# Lumbar spine

# Additional scientific considerations on musculoskeletal medicine

By Steven De Coninck, PT, ETGOM-GCI

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# Recommended literature

"A practical approach to musculoskeletal medicine ; assessment, diagnosis and treatment" Elaine Atkins et al., 5th edition, 2024, Elsevier

"A system of orthopaedic medicine" Ludwig Ombregt, 3rd edition, 2013, Churchill Livingstone, Elsevier

# Be careful, serious pathology?

- An unwell patient
- With unexplained weight loss
- Unremitting non-mechanical pain
- Night pain
- Possible fever and systemic symptoms (high blood pressure; infection in the bloodstream, influenza,…)

"A practical approach to musculoskeletal medicine", Atkins et al., Elsevier, 2024, p448

# Facet joints

Innervation by the medial branches of the dorsal rami (Bogduk et al., 1982)

Weak correlation between MRI findings and the response to facet joint intervention (Stojanovic et al., 2010)

"A practical approach to musculoskeletal medicine", Atkins et al., Elsevier, 2024, p11

# Sciatica – radicular pain

Prevalence is 3% to 5% of the population

Most commonly the L5 or S1 nerve root, and less L4

Most people with sciatica will improve regardless of the treatment and improve spontaneously without surgery, **within 8 weeks to one year**

PPLP can recover spontaneously over several weeks

Caplan, 1994; Benoist, 2002; Kesikburun et al., 2019; Legrand, 2007
"A practical approach to musculoskeletal medicine", Atkins et al., Elsevier, 2024, p449

# Radicular pain → pain in one dermatome?

This seems to be questionnable

In most cases the sensitivity and specificity for the dermatomal pattern of pain are low for all nerve root levels (except for S1 and C4)

If present, dermatomal distribution of paraethesia appears to be more specific for all levels

Nitta et al., 1993; Bove et al., 2005; Murphy et al., 2009; Van Boxem et al., 2010; Tarulli and Raynor, 2007

“A practical approach to musculoskeletal medicine”, Atkins et al., Elsevier, 2024, p12

# Why?

Patients with radicular pain may also have other sources of pain

- Disc, dura mater, or other tissues which produce nociceptive pain
- Overlap between dermatomes of adjacent segments

Itomi et al., 2000

# Mechanism of radicular pain

- Complex and not fully understood
- Current view:

> *“it is a result of ectopic action potential emanating from a demyelinated or damaged axon of a nerve at the dorsal root or at the nerve root ganglion, as opposed to resulting from stimulation of the nerve’s peripheral terminals”*

Bogduk, 2009; Baron et al., 2016

“A practical approach to musculoskeletal medicine”, Atkins et al., Elsevier, 2024, p13

# Pressure on a nerve root → immediate pain?

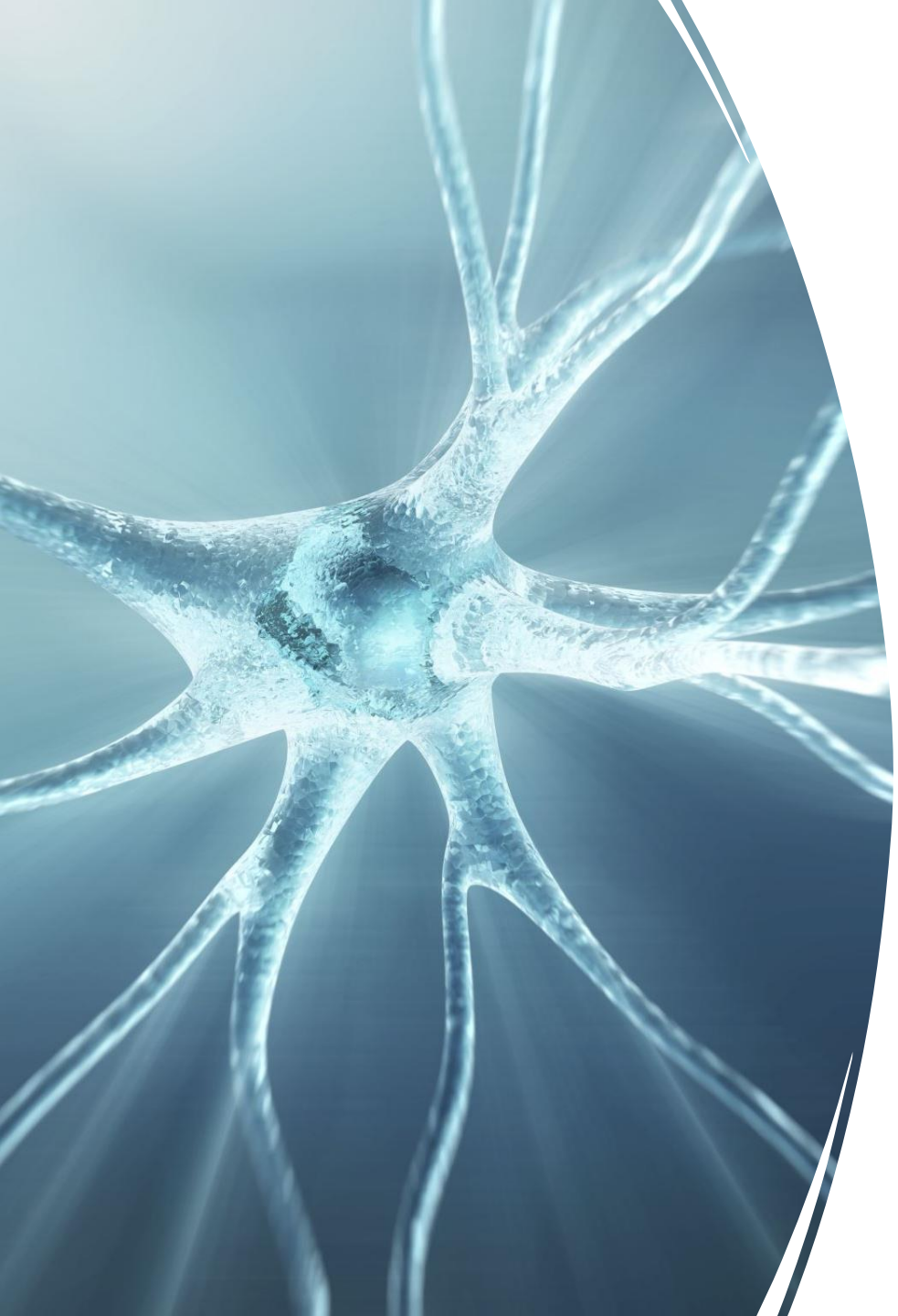
An inflammatory component or already damaged nerve root is necessary before a nerve root will produce pain

