



Module 1

Course Highlight Day-1

Lumbar SpineBasic Science & Pathology

Lumbar Disc Herniation and Sciatica

Lumbar Canal Stenosis (LCS)
Spondylolisthesis
Degenerative Spine Disease
Serious Spinal Conditions









Dubai, UAE

Dear Participant,

It is our pleasure to welcome you all to the ArabSpine Course Diploma.

The course is being presented by renowned experts in the field of Spine Surgery. It is intended for Neurosurgeons, Orthopedists, Spine Specialists and Spine related physicians wishing to acquire advanced theoretical knowledge and improve their practical skills.

ArabSpine Course Diploma offers an up to date knowledge on diagnosis, treatment options of spine pathologies in addition to wide exposure to different surgical techniques practiced in the laboratory on fresh cadavers along with hands-on training on advanced technology such as spinal navigation and 3D imaging using O-Arm.

After the completion of 4 modules each attendee will be well proficient in the evaluation, diagnosis and management of spinal disorders.

We are certain that you will acquire the best knowledge and training in the spinal treatment through the courses of ArabSpine Course Diploma.

Best wishes

Prof. Jeffrey Wang President

North American Spine Society

(NASS)

Prof. Richard Assaker Chairman

Educational Committee (ASCD)

Prof. Ciaran Bolger Head of Clinical Neuroscience Royal College of Surgeons Ireland

(RCSI)

Prof. Abdul Karim Msaddi Chairman ArabSpine Course Diploma

ArabSpine Course Diploma (ASCD)

MODULE 1



INTRODUCTION:

The ASCD strive to establish Arab education high standards and position itself as a major driving force in Spine Education for the Arab region to act as a reference point and resource for spine specialists wishing to acquire up to date knowledge on the evaluation and management of spinal disorders. It aims to provide excellence in spine education and hands-on training in spinal surgery.

The ArabSpine Course Diploma is already accredited by the North American Spine Society (NASS), Royal College of Surgeons in Ireland (RCSI) and University of Basrah.

The ASCD will offer to the participant an opportunity to learn, interact, discuss with the experts and practice hands-on workshops.

We believe that this initiative will further strengthen the Spine Care in the whole Arab Region and Neighbouring Countries.

The diploma outlines includes:

| ArabSpine Course Diploma | | | | |
|---|--------------------------------|--|--|--|
| MODULES | Surgical Training | | | |
| Module No. 1 Basic Science & Degenrative Lumbar Spine | Hands-on Cadaveric Workshop | | | |
| Module No. 2 Cervical Spine Degenerative / Spinal Navigation / Intra-operative Monitoring - IOM | Hands-on Cadaveric Workshop | | | |
| Module No. 3 Tumor / Trauma / Infection | Hands-on Cadaveric Workshop | | | |
| Module No. 4 Deformity / Complications / Malformations | Hands-on Cadaveric Workshop | | | |

Module 1:

Learning Objectives

Understand basic science, pathology and management updates of lumbar spine.

Perform a thorough clinical evaluation in a spinal patient

Target Participants

Neurosurgeons, Orthopedists, Spine Specialists & Spine Care Related Physicians

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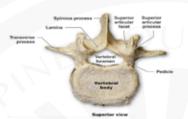
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SURGICAL ANATOMY OF THE LUMBAR SPINE

Surgical Anatomy of the Lumbar Spine : Vertebral Body

Lumbar Vertebral Body:

- Height is :20-30 mm
- Width vary from 35 to 40 mm at L1 to 50-55 mm at L5
- Superior articular facet : most common contributor to osseous foraminal stenosis

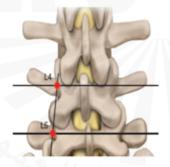




Surgical Anatomy of the Lumbar Spine : Lumbar Pedicle

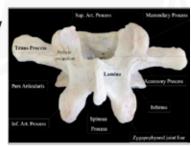
■ Lumbar Pedicle:

- Outer margin cortical bone
- Core cancellous bone
- Transverse width anatomic landmark for screw insertion
- Entry point center of transverse process and facet joint intersection



Surgical anatomy of the Lumbar spine : Lumbar pedicle screw insertion

- Anatomical landmarks for screw insertion:
 - Midtransverse process line
 - Zygapophyseal joint line
 - Mamillary process
 - Accessory process
 - Isthmus of pars articularis



Surgical Anatomy of the Lumbar Spine: Facet Joints/Zygapophyseal Joints

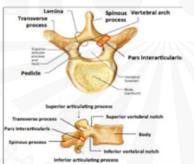
- ROM : Flexion-Extension
- Greatest surface area at: L5 - S1 level
- Transforaminal approach to the nerve root/disc: resection of superior and inferior articular process





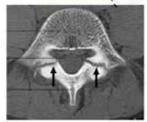
Surgical Anatomy of Lumbar Spine: Pars Interarticularis

- Important to preserve during laminectomy to maintain spinal stability
- Spondylolysis : chronic fracture of pars interarticularis
- Spondylolisthesis: anterior slippage of vertebra resulting from bilateral pars defects

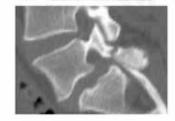


Spondylolysis/Spondylolisthesis

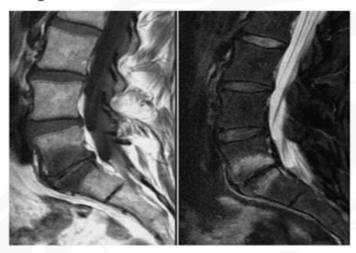








Degenerative Disc/Facet Joint Disease



Degenerative Disc/Facet Joint Disease





Degenerative Disc/Facet Joint Disease





Surgical Anatomy of Lumbar Spine: Ligaments

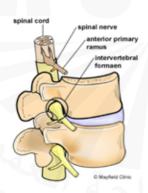
· ALL - Prevents hyperextensic PLL - Prevents hyperflexion · Ligamentum Flavum - Absent along the rostra half of ventral laminar

Surgical Anatomy of Lumbar Spine: **Spinal Canal and Foramina**

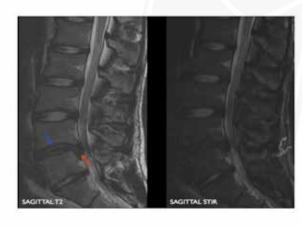
■ Oval on upper lumbar spine and triangular caudally

surface

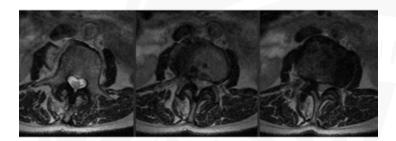
- Anterior part disc
- Posterior part ligamentum flavum and the facets



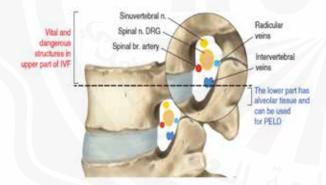
Lumbar Spinal Stenosis



Lumbar Spinal Stenosis

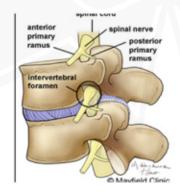


Intervertebral Foramen: Contents

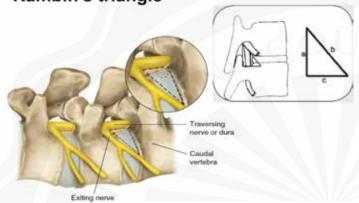


Intervertebral Foramen: Bony margin

- · Roof : inferior vertebral notch of the pedicle
- Floor: Superior vertebral notch of the pedicle
- · Anterior wall : posterior aspect of afjacent vertebral body
- · Posterior wall : Superior and Inferior articular process of corresponding facet joint
- · Medial wall : Dura
- · Lateral wall : fascia overlying the psoas muscle



Transforaminal Approach: Kambin's triangle



Minimally invasive decompressive lumbar **laminectomy AND Discectomy for Foraminal Disc Disease**

Pathophysiology of Spinal Stenosis

Disc degeneration



Loss of disc height



Disc bulging



Facet Hypertrophy



Ligamentum Flavum buckling



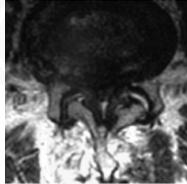
Stenosis

Radiographic Findings





Ragiographic findings





Minimally invasive Lumbar Decompressi **Surgical Approaches**

Decompression Risks

- Restenosis
- Post-op instability
- Injury to nerve roots
- Unintentional durotomy



Microsurgical Ipsilateral Decompression



Microsurgical Contralateral Decompression



Microsurgical Contralateral Decompression



BIOMECHANICS OF LUMBAR SPINE

Spinal Column Function

- ≥ Support.
- Link between UL & LL.
- Protects spinal cord.
- ≈Stability vs. mobility
 - · Example: cervical vs. thoracic spine

5 Regions of Vertebral

Column

- → Cervical Spines
- Thoracic Spines
- Lumbar Spines
- ≥ Sacrum
- ≈ Coccyx

Lateral (Side) Spinal Column



Posterior (Back) Spinal Column

Curvatures Of Spine

- ≥ Balance
- Prior to birth "Cshaped".
- Adult -
 - · Cervical lordosis
 - · Thoracic kyphosis
 - · Lumbar lordosis
 - Sacral kyphosis.



