Sports Related Spine Injuries

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Spine Anatomy
Spine Anatomy

Neural Arch
Spine Anatomy
Spine Anatomy
Spine Anatomy

Vertebral Foramen
Spine Anatomy

Intervertebral Foramen
Spine Anatomy

Spinal Ligaments
Spine Anatomy

Back Muscles

- sternocleidomastoid
- trapezius
- deltoid
- teres major
- latissimus dorsi
- iliac crest
- splenius capitis
- splenius cervicis
- levator scapulae
- supraspinatus
- rhomboid minor
- serratus posterior superior
- rhomboid major
- erector spinae group
- serratus posterior inferior
- external oblique
- internal oblique
- gluteus maximus
- Longissimus capitis m.
- Semispinalis capitis m.
- Semispinalis cervicis m.
- Spinalis thoracis m.
- Iliocostalis thoracis m.
- Iliocostalis lumborum m.
- Multifidus m.
Spine Anatomy
Intervertebral Disk

Anulus Fibrosis
Nucleus Pulposus
Disk Loading

- Intradiscal pressure (kg)
  - 350
  - 325
  - 300
  - 275
  - 250
  - 225
  - 200
  - 175
  - 150
  - 125
  - 100
  - 75
  - 50
  - 25
  - 0

- Diagram showing the effect of different postures on intradiscal pressure.

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Figure 13 Disc as Shock Absorber

Axial (Overhead) View of Intervertebral Disc
- Annulus Fibrosus
- Nucleus Pulposus

Normal disc
- Spinal canal
- Compressed nerve root

Herniated disc

Top views of vertebrae
D.D.D.
Disk Degenerative Disease
Mechanism of Disk Injury

- Forward flexion of the spine (bending forward).
- Lifting heavy weights presses one vertebrae against another, increasing the pressure on the disk.
- Increasing pressure on the disk “squeezing” the disk. Coughing, sneezing.
How is the diagnosis of a herniated disk made?

• The diagnosis of a herniated disc can be made by physical examination through testing sensation, muscle strength, and reflexes.

• MRI pictures determine the final diagnosis.
Patterns of pain
<table>
<thead>
<tr>
<th>Investigation</th>
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<tr>
<td><strong>Scan type</strong></td>
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<tr>
<td>X-Ray of extremity</td>
</tr>
<tr>
<td>Bone Density</td>
</tr>
<tr>
<td>X-Ray of spine or pelvis</td>
</tr>
<tr>
<td>CT Brain</td>
</tr>
<tr>
<td><strong>CT spine (cervical or lumbar)</strong></td>
</tr>
<tr>
<td>Bone Scan</td>
</tr>
<tr>
<td>CT Abdomen / Pelvis</td>
</tr>
<tr>
<td>MRI</td>
</tr>
<tr>
<td>Ultrasound</td>
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</table>
Table 2: Age-specific prevalence estimates of degenerative spine imaging findings in asymptomatic patients

<table>
<thead>
<tr>
<th>Imaging Finding</th>
<th>Age (yr)</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
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<tbody>
<tr>
<td>Disk degeneration</td>
<td></td>
<td>37%</td>
<td>52%</td>
<td>68%</td>
<td>80%</td>
<td>88%</td>
<td>93%</td>
<td>96%</td>
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<tr>
<td>Disk signal loss</td>
<td></td>
<td>17%</td>
<td>33%</td>
<td>54%</td>
<td>73%</td>
<td>86%</td>
<td>94%</td>
<td>97%</td>
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<tr>
<td>Disk height loss</td>
<td></td>
<td>24%</td>
<td>34%</td>
<td>45%</td>
<td>56%</td>
<td>67%</td>
<td>76%</td>
<td>84%</td>
</tr>
<tr>
<td>Disk bulge</td>
<td></td>
<td>30%</td>
<td>40%</td>
<td>50%</td>
<td>60%</td>
<td>69%</td>
<td>77%</td>
<td>84%</td>
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<tr>
<td>Disk protrusion</td>
<td></td>
<td>29%</td>
<td>31%</td>
<td>33%</td>
<td>36%</td>
<td>38%</td>
<td>40%</td>
<td>43%</td>
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<tr>
<td>Annular fissure</td>
<td></td>
<td>19%</td>
<td>20%</td>
<td>22%</td>
<td>23%</td>
<td>25%</td>
<td>27%</td>
<td>29%</td>
</tr>
<tr>
<td>Facet degeneration</td>
<td></td>
<td>4%</td>
<td>9%</td>
<td>18%</td>
<td>32%</td>
<td>50%</td>
<td>69%</td>
<td>83%</td>
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<tr>
<td>Spondylolisthesis</td>
<td></td>
<td>3%</td>
<td>5%</td>
<td>8%</td>
<td>14%</td>
<td>23%</td>
<td>35%</td>
<td>50%</td>
</tr>
</tbody>
</table>

*Prevalence rates estimated with a generalized linear mixed-effects model for the age-specific prevalence estimate (binomial outcome) clustering on study and adjusting for the midpoint of each reported age interval of the study.*
Sports Related Spine Injuries

- Acute trauma
- Repetitive use
- Wrong use / poor technique
- Over use
- Poor anatomy issues
- Hidden pathology
Sprains and Strains

- Most common causes of low back pain.
- A muscle **strain** occurs when the muscle fibers are abnormally stretched or torn.
- A lumbar **sprain** occurs when the ligaments are torn from their attachments.
- Both injuries will show similar symptoms.
- Referred to as "**musculoligamentous injuries**" of the spine.
- The treatment and prognosis for both back strains and sprains is the same → **conservative**
Acute Injuries
Spinal Fractures
**SCI (Spinal Cord Injury): Definition**