Dilley et al., 2005; Albrecht et al., 2018; Robinson, 2003
"A practical approach to musculoskeletal medicine", Atkins et al., Elsevier, 2024, p13

# But…?

Spinal nerves do not possess the same protective connected tissue  sheaths as peripheral nerves and are said to be vulnerable to direct mechanical injury

Rydevik and Olmarker, 1992
“A practical approach to musculoskeletal medicine”, Atkins et al., Elsevier, 2024, p443



# Effect / mechanism of manipulation?

**Manipulation-induced hypoalgesia** (pain relief) is well documented

Wright, 1995; Vincenzino et al., 1998, 2001; Goodsell et al., 2000; Vernon, 2000; Sterling et al., 2001; Paungmali et al. 2003, 2004; Mohammadian et al., 2004; George et al., 2006; Bialosky et al., 2008 “A practical approach to musculoskeletal medicine”, Atkins et al., Elsevier, 2024, p17

- Spinal manipulation may have a direct neurophysiological effect on pain perception through dorsal horn inhibition

- Other factors
  - Placebo and patient's expectations
  - Reduction or prevention of neuroplastic changes associated with central sensitisation

Hanai, 1998; Cuellar et al., 2005; George et al., 2006; Guan et al., 2006; Bialosky et al., 2008, 2009
"A practical approach to musculoskeletal medicine", Atkins et al., Elsevier, 2024, p87

# Chronic back pain patient

Less optimal tissue modelling

Return to inflammation phase could be interesting to optimalize recovery and proliferation phase

# “I am getting stiffer and stiffer…”

| | |
|---|---|
| Tissue degradation in the disc | • Protoglycans < collagen, less osmotic capability |
| If the end plate is damaged | • Circulation is also damaged |

# “My back pain gets worse during the day…”

- Patient is more tired and reacts less on proprioceptive signals from the disc “too much tension”

# Blood supply discs?

- Nutrition through blood vessels around the peripheral annulus and those in the central portion of the vertebral endplate
- As from the age of 8m (!) there's a shift from central to lateral
  - Because, as from that moment there's more compression

# Scheuermann?

- Osteochondrosis – damage to the vertebral end plates
  - Trampoline jumping is not advised for young children
    - Higher risc for later development of Scheuermann
  - Topsport should be avoided under the age of 20y (men) / 18y (women)
    - Bones are not fully developped and can't follow the development of the muscles → higher risc for problems at the epiphyse

*Tim Daelemans, principal FICO Osteopathy Academy, personal communication during course, sept 2024*

# Acute lumbago / disc structure

- 2-3 lamellae of the annulus are damaged
  - In total there are about 22-25 lamellae consisting of type I collagen (strongest collagen)
- Recurrent episodes of backpain → the load capacity of the disc decreases
- Biochemical damage of the disc?
  - Higher lactate concentration (acid!) destroys the collagen

*Tim Daelemans, principal FICO Osteopathy Academy, personal communication during course, sept 2024*

# Something to consider?

- Annulus becomes stronger because of tensile forces (e.g. flexion)
- Annulus weakens because of extension
- Nucleus becomes stronger because of compressive forces / hydrostatic pressure

- → running is the best preventive sport (factor 4x better than just walking)

*Tim Daelemans, principal FICO Osteopathy Academy, personal communication during course, sept 2024*

# Discs are very strong

- Can withstand up to 380kg shearing forces and 1000kg compressive forces.
- The more pathological – the more vulnerable