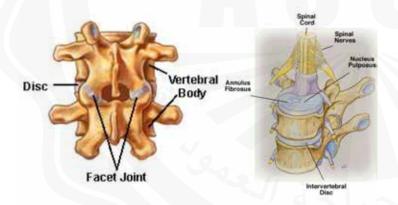


Spinal Motion

≥ Combination of:

- Intervertebral joints
- · Facet joints

Intervertebral Joints (Disc)



Intervertebral Disc

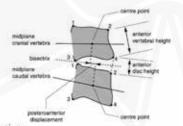
≥ 20-30% VC ht.

Thickness varies from

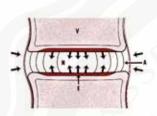
- · 3mm in cervical
- · 5mm in thoracic
- · 9 mm in the lumbar

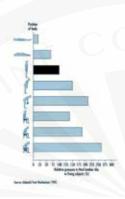
> Disc Ht.: Vertebra

- · Highest cervical more motion
- · Lowest thoracic less motion



Disc load



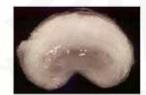


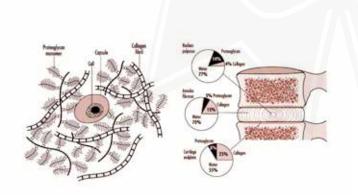
Disc Structure

™ Nucleus Pulposus (NP)

- · Located in the center
- Slightly posterior
- Gelatinous mass
- · Rich in PG
 - · water binding
- · Chondrotin-4 sulfate
 - · Maintain capacity (hydrophyllic)
- · Decreases with age.







Annulus Fibrosis

Collagen arranged lamellae

≥ 10-12 Concentric rings

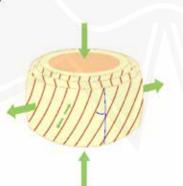
- · Decreased with aging
- Number & thickness
- Enclose the nucleus
- Oriented in opposite directions
- At an angle of 120 degrees
- Controls the tensile loading
 - Shear



- ™ Mostly avascular
- ≥ Lack innervation
 - · Outermost layers
 - · Sinovertebral nerve
- Thickest anteriorly.
- Sharpie's fibers
 - · Connected to body
 - · Outer 2/3 connect to the end plate

Disc Physiology

- ≈ Compressive stresses
- Tensile stresses
- ≥ By annulus fibrosis
 - · Makes the disc stiffer
 - · Adds stability
 - · Support to spine.
- ≥ Bears weight and guides motion.
- * Avascular Structure
 - · Nutrition by diffusion.



Disc physiology

- ➣ Compressive load decrease hydration
- » Decreases its mechanical function.
- ≥ Water content
 - · Decreased by 80-90% with age.
- ≥ Disc volume
 - · Reduced 20% daily (reversible)
 - · Loss 15-25 mm of VC height
- → Acts as a hydrostatic
- w Uniform distribution of pressure

Disc Herniation

- ≈ Cervical C5-6 & C6-7
- ≥ Lumbar L4-5 & L6-S1
- ≥ Disc herniation
 - · Protrusion or bulge contained
 - · Annulus intact.
 - · Extrusion migration through all layers

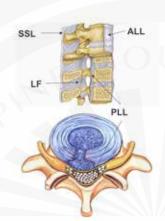




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Ligaments

- Anterior longitudinal ligament
- Posterior longitudinal ligament
- ≈ Ligamentum Flavum
- ≥ Intersspinous ligament
- ≥ Spuraspinous ligament



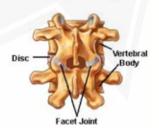
Posterior Structures

- Pedicles and lamina form the neural arch.
- Facet joints between the superior and inferior articulating surfaces.
- Transverse and spinous processes.
- Interspinous and supraspinous ligaments.
- Ligamentum lavum.
- ➣Intervertebral foramina.

Facet Joint

- ➢ Articulation
 - superior (concave)
 - inferior (convex)
- [≥]Guide intervertebral motion
 - · orientation in
 - · transverse plane
 - · frontal planes.

Posterior Spinal Segment

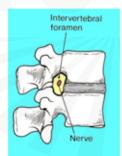


Facet Joint Capsule

- ≥ Limit motions.
- ≈ Strongest
 - Thoracolumbar
 - · Cervicothoracic
 - · Curvatures change.
- ≈ Resist
 - Flexion
 - · Rotation lumbar region.
- Undertake tensile loading
 - · Superior portion
 - · Axial loading or extension.

Intervebral Foramina

- Exit for nerve root.
- The size monitored by
 - Disc heights
 - · Pedicle shape.
- Reduce size with
 - · Osteophyte formation
 - · Hypertrophy of ligaments
- Loss of disc height
 - Aging lateral stenosis.
 - Extension reduced by 20%
 - Flexion increases 24%



Spinal Stability

- ≥ Ability to the spine
 - React to multiple forces
 - Maintain normal relation
 - · Under physiological load
- ≥ Degeneration increases instability.
- ■Body reacts
 - Fibrosis
 - Osteophyte

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- Amount & direct of motion
 - Vertebral body
 - Disc size.
 - Facet orientation
 - Frontal
 - · Sagittal.

Flexion

- Superior vertebra
 - Anterior tilt
 - · Forward gliding:
- ™ Intervertebral foramina wider by 24%.
- Nucleus pulposus pushed posteriorly
- Tensile forces placed on
 - · Posterior annulus
 - · L flavum
 - · Facet capsule
 - · PLL.
- Central canal is widened
- Rationale for some flexion exercises

Extension

- Superior vertebra
 - · Posterior tilt
 - · Posterior glide
- Intervertebral foramina narrowed up to 20%.
- The central canal is also narrowed.
- ≥ Nucleus pulposus
 - · moves anterior

Lateral Flexion

- Superior vertebra
 - Translate
 - Tilt
 - · Rotate over inferior
 - · Direction will differ.
- Tensile forces on convexity
- 2 Compressive forces on concavity
- Extension in ipsilateral facet.
- Flexion in contralateral facet.

Rotation

- ≥ Accessory motions
- Like lateral flexion rotation occur
- Same coupling
 - Cervical
 - · Upper thoracic spine.
- ≥ Neutral coupling in
 - · Lower thoracic
 - Lumbosacral spines
- If the motion segment is flexed or extended
- spine coupling will be the same.

Types of Segmental Loading

→ Axial Compression

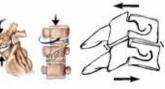




Torsion

≥ Bending

> Shear



Axial Compression

≈ Caused by:

- gravity
- · Ground reaction forces
- · Muscle contraction
- · Ligaments reaction to tensile forces.



Axial Compression

- ™Intra-discal loads
 - · Range from 294N to 3332N
 - · Position.
 - · Most load in anterior segment
 - Posterior can load 0-30%
 - · Compression at disk
 - · Tension at annulus
 - Changing the angle of the fibers
 - · More stability.



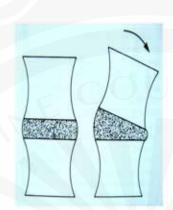
Axial Compression

- ™Creep occur in the disc
 - Larger increased force
 - Larger with aging.
 - . 5-11% of water is lost
 - · Creep is rapid
 - About 1.5-2mm in 10 min.
 - Plateau at 90 minutes.



Bending

- ≥ Combination of
 - Compression
 - Shear
 - · Tensile forces
 - Translation
- Bending flexion resisted by
 - · PLL
 - · Facet capsule
 - · Anterior compressive
 - Anterior structures
 - Causing disc displacement.



Bending

- Extension resisted by
 - · Posterior compressive forces
 - · Tensile load in facet capsule
 - · ALL



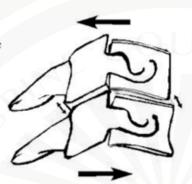
Torsion

- Caused by axial rotation
- Facet increase stiffness
- [™] Compression increases torsional stiffness
- Manulus fibrosus resists
- Facets may help.
- * When combined with flexion
 - · Amount of force required for tissue failure is decreased.



Shear

- Facet joint resists
 - · Especially in lumbar
- Annulus will undergo some
 - Tensile forces
 - · Depending on fiber
 - Direction
 - · Orientation/angle.
- Discs also resist
 - · Creep occurs
 - · Facet more loading.



Regional Structural and Functional Differences

- Differences due to
 - · Connection requirements
 - Sacral
 - Upper C-spine
 - · All junctions
- → Vertebral body size
 - · Increases with support requirements.
 - Cervical
 - Thoracic
 - Lumbar
 - · Sacral /coccyx

Lumbar Spine

- Most load
- ≈ Sagittal plane motion
- ≥ Largest body/disc ratio
- ≥ Short lamina
- ≥ Short pedicles
- Thick for load bearing.