- Insult to spinal cord resulting in a change, in the normal motor, sensory or autonomic function
  - Either temporary or permanent

**Mechanisms:**
- Direct trauma
- Compression by bone fragments / haematoma / disc material
- Ischemia from damage / impingement on the spinal arteries
SCI (Spinal Cord Injury)

• Prevalence: 500~900 per million population
• Male : female = 3~4 : 1
• Median age: 25 y/o

• Cause: vehicle accidents (45%)
  falls (22%)
  sports (14%)
  violence (14%)
Neurological deficit Evaluation

Sensation

Motor function

Reflexes

*Sensory function of sacral roots → sparing spinal cord function*
**Dermatomes**

- Area of skin innervated by sensory axons within a particular segmental nerve root
- Knowledge is essential in determining level of injury
- Useful in assessing improvement or deterioration
Myotomes:

- Segmental nerve root innervating a muscle
- Again important in determining level of injury

**Upper limbs:**
- $C_5$ - Deltoid
- $C_6$ - Wrist extensors
- $C_7$ - Elbow extensors
- $C_8$ - Long finger flexors
- $T_1$ - Small hand muscles

**Lower Limbs:**
- $L_2$ - Hip flexors
- $L_{3,4}$ - Knee extensors
- $L_{4,5}$ - $S_1$ - Knee flexion
- $L_5$ - Ankle dorsiflexion
- $S_1$ - Ankle plantar flexion
Spinal Cord Injury Classification

• **Quadriplegia**: injury in cervical region
  all 4 extremities affected

• **Paraplegia**: injury in thoracic, lumbar or sacral segments
  2 extremities affected
Neurological deficit → Evaluation

Acute paralysis → flaccid with absence of reflexes

Final clinical picture after the resolution of spinal shock (12-48 h)

Spinal/Neurogenic shock → hypotension and low heart rate

Sacral reflexes → evidence of resolution of spinal shock
<table>
<thead>
<tr>
<th>SCI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Complete:</strong></td>
</tr>
<tr>
<td>Loss of voluntary movement of parts innervated by segment, this is <strong>irreversible</strong></td>
</tr>
<tr>
<td>Loss of sensation</td>
</tr>
<tr>
<td>Spinal shock</td>
</tr>
<tr>
<td><strong>Incomplete:</strong></td>
</tr>
<tr>
<td>Some function is present below site of injury</td>
</tr>
<tr>
<td>More favorable prognosis</td>
</tr>
<tr>
<td>Recognizable patterns of injury, although they are rarely pure and variations occur</td>
</tr>
</tbody>
</table>
Muscle Strength Grading:

- 5 – Normal strength
- 4 – Full range of motion, but less than normal strength against resistance
- 3 – Full range of motion against gravity
- 2 – Movement with gravity eliminated
- 1 – Flicker of movement
- 0 – Total paralysis
ASIA (American Spinal Injury Association) Impairment Scale

A – **Complete**: no sensory or motor function preserved in sacral segments $S_4 – S_5$

B – Incomplete: sensory, but no motor function in sacral segments

C – Incomplete: motor function preserved below level and power graded $< 3$

D – Incomplete: motor function preserved below level and power graded 3 or more

E – Normal: sensory and motor function normal
Despite the Medical Advances of the last 50 years, Prediction of Functional Capacity Based on Neurologic Level is still similar to that described in:

Holdsworth (1963)

2 Column theory
Holdsworth (1963)

**Stable**
1. Wedge compressive (flexion)
2. Burst compressive (vertical compression)

**Unstable**
3. Dislocation (shear forces)
4. Fracture - dislocation
   hyperextension (extension)
5. Fracture - dislocation
   rotation (flexion-rotation)
Denis (1982)

3 Column theory
Denis classification 1982

1. Compressive fractures
2. Burst fractures
3. Flexion - extension (seat- belt injuries)
4. Fractures - Dislocations
Spinal stability?

3-column theory (*Denis*)

**Middle** = posterior $\frac{1}{2}$ VB, posterior disc, post longitudinal lig

2-column theory (*Holdsworth*)

anterior = VB, disc, ALL, PLL

**Posterior** = neural arch, Post lig complex
Compressive fractures
Compression Fractures

- A compression fracture occurs when the normal vertebral body of the spine is squished, or compressed, to a smaller height.
- Mechanism: falling on rear end, or a heavy vertical load is placed on the spine.
Burst fractures
Flexion-Distraction (Lap - belt injuries)
FRACTURES - DISLOCATIONS

Shear

Flexion-distraction

Flexion-rotation

Dislocation-extension
Patient transportation & immobilization?
When do you spine board an athlete?

- Athlete is unconscious.
- The athlete presents with signs or symptoms of a spinal cord injury.
  1. Numbness and tingling in extremities.
  2. Lack of movement or sensation in extremities.
  3. Pain or deformity over vertebrae.
Preparing the Athlete to be Spine Boarded

- Place a cervical collar on the athlete.
- If a facemask is present remove the facemask from the helmet.
- Make sure straps are in position.
- Keep shoulder pads on, as they provide proper spinal alignment along with the helmet.
Log Roll Technique (spine boarding)

- Person at the head is in charge of the maneuver and gives the cadence for the roll, holds inline traction.
- Ideally there are 2 people above waist and below the waist of the victim.
- Victim is rolled to the side, board is placed under the victim.
Acute Cervical Injuries

A. Neck Pain

Does the athlete have neck pain?