# Is the nucleus a separate entity?

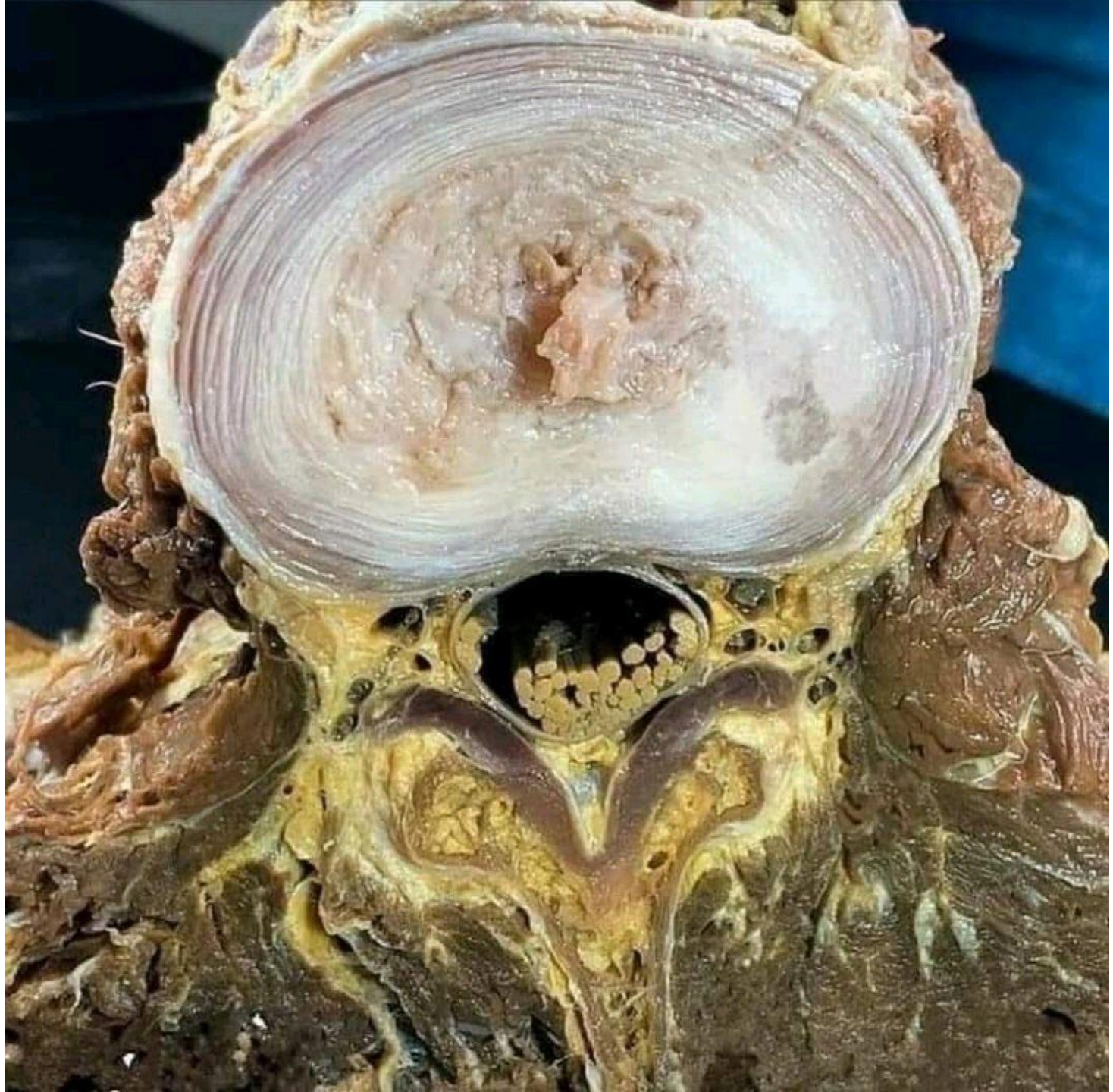
- No!
- Consists of proteoglycans, type 2 collagen and elastine fibres.
- The nucleus is connected with the annulus and end plates through fibers in a cross shape