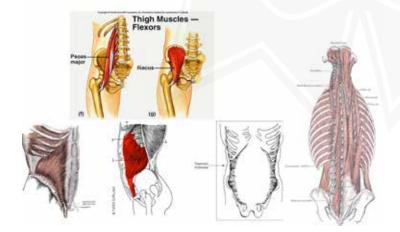
Lumbar Spine

- 20℃L5
 - Transitional
 - · Wedge shape body
- ZDL5-S1
 - · Most flexion extension.
- [∞]Coupling motion
- Right lateral flexion
 - · Right side-bend
 - · Left rotation of VB

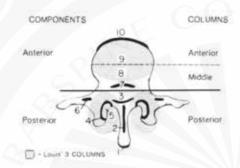
Spinal Musculature

- Mobility vs. Stability
- Energy storage
- ≈ Consider the line-of-pull of all spinal muscles

Para-spinal Muscles



Denis Three columns



Goals of surgery

- ≥ Decompression
- ≥ Deformity correction
- ≥ Stabilization

Stability versus Decompression

- Destabilizing surgery
- ≥ Adequate exposure
- ≥ Instability
- ≥ Bone loss
- ≥ Ligaments loss
- Muscle dysfunction
 - Denervation
 - Fibrosis

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- ≥ Non-operative
 - Braces
- Ventral bone strut
- ≥ Dorsal instrumentation

Construct Failure

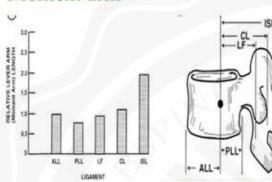
- ≥ Failure
 - Implant
 - Implant bone interface
 - Component-component junction

Stability

- ≥w ALL
- ≥ PLL
- Annulus Fibrosus
- ≥ Pre operative planning

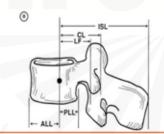
Moment arm

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ALL

- Strong physical ch.
- ≥ Ventral to IAR
- ≥ Moment arm
- ≥ Resist extension
- Act Tension band
- Extensive width
 - · Disruption in anterior approach
 - · Anulotomy ventral



PLL

- ≥ Less strength
- Short moment arm
- Posterior to IAR
- ≥ Less resistance
 - Extension
- ≥ Impaired in
 - Anulotomy
 - · Ventral approaches



Assess Ligamentous Stability

- ≥ Intra operative
- ≥ By distraction
- Stand alone strut graft
- ≥ Clamp down
- Tension band effect











Disc

- ≥ Significant contribution
- ≈ AF-ALL-PLL complex
- Disruption lead instability

Vertebral Body

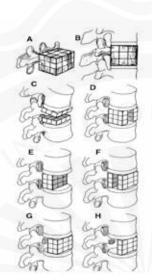
- ≥ Diminished VB
 - Tumor
 - Trauma
 - Surgery
- ➣ Instability
 - Amount
 - · Site
 - Portion



Vertebrectomy

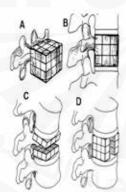
- ≥ Location
- ≈ Extent

consequence of fattegrain Spinal Destabilization and Implant Fadul chard P. Schlerk, M.D., Todd Stewart, M.D., Edward C. Donzel, M.D. Immutarg Focia, 2002;15(3)



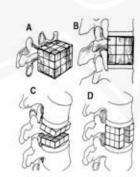
Vertebrectomy

- ≥ Disruption
 - Middle horizontal plane
 - Instability
 - Kyphosis



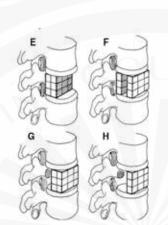
Vertebectomy

- ≥ Disruption of
 - · Middle coronal plane
 - · No instability
 - Mild disruption
 - · Anterior column
 - · Middle column



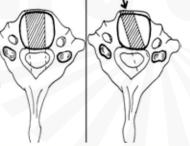
Vertebrectomy

- ≥ Loss of
 - · Anterior column
 - Instability
- Loss of
 - · Middle or posterior
 - · No instability



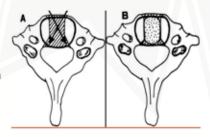
Vertebrectomy

- ≥ Extent
- ≥ Minimize amount
- ≥ Suboptimal decompression



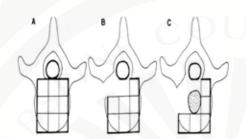
Vertebrectomy

- ➣ Flask shape
 - Narrow anterior
 - · Wider posterior
 - More decompression
 - Easy graft fit



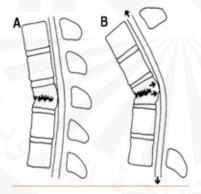
Verebrectomy

- ≥ Lumbar spine
 - Start dorsal part
 - · Apply graft
 - Narrow graft
 - Subsidence



Dorsal Approach

- ≥ VB integrity
- ≥ Previous kyphosis
- 2 Laminectomy
- ≥ Laminoplasy
 - · Preserve tension band
- Fulcrum moves anterior



Posterior instabillity

- ≥ ISL resection
 - · Long moment arm
 - Deficient at 14-5
 - Absent at L5-S1
 - Facet joint
 - · Pars disruption

Facet joint

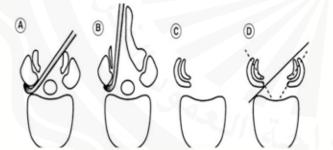
- · 30-50% can be resected
- · No instability
- · Glacial instability
- Slowly progressive
- · Conservative with FJ

Facet Joint

- ≥ Laminotomy
 - More vertical access

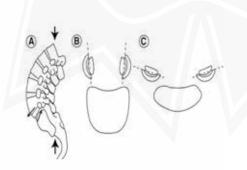
≥ Laminectomy

Access to lateral recess

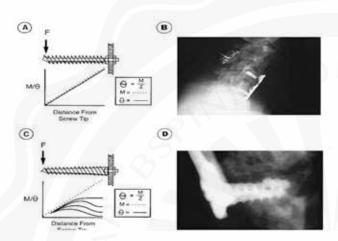


Facet Joint

- Orientation
 - Horizontal
 - · Cuplike shape
- Excessive lordosis
- 20 L4-5
 - Sagittal facets
- * Horizontal disc
- Less resistance to translation
- ≥ L5-S1
 - · Facets more coronal

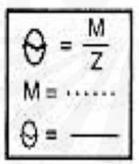


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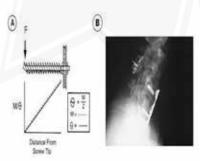
Spine implant

- Fixed Countelavour
- ™ Usually fail
- Maximal stress
- Stress $\Theta = M/Z$
- ≥ Bending moment M
- Section modulus Z
 - · Screw resistance to bending
 - · Strength indicator
 - $Z = Pi \times D^3/32$
 - Diameter
 - · Rod or core of screw



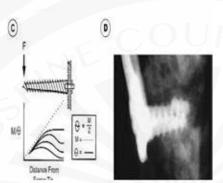
Fixed Diameter Screws

- Fixed moment arm
- Fixed stress
- Unchanged section modulus
- Through the length
- Failure screw plate junction



Tapered Diameter Screw

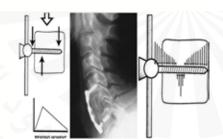
- Fixed moment arm
- Rising stress
- ≥ Section modulus rises
 - · Through the length
- Failure mid-shaft



Non-fixed cantilever moment

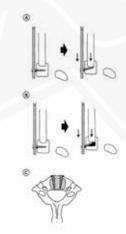
- ≥ Moment arm
 - · 3 point bending moment
- ≥ Different vectors
 - Amount
 - direction
 - · Various points
- Path material
 - Metal
 - · Cortical bone
 - Cancellous





Toggling

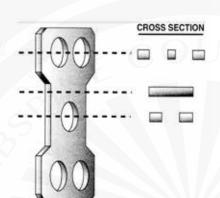
- Non-fixed screw
- → Degrade bone
- Windshield wiping
- ≥ Sweeping
- Abut end plat
- ≥ Decrease fusion



Plate

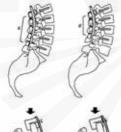
- Z section modulus
- Cross section area
- **™** Geometry
- ≥ Weakest link
- ≥ Maximum stress
 - · Failure point
 - O = M/Z.





Rigid long fixation

- ≥ Multi-segmental
- More stress at distal
- Than rostral
- Long fixed moment arm
- · High failure rate
- Short moment arm
- Less failure





Implant-Bone Interface IBI

- ≥ Distribute load
- ≥ Improve IBI
- → Additional IBI
- ≥ Improve bone integrity
- Normalize geometry
- > Dynamic implant
 - · Sharing of load
 - Bone
 - Graft

Minimize Screw Pollout

- Screw anatomy
- ≈ Geometry
- ™ Head
- ≈ Core
- Thread
- ≈ Tip
- Pitch



Minimize Screw Pullout

- Amount of bone
 - · Between threads
 - · Increase pitch
 - Two screws
 - Triangle
 - Triangulation





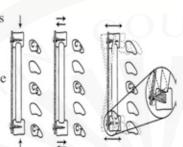
Minimize Screw Pullou

- ➣ Screw augmentation
 - · Bone cement
 - · Screw expansion
 - · Fenestrated screws



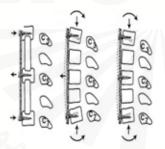
Single fixation point

- > High quality fixation points
- ≥ Biomechanical advantage
- Tow point fixation
- ≈ Compressive load residence
 - · Implant share
 - · Graft share
- ➢ Poor translation resistance
- Degradation of bone
 - Failure



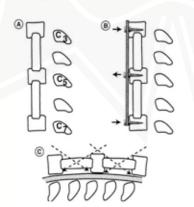
Multiple fixation point

- ≥ Intermediate fixation point
- Three point bending
- ≥ More resistance
 - w axial load
 - ➤ Translation
 - > Limit deformation
- In vertebral body
 - · Not in graft
 - · Weaker construct