- No
  Proceed to B. Extremity Symptoms
- Yes
  Does the athlete have extremity symptoms?
    - No
    - Yes
      Are the symptoms unilateral or bilateral?
        - Unilateral
          Does the athlete have neck pain?
            - No
        - Bilateral
          Observation

B. Extremity Symptoms

Does the athlete have extremity symptoms?

- Yes
  Are the symptoms unilateral or bilateral?
    - Unilateral
      Does the athlete have neck pain?
        - No
    - Bilateral
      Observation
- No
  Proceed to B. Extremity Symptoms

Possible Diagnoses
- 1. Osseous Injury
   - a. Stable Fracture
   - b. Unstable Fracture
- 2. Ligament Injury
   - a. Stable
   - b. Unstable
- 3. Intervertebral Disk Injury

Possible Diagnoses
- 1. Paracentral HNP
- 2. Unilateral Facet Fracture/Dislocation

Possible Diagnoses
- Nerve Root or Brachial Plexus Neurapraxia

Possible Diagnoses
- 1. Unstable Fracture/Dislocation
- 2. Transient Quadriplegia
- 3. Central HNP
- 4. Congenital Anomalies
Fig. 4
The effect of the 1976 rule changes banning spearing and head-impact playing techniques was dramatic, with a sustained decrease in the number of players who sustained permanent cervical quadriplegia.
Transient quadriplegia

- Sensation: burning pain, numbness, tingling,
- Motor: weakness to complete paralysis.
- **Transient and complete recovery usually 10-15min, although gradual resolution occurs over 36-48 hr rarely.**
- Except for burning paresthesia, no neck pain
- Complete return of motor function and full, pain-free motion of the cervical spine
- Pincer effect
- Adults: spinal stenosis
- Children: spinal column mobility
<table>
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<td>Auto</td>
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<td>4.3</td>
<td>6.9</td>
<td>5.4</td>
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<td>0.1</td>
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<td>≤0.2</td>
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<td>Violence</td>
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<td>0.1</td>
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<td>Other*</td>
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<td>≤0.2</td>
<td>≤0.2</td>
<td>≤0.2</td>
<td>≤0.2</td>
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<td>Falls</td>
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<td>18.5</td>
<td>20.7</td>
<td>23.8</td>
<td>19.6</td>
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<tr>
<td>Other</td>
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<td></td>
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<tr>
<td>Falling object</td>
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<td>2.8</td>
<td>3.1</td>
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<td>2.1</td>
<td>2.2</td>
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<td>1.2</td>
<td>0.9</td>
<td>0.7</td>
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<tr>
<td>Total cases</td>
<td>4562</td>
<td>10,263</td>
<td>12,563</td>
<td>3140</td>
<td>30,501</td>
</tr>
</tbody>
</table>

**NOTE.** Values are in percentage; total cases are N. Values may not equal 100% because of rounding.

*Includes boats and rotating wing aircraft.

†Includes water skiing, baseball, basketball, rodeo, track, field, hang gliding, air sports, and skateboarding.
Cervical Disk syndrome EPIDEMIOLOGY

Cervical Spine:

- Annual incidence of cervical radiculopathy < 1 / 10,000
- Pure soft disc herniations < than hard disc abnormalities (spondylosis) as a cause of radicular arm pain
- In a study of 395 patients with nerve root abnormalities, radiculopathy occurred in the cervical in 93 (24%) and lumbar spine 302 (76%)
PATHOGENESIS - CERVICAL SPINE

- In the early 1940→ reports with cervical intervertebral disc herniation with radiculopathy
- The eight cervical nerve roots exit via intervertebral foramina
- The foramina are largest at C2-C3 and decrease in size until C6-C7.
- The nerve root occupies 25% to 33% of the volume of the foramen
- The C1 root exits between the occiput and the atlas (C1)
- All lower roots exit above their corresponding cervical vertebrae (the C6 root at the C5-C6 interspace), except C8, which exits between C7 and T1
- Disc herniations usually affects the nerve root numbered most caudally for the given disc level
PATHOGENESIS-CERVICAL SPINE

• Most acute disc herniations occur posterolaterally and in patients around the forth decade of life, when the nucleus is still gelatinous.

• The uncovertebral prominences play a role in the location of ruptured dics material

• Most common C6-C7 & C5-C6

• C7-T1 & C3-C4 disc herniations are infrequent (<15 %)

• C2-C3 is rare

• C2-C3 region have symptoms that include suboccipital pain, loss of hand dexterity, and paresthesias over the face and unilateral arm

• Unlike lumber herniated discs, cervical herniated discs may cause myelopathy in addition to radicular pain because of spinal cord in the cervical region.
CLINICAL HISTORY CERVICAL SPINE

- Arm pain (radiculopathy) → the major complaint.
- Pain starting in the neck area and then radiating down to shoulder, arm, forearm and usually into the hand.
- The onset of the radicular pain is often gradual, although it can be sudden and occur in association with a tearing or snapping sensation.
- The pain is usually severe enough to awaken the patient at night.
- Additionally, associated headaches as well as muscle spasm, which can radiate from the cervical spine to below the scapulae.
- The pain may also radiate to the chest and mimic angina (pseudoangina) or to the breast.
- Symptoms such as back pain, leg pain, leg weakness, gait disturbance, or incontinence suggest compression of the spinal cord (Myelopathy).
# Cervical Disc Syndrome

