Age Changes in the Lumbar Spine

1. Age changes in vertebrae & intervertebral discs
2. Age changes in facet joints
3. Spinal stenosis

Acknowledgment:
The slides are the work of Professor James Taylor & are presented with permission.
Age changes in lumbar vertebrae: Osteoporosis

- Lumbar vertebrae are shorter & wider with more concave endplates in old age.
- Selective loss of transverse trabeculae from the cancellous bone within vertebral bodies →
- Loss of the stiffness provided by transverse ties → collapse of the vertical load bearing beams →
- Vertebral end plates collapse → increased concavity
- Loss of stature with ageing
Vertebral osteoporosis: bowing of endplates with central expansion of discs: note collapse of thoracic vertebra

Tracings from cadaver lumbar discs (Twomey 1981)
AGEING IN LUMBAR DISCS

MORPHOLOGY AND CHEMISTRY

• Increased convexity at vertebral end plates
• Loss of proteoglycans (PG) & water
• Disc bulging at posterior margin
• Disc fissuring: circumferential + radial
• Loss of disc height in 33% of L4-5 & L5-S1
Lumbar disc degeneration (LDD)

- Bulge or Prolapse: usually asymptomatic
- Herniation (less common): may result from trauma and produce nerve root irritation (chemical) or nerve root compression (stenosis)
- Internal disruption: acute fissuring of the innervated outer 1/3rd of the annulus is the most common cause of discogenic pain (Crock Spine 11:650, 1986)
Lumbar Disc Degeneration (LDD) & Symptoms

- Accelerated by lifetime overloading, in heavy manual work or some elite sports
- LDD shows significant genetic predisposition
- Discography in a fissured disc may provoke a patient’s pain
“Normal” age changes: lumbar disc bulge: does not impinge on a nerve, is not necessarily accompanied by fissuring of the annulus & is therefore asymptomatic. (sagittal section of posterior 1/2 of IV disc + IV foramen + facet joint)
Internal Disc Disruption:
circumferential & radial fissuring in a patient shown by axial discography
radial fissure in a cadaver disc
AGEING IN LUMBAR DISCS

FUNCTIONAL CHANGES

• Increased disc stiffness
• Decreased ranges of movement
• Increased creep
  – progressive deformation (strain) of a structure under prolonged loading (stress)
• Increased hysteresis
  – the recovery from distortion: the lag of recovery from deformation (strain) after the load (stress) has been removed
Age changes in lumbar facet joints

- **Chondromalacia**: in young adults in response to compressive loading in anterior (coronal) part of superior articular process (SAP)
- **Osteoarthrosis** with cartilage loss
- **Bony hypertrophy of facets**: thickening & sclerosis in anterior coronal part of subchondral bone plate of superior articular process -> increased size of facets with marginal osteophytes
Chondromalacia: TS facets from different 36 year old adults
Left: early effects of loadbearing; chondromalacia affects the anterior AC on the superior articular process
Right: chondromalacia

Subchondral bone sclerosis;
chondrocyte swelling + splits in AC

chondromalacia

Blue arrows = direction of loading in flexion

Thickened bone plate
With progression of OA, subchondral cysts may appear (arrow) & eventually all AC may be lost.

Pain may arise because articular cartilage no longer protects the innervated subchondral bone.
A strip of AC torn off the posterior joint margin may form a loose flap in the joint with the potential for joint locking if the flap is displaced.
CT views of facet enlargement & osteoarthrosis:
Measurement of facets in large numbers of CTs show an average 25% enlargement between 25 years & 65 years accompanied by partial loss of joint space. Gross facet enlargement is a cause of spinal stenosis.

Marginal osteophytes enlarge superior articular processes.

Facet osteoarthrosis

Narrow lateral recess

Capsular calcification

deep muscle replaced by fat

CC McCormick
LUMBAR SPINAL STENOSIS

- CENTRAL CANAL STENOSIS
- LATERAL RECESS STENOSIS
- FORAMINAL STENOSIS
The normal lumbar spinal canal in an adult L3

Hypertrophy of the facets & pars interarticularaes narrows the lateral recesses at L5
Myelograms of cadaver spines:

normal canal

stenotic canal at L3-4 & L4-5

Central stenosis

Note the smooth outlines of the wide canal

Disc bulges and facet hypertrophy indent the canal

This spine also shows osteoporosis
Lateral recess stenosis: diagram & CT scan: facet hypertrophy compresses nerve roots

Diagram of lumbar vertebra showing facet hypertrophy

Enlarged superior articular process

Compressed nerve roots
Lumbar foraminal stenosis: the nerve roots are unaffected but veins in the lower foramen may be intermittently compressed.