Multilevel corpoctomy

- ≥ Intermediate VB
- Three point fixation
- More fusion surfaces
- Anterior graft



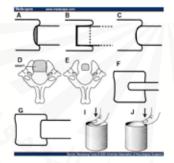
Implant bone interface

- ≥ Metal spikes
- Interference screw
- **™** Gripping
 - · Bone graft
 - · Vertebral body
- ≥ Drilling cortex
 - Tapping
 - · Cortical bone
 - · Not cancellous



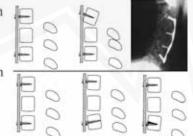
Graft bone fitting

- Fitness
- Fusion surface
- ≥ Decrease
 - Subsidence
 - Pistoning
 - Nonunion
 - Boundary effect



Dynamic Implant

- ≈ Controlled deformation
- ➤ Angular deformation
- Toggling *
- Non-fixed moment arm
- ≈ Cantilever
- Failure of fixed arm
 - · At plate screw link
 - Implant bone interface



Axial deformation

- Slotted plate
- collapsible plate
- · Sliding screws
- Sliding platform
- Early subsidence
- Kick plates
 - · Allows subsidence
 - · No angulation
 - · Graft dislodgment

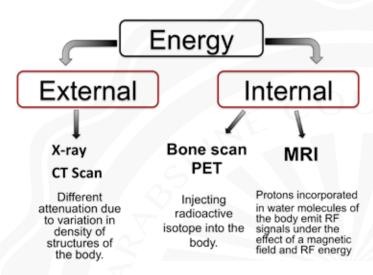


Conclusion

- * Better biomechanics
- ≈ Failure
 - Implant failure
 - · Implant bone interface
 - Component-component

IMAGING MODALITIES OF NORMAL SPINE

| Imaging is a cornerstone in diagnosis of spine pathologies. | |
|--|--|
| For spine imaging, there are many Radiological modalities available. | |
| In order to diagnose spine pathologies, we have to be familiar with the normal imaging appearance, the normal variant and normal measures. | |
| | |
| | |
| Outline | |
| | |
| Different imaging modalities. | |
| Normal Radiological anatomy of the spine. | |
| Scanning protocols/ imaging views. Image interpretation. | |
| Normal variant. | |
| | |
| | |
| | |
| | |
| | |
| Different imaging modalities: | |
| De die amerika (M. ee M. M. et e emere | |
| Radiography (X-ray)/ Myelogram. Computed Tomography (CT)/ Myelography. | |
| Magnetic Resonance Imaging (MRI)/ DTI. | |
| Nuclear Medicine (Bone Scan/ PET scan). | |
| | |
| The basis is the interaction | |
| between energy and matter | |



1. Radiography

 Initial screening examination (quick and inexpensive).

Fractures, Malalignment, Congenital spinal defects, Abnormal spinal curves, Tumors, Spondylolysis and spondylolis- thesis.

- Harmful radiation.
- Limited contrast resolution.

1. Radiography



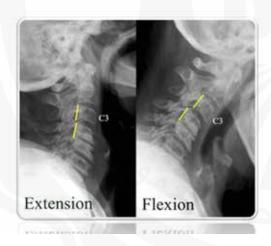




Lateral

Oblique







Lumbar myelography





2. Computed Tomography

- · Higher resolution.
- · Multi-planar reformatting. Trauma, Dislocations, Posterior spinal elements.
- · Lack soft tissue details.
- · Bone marrow pathologies.
- · High radiation dose.

Multisclice CT scanner innovation

- Acquisition of sectional images.
- · Great improvement in soft tissue contrast resolution.
- Image reconstruction.

CT scan and CT myelography







Sagittal

Axial

Myelography

3. Magnetic Resonance Imaging

- · Excellent soft tissue contrast.
- Multiplanar imaging. Degenerative spine pathology, inflammation, neoplasm, trauma.
- · Safety precautions.
- · Cardiac pacemaker, Cochlear implant.
- · Artifacts.

Magnetic Resonance Imaging



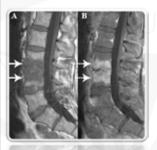
T₁W₁



T2WI



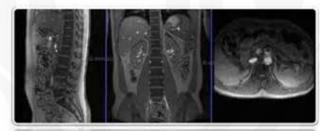




PD WI FAT SAT

Post contrast

Multiplanar imaging



Sagittal

Coronal

Axial

Tissue and sequences

- Water:
 - White on T2, dark on T1.
 - Pathology stays white on FLAIR, water doesn't.
- - White on T1 and T2
 - Dark on STIR
- Bone Marrow: (normally fatty)
 White on T1, White on T2

 - Dark on STIR.
- · Cortex, stones, and ligaments
 - Dark on everything
 - Contusion is white

| | T1WI | T2WI | STIR |
|----------------|-------|-------|-------|
| Water | black | white | white |
| Fat | white | white | black |
| Bone marrow | white | white | black |
| Blood | white | white | white |
| Bone | black | black | black |

Contrast enhanced MRI

- · Delineate infections, malignancies.
- · Differentiate the postoperative conditions.

MR Myelography

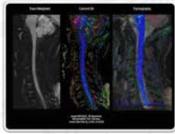




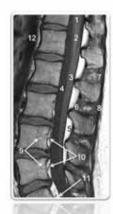
· Advanced open MRI devices are developed to perform positional scans in the position of pain or symptom (Uprigh and Dynamic MRI)

Diffusion Weighted Imaging/ Tractography



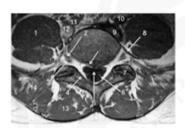


Normal findings





Leveling





Artifacts

Patient motion. Cardiac motion. Respiratory motion. CSF pulsation.

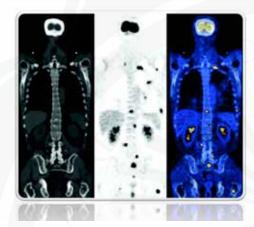




4. Bone Scan



5. PET/CT



Summary

- · Among many imaging modalities, choose the one suitable for the suspected diagnosis.
- · Each modality can be tailored to triage each pathology.
- · Neurosurgeon/Radiologist cooperation is a must.
- · X ray and CT scan for bony pathologies.
- · MRI is excellent method for soft tissue and marrow lesions.

RADIATION EXPOSURE IN SPINE SURGERY

The increasing use of fluoroscopy-based surgical procedures in spine surgery and the associated exposure to radiation raise questions regarding potential risks for the patients and the operating room personnel.



- Radiation dose: X-Ray CT Bone Scan
- Radiobiology: Stochastic damages

Patients and surgeons are exposed to Stochastic effects

Those are effects that occur on a random basis with its effect being independent of the size of dose. The effect typically has no threshold and is based on probabilities, with the chances of seeing the effect increasing with dose.

Cancer is a stochastic effect.

ALARA

"As Low As Reasonably Achievable,,

- acronym for an important principle in exposure to radiation and other occupational health risks
- The aim is to minimize the risk of <u>radioactive exposure</u> or other hazard while keeping in mind that some exposure may be acceptable in order to further the task at hand.

There are four major ways to reduce radiation exposure: DAST

Distance: Increase distance between radioactive sources and workers Amount: Reduce the quantity of radiation for each practice Shielding: Use proper barriers and aprons to block or reduce radiation Time: Spend less time in radiation fields.

Radiation Dose from Diagnostic Xray single exposure

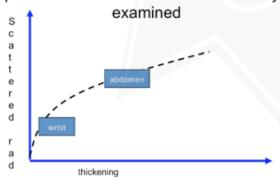


Sievert: attempts to quantitatively evaluate the biological effects of ionizing radiation

X-Ray dose concerns

- Studies have shown that spine surgeons may be exposed to significantly more radiation than that observed in surgery on the appendicular skeleton.
- · The dose is 10 to 12 time higher for spine surgeons

Spine surgeon's nightmare: scattered radiation is proportional with the thickness of the body part



Modalities of image guidance in spinal surgery

- · Static modalities:
 - Plain film
 - Fluoroscopy (2D)
- Navigation systems:
 - CT scan
 - Isocentric C-arm (3D fluoroscopy)
 - O-arm

Radiation exposure to patients

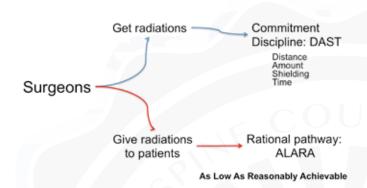
- - 4.33 +- 2.7 mRem (C-arm fluoroscopy)
 - 0.33 +- 0.8 mRem (3D navigation system)
 - p= 0.0012 statistically significant
- - 0.33 +- 0.52 mRem (C-arm fluoroscopy)
 - 0.66 +- 1.6 mRem (3D navigation system)
 - p= 0.65 not statistically significant
- Smith et al. J Spinal Cord Med 2008