## Signs & Symptoms

<table>
<thead>
<tr>
<th>Root Affected</th>
<th>Muscles Affected</th>
<th>Area of pain &amp; Sensory Loss</th>
<th>Reflex diminished</th>
</tr>
</thead>
<tbody>
<tr>
<td>C5</td>
<td>Deltoid, Biceps</td>
<td>Shoulder, anterior arm, radial forearm</td>
<td>Biceps</td>
</tr>
<tr>
<td>C6</td>
<td>Biceps</td>
<td>Thumb</td>
<td>Biceps</td>
</tr>
<tr>
<td>C7</td>
<td>Triceps, wrist extensors, and pectoral muscles</td>
<td>Thumb, index and middle fingers</td>
<td>Triceps</td>
</tr>
<tr>
<td>C8</td>
<td>Intrinsic hand muscles</td>
<td>Index, fourth, and fifth fingers</td>
<td>Triceps</td>
</tr>
</tbody>
</table>
Physical Examination Cervical Spine

- Observe for any **gait disturbance**
- Observe the neck, thorax, and upper extremities for symmetry, deformity or any unusual characteristics
- **Palpation** of the spine may help localize the point of tenderness
- **Neck compression test (Sperlings Maneuver)** for radiculopathy that is performed by extending and rotating the neck towards the affected side and then applying downward pressure on the head. The test is positive if limb pain and paresthesias are reproduced
- ROM, loss of sensations, paresthesias and muscle weakness of the arms Hyporeflexia in the area corresponding to the affected nerve root needs to be checked
- Hyperreflexia
- Babinski reflex
- **Lhermittes sign (Barber Chair Phenomenon)** A jolt down the spine may result upon neck flexion
- ROM, loss of sensations, paresthesias and muscle weakness of BOTH legs
Cervical Disc Syndrome
Differential Diagnoses

- Supraspinatus tendinitis
- Acromioclavicular joint arthritis
- Rotator cuff tears → Red Flag
- Tumors that compress the nerves or spinal cord → Red Flag
- Epi/Subdural abscess → Red Flag
- Entrapment neuropathy of the median, ulnar nerves
- Brachial plexus neuritis
- Spinal fracture → Red Flag
- Spondylosis
- Rheumatoid arthritis
- Neck strain and whiplash injuries

➢ Spinal cord lesions such as syringomyelia
➢ Motor neuron disease is identified by EMG.
➢ Multiple sclerosis
➢ Lesions of the parietal lobe corresponding to the arm
Cervical Disc Syndrome
Diagnostic Tests

- MRI → preferred diagnostic test for CDS, can identify spinal cord and/or nerve root compression
- X-ray → views of bony structures

70% of asymptomatic women and 95% of asymptomatic men between the ages of 60 and 65 years have evidence of degenerative disc disease on plain roentgenograms

- Needle EMG → to confirm radiculopathy & identify the affected nerve
- Myelography → detects spinal stenosis
- CT → when MRI is contraindicated
- Lab tests → only to rule out infection & other etiologies
Severe neurological deficits or myelopathy

Muscles supplied by C5 & C8 rapidly atrophy → irreversible shoulder-arm-hand disorders

Patients with persistent symptoms, those with only limited improvement after six weeks of conservative therapy, or those who get worse
Πρόσθια προσπέλαση
Δισκεκτομή
Αντικατάσταση Δίσκου
Cervical Disc Syndrome Conservative Treatment

Consider conservative management in the following patients:

★ C6 or C7 involvement. These nerves supply larger muscles and can tolerate more compressive pressure before irreversible damage occurs.

★ Mild to moderate radiculopathy in the absence of myelopathy

★ Non-surgical candidates

Approach:

★ 2-3 days of rest

★ F/U visit

★ Start activity using soft neck collar to limit mobilization of the cervical spine

★ F/U visit after 2 weeks make sure the patient’s condition still calls for conservative management

★ Working patients may return at the earlier possible time on light duty.
Medications:

- **Analgesics**: acetaminophen or aspirin as a first line of therapy;
- **NSAIDs / corticosteroids**
- **Muscle relaxers**
- **Narcotics** (tramadol, hydrocodone, oxycodone)

- Cervical epidural **steroid injections** may be considered for radiculopathy alone. 60% achieve sustained pain relief
- **Physical therapy**
- **Cervical traction**: the evidence is of inadequate quality to make an objective determination
Cervical Disc Syndrome Prognosis

Dependent on:

- the initial level of involvement
- duration of symptoms
- presence of myelopathy

- Complete recovery is rare with myelopathy

*Set realistic expectations for patients*
Acute Cervical Injuries
Mountain Biking

- *Dodwell et. al. (Am J Sports Med, 2010)*
- 74% of spine injuries cervical
- 82% lower cervical spine (C3-7)
- 40% w/ spinal cord injuries
- 76% over the bars (“endo”)
- 91% direct impact
Acute Spine Injuries
Skiing

*Hubbard et. al. (Neurosurg Focus, 2011)*

- Spinal cord injuries 0.01 - 0.075 for every 1,000 hours
- Head/Spine 3-15% Skiing
- Cervical spine more prevalent – 41%
- Lumbar spine – 35%
- Spinal cord injury rate 1.07%
Water Sports

