Current Thinking About Spine Health and Disorders

Paul Young, MD
Spine Health and Disorders: Current Thinking

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Paul H. Young, MD
St. Anthony’s Neurosurgery
St. Louis

Spinal Column
- Segmentation

Cervical
- neck
- Cervical
  - Mobility

Thoracic

- chest

- Thoracic
  - Protection
Lumbar

lower back

\[\text{Diagram of lumbar region with labels for thoracic protection and lumbar weight bearing.}\]

SACRUM

\[\text{Diagram of sacrum region with labels for various anatomical structures.}\]
Vertebra

bony part of spine

Anatomy
Vertebra
- bony part of spine

Anatomy

Disc
- cushion between vertebrae
Annulus Fibrosis

- ligamentous periphery of disc

Nucleus Pulposus

- gelatinous center of disc

Disc Components

- Annulus Fibrosis
- Nucleus Pulposus
Disc Components

- Annulus Fibrosis
- Nucleus Pulposus

Disc Composition

- Collagen
  - Types 1 and 2
- Proteoglycan
- Water
Disc Composition

Chemical Constituent
- Water
- Proteoglycan
- Total collagen (types 1 and 2)
- Collagen (type I)
- Collagen (type II)

Disc Physiology

Disc vs. Axial Compression
Disc Composition

- Collagen
- Types 1 and 2
- Proteoglycan
- Water

Disc Physiology

Disc vs. Axial Compression

Disc Loading

Disc Strength

End plate Compression Fracture

- 17 y/o pole-vaulter

Facet Joint

- Motion regulator of spine
- Zygapophyseal Joint
- Superior- directed dorsal
- Inferior- directed ventral
End plate Compression Fracture

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Facet Joint

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  - Superior- directed dorsal
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Muscle and Ligament Attachment Processes

- Ligament: attaches bone to bone
- Tendon: attaches muscle to bone
Muscle and Ligament Attachment Processes

**Ligament**
- attaches bone to bone

**Tendon**
- attaches muscle to bone

**Mechanical Factors in Spinal Function**
- Spinal Curves and Alignment
46 y/o Ophthalmologist

- Headaches
- Neck and Shoulder Stiffness
- Forearm and Hand Numbness and Tingling
- Positive EMG/NCV for CTS and CubTS
- Negative Tinel's
- Worse at Night
- Normal Neuro Exam

32 y/o Mail Carrier

- Bilateral leg pain
- Hip, medial and lateral thigh, groin and shin
- Burning type Pain
- Failed ESI's and PT
- Normal Neuro exam
- Advised to have cage inserted or fusion
52 y/o Dentist

- Chronic Neck and Back Pain
- Marathon Runner
- Occasional Numbness Hands and Feet
- Plantar Fasciitis
- Norma Neuro Exam

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- Hip, medial and lateral thigh, groin and shin
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52 y/o Dentist
Scoliosis

Spinal Canal

space for spinal cord and nerves

- vertebra
- dura
- epidural space
Intervertebral Foramen

Nerve Roots exit the Spinal Canal

Dermatomes

Cauda Equina

nerve roots in lumbar spinal canal
Common Spinal Syndromes

- Soft Tissue Injuries
- Congenital Abnormalities
- Degenerative Disease
- Disc Disease

Strain

- Muscle pull
Sacro-iliac Joint Pain

Subluxation
slippage of vertebrae

Spondylolysis
congenital abnormality in bone structure
Congenital Abnormalities

Spondylolysis

congenital abnormality in bone structure

Spondylolysis

15 y/o gymnast

16 y/o basketball player

16 y/o diver

Congenital Abnormalities

Sacro-iliac Joint Pain

Subluxation

• slippage of vertebrae

Congenital Abnormalities

Spondylolysis

• congenital abnormality in bone structure

Osteoporosis
Spondylolysis
16 y/o diver
16 y/o basketball player
15 y/o gymnast

Osteoporosis

Normal  Osteoporosis
Spondylolysis
16 y/o diver
16 y/o basketball player
15 y/o gymnast

Osteoporosis

Stress "Fractures"
11 y/o gymnast

Spondylolisthesis
• chronic slippage of vertebrae

Degenerative Disease
Spondylosis
• degenerative joint changes
Spondylolisthesis

Degenerative Disease

Spondylosis
degenerative joint changes
Osteophyte or Spur

calcification in/around joint
Degenerative Disc Disease

- Motion Segment Disease:
  - Vertebral Bodies
  - Intervertebral Disc
  - Facet Joints
  - Foramen and Nerve Roots
  - Supporting Ligaments

Degenerative Spinal Disease Components

- Degenerative Disc
- Disc Herniation
- Degenerative Facet
- Stenosis
- Spondylolisthesis

Pathophysiology of Degenerative Disc Disease
Degenerative Disc Disease

Pathophysiology of Degenerative Disc Disease

Water Content of Disc with Aging

Composition of Disc with Aging
Pathophysiology of Degenerative Disc Disease

**Risk Factors**
- Hereditary predisposition
- Congenital defect
- Post-traumatic insult
- Inflammatory disorder
- Metabolic disease
- Drug exposure
- Age over 25
- Idiopathic
- Physical construct inefficient
- Repetitive stress
- Weight
- Strenuous activity
- Vascular (small vessel) disease
- Cigarette exposure
- Diabetes

16 y/o volleyball player with back pain and sciatica
### Degenerative Disc Disease

#### Risk Factors
- Hereditary predisposition
- Congenital defect
- Post-traumatic insult
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#### Example Case
16 y/o volleyball player with back pain and sciatica.