Smith et al. J Spinal Cord Med 2008; 31:532-537

Navigation reduces the dose, does not nullifie it

| | | navigated versus nontunigated spir | - spenisses |
|------------------------------|--|--|---|
| Study | Study design | Materials and methods | Kenshiricoschmins |
| Instrume et al. [9] | 30 navigated versus 30 conventional halloon hyphoplastics in esteoporotic fractions | Measurement of indution time and dose are product | Radiation exposure of surgicio and patient could be reduced significantly |
| Kim et al. [11] | Combined human and cadaretic study, comparing minimally invasive transferunised humber interbudy fusion | 18 cadavers, 10 patients, navigated versus conventional, compared flaorescopy time and dose measurements | Fluorescopy shorter for navigated operations, no emission detected for navigated, 12.4 mRFM surgeon dose |
| Smith et al. [25] | Oldavor study comparing 3-D navigation serios conventional lumbar spitual fusion | Budge measurement above spron of surpose | 4.33 mREM torse exposure without and 0.33 mREM with navigation |
| Slomezykowski et al. [24] | 20 cases with lumber spind fusion analyzed argueting duration of redistion and position of theoretope, comprises of CT-based navigation and theoretopy assisted remarrigated surgery. | REMAB and RANDO-Phanrom used, testing of CT protocols, measurement of organ and effective doses of patients | Effective doses: Placroscopy: 1 m5 Sequential CT: 4.1 m5 Spiral CT optomized: 3.0 m5 Sequential CT optomized: 2.4 m5 |
| Gebbard et al. [4] | 36 patients, compation of different types of navigation for pedide screw placement | TLD on patient, usures and receiver, spinul fusion, four screws | Lowest emission in 3-D navigation, highest in conventional fusion. |

X-Ray dose concerns



Basic Science and Pathology

SPINE BASIC MEASUREMENT SCALES

Denver, Colorado, USA "Mile High City"

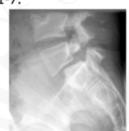






Spondylolisthesis Meyerding Classification

- Meyerding HW. Spondylolisthesis. Surg Gynecol Obstet 1932;54:371-7.
 - Grade I 0-25% offset
 - Grade II 25-%-50% offset
 - Grade III- 50-75%
 - Grade IV- 75- 100%
 - Grade V 100%+ (spondyloptosis)





Wiltse LL, Newman PH, Macnab I. Classification of spondylolysis and spondylolisthesis. Clin Orthop. 1976;117:23-29.

Dysplastic SBO/Asymetric lamina/ small pedicles

Type II Isthmic Slip associated with a a. Lytic displaced pars articularis

> b. Elongation Repeated pars stress fractures have healed with elongation and attenuation. A defect may

not be present

c. Acute fracture

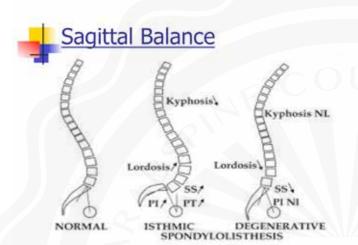
Type III Degenerative Type IV Traumatic Type V Pathological



Instability Biomechanical Definition

- ISSLS 1982
- Pope and Punjabi
 - Loss of stiffness in spine
 - "stiffness" = amount of motion within a system relative to a load applied to the structure
 - Horizontal translation >4mm
 - Angular motion >12°



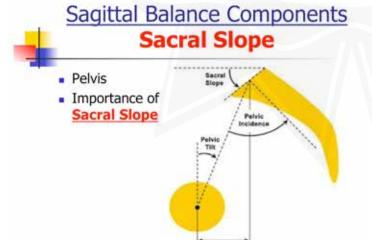




Sagittal Balance - Normal

- Sagittal Vertical Axis (SVA)
 - C7 Plumb Line fall over sacrum
 - Thoracic Kyphosis
 - Lumbar Lordosis

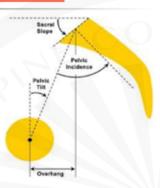




Sagittal Balance Components **Pelvic Tilt**



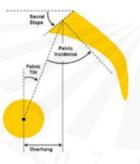
 Importance of Pelvic Tilt



Sagittal Balance Components **Pelvic Tilt**



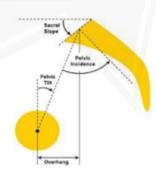
 Angle between the vertical and a line through the midpoint of the sacral plate to the centre of the femoral head



Sagittal Balance Components **Pelvic Incidence**



PI=PT+SS

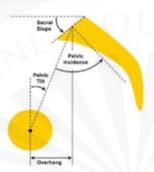


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Sagittal Balance Components

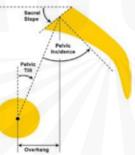
- High pelvic incidence is associated with high sacral slope and high lordosis
- Low pelvic incidence is associated with low sacral slope and low lordosis





Sagittal Balance

- Pelvic Incidence determines lumbar lordosis
- Pelvic Tilt reflects compensation to spinal deformity
- High <u>Pelvic Tilt</u> values express compensatory pelvic retroversion for sagittal spinal misalignment





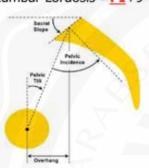
Sagittal Balance

| Age | PI | PT | SS |
|--------------------------|----|----|----|
| 20-40 | 52 | 13 | 39 |
| 41-60 | 54 | 14 | 40 |
| >60 | 51 | 16 | 35 |



Sagittal Balance

Lumbar Lordosis = PI+9°







Sagittal Balance

- Pelvic Incidence can be used to estimate optimal Lumbar Lordosis
- Pelvic Tilt is a compensatory mechanism used to maintain standing posture
- Sagittal plane spinal deformity can be compensated by pelvis translation
- Pelvic Tilt is directly correlated with function



Bibliography

- Meyerding HW. Spondylolisthesis. Surg Gynecol Obstet 1932;54:371-7.
- Wiltse LL, Newman PH, Macnab I. Classification of spondylolisis and spondylolisthesis. Clin Orthop Relat Res 1976 Jun;(117):23-9.
- Labelle H, Mac-Thiong JM, Roussouly P. Spino-pelvic sagittal balance of spondylolisthesis: a review and classification. Eur Spine J 2011 Sep;20 Suppl 5:641-6
- Vialle R, Ilharreborde B, Dauzac C, Lenoir T, Rillardon L, Guigui P. Is there a sagittal imbalance of the spine in isthmic spondylolisthesis? A correlation study. Eur Spine J 2007 Oct; 16(10):1641-9.



Instability Biomechanical Definition Classic Reading

- Pope MH, Panjabi M. Biomechanical definitions of spinal instability. Spine (Phila Pa 1976) 1985;10: 255-6.
- · Panjabi MM. The stabilizing system of the spine. Part I. Function, dysfunction, adaptation, and enhancement. J Spinal Disord 1992;5: 383-9.
- Panjabi MM. The stabilizing system of the spine. Part II. Neutral zone and instability hypothesis. J Spinal Disord 1992;5:390-6.



NEUROPHYSIOLOGY IN SPINE PATHOLOGIES



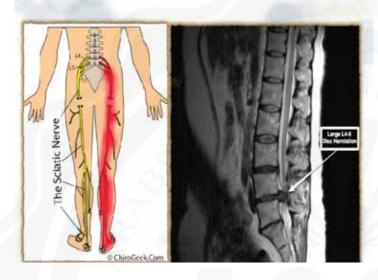
the vast majority of patients seen in primary care will have "mechanical" or non-specific low back pain,

meaning that there is no neoplastic, infectious, or primarily inflammatory cause

Among all primary care patients with low back pain,

less than 5 percent will have serious systemic pathology.

Although patients are often told a specific diagnosis for their back pain,
Reproducibility of these diagnoses (ie, muscle spasm, sacroiliac pain, trigger points) among providers is poor



The aim of EMG/NC in Lumbar Back Pain

- the abnormality found by MRI or CT is not always the cause of the patient complaints.
- to confirm root lesion by finding changes in the muscles supplied by that root including the paraspinal muscles, and normal result in other muscles.

- And nerve conduction specially presence of Sensory Action Potential and absence of H wave.
- •4. To rule out conditions which clinically simulate LDH.

TO EXCLUDE

 Compression of the Lumbosacral Plexus, Sciatic Nerve, peroneal and Tibial Nerves.



Neurologic involvement is suggested by symptoms of sciatica or pseudoclaudication. Pain radiating below the knee is more likely to represent true radiculopathy than pain radiating only to the posterior thigh.

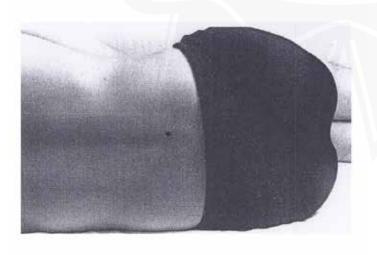
Nerve conduction studies with abnormal motor (Cmap &NCV) and intact sensory responses of lower limb,

along with EMG findings in a myotomal distribution

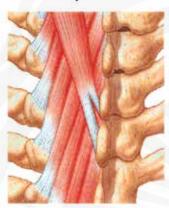
with paraspinal muscle involvement, typically indicate a radicular process rather than LSP.