- *Chang et. al. Trauma 2006*
- Often related to seafloor impact
- Most common level C6
- 75% with neurologic deficit
- 26/100 had neuro deficient w/o fracture, dislocation, other
- Shore break affects injury rates
Rock-climbing/Ice Climbing

- **Thoracolumbar** extension w/ fall (harness)
- Falling rock
- 12.5% suspected spine injury – Boulder area
- *Hohlrieder et. al. Wilderness and Environ Med 2007*
- 8 spine fractures
- 6 T/L (4 Type A, 1 Type C)
- 2 Cervical
Snowboarding

*Hubbard et. al. (Neurosurg Focus, 2011)*

- 2-4% of injuries head/spine related
- Up to 80% related to jumping
- **Thoracolumbar** more common
- 0.93% w/ SCI
BASE jumping, Skydiving, Paragliding and other airborne sports

- *Hasler et. al. Injury 2012*

- Majority **thoracolumbar** spine
- L1 most common
- Of admitted 49% w/ spine
- 92% Type A
- 35% L1
- SCI rates not calculated
- 23 w/ neurologic deficits
Acute Spinopelvic Dissociation

- Rare Injuries
- Hasler et. al.
- 4.4% of admitted paragliders
- 21-fold higher than non-airborne injured
- 50/50 flexion/extension
Chronic (Repetitive) Injuries

- Spondylolysis/listhesis
  - Repetitive hyperextension

- Disc herniations/degeneration
  - Repetitive loading
Low back pain in young athletes

- 10% to 15% of young athletes, but the prevalence may be **higher in certain sports** → college football players (27%), artistic gymnasts (50%), and rhythmic gymnasts (86%)
- Frequently results from a structural injury that requires a **high degree of suspicion** to diagnose and treat appropriately
- Sports involving **repetitive extension, flexion, and rotation**, such as rowing, gymnastics, dance, and soccer.
- Both acute and overuse injuries occur, although **overuse injuries** are more common
Low back pain in young athletes

- high incidence of structural injuries to the **posterior elements** of the spine
- Pars interarticularis injuries (spondylolysis) are more common, occurring in up to 47% of young athletes
- **Disc pathology** is much less common → 11% of children have disc-related pathology compared with 48% of adults
- Simple **muscle strains** are much less likely in this population and should be a diagnosis of exclusion only
Risk Factors

• During periods of rapid growth, soft tissues such as muscles and ligaments are unable to keep pace with the rate of bone growth, resulting in muscle imbalances and a decrease in flexibility.

• This can place young athletes at greater risk for injury when excess sport forces are applied additionally.
Risk Factors

• Growth cartilage and secondary ossification centers, present only in the skeletally immature, are the weakest link of force transfer and vulnerable to injury.

• Ossification of the posterior column of the spine progresses from anterior to posterior and may be congenitally incomplete in the area of the superior portion of the pars interarticularis of the lower lumbar vertebrae, particularly L5, predisposing to spondylolytic stress fracture.

• Growth cartilage of the facet joint and spinous process apophysis of the posterior arch is subjected to traction from the dorsolumbar fascia and lordotic impingement.
Risk Factors

• Training volume and intensity can also cause injury, more often when young athletes participate in a sport for longer periods of time such as during tournaments and specialized sports camps.

• It is difficult to determine the appropriate amount of training for young athletes because not all athletes will tolerate the same volume of training.

• Poor technique is a risk factor for injury
Risk Factors

Additional risk factors for low back injury include

- abdominal muscle weakness
- hip flexor, hamstring, and thoracolumbar fascia tightness
- increased femoral anteversion
- genu recurvatum
- increased thoracic kyphosis

- All these factors increase lumbar lordosis →

additional stress on the posterior elements of the spine
Red Flags

• Red flag” symptoms such as fever, malaise, weight loss, neurologic abnormalities, night pain, and morning stiffness may suggest more sinister causes of low back pain, such as infection, tumor, or arthritis

• Family history of antigen (HLA)-B27 associated conditions, such as psoriatic or ankylosing spondylitis, or inflammatory bowel disease, may help point to other conditions
Posterior Element Overuse Syndrome

- Resulting from repeated extension and rotation of the spine.
- Conditions involving muscle-tendon units, ligaments, facet joints, and joint capsules.
- It is also called hyperlordotic or mechanical or muscular low back pain.
- After spondylolysis, it is the most common cause of low back pain in adolescents.
- Pain is associated with extension of the spine and sometimes with rotation.
- There may be paraspinal muscle tenderness, as well as focal tenderness over the lower lumbar spine, adjacent to the midline.
- Imaging is typically negative, ruling out spondylolysis.
Posterior Element Overuse Syndrome

- Management includes ice and non steroidal anti-inflammatory drugs (NSAIDs) to relieve pain and inflammation.
- Pain-free activities are permitted and extension of the spine is avoided.
- An exercise program emphasizing abdominal strengthening, antilordotic exercises, and hamstring and thoracolumbar stretches.
- An antilordotic brace may be helpful in the short term.
The sacroiliac (SI) joint disperses the forces between the trunk and the lower extremities. Pathology of the lumbar spine can alter the mechanics, resulting in stress to the SI joints. SI joint inflammation can occur from seronegative spondyloarthropathies, such as Crohn disease, psoriatic arthritis, and juvenile ankylosing spondylitis. Another cause of SI joint pain is a stress fracture of the sacrum.
Sacroiliac Joint

- Athletes with SI joint pain present with extension pain that is insidious in onset.
- On examination, pain is localized to the lumbar or buttock region with extension of the spine.
- Palpation elicits tenderness over the affected SI joint.
- They may have poor pelvic stability on Trendelenburg testing, as well as a positive FABER test.
Sacroiliac Joint