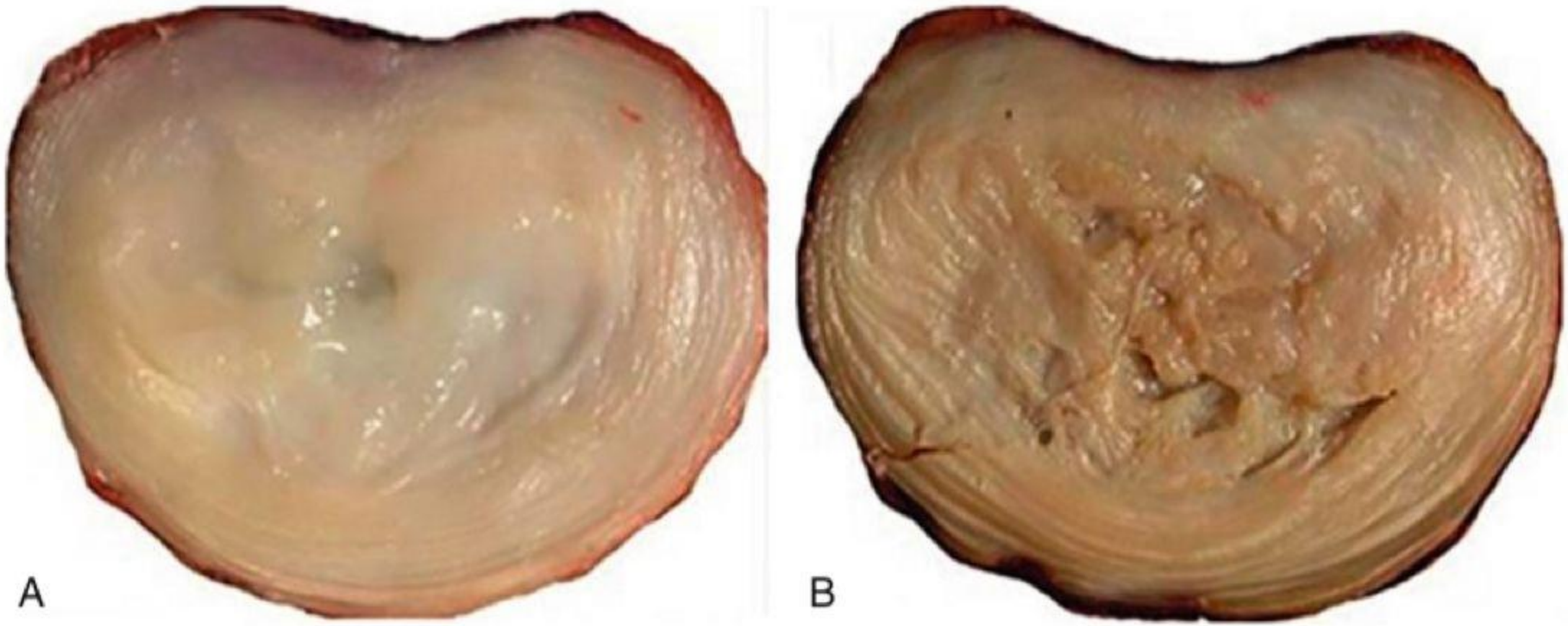
  - → is the former theory of Kapandji still correct?
  - → the nucleus doesn't really seem to "move"

# Posterior portion of the annulus is thinner!

- Particularly at the postero-lateral corners of the disc, there are irregularities within the laminate structure of the disc ; a number of incomplete layers were seen
- Up to 40% of the lamellae are incomplete throughout the disc
- 50% are incomplete in the posterolateral quadrants
  - → making this area vulnerable to increased stress

Marchand and Achmed, 1990; Bogduk, 2023
"A practical approach to musculoskeletal medicine", Atkins et al., Elsevier, 2024, p441






Disc dehydratation 16y versus 55y

# Quadripodal → bipodal

- Our discs became bigger and thicker in comparison to those of the old Egyptians

*Tim Daelemans, principal FICO Osteopathy Academy, personal communication during course, sept 2024*

# Nachemson – intradiscal pressure

- Irrelevant!
- Study dating from 1970 ; poor design
  - N= 9
  - Level L3
  - BIAS of putting a needle in healthy spine

- Better studies show different results
  - Less intradiscal pressure during slouched sitting *(Hans-Joachim Wilke, 1999)*
  - On flexion the disc moves anteriorly ; vice versa

**Table 1. Intradiscal Pressure Values for Different Positions and Exercises**

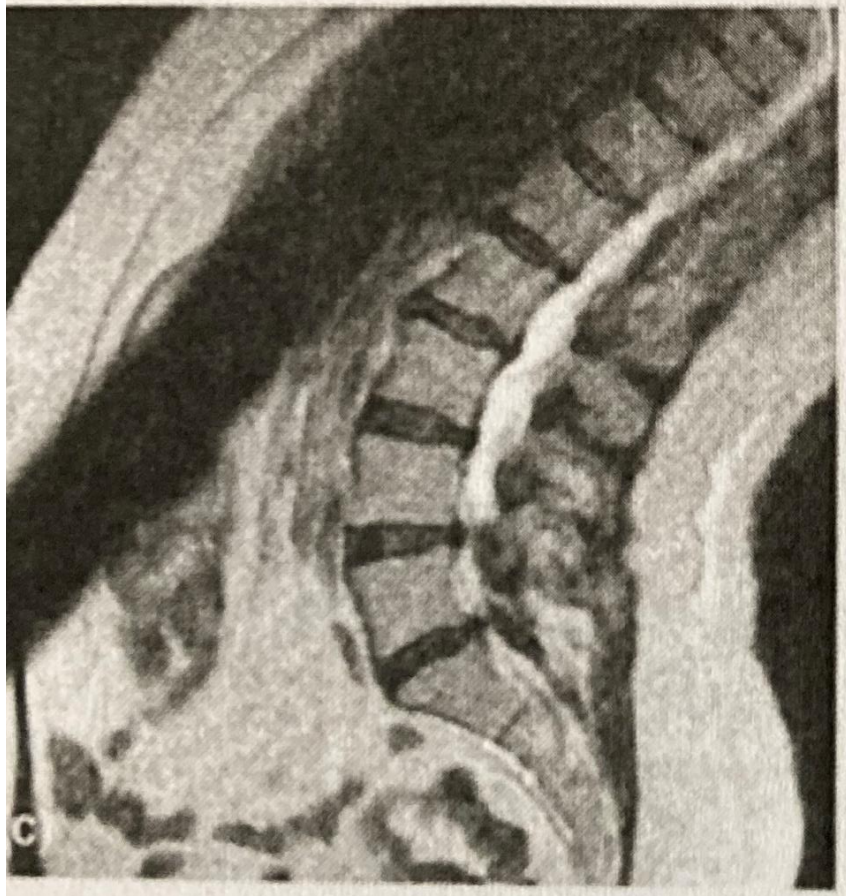
| Position | Pressure (MPa |
|---|---|
| Lying supine | 0.10 |
| Lying on the side | 0.12 |
| Lying prone | 0.11 |
| Lying prone, extended back, supporting on elbows | 0.25 |
| Laughing heartily, lying laterally | 0.15 |
| Sneezing, lying laterally | 0.38 |
| Peaks by turning around | 0.70–0.80 |
| Relaxed standing | 0.50 |
| Standing, performing vasalva maneuver | 0.92 |
| Standing, bent forward | 1.10 |
| Sitting relaxed, without backrest | 0.46 |
| Sitting actively straightening the back | 0.55 |
| Sitting with maximum flexion | 0.83 |
| Sitting bent forward with tight supporting the elbows | 0.43 |
| Sitting slouched into the chair | 0.27 |
| Standing up from a chair | 1.10 |
| Walking barefoot | 0.53–0.65 |
| Walking with tennis shoes | 0.53–0.65 |
| Jogging with hard street shoes | 0.35–0.95 |
| Jogging with tennis shoes | 0.35–0.85 |