- 1. Slightly low NCV. Prolonged F wave.
- 2. low amplitude of the Cmap.
- 3. EMG evidence of denervation myotomal. Including the paraspinal muscle.
- 4. Sparing of the SAP in the same dermatome

| Spinal roots | Muscle innervated | |
|--------------|---|--|
| L 2/3 | hip flexors ILIOPSOAS | |
| L3 | hip adductors ADDUCTOR LONGUS | |
| L 3/4 | knee extensors VASTUS LATERALIS VASTUS MEDIALIS | |
| L5 | ankle dorsiflexion eversion and inversion. | |
| \$1 | Gastrocnemius, soleus, biceps femoris lateral head, gluteus maximus | |



| Para | spina | LMI |
|------|--------|--------|
| ala | Spilla | I IVI. |



Nerve root entrapment in lumbar spinal stenosis is caused by

Narrowing of the spinal canal (congenital or acquired), nerve root canals, or intervertebral foramina

This narrowing is usually caused by

bony hypertrophic changes in the facet joints and by

Thickening of the ligamentum flavum.

Disc bulging and Spondylolisthesis may contribute Symptoms of significant lumbar spinal stenosis include

back pain, transient tingling in the legs, ambulation-induced pain localized to the calf and distal lower extremity, resolving with rest.

This pain with walking, referred to as "pseudoclaudication" or neurogenic claudication



Lumbosacral plexopathies have a multitude of clinical features. They most often present with asymmetric, focal weakness, numbness, dysesthesia, and/ or paresthesia in multiple contiguous lumbosacral nerve root distributions.

Patterns of weakness usually help localize the "lesion" to a more specific area within the plexus.

Lumbar plexus lesions tend to cause weakness of hip flexion and adduction and/or knee extension.

Lumbosacral trunk and upper sacral plexus lesions result in foot drop or flail foot depending on the extent of involvement, and weakness of knee flexion or hip abduction.

Patterns of sensory disturbance are less reliable given the difficult clinical delineation between dermatomal and named nerve sensory loss.

However, in general, sensory disturbance involving the anterior and medial thigh typically represents lumbar plexus involvement.

while sensory disturbance involving the foreleg, dorsum of the foot, and posterior thigh suggests a lumbosacral trunk and/or sacral plexus lesion

Upper lumbar plexopathy

 Normal Peroneal & tibial N motor study, normal F wave & H reflex. Normal sural & superficial peroneal SAP.

-Abnormal Saphenous sensory response, lower femoral motor amplitude, Abn EMG in Femoral N supplied M. & Obturater N supplied M.

·Normal Paraspinal M.

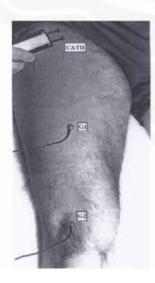
| U | pper | lumbar | pl | exo | pathy | , |
|---|------|----------|----|-----|---------|---|
| • | 2001 | IUIIIDUI | ρ, | 2 | outily, | , |

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Upper lumbar plexopathy

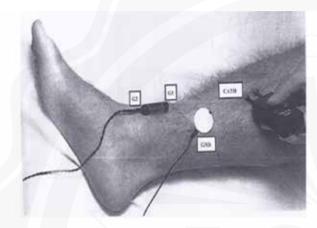
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- Normal Paraspinal M.

- FEMORAL
- NERVE



| 6 | 9 |
|---|---|

SAPHENOUS NERVE



EMG abnormalities favoring acute denervation and chronic reinnervation of L2-, L3-, and L4innervated thigh muscles but sparing thigh adductors, tibialis anterior, and corresponding paraspinal muscles can differentiate an isolated femoral neuropathy from LSP or lumbar radiculopathy.

Lower lumbar plexopathy

- Reduced tibial & peroneal CMAP amplitude, normal or slightly prolonged distal M latency,
- normal or slightly reduced NCV.
- •Prolonged or absent F waves.& H reflex.
- •reduced amp or absent Sural or Sup Peroneal SAP.
- •EMG denervation / reinnervation in Muscles supplied by tibial N, Peroneal N, sciatic N in the thigh.
- ·Lumosacral paraspinal M sparing.

| Lower | lumbar | n | lexo | pathy | , |
|-------|----------|-----|------|--------|---|
| LOWCI | Idilibai | - Μ | CAU | patriy | |

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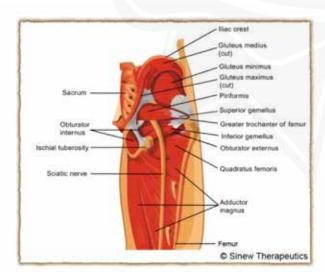
Lower lumbar plexopathy

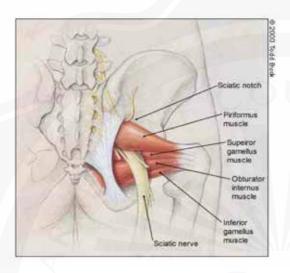
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Peroneal N, sciatic N in the thigh.

·Lumosacral paraspinal M sparing.







Begin by lying on your back. your legs to be flat to begin with.

And then pull one knee up and grab your ankle with your opposite hand. Pull with that ankle so that knee is coming towards the opposite shoulder.



· Often times this can place a little bit of stress on the knee so feel free to pull with the knee as well, but do not lead with the knee

H reflex changes in piriformis strech position

Sciatic N lesion

- Low amp of Cmap in tibial & peroneal N.
- Slightly low NCV.
- · EMG denervation in tibial N & peroneal N muscles,
- & short head of Biceps femoris, sparing gluteus medius M, and paraspinal M.
- Abn SAP

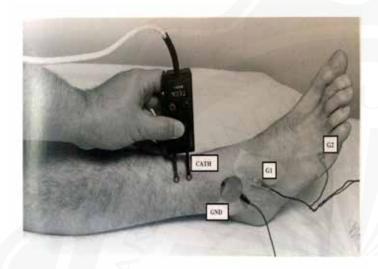
| NERVE CONDUCTION STUDY FINDINGS | DEEP PERONEAL NERVE | COMMON PERONEAL NERVE | SCIATIC NERVE | LUMBO SACRAL PLEXUS | L 5/S1 ROOT |
|---|---------------------------|-----------------------------|------------------|---------------------------|----------------|
| ABORMAL PERONEAL SNAP | | × | × | × | |
| ABNORMAL SURAL SNAP | | | × | × | |
| LOW PERONEAL CMAP | × | × | × | × | × |
| LOW TIBIAL CMAP | | | × | × | × |
| ABNORMAL H REFLEX | | | × | × | × |
| CONDUCTION SOWING / BLOCK FIBULA NECK | × | × | | | |

| ABORMAL PERONEAL SNAP | | * | × | × | |
|---|---|---|---|---|---|
| ABNORMAL SURAL SNAP | | | * | × | |
| LOW PERONEAL CMAP | × | × | × | × | * |
| LOW TIBIAL CMAP | | | × | × | × |
| ABNORMAL H REFLEX | | | × | × | × |
| CONDUCTION SOWING / BLOCK FIBULA NECK | × | × | | | |

| ELECTRO MYOGRAPHIC FINDING | DEEP PERONE AL NERVE | COMMON PERONEA L NERVE | SCIATIC NERVE | LUMBO SACRAL PLEXUS | L 5/S1 ROOT |
|----------------------------------|-------------------------------|------------------------------|------------------|---------------------------|----------------|
| TIBIALIS ANTERIOR M | × | × | × | × | _x |
| EXTENSOR HALLUCIS | × | × | × | × | × |
| PERONEUS LONGUS | | × | × | × | × |
| TIBIALIS POSTERIOR M | | | × | × | × |
| FLEXOR DIGITORIUM LONGUS | | | × | × | × |
| BICEPS FEMORIS SHORT HEAD | | | × | × | × |
| GLUTEUS MEDIUS M | | | | × | × |
| PARASPINAL M | | | | | × |



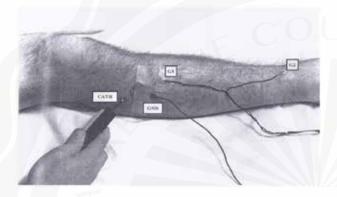




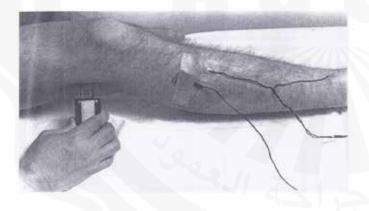




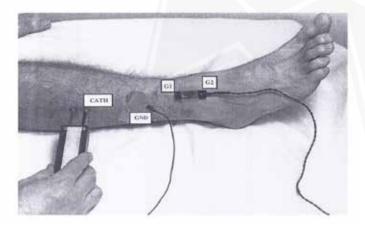
Peroneal nerve. Fibula neck-> tibialis anterior.



peroneal nerve popliteal fossa→ tibialis anterior m.