- Plain radiographs should be obtained if symptoms have been present for more than 3 weeks.
- Bone scan or MRI can more precisely demonstrate a stress fracture of the sacrum.
- If infection or a spondyloarthropathy is suspected, blood work, including ESR, CRP, rheumatoid factor, antinuclear antibody, and HLA-B27, should be obtained.
Sacroiliac Joint

- Ice and NSAIDs help alleviate pain and inflammation.
- Activity should be restricted to those that do not provoke pain. If a sacral stress fracture is present, protected weight bearing is necessary until pain resolves.
- Bracing can help stabilize the joint.
- Physical therapy involves manipulation of the SI joint, pelvic stabilization exercises, hip and abdominal strengthening
Atypical (Lumbar) Scheuermann

• Lumbar Scheuermann can present in athletes who participate in sports involving rapid flexion and extension, such as diving, rowing, and gymnastics.
• This results in end-plate fractures of the lumbar vertebrae, Schmorl nodes, and vertebral apophyseal avulsions visible on plain x-rays of the lumbar spine.
• Young athletes present with low back pain, a flat back (decreased thoracic kyphosis and lumbar lordosis) and tight thoracolumbar fascia.
• Management includes a physiotherapy program of stretching the thoracolumbar fascia and core stabilization exercises.
• Bracing in 15° of lordosis can help athletes return to their sport.
Vertebral Body Apophyseal Avulsion Fracture

- Activities that involve repetitive flexion and extension of the spine can result in injury to the ring apophysis.
- Fractures of the cartilaginous ring apophysis may occur with displacement posteriorly into the spinal canal, along with the intervertebral disc.
- Avulsion fractures occur most often in sports such as gymnastics, wrestling, volleyball, and weight lifting.
- Athletes present with lumbar pain on flexion of the spine.
- Usually no associated neurologic symptoms.
- On examination, both spine flexion and extension are limited due to Paraspinal muscle spasm.
Vertebral Body Apophyseal Avulsion Fracture

- Lateral radiographs of the lumbar spine may show an ossified fragment in the canal.

- **Computed tomography** can better identify the fractured apophysis and displaced piece of bone, which may be missed on MRI.

- Management consists of rest, heat, NSAIDs, and possibly massage for pain relief.

- If there are significant neurologic findings resulting from neural compression, the fragment may need to be surgically excised.
Disc Herniation

• Acute herniation of the nucleus pulposus is uncommon in young athletes.
• Adolescents present flexion-related back pain, associated with back muscle spasm, hamstring tightness, and possibly buttock pain and positive straight leg raise.
• Radicular symptoms in this age group are often not present.
• A potential complication of disc herniation is cauda equina syndrome
  • Cauda equina syndrome is caused by the compression of the nerves in the lower portion of the spinal canal and can result in the loss of bowel and bladder function, as well as paralysis of the legs.
  • It is considered a surgical emergency because the deficits may be permanent if left untreated.
• Morning → increased force on the disc

• In the lumbar region → defect just lateral to the posterior midline (*posterior longitudinal ligament is weakest*)

• Cervical disc Prolapse is usually in the postero-lateral direction, because the strong posterior longitudinal ligament prevents direct posterior herniation
Cycle disk loading

During day
Disk space reduction

During night
Disk space increase
Different phases of disc injury

When the inner nucleus pulposis is exposed to the environment of the body it can be resorbed.

Therefore disc herniations in the absence of neurologic deficit can be treated conservatively.
PATHOGENESIS-LUMBAR SPINE

- 98% of lesions → L4-L5 & L5-S1
- Pathology can occur at L2-L3 and L3-L4 but is relatively uncommon
- L5-S1 usually compromise S1 nerve root
- L4-L5 most often compress L5 nerve root
- L3-L4 more frequently involves the L4 nerve root
PATHOGENESIS-LUMBAR SPINE

- Disc resorption = the natural healing process
- Resolution of compressive effects
- Resorption associated with a marked increase in infiltrating macrophages and the production of matrix metalloproteinases (MMPs) 3 and 7
- Nerlich and associates → phagocytic cells = transformed local cells rather than invaded macrophages identified in degenerated intervertebral discs
- Degenerative discs contain the cells that add to their continued dissolution
PHYSICAL EXAMINATION LUMBAR SPINE

- Decrease in range of motion
- Patients may tilt to one side and bend forward
- The side of the disc herniation corresponds to the location of the scoliotic tilt
- Antalgic gait in with the involved leg flexed
- Neurologic examination → evaluate of reflex testing, muscle power, and sensation
For both cervical and lumbosacral disc herniations, the nerve root involved usually corresponds to the lower of the adjacent two.
PHYSICAL EXAMINATION
LUMBAR SPINE

- Nerve root sensitivity can be elicited by any method that creates tension.
- The straight leg-raising (SLR) test is the one most commonly used.
- This test is performed with the patient supine.
FLIP TEST

A

B
NAFFZIGER TEST

VALSALVA MANEUvre
DIFFERENTIAL DIAGNOSIS & EVALUATION
LUMBAR SPINE

- The initial diagnosis → history and physical examination
- Plain radiographs → rule out other causes of pain such as infection or tumor.
- MRI, CT, and myelography are confirmatory by nature and can be misleading when used as screening tests
- **Spinal Stenosis** → older / pseudoclaudication=neurogenic claudication
- **Facet Syndrome** → Degeneration of articular structures / may be associated with radiation of pain
- External **compression of the sciatic nerve** (wallet in a back pants pocket), and muscular compression of the nerve (piriformis syndrome)
- Tumors / infections
Disc Herniation