Dynamic NMR images

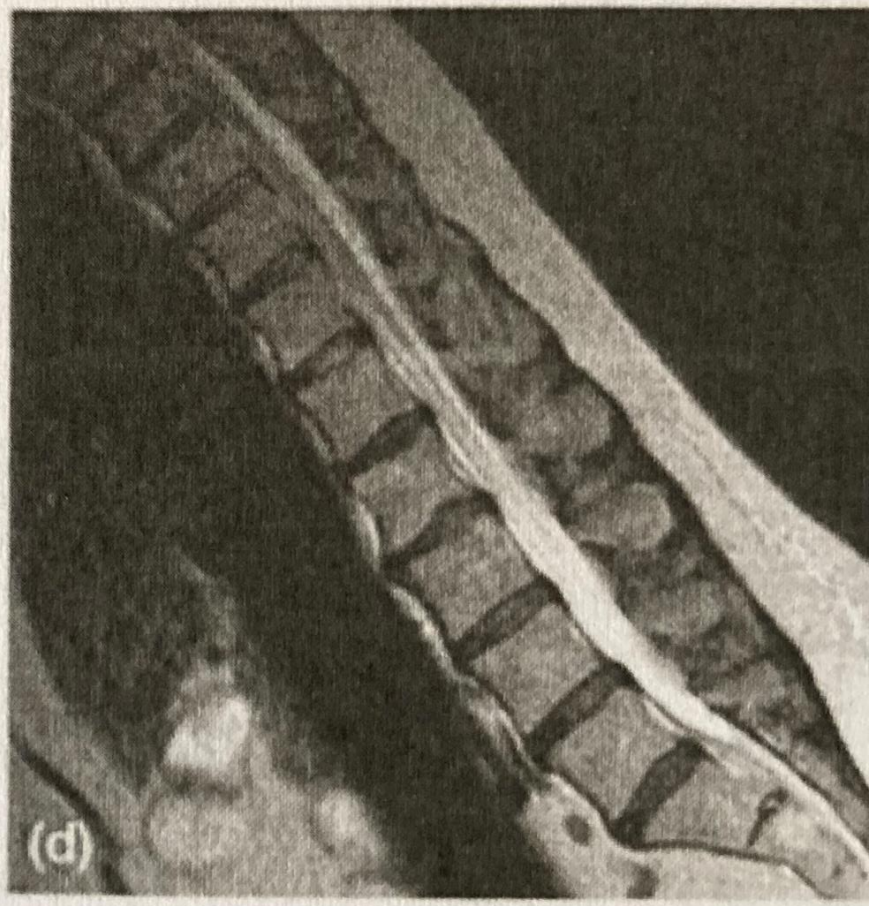
- Protrusion on L4L5, L5S1 level increases during extension and decreases during flexion!
- Jinkins J., Dworking J., 2012 ; Prof. Tom Van Hoof, Ghent University

According to Berger-Roscher N., 2016, flexion has a very unlikely potential to damage discs fibres.

# LUMBAR DISC PROTRUSION
## MRI in Standing Flexion/extension




Extension - disc protrusions at L4-5 and L5-S1 increase.




Same patient - flexion, disc protrusions reduce.