Superficial peroneal sensory study





H Reflex



Basic Science and Pathology

PATHOPHYSIOLOGY OF SPINAL PAIN

Pain

An unpleasant sensory and emotional experience which we primarily associate with tissue damage

The International Association for the Study of Pain (IASP)

| N | OCICO | ntion |
|-----|-------|-------|
| 1 1 | ocice | puon |

The detection of tissue damage by specialized transducers connected to A-delta and C-fibers

Classification of Pain: Nociception

- · Proportionate to the stimulation of the nociceptor
- When acute
 - Physiologic pain
 - Serves a protective function
 - Normal pain
- · Pathologic when chronic

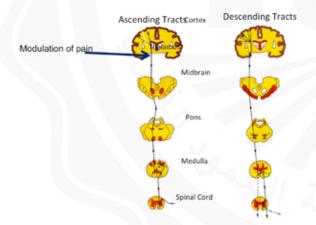
Classification of Pain: Neuropathic Pain

- · Sustained by aberrant processes in PNS or CNS
- · Disproportionate to the stimulation of nociceptor
- · Serves no protective function
- Pathologic pain

Classification of Pain: Mixed Pain

- · Nociceptive components
- Neuropathic components
- Examples
 - Failed low-back-surgery syndrome
 - Complex regional pain syndrome

Peripheral and Central Pathways for Pain



Gate-Control Theory

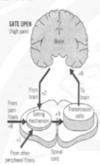
Ronald Melzack (1960s)

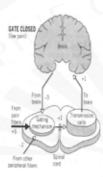
- Described physiological mechanism by which psychological factors can affect the experience of pain.
- · Neural gate can open and close thereby modulating pain.
- · Gate is located in the spinal cord.
 - It is the SG

Opening and Closing the Gate

When the gate is open pain signals excite the transmission cells

When the gate is closed signals from small diameter pain fibres do not excite the transmission neurons.





Three Factors Involved in Opening and Closing the Gate

- · The amount of activity in the pain fibers.
- · The amount of activity in other peripheral fibers.
- · Messages that descend from the brain.

Conditions that Open the Gate "Increased Pain"

- · Physical conditions
 - Extent of injury
 - Inappropriate activity level
- · Emotional conditions
 - Anxiety or worry
 - Tension
 - Depression
- Mental Conditions
 - Focusing on pain
 - Boredom

Conditions That Close the Gate "decreased pain"

- · Physical conditions
 - Medications
 - Counter stimulation (e.g., heat, massage)
- Emotional conditions
 - Positive emotions
 - Relaxation, Rest
- Mental conditions
 - Intense concentration or distraction
 - Involvement and interest in life activities

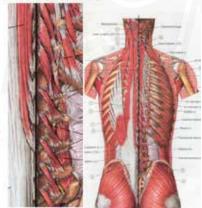
Causes of Spinal Pain "the usual suspects"

- Lumbar Strain 70%
- Disc herniation/Degenerative disc disease (spondylosis) 15%
- Lumbar stenosis 3%
- Scoliosis/deformity/flat back
- Spondylolisthesis 2%
- Infection
- Osteoporosis 4%
- Trauma
- Neoplasm
- Others: i.e. Pyriformis syndrome, SIJ etc..

Key Players Trunk Musculature

Musculature

- Superficial
 - Thoracic group
 - Abdominal group
 - Erector Spinae group
 - · Spinalis
 - · Longissimus · Iliocostalis
- Deep
 - Transversospinal group
 - Multifidus
 - Rotatores
 - Intertransversarius



Key Players Nerves

- Spinal Nerves and Plexi
 - 31 spinal nerves
 - 4 Plexi
 - Cervical
 - Brachial
 - · Lumbar (T12-L5)
 - Femoral, Obturator
 - · Sacral (L4-S5)
 - Sciatic
 - » Tibial and Common Peroneal



Key Players Joints/Ligaments



Case Presentation spinal pain --- the disc

- 53 YOM- Chief of Police in a nearby county
 - -5 years ago, attended to a rollover MVA.
 - -Attempted to open the truck door
 - -Felt a pop in his LB.
 - -c/o severe LBP with LLE pain

| Case | Pres | entati | on |
|--------|--------|--------|------|
| spinal | pain - | the | disc |

- Microdiscectomy at L4-5, 5-S1 --- no benefit

Case Presentation spinal pain --- DDD/Facet/ spondylosis

Followed by: L4-S1 fusion (ALIF/PIF) w IC "Dr.'s Combo"

> Case Presentation spinal pain ---infection

Complicated with infection--- pain worse Underwent revision surgery (anterior) L4-5 corpectomies, fibular struts

Case Presentation spinal pain - More Pain!!!

- ·Pain is worse --- can't walk
- •Removal of old hardware at L4-S1
- •L2-4 PIF





Case Presentation spinal pain --- More Pain!!! Flat

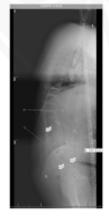
- Back Pain is worse-LB
- ·Walk less than a block now
- •Surgery: L1-2 SPO extension of fusion to T10 (T10-L2)---T10-S1 PF





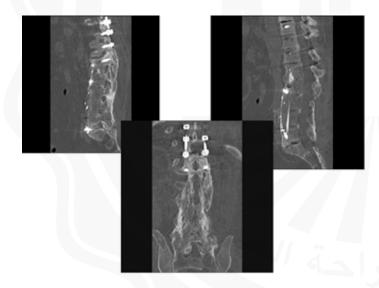
Case Presentation spinal pain --- More Pain!!! Flat Back

Worse now that he can barely walk 100 feet Frequent falls

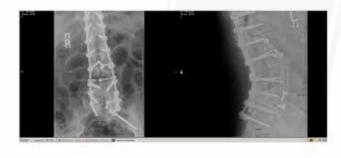




Ames 2013



Case Presentation



Pre

Post



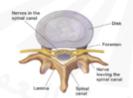


The Intervertebral Disc



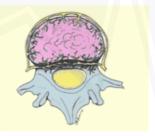
The intervertebral disc is comprised of:

- The nucleus pulposus
- · The anulus fibrosus
- The vertebral endplates



Nerve Supply

- · Anterior annulus is innervated by nerves derived from the ventral rami and gray ramus communicans
 - Yamashita et al. 1993
- · The posterior annulus is innervated by the sinuvertebral nerve - McCarthy et al. 1991
- · No nerve fibers identified in normal nucleus pulposus
 - Ashton et al. 1994



- Modified from Postacchini and Rausching, Anatomy, 1999

Innervation of the Disc

- · Nerve endings in the outer half of the anulus in normal and degenerated discs - Yoshizawa et al.
- · Nerve fibers may extend 3mm into the anulus of a normal disc
- · Nerve endings in abnormal discs may reach the nucleus

- Ashton et al. 1994

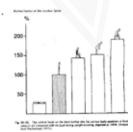
Biochemical Composition of Intervertebral Disc

| | NP | AF |
|------------------|---------|--------|
| Water | | |
| Young Disc | 85-90 % | 78% |
| Older Disc | 70% | 70% |
| Solids 30-40% | 10-20% | |
| Proteoglycans | 65% | 20% |
| Collagen | 20-30% | 50-60% |
| Elastin | ~1% | ~1% |

- Gumina and Postacchini, 1998, Mirza and White, 1995

Intradiscal Pressure

- IP:
 - lowest in supine position
 - rises in the sitting, leaning forward position
- · 65% of height loss occurs in the first 6 min after a 10 kg weight is lifted



Krag et al. 1990

Nachemson, 1960

The Leaky Disc

- · MacMillam et al analyzed 105 discs with methylene blue dye injected in the nucleus
 - 14% showed leaks
 - 93% of the leaks were in the posterolateral region
 - Injected dye showed contact with the adjacent nerve root in 27% of the leaks

MacMillan et al. 1991

Degeneration at one level may effect an adjacent level

- Degeneration at the L4-5 disc
 - increased intradiscal pressure (by 10%)
 - increased disc bulge at the L3-4 level in a finite element model
 - Kim et al. 1991

Mechanisms of Disc Injury

- · Intervertebral disc prolapse is peripheral in origin with the anulus being the site of primary pathological change
 - Gordon et al. 1991
- · Bending in addition to axial compression in predisposing a disc to prolapse
 - Adams, 1994
- The normal disc is protected by the posterior elements from overstretching, however not from fatigue failure

- Adams et al. 1994

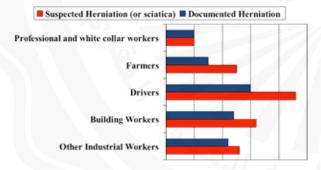
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| |

Lifting disc injury

| Method of Lifting | Relative Risk |
|--|---------------|
| Knees bent and back straight | 0.71 |
| Knees bent and back bent | 2.02 |
| Knees straight and back bent | 3.95 |
| Lifting starting and ending at floor level | 1.84 |
| Lifting starting and ending at waist level | 2.53 |
| Lifting started with arms extended | 1.87 |
| Twisting while lifting | 1.90 |

Adapted from Mundt et al. 1993

Occupational Risk in 57,000 Workers



Adapted from Heliovaara, 1987

Pathology of Disc Herniation

- · 21.5% of herniated discs contain both nuclear and anular material
- · 29% of herniated discs contain only anular material
 - Lebkowski and Dzieciol 2002
- · Most recurrent disc herniations and herniations with multiple extruded fragments contain portions of endplate
 - Brock et al. 1992

Disc Pain

- · Neuropeptides involved in the transmission of pain have been identified in the intervertebral disc:
 - CGRP, VIP, and SP are present in the outer anulus of dog discs
- · Chemical events in the disc following injury may sensitize the DRG and generate pain

- Weinstein et al. 1988

End Plate

- · Consist of thin flat layer of Hyaline cartilage
- · Composed of parallel lamellae of chondrocytes and collagen



Ghosh, 1990

End Plates Modic Changes

Type: T1 T2

0/+











End Plates Modic changes and infection

- Albert et al, ESJ, 2013
 - DB RCT, 162 pts
 - LBP > 6mos after HNP with Type 1 Modic changes (+/-surgery)
 - Randomized to 100 days of abx (augmentin) vs placebo
 - The abx group improved SS from 100 days to 1 year fu

Nerve Root

- Located cephalad in the foramen and bathed in CSF
- With SLR, the lumbar nerve roots move 0.5-5 mm and sustain 2-4% strain. - Smith et al. 1993
- A more transverse course of the nerve root may be associated with an increased risk of sciatica
 - Sato and Kikuchi, 1993
- Conjoined nerve roots:
 - 2-4% of patients undergoing imaging studies Okuwaki et al. 1991
 - 14% of anatomic studies
 - May be associated with developmental anomalies and increased risk of disc herniation - Gomez et al. 1993

Nerve Root Compression

Acute compression of the nerve root with disc protrusion is estimated to generate a contact pressure of ~ 400 mm Hg compression.