- Lumbar radiographs should be obtained to rule out osseous injury.
- Magnetic resonance imaging studies can indicate the extent of the herniation and show nerve root impingement.
- Almost 90% of patients improve with conservative management.
- A temporary lordotic brace may allow for early resumption of daily activities.
- Physical therapy should be initiated to help relieve pain and to establish an extension-based stabilization program.
- Pain is managed with NSAIDs and, occasionally, epidural corticosteroids.
- Surgery is indicated if cauda equina is present, neurologic deficit is progressive, or if pain is refractory to conservative management.
- Athletes with disc herniation may return to activity once they have attained full pain-free range of motion, full strength, and have progressed through sport-specific activities in a controlled setting.
Lumbar Spine TREATMENT

- Treatment for most patients with a herniated disc is nonoperative as 80% of them will respond.
- The efficacy of nonoperative treatment, however, depends on a healthy relationship between a capable physician and a well-informed patient.
- Controlled Physical Activity / short bed rest / sitting is prohibited.
- NSAIDs/Corticosteroids (*initial dose of corticosteroid is 20 mg/day of prednisone, gradually tapered over 6 weeks max*).
- Analgesics.
- Muscle Relaxants (*diazepam is depressant*).
- Injection Therapy.
- Physiotherapy.
EPIDURAL STEROID INJECTION

Epidural steroid injection
The steroid medication is injected into the epidural space.

Epidural space
Dura
Subdural space containing spinal fluid
Spinal cord
Cross-section of vertebrae

©MMG 2002
Surgical treatment

• Cauda equina syndrome

  poor outcome $\rightarrow$ perineal sensory loss and urinary dysfunction / delayed intervention > 30 hours

  Good outcome $\rightarrow$ early intervention < 14 hours

• Progressive neurological deficit

• Failure of conservative treatment
What surgical treatment?

- Whatever achieves adequate neural tissue decompression
KNEE CHEST POSITION
TOTAL LAMINECTOMY
HEMI OR PARTIAL LAMINECTOMY
LAMINOTOMY & DISCECTOMY
MICRODISCECTOMY
MICROENDOSCOPIC DISCECTOMY

Select the appropriate Endoscopic Discectomy (SED).

YESS scope used to inspect disc surface. Peri-annular fat is removed and small capillaries are cauterized. Small nerves in the annular fat can be removed along with peri-annular tissue.

TRACING NERVE & EXITING NERVE are OUTSIDE OF and PROTECTED BY the CANNULA.
Intradiscal Electrothermal Annuloplasty

Beating the Back Ache
A new procedure could revolutionize disc surgery

Damage: The ligaments that encase a disc may tear and loosen with age. Veins can then invade the disc, accompanied by nerves that get pinched by the weight of the spine.

Treatment: Doctors run a flexible catheter into the disc and heat it to 194 degrees. Heat destroys painful nerve endings and shrinks loose ligaments to reseal the disc.
PERCUTANEOUS SUCTION DISCECTOMY
PERCUTANEOUS LASER DISCECTOMY

1. A thin needle called a cannula is inserted through the back.
2. The laser catheter is inserted.
3. Pulses of laser light shrink the disc wall.

HERNIATED DISC BEFORE PROCEDURE
Disc hernia pinches spinal cord or nerve root, causing pain.

HERNIATED DISC REDUCED AFTER PROCEDURE
Because no muscles or bone are cut during the procedure, recovery is fast.

Pulses of laser light shrink the disc wall.
DiscoGel
FLEXIBLE GEL PROSTHESIS OF THE NUCLEUS PULPOSUS
FOR PERCUTANEOUS IMPLANTATION IN THE TREATMENT OF HERNIA IN THE CERVICAL, THORACIC AND LUMBAR SPINE UNDER LOCAL ANESTHESIA.
Dynamic stabilization
Lumbar Artificial Disc Replacement
Spondylo-lysis/listhesis

- Age related
- < 5 years → 0%
- 5½-6½ ετών → 5%, boys/girls = 2/1, asymptomatic
- 5-15 years → high risk (sport involvement)
- General population 5% < Diving 66%, Weight lifting 36%, Wrestling 33%, Gymnastics 32%, Track 22%, Soccer 22%
- 25% - 39% of low back pain in Athletes
Spondylolysis
Spondylolysis

- Sports involving repetitive extension and rotation of the lumbar spine, such as dance, figure skating, and gymnastics, increase the risk of injury to the posterior elements of the spine.
- Spondylolysis refers to a defect in the pars interarticularis, a stress fracture caused by repetitive extension and torsion of the spine.
- One study indicated that 47% of young athletes with back pain had spondylolysis. This occurs most often at L5.
Spondylolysis

- Athletes with spondylolysis typically present with insidious onset of extension-related low back pain.
- Frequently, there is an associated reduction in hamstring flexibility.
- The athlete may complain of pain with impact, such as during running and jumping.
- Occasionally, radiating pain, numbness, or weakness may be present. These symptoms may make the diagnosis more difficult, as these symptoms also present with disc herniation.
Spondylolysis

- On examination, there may be hyperlordosis, ipsilateral paraspinal muscle spasm, and hamstring tightness.
- Pain is elicited with extension of the spine.
- The single-legged hyperextension test localizes the spondylolysis when standing on the ipsilateral leg.
- There may be focal tenderness to palpation.
Spondylolysis - Imaging

• Low back pain in the young athlete that has been present for more than 3 weeks should be investigated.