# Core stability training – back school

- Has no added value over other exercises

- *"There is strong evidence stabilisation exercises are not more effective than any other form of active exercise in the long term. The low levels of heterogenity and large numbers of high methodological quality of available studies, at long-term follow up, strengthen our current findings and further research is unlikely to considerably this conclusion"*

Benjamin Smith, 2014 ; N=2258

# Slouched sitting: yes or no?

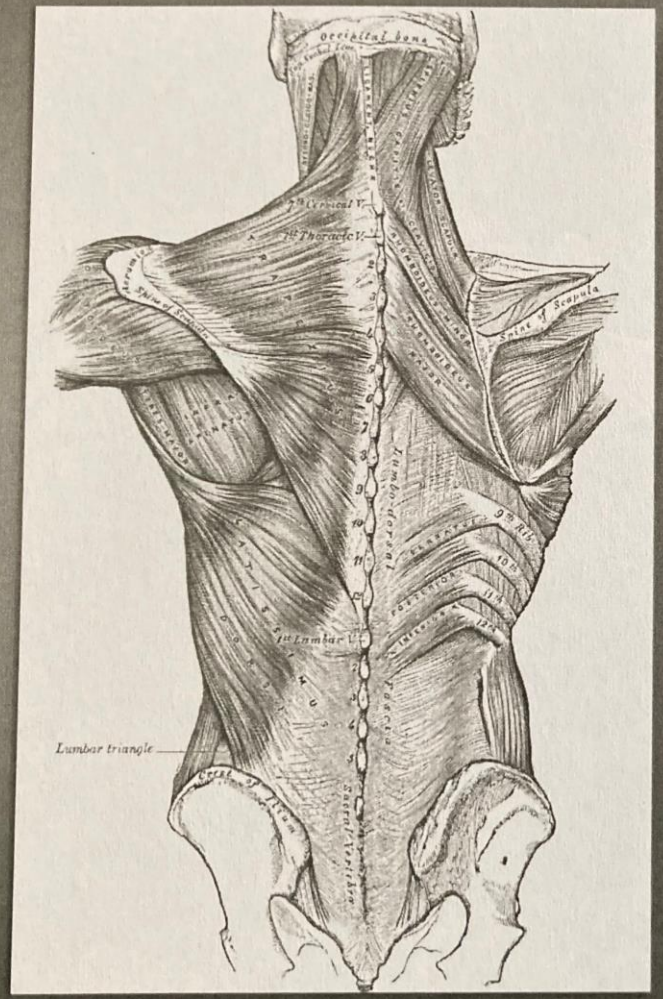
- The biggest problem of office workers is underload!
  - Not enough hydrostatic pressure – the more loading / movement the better
    - Only through movement lactate (pH 2-4) can be evacuated and will cause less damage to cells which promote healing
  - The best sitting position in slouched, with knees flexed

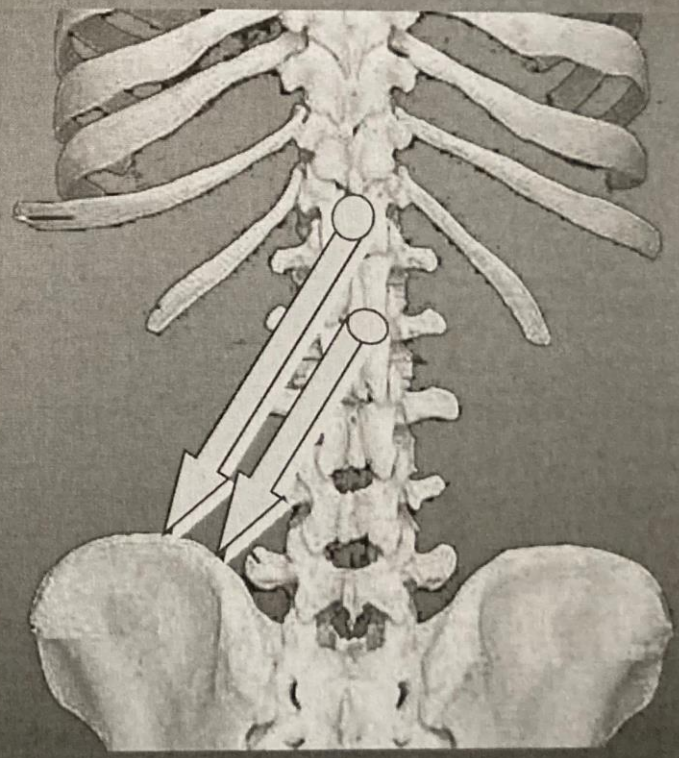
# The thoracolumbar fascia

- During a movement from flexion → extension (e.g. lifting loads)
  - 80% of the forces are transmitted through the fascia
  - It acts as a spring: during flexion it elongates and stores potential energy
  - On returning to extension, the stored energy is released

# What about the fascia?

That's an interesting structure …



# So, ideal postion to lift loads…

- Is not in lordosis(!)
  - We need up to 30% more caloric consumption
  - In lordose the fascia is relaxed → muscles need to be more activated

- Optimal building up the tension in the fascia
  - How to lift loads: some flexion in the knees, hips and lumbar spine (cfr weightlifters)

# Fascia stretch technique

- Minimal 7’ sustained stretch
- Up to 15’


Cauda equina

# Cauda equina syndrome (CES)

A complication of approx. 2% of all herniated discs

Considerable improvements in sensory, motor and sphincter deficits are more likely if surgery is performed within 48 hrs

But…it is common (40% to 50%) for those deficits to continue after surgery

Finucane et al., 2020; Korse et al., 2013
"A practical approach to musculoskeletal medicine", Atkins et al., Elsevier, 2024, p451

# Spinal stenosis

- Most common at level L4 to L5, followed by L5 to S1 and L3 to L4
- It can produce **neurogenic claudication**
  - Discomfort, pain, paraesthesia and heaviness in one or both legs, on prolonged standing and walking
  - Perhaps night cramps and restless legs