### Progressive DDD

### Degenerative Facet Disease

### Spinal Stenosis
Degenerative Stenosis - Cervical Spine

Critical A-P Diameter

Sports Evaluation

Congenital Diameter

Intervertebral Disc “Herniation”

“generic term”
- disc movement out of normal position
Synonyms for “Herniated Disc”

- “Disc”
- Bad Disc
- Broken Disc
- Bulging Disc
- Busted Disc
- Cracked Disc
- Dried Up Disc
- Extruded Disc
- Leaking Disc

- Migrated Disc
- Popped Disc
- Prolapsed Disc
- Protruding Disc
- Ruptured Disc
- Sequestrated Disc
- Softened Disc
- Slipped Disc
- Smashed Disc

Clinical Evaluation of LBP and Nerve Root Compression
Clinical Evaluation of LBP and Nerve Root Compression Symptomatology in HNP

- Dermatome
- Myotome

Neurological Findings in HNP

- 19 y/o with LBP and Sciatica

Disc Abnormalities
- Bulging
- Herniated
- Ruptured
- Sequestered or Fragmented
TABLE 5. Differential diagnosis of sciatica

A. Intraspinal causes
1. Proximal to disc—conus and cauda equina lesions (e.g., neurofibroma, ependymoma)
2. Disc level
   a. Herniated nucleus pulposus
   b. Stenosis (canal or recess)
   c. Infection—osteomyelitis or discitis (with nerve root pressure)
   d. Inflammation—arachnoiditis
   e. Neoplasm—benign or malignant with nerve root pressure

B. Extraspinal causes
1. Pelvis
   a. Cardiovascular conditions (e.g., peripheral vascular disease)
   b. Gynecological conditions
   c. Orthopedic conditions (e.g., osteoarthritis of hip)
   d. Sacroiliac joint disease
   e. Neoplasms (invading or compression lumbo-sacral plexus)
2. Peripheral nerve lesions
   a. Neuropathy (diabetic, tumor, alcohol)
   b. Local sciatic nerve conditions (trauma, tumor)
   c. Inflammation (herpes zoster)
Diagnostic Testing

Radiographic Evaluation
- Plain films
  - AP
  - Obliques
  - Lateral
    - Sitting
    - Standing
    - Neutral
    - Flexion
    - Extension

Schmorl’s Node
CT SCAN

Computed Tomography Scan
Computerized x-ray done in sections

Myelography

- X-ray with contrast injection into spinal canal
- Dynamic Study
Myelography - Limits

- Subarachnoid Space

MRI

Magnetic Resonance Imaging
Pictorial display of nuclear mass

MRI in Disc Herniation
Bone Scan/ SPECT

Epidural Venogram

Discogram

- x-ray with contrast injection into disc(s)
MRI in Disc Herniation

Bone Scan/ SPECT

Epidural Venogram

Discogram
• x-ray with contrast injection

Discography

Electromyography [EMG]
• muscle response to stimulation test

Comparison of Terminal Latency, Amplitude, and Motor Conduction Velocity for Several Common Nerves

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Terminal Latency</th>
<th>Amplitude</th>
<th>Motor Conduction Velocity</th>
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<tbody>
<tr>
<td>Ulnar</td>
<td>2.7 (1.5-4.1)</td>
<td>10.9 (6.0)</td>
<td>59 (49-66)</td>
</tr>
<tr>
<td></td>
<td>2.7 (1.8-3.6)</td>
<td>10.5 (4.3-15)</td>
<td>58 (49-66)</td>
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<tr>
<td>Median</td>
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<td>9.6 (6.5-12.2)</td>
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Nerve Conduction Velocity [NCV]

Thermogram
• pictorial display of surface temperature differences

Treatment Options for Degenerative Disc Disease
- Conservative
- Rest
- Medication
- Therapy
- Passive
- Active (exercise)
- Risk Factor Reduction
- Semi-conservative
- Electrical Injection
- Surgical
- Discectomy
- Decompression
- Fusion
- Disc Replacement
### Thermogram