• **Plain radiographs** → **anteroposterior view** may identify anatomic variants or developmental defects, **lateral view** may demonstrate spondylolisthesis or a lytic lesion, **Oblique views** may demonstrate a stress reaction of the pars interarticularis, the pathognomonic “neck of the Scotty dog” lesion.

• **Computed tomography (CT)** can be used to confirm the presence of a pars interarticularis stress fracture and to monitor the process of healing.

• **Magnetic resonance imaging (MRI)** would be preferable because of the lack of ionizing radiation. However, MRI is not as sensitive for detecting spondylolysis as is a **SPECT bone scan**
Spondylolysis - Treatment

- Management of spondylolysis includes **activity modification**. Any activities that cause pain should be avoided, particularly extension activities.
- An **exercise program** including strengthening of the abdominal muscles, hip flexor and hamstring stretches, and antilordotic exercises for the lumbar spine should be initiated, either at home or under the supervision of a physiotherapist.
- **Bracing** is somewhat controversial. Some authors recommend early use of custom thoracolumbar orthoses to limit extension and rotation of the spine. Others simply restrict activities without bracing, in conjunction with physiotherapy.
- One study in young soccer players illustrated that the best results were obtained with a period of **rest from sport** for 3 months, regardless of whether bracing was used.
Extension-related low back pain

Radiographs
SPECT bone scan

- Rest, physiotherapy

+ Rest, brace, physiotherapy
  +/-CT scan

Improving
  Return to sport

Not improving
  CT scan
Spondylolysis - Treatment

- Once the athlete becomes pain-free, activity can be gradually increased. If bracing is used, bracing continues until the athlete has resumed full activities without pain.
- A patient who has resumed full pain-free activities out of the brace is considered clinically healed.
- Patients with spondylolisthesis should be followed every 4 to 6 months with standing lateral films until skeletal maturity to assess for progression of slip.
- Athletes are at low risk for worsening of spondylolisthesis. However, if the slip > 50%, or if there are neurologic symptoms or persistent pain, surgical stabilization is indicated.
Spondylolisthesis

Meyerding

Boxall

\[
\frac{X}{X+Y} = \text{% slip (Boxall)}
\]
Spondylolisthesis Classification

- Isthmic (Spondylolysis)
  - Dysplastic
  - Traumatic
  - Pathologic
  - Congenital
- Degenerative
Epidemiology

• 5.8% of men

• 9.1% of women

• 3 times greater in African American women

• Most are asymptomatic
Progression?

• Patients will have 80 to 90% of their total slip at presentation

• 44% will have a progression in their slip

• Risk Factors:
  Greater than 20 to 30% slip at diagnosis
  Adolescence
  Mobility of motion segment
  Sagitally aligned facets
Spondylolisthesis

- Slippage of the hole spine
- Usually L5-S1
- Bilateral spondylolysis
- 4 grades (Meyerding classification)
- < 50 % → low intensity athletic activity is possible
- > 50 % → surgical stabilization
- Slight progression < 10% → 75 % of adolescent athletes. No symptom related
- Minor progression after skeletal maturity due to disk degeneration
- High risk → females with dysplastic olisthesis
Radiologic Analysis: Anterior Displacement

- Greater than 50% slip is associated with risk for progressive deformity
Radiographic Analysis: Sagittal Rotation

- Increased sagittal rotation is a sign of instability and risk of progression.
Οσφυικός δείκτης

\[
\frac{18}{32} \times 100 = 56.4\%
\]
Radiographic Instability
Spondylolisthesis
Treatment Options

- Surgery
- Non-op management
- Observation
Conservative care

- A. The surgeon requesting the lumbar fusion should have **personally evaluated the patient on at least two occasions** prior to requesting the fusion and

- B. The patient should have **at least three months of conservative therapy for low back pain**, which predominantly emphasizes physical reconditioning.
Operative treatment

10-15% will fail conservative therapy

Absolute indications

- Progressive weakness

- Cauda Equina-type symptoms

Strong Indications

- Radiculopathy or neurogenic claudication

- Radiographically documented instability
Harms → true reduction
Hook-pedicle screw fixation (Tokuhashi technique) (1996)

1. Exposure of pars defect
2. Removal of fibrous tissue
3. Placement of pedicle screws
4. Onlay autograft harvested from posterior superior iliac spine
5. Autograft placement onto the defect
6. Placement of infralaminar hooks
7. Rod fixation and compression
Return to sports?

- Possible when the athlete is symptom free regardless of imaging.
- High level contact sport athletes → 5 times more likely to have a poor outcome comparing with less demanding sports.
- Poor data considering full return to sports after spinal fusion.
- Possible full activity after solid fusion.
Other Causes of Low Back Pain

- **Infection** (discitis or osteomyelitis)
- **Inflammation** (seronegative spondyloarthropathies)
- **Tumors** *(e.g., osteoid osteoma, osteoblastoma, bone cysts, Ewing sarcoma, osteogenic sarcoma)*
- **Visceral pathology** such as pyelonephritis
Prevention

• Prior to the start of a sport season, a pre-participation evaluation may identify certain risk factors, such as previous injuries that have not been fully rehabilitated or muscle weaknesses or inflexibility.

• Athletes should start general strength and fitness several weeks before the season start.