- There is a **threshold distance** for walking when the symptoms of claudication develop ; the tolerance distance is about twice the treshold distance

Munakomi et al., 2021; Porter, 1992
“A practical approach to musculoskeletal medicine”, Atkins et al., Elsevier, 2024, p450

# Spinal stenosis…

- Examination – inspection
  - The patient stands with a stooped posture, with flexed hips and knees and a flattened lumbar spine, with loss of the lordosis

- Poor correlation between imaging findings and symptoms

- Exercise and manual therapy may be helpful
  - 30% to 50% of the patients with mild to moderate symptoms: marked improvement in pain and the ability to walk long distances

Knezevic et al., 2021; Jensen et al., 2021
"A practical approach to musculoskeletal medicine", Atkins et al., Elsevier, 2024, p450

# Spondylolisthesis?

- **If symptomatic**
  - Back pain – usually referred to the buttocks
  - May also present with symptoms of radiculopathy
    - Pain, paraesthesia and weakness in the lower limbs

- Inspection may reveal excessive skin folds above the defect and a shelf (step defect) may be felt on palpation

Gagnet et al., 2018; Norris, 2004; Brukner et al., 2017
"A practical approach to musculoskeletal medicine", Atkins et al., Elsevier, 2024, p451

Athletes with more than 50% slippage should be advised to avoid high-speed or contact sports

Bruckner et al., 2017
“A practical approach to musculoskeletal medicine”, Atkins et al., Elsevier, 2024, p451

# Ankylosing spondylitis (Bechterew)

Often misdiagnosed as mechanical back pain

Average delay of 8,5 years (!!) between onset and diagnosis

Around 15% of the cases receive a diagnosis within 3 months of initial presentation

McAllister et al., 2017
“A practical approach to musculoskeletal medicine”, Atkins et al., Elsevier, 2024, p452

# The “crossed” SLR

- Production of pain in the back or leg on the painful side on SLR of the painless limb

- Usually occurs at the L4 level
- It’s a strong indicator of nerve root compression
- “the most useful test in the diagnosis of a lumbar disc herniation”

Khuffash and Porter, 1989; Vroomen et al., 1999; McCarthy, 2014
“A practical approach to musculoskeletal medicine”, Atkins et al., Elsevier, 2024, p462

# Controversy about lumbar mechanical traction…

There is some evidence for some effects; some are theoretical and anecdotal

"A practical approach to musculoskeletal medicine", Atkins et al., Elsevier, 2024, p476-477

# Physiological / anatomical effects

To change the position of the nucleus relative to the posterior annulus (Pellechia, 1994; Cox et al., 1996)

To change the disc-nerve interface (Knutsson et al., 2008)

To increase intervertebral disc height (Mathews, 1968; Colachis and Strohm, 1969; Gupta and Ramarao, 1978)

To reduce disc herniation/abnormality (BenEliyahu, 1996; Neault, 1992)

To reduce intradiscal pressure (Andersson et al., 1983; Sheng et al., 2002)

To stimulate mechanoreceptors (Brumagne et al., 2000; Gay et al., 2005)

Lumbar traction exhibited significantly more pain reduction and functional improvement in the short term, but not in the long term

Cheng et al., 2020; Vanti et al., 2021
“A practical approach to musculoskeletal medicine”, Atkins et al., Elsevier, 2024, p476-477

# Sacroiliac tests?

Pain provocation tests are more reliable than mobility tests

However, no individual pain provocation test has sufficient validity

Kokmeyer et al., 2002; Robinson et al., 2007; Broadhurst and Bond, 1998; Chen et al., 2002; Laslett et al., 2005; van der Wurff et al., 2006; Arab et al., 2009
"A practical approach to musculoskeletal medicine", Atkins et al., Elsevier, 2024, p502-503

- A battery of tests is used
  - Select 3 or 4 individual tests
  - Other suggest to use 6 tests

# Tests…

- The **“distraction test”** was found to have the highest single positive predictive value and was the most specific

- Some suggest **active SLR** as a means of testing the SI-joint
  - The patient raises each leg in turn 5cm off the treatment table
  - The test is positive if it brings on the patient’s pain + a profound heaviness in the leg
  - The pain can be relieved by applying compression to the ilia

O’Sullivan and Beales, 2007
“A practical approach to musculoskeletal medicine”,
Atkins et al., Elsevier, 2024, p507

# Cervical spine

# Supplementary considerations on musculoskeletal medicine

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“A practical approach to musculoskeletal medicine ; assessment, diagnosis and treatment” Elaine Atkins et al., 5th edition, 2024, Elsevier

“A system of orthopaedic medicine” Ludwig Ombregt, 3rd edition, 2013, Churchill Livingstone, Elsevier

# The cervical disc

Annulus, nucleus and superior and inferior vertebral end-plates

Its intrinsic structure is unlike that of lumbar discs and differs with age

Nucleus undergoes rapid degeneration ; by the age of 30, the nucleus is undistinguishable and froms a firm fibrocartilaginous plate

Mercer and Bogduk, 1999; Peng and Bogduk, 2019
“A practical approach to musculoskeletal medicine”, Atkins et al., Elsevier, 2024, p232