- Osteophyte
- Sclerosis adjacent to degenerate disc
- LF bulge
Central stenosis may cause multilevel radicular signs & symptoms;

Lateral recess stenosis usually affects a specific nerve root with single segment sensory ± motor effects

Foraminal stenosis is less likely to impinge on a nerve due to the high position of the nerve in the foramen but it may affect veins
Clinical Note on Ageing

The importance of movement in maintaining good muscle tone & good posture

• Reduced bone density & reduced ranges of movement with ageing are not inevitable

• Exercise can strengthen bone & reduce the likelihood of osteoporosis

• Exercise with reduced lordosis may benefit patients with spinal stenosis
LBP & Injuries

*Lumbar Spine Innervation*

- Pain sensitive
  - Outer 1/3rd annulus
  - Longitudinal ligaments
  - Facet posterior capsule and synovial folds
  - Subchondral bone and vertebral periosteum
  - Anterior dura mater
  - ? internal structure of vertebra
  - Muscles

- Not innervated
  - Nucleus pulposus
  - Articular cartilage
  - Ligamentum flavum
Chronic Low Back Pain a variety of factors should be considered

• Nociception may persist, months or years after an injury and its segmental origin should be investigated

• Increased pain sensitivity
  – central changes
  – hyperalgesia
  – allodynia

• Psychosocial influences
THORACIC & LUMBAR SPINAL INJURIES

FLEXION-COMPRESSION TRAUMA

- Anterior elements
  - End plate fracture
  - Bone bruising (trabecular fractures)
  - Wedge compression fracture
  - Burst fracture
  - Disc disruption
Severe axial compression injuries: burst fractures:
Left: 49 year old man struck by falling tree; Right: 21 year old pedestrian struck by a motor vehicle (posterior fragment L4 occludes spinal canal).
LUMBAR DISC INJURIES

• The Disc is vulnerable to ROTATIONAL STRAIN IN FLEXION as the facets offer less protection:

• Circumferential or radial tear of posterior annulus is more common than disc herniation

• In axial compression or flexion compression injury a disc injury may be associated with an end plate # or vertebral wedge #. The fracture is visible on x-ray but the disc injury may not be visible. This may cause accelerated disc degeneration.
Disc injuries from a motor vehicle accident (19M)

Left: general view: all the discs show annular haemorrhage:

Right: closer view of L4-5 shows end plate injury & disc disruption
L5-S1 isolated disc injury (from a fall)

Para-sagittal section 43M

Note the extensive tear with haemorrhage & associated posterior prolapse

Midline section
LUMBAR FACET JOINT INJURIES

- Soft tissue injury with haemarthrosis
- Articular surface micro-fracture + haemarthrosis
- Central vertical fracture to Superior Articular Process (SAP)
- Mamillary process fracture

These injuries were not visible on post-mortem x-rays
Facet Haemarthrosis with blood in the joint recesses: there is local damage to the articular cartilage (arrow)
Fracture of the subchondral bone plate and articular cartilage with local haemorrhage
Central fracture of the subchondral bone of the inferior articular process in a 7 year old boy who fell from a tree, suffered concussion & drowned in a back yard pool 3 weeks later (a subdural haematoma was found at autopsy). There is an organising haematoma (arrow) with early callus formation around the micro-fracture.
Low Back Pain: Possible Serious Pathology

Cauda equina e.g. from central disc

Upper motor neurone e.g. spinal stenosis, spinal cord tumor

Metastatic tumours e.g. from lung, breast, prostate etc

Infection discitis, osteomyelitis (rare)

Inflammatory joint disease e.g. ankylosing spondylitis (rare)

Vertebral Erosion by abdominal aortic aneurysm etc (rare)
In middle aged or older people the possibility of a metastasis should be borne in mind:

Left: ovarian metastases:
Right: lung metastases

Infiltration of vertebral body, replacing bone by tumour

Discrete tumour with vascular reaction at margins