- Pictorial display of surface temperature differences

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Conservative Modalities

Rest: bedrest, brace
Medication: analgesic, anti-inflammatory, muscle relaxant
Therapy: heat and/or cold, massage, manipulation, stretch, relaxation
Exercise: flexion, extension, isokinetic, low impact, pool
Risk Factor Reduction: weight loss, job modification, cigarette consumption/exposure
Electrical: ultrasound, diathermy, muscle stimulation, acupuncture, TENS, biofeedback
Injection: epidural, trigger point, facet, nerve root
Miscellaneous: time

Flexibility- Stretching

Passive Therapy
Current Thinking About Spine Health and Disorders

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**Flexibility - Stretching**

**Passive Therapy**

**Spinal Decompression**

- **Injection Therapy**
  - Trigger Point Injection
  - Epidural Steroid Injection
  - Facet Block/Rhizolysis
  - Selective Nerve Root Block

**Epidural Steroid Injection**
- placement of drugs within spinal canal

**Facet Block**
- placement of drugs within facet joint(s)

**Facet Rhizolysis**
- electrolysis of facet joint nerves

**Surgical Options:** Established
- **Discectomy**
- **Open**
- **Micro**
- **Endoscopic**
- **Decompression**
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Surgical Options: Established

- Discectomy
  - Open
  - Micro
  - Endoscopic
  - Decompression

Laminectomy

- removal of lamina

Discectomy

- removal of disc
Laminectomy
- removal of lamina

Discectomy
- removal of disc

Microdiscectomy

Chemo Nucleolysis
- enzymatic destruction of disc

Percutaneous Discectomy
- suction removal of disc through needle
Laser Discectomy
vaporization of disc

IDET (IntraDiscal ElectroTherapy)

Surgical Options for Degenerative Disc Disease: Unproven (?)
- Fusion
  - Bone
  - BMP
  - Instrumentation
  - Cage
Spinal Fusion

Arthrodesis
stabilization of spine with bone

Spinal Fixation

stabilization of spine with metal

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Current Fusion Approaches
Spinal Fixation

- stabilization of spine with metal

Fusion

- Pedicle Screws
  - Rods
  - Plates

Bone and Bone Growth Promoters

- Autograft
- Allograft
- DBM
  - Demineralized bone matrix
- Bone Growth Stimulators
- BMP
  - Bone Morphogenetic Proteins
Current Fusion Approaches

- **LLIF**
  - Lateral lumbar interbody fusion
  - Approach: Side of the body
  - Does not require entry through spinal column, vertebrae, or ligaments.

- **PLIF**
  - Posterior lumbar interbody fusion
  - Approach: Side of the body
  - Does not require entry through spinal column, vertebrae, or ligaments.

- **ALIF**
  - Anterior lumbar interbody fusion
  - Approach: Front of the body
  - Does not require entry through spinal column, vertebrae, or ligaments.

- **TLIF**
  - Transforaminal lumbar interbody fusion
  - Approach: Side of the body
  - Does not require entry through spinal column, vertebrae, or ligaments.

**Bone and Bone Growth Promoters**

- **Autograft**
- **Allograft**
- **DBM**
- **Demineralized bone matrix**
- **Bone Growth Stimulators**
- **BMP**
- **Bone Morphogenetic Proteins**

**Current Fusion Approaches**

- **PLIF**
- **ALIF**
- **TLIF**

**Minimally Invasive Fixation**

- **XLIF**
TLIF

Minimally Invasive Fixation

XLIF
Minimally Invasive Fixation

Surgical Options: Futuristic

- Disc Replacement
- Nucleus
- Mechanical

Fernstrom-Sweden
- Stainless steel sphere
- 155 prostheses in 103 patients
- 1964-1995
- 95% RTW

Pre-op 1 year 17 years

Schellnack and Buttner-Janz

SB Charite-1984

Composed of:
- 2 metal endplates
- Polyethylene core
- Over 3000 implanted worldwide
- 54% Highly satisfied
- 29% Better than pre-op

The doctor is to be feared more than the disease.

Latin proverb
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Components of the CHARITE Artificial Disc

Figure 3. The CHARITE Artificial Disc was designed to maintain segmental motion in the lumbar spine. It is composed of two CoCrMo endplates and a sliding UHMWPE core.

Figure 4. The CHARITE Artificial Disc employs two concave endplates and a convex sliding core.

Figure 5. The disc surrounding the UHMWPE core allows for visualization on plain radiographs.
ProDisc
- Marnay, France (1989)
- Composed of:
  - 2 Titanium plates covered with plasmophore
  - Articulating polyethylene surfaces
- 70 Patients
  - 78% good and excellent

Acroflex
- Enker and Steffee (1993)
- Composed of:
  - Rubber core vulcanized to titanium endplates

Spring Disc
- Kostuik (1997)
- Composed of:
  - Cobalt-chromium and titanium
  - Fixed with pegs and screws
Cervical Disc Replacement

Prosthetic Disc Nucleus (PDN)
- Ray- 1996
- Composed of:
  - Hydrogel core covered by polyethylene jacket
  - Hydrophilic

When a lot of remedies are suggested for a disease, that means it cannot be cured...

Anton Chekhov
THE END