# Nerve root compression – from which direction?

- Motor impairment is suggestive of anterior compression from a disc prolapse or degenerative changes in the uncovertebral region
- Sensory changes are indicative of compression due to changes in the posterior structures
- Both elements of a nerve root may be compressed

Tanaka et al., 2000
"A practical approach to musculoskeletal medicine", Atkins et al., Elsevier, 2024, p235

# Sinuvertebral nerve

- Ascending, descending and transverse branches to supply structures at, above and below the segment!
- Innervation of the dura mater, PLL and the outer part of the annulus of the disc

Middleditch and Oliver, 2005; Standring, 2015; Soames and Palastanga, 2018; Bogduk, 1993, 2023
"A practical approach to musculoskeletal medicine", Atkins et al., Elsevier, 2024, p225

# Frequency of nerve root compression

Kuijper et al., 2009
“A practical approach to musculoskeletal medicine”, Atkins et al., Elsevier, 2024, p241

50% to 70% → C7

> 20% → C6

10% → C8

2% to 10% → C5

Most common between the age of 50 – 54 years

# Brachial neuritis

- Also known as neuralgic amyotrophy
- Rare – affects more young adults
- Cause?
  - Trauma, infection, virus, hearvy exercise, surgery, autoimmune conditions

# Brachial neuritis – 3 stages

- Acute onset of severe pain in the shoulder; distal reference of pain in the arm and proximal into the neck
  - May persist from days to weeks
- Resolution of pain; onset of painless paresis, atrophy and sensory impairment of the shoulder girdle and/or upper limb
- Gradual recovery
- 75% of patients fully recovered at 2 years

Miller et al., 2000; Mamula et al., 2005; Hussey et al., 2007; Sumner, 2009
"A practical approach to musculoskeletal medicine", Atkins et al., Elsevier, 2024, p242

# Other types of neuritis / nerve entrapments

- Suprascapular nerve
- Long thoracic nerve
- Spinal accessory nerve
- Dorsal scapular nerve
- Axillary nerve

- Most cases respond to conservative management within 6 months
- Some authors advice early surgical intervention to avoid permanent nerve impairment

Trojian et al., 2018; Ganzhorn et al., 1981; Walsworth et al., 2004; Pratt, 2005
"A practical approach to musculoskeletal medicine", Atkins et al., Elsevier, 2024, p242

# The ankle clonus test/reflex

- Quickly dorsiflexing the foot and holding it in a dorsiflexed position
- A positive sign =
  - Repeated oscillations or “beats” that can be felt and seen b the practitioner
  - Indicative for an upper motor neuron lesion (in the context of other signs and symptoms)

“A practical approach to musculoskeletal medicine”, Atkins et al., Elsevier, 2024, p258

# Vertigo because of a. vertebralis – a. carotis dysfuntion? How to test?

- The predictive ability of provocative positional tests to identify at risk individuals is lacking
- There is some evidence **against** its use, therefore not recommended

Hutting et al., 2020
"A practical approach to musculoskeletal medicine", Atkins et al., Elsevier, 2024, p258

# Benign postural vertigo?

Lempert et al., 1995; Magaray et al., 2004; Johnson et al., 2008
"A practical approach to musculoskeletal medicine", Atkins et al., Elsevier, 2024, p242

- Hallpike-Dix positional testing
  - If **positive**: a torsional nystagmus when the head is reclined, and turned to the affected side is seen
- The test should not be considered in isolation, but in the context of the whole assessment

# Cervical manipulation – contraindication categories: **COINS**

Circulatory

Osseous

Inflammatory

Neurological

Serious

"A practical approach to musculoskeletal medicine", Atkins et al., Elsevier, 2024, p262

# Link cervical – thoracic spine?

There is some evidence that manipulation to the thoracis spine may be useful in the management of patients with neck pain

Cleland et al., 2005, 2007; Huisman et al., 2013
"A practical approach to musculoskeletal medicine", Atkins et al., Elsevier, 2024, p263

# Thoracic spine

# Thoracic pain…internal derangements are less frequent

- Minor subluxation of the posterior rib joints (relatively unstable joints)
- Inflammatory, malignant and infective conditions ; ribs and thoracic vertebrae are common sites for metastases
- Visceral problems (gastrointestinal, cardiopulmonary, renal)
- Spinal fractures due to osteoporosis

Fukui et al., 1997; Fruth, 2006; Briggs et al., 2007; Singer, 2000 "A practical approach to musculoskeletal medicine", Atkins et al., Elsevier, 2024, p281

# Vertebral fractures?

Start to be a clinical problem 10 to 15 years after menopause

Most fractures between T8 and L4 levels

Majority of compression fractures (50% to 70%) are asymptomatic

Greenhalgh and Selfe, 2019; Finucane et al., 2020; NICE, 2010
"A practical approach to musculoskeletal medicine",
Atkins et al., Elsevier, 2024, p282

# To consider

- If pain is constant, severe and progressive, without any relief from bed rest or postural modification
  - Suspicious!

- Sudden onset?
  - Minor mechanical lesion/subluxation of the posterior rib joint

- An internal derangement may have a sudden or gradual onset

- Pain in the second half of the night, significant early morning stifness (> 1hr)
  - Inflammatory arthritis?

"A practical approach to musculoskeletal medicine", Atkins et al., Elsevier, 2024, p287