic exertional compartment syndrome: runners' leg pain during exercise, relieved by rest; pressures measured after exercise; elective fasciotomy.

Hand and wrist

Hand infections

- **Paronychia**: nail-fold infection, **the commonest hand infection** (Staphylococcus aureus). **Felon**: closed-space infection of the **finger pulp**, divided by fibrous septa, so pressure rises and the distal phalanx is threatened; drained early.
- **Suppurative flexor tenosynovitis**: **Kanavel's four signs**: semi-flexed finger, fusiform swelling, tenderness along the flexor sheath, **pain on passive extension** (usually the earliest sign; tenderness along the sheath tends to come later, and no one sign is reliable alone). An emergency: drainage. An index-finger infection can spread to the thenar space; the thumb and little-finger sheaths join the radial and ulnar bursae, so pus can spread between them (horseshoe abscess).

Tendon and fascial conditions

- **Dupuytren contracture**: thickening and shortening of the **palmar aponeurosis** (nodules and cords), older men of northern European ancestry, often familial; **ring finger first**, then little; the flexor tendons are normal. Associated with plantar (Ledderhose) and penile (Peyronie) fibromatosis, diabetes, alcohol, smoking and antiepileptic drugs. Treated when the hand will not lie flat on a table (Hueston's test), usually an MCP contracture of about 30° or any PIP contracture: **fasciectomy** (the standard), needle fasciotomy, or collagenase injection where available.
- **De Quervain tenosynovitis**: **abductor pollicis longus and extensor pollicis brevis** in the first dorsal compartment; **Finkelstein test** (pain on ulnar deviation with the thumb in the fist). Extensor pollicis longus lies in the third compartment (the posterior border of the snuff-box).
- **Trigger finger**: stenosing tenosynovitis of the flexor sheath at the **A1 pulley** over the MCP head, commonest in the ring finger and thumb, and with diabetes; steroid injection, then release. **Mallet finger**: loss of the extensor insertion at the base of the distal phalanx (tendon rupture or a bony avulsion), so the DIP rests flexed and cannot be actively straightened; **a splint holding the DIP straight, continuously, for 6-8 weeks** (surgery only for a large fragment with subluxation); untreated, a swan-neck deformity can follow. **Boutonniere deformity** follows rupture of the central slip over the PIP joint (the swan-neck and boutonniere postures of rheumatoid arthritis are under Arthritis in the examinations).

Thumb injuries

- **Bennett fracture**: intra-articular fracture-dislocation of the first metacarpal base; a small volar-ulnar fragment stays held to the trapezium by the anterior oblique ligament, while the shaft is pulled proximally and radially by **abductor pollicis longus** (and adducted by adductor pollicis), so it is unstable and needs fixation. **Rolando**: comminuted Y or T fracture of the same base.
- **Stener lesion**: in a complete ulnar collateral ligament tear of the thumb MCP joint (gamekeeper's or skier's thumb) the **adductor aponeurosis lies between ligament and bone**, preventing healing: surgery.

Sources

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- Bailey and Love's Short Practice of Surgery; Robbins and Cotran Pathologic Basis of Disease and the WHO Classification of Tumours of Soft Tissue and Bone (5th edition, 2020); Harrison's Principles of Internal Medicine; Nelson Textbook of Pediatrics; Gray's Anatomy.
- Guidelines: WHO DEXA definitions and FRAX; WHO consolidated TB guidelines, Module 4 (2022; 2025 edition); BOAST 4 open fractures (BOA 2017); NICE NG38 fractures (2016) and CG124 hip fracture (updated 2023); ACR gout guideline 2020; ASAS 2009 criteria and ASAS-EULAR axial spondyloarthritis recommendations 2022; Endocrine Society osteoporosis guideline 2019 (update 2020) and AACE 2020; ISNCSCI (ASIA) 2019; AANS/CNS 2013 and AO Spine 2017 on methylprednisolone; IMWG imaging in myeloma 2019; ESPID bone and joint infection guidance 2017; IWGDF guideline on active Charcot neuro-osteoarthropathy (2023); Shen and colleagues, an update on the Pauwels classification (Journal of Orthopaedic Surgery and Research, 2016); WHO Guidelines for Drinking-water Quality (fluoride 1.5 mg/L); Johansen and colleagues, the MESS (Journal of Trauma, 1990).
- Trials: UKSTAR Achilles rupture (Lancet 2020); trials of arthroscopic partial meniscectomy (2013-2016).
- First Aid for the USMLE Step 1 2022, for the basic-science checks (bone tumours, metabolic bone disease).
- Curriculum additions: Pott, Some Few General Remarks on Fractures and Dislocations (1768); Lauge-Hansen and Weber

ankle classifications; Ramsey and Hamilton, talar shift (JBJS Am 1976); ACR gout guideline (2020) and BSR gout guideline (2017); NICE NG226 osteoarthritis (2022); EULAR rheumatoid arthritis recommendations (2022) and ASAS-EULAR axial spondyloarthritis (2022); AAOS paediatric femoral shaft fracture guideline (2015); MOMS trial (NEJM 2011); Sever and Vanholder, crush syndrome recommendations (Nephrol Dial Transplant 2012).