This compression may cause numbness, parasthesiae, and weakness but not pain.

Rydevik et al. 1984, Garfin et al. 1991

- 5-10 mm Hg of pressure causes impairment in blood flow
- 50-75 mm Hg of pressure causes increased permeability of blood vessels, edema, increased tissue pressure, altered local ion balance, and altered impulse contraction

Olmarker et al. 1989. Lind et al. 1993

Nerve Root Pain

- · Compression of an inflamed nerve root may cause pain
- · Proposed mechanisms of inflammation
 - Lowered pH
 - Breakdown products from nucleus
 - Proteoglycans from disc
 - Autoimmune reaction to exposed disc tissue
 - Mirza and White, 1995

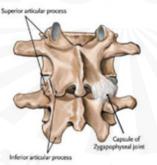
Facet Joint Pain Related to Disc Disease

· Provide torsional rigidity and provide structural support in axial loading

- Zimmerman et al. 1992

- · Posterior elements restrict the disc to 80% of its full range of flexion
- · Degeneration and arthritis of the facet joint is linked with decreased disc height as a result of DDD.

- Adams et al. 1994



Facet Joints

Aging may lead to:

- · Increased contact forces over the facet joints due to loss of disc height
 - Shirazie-Adl, 1992
- · Facet osteoarthritis may occur secondary to mechanical changes resulting from disc degeneration

- Butler et al. 1990

Piriformis Syndrome

- It is a syndrome of low back & leg pain due to ch. Contracture of the piriformis muscle that causes irritation of sciatic n
- Gluteal pain radiates to sciatic nerve
- It occurs by compression of nerve between ms. Or ms & pelvis

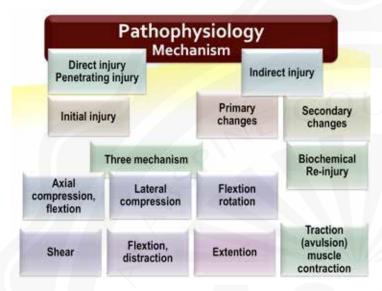


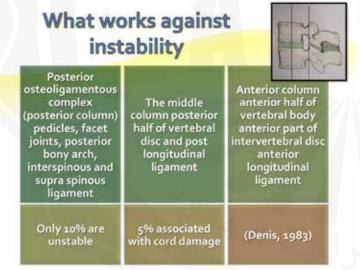
Basic Science and Pathology

UNDERSTANDING SPINAL INSTABILITY

Points of interest (Percentage)

- > 5% of spinal injuries have a second, possibly non-adjacent, fracture else where in the spine
- > Lateral view alone is inadequate and will miss to 15% of spinal injury
- > The combination of plain radiography and directed CT scanning provide a false negative rate of less than 0.1%
- Some studies of spinal trauma have recoded a missed injury rate as high as 33%,





When the spine becomes unstable Birth related problems Trauma Degenerative disease Tumors Spine surgery itself (latrogenic)

Questions

Was the spine normal prior to trauma?

Any underlying pathology? History of collagen disease?

The mechanism of injury

History of drug intake? **Psychological** background?

Types of traumatic instability



Chronic Overt instability Anticipated instability Covert instability

The stabilizing system of the spine (Personal view)

Manohar M Panjabi J. of Spine Disorders, Vol.5, No.4, 1992

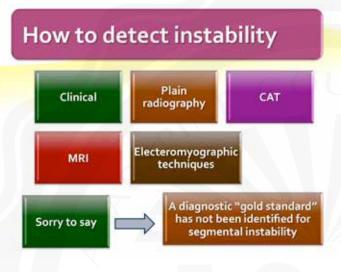
The passive (ligamentous) subsystem

The active (musculoskeletal) subsystem

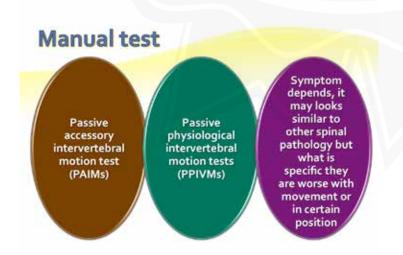
The neural control subsystem

So degradation of the spinal system may be due to, degeneration, and/or disease of any one of the system

Overtime, the consequence may be chronic dysfunction and pain







Massahiro Kanayama etal, Spine, Vol.28, No.20, 2003

Assessment of lumbar spinal instability

Disc angle in flextion and range of movement were the most prognostic parameters of lumbar distraction instability

Imaging studies



How useful is MRI in detecting instability

Very useful in the mind of everybody but Weisskopf M, etal 1999 Der Unfallchirurg; 102(12) says

MRI is only of limited value in diagnosing traumatic discoligamentous instabilities

Specific but not sensitive to ALL, PLL disruption

Gregory M Malham etal 2009

The ability of cervical MRI to detect surgically verified disruption of ALL, intervertebral disc, or PLL varied depending on the structure examined, MRI was sensitive but not specific for disc injury

Despite

Normal cervical alignment

Lack of bony lesion

Neurological recovery

MRI and dynamic studies may reveal marked transitional spinal motion segment instability requiring segment fusion

On CAT

Widening, slippage, or rotational abnormalities of the vertebrae suggest soft tissue injury, an absence of such signs appear to exclude significant instability























Compression versus Distraction





Flexion versus Extension views







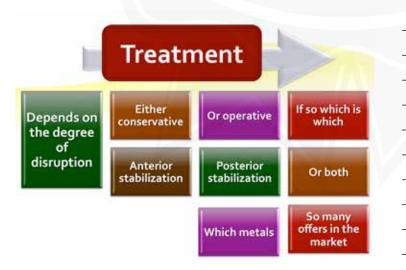


Post traumatic instability

Discogenic spinal instability

Lateral view alone is inadequate and will miss up to 15% of cervical spine injury





Treatment

Depends on where the gold is located

If the disruption is located posterior, posterior stabilisation and fusion is sufficient if the anterior is also affected, then both ways are required

(Supported by Oda. Spine, Vol.28, No.14, 2003)

Conclusions

Assessment of spinal stability is an important element of diagnostic work

Segmental instability in the coronal plane though rare should be not far away from our thinking

Much contraversy exists regarding the proper definition, the best diagnostic tool and the efficacious approaches

Clinical presentation is not specific Irrespective of the degree of instability

Conclusions

Clinical presentation is not specific

The relationship between radiological evidence of instability and its symptoms is controversial

Probably functional flextion extension radiography is the most widely used should be taken seriously

Treatment depends on many parameters, the corner stone is restabilization

INFORMED CONSENT



What is Informed Consent?

- The process of communication between a patient and physician that results in the patient's authorization or agreement to undergo a specific medical intervention (American Medical Association 1998)
- ...It's more than a signature on a piece of paper!
- Failure to obtain informed consent renders any U.S. physician liable for negligence or battery and constitutes medical malpractice



Why Do We Need Informed Consent?

- The Short Answer:
 - It's the law
- Beyond the Law
 - . It's the ethical thing to do
 - It's an access/diversity issue
 - It's a safety and quality of care issue
 - Patient identification
 - Procedure confirmation



Why Do We Need Informed Consent?

The Slightly Longer Answer:

- Greater patient safety and satisfaction
- Attainment of higher ethical standards and organizational morale
- Closer adherence to legal requirements and reduced risk of litigation
- Increased levels of institutional quality (e.g., compliance with accreditation standards)
- Potential time and money savings (or offsets) related to reduced litigation

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Who is Responsible for Informed Consent?

- The clinician has core responsibility...
 - ... a team approach is required with contributions from:
 - entire clinical staff (clinician, nurse, technicians, pharmacist)
 - administrative and clinical leadership
 - legal counsel



When is Informed Consent Required?

- In most institutions, for:
 - surgery
 - anesthesia
 - other invasive or complex medical or radiologic procedures
- Laws vary from state to state about exactly when and how formal informed consent must be provided.



Why Do We Need to Improve Informed Consent?

- Even after signing a consent form, many patients still do not understand basic information about the risks and benefits of their proposed treatment options.
- Patient Factors:
 - Low health literacy
 - Limited English proficiency
 - Cognitive impairments
 - Confusion about the purpose of consent process
 - · Feeling of intimidation, and stress or time pressure



Why Do We Need to Improve Informed Consent?

 Even after signing a consent form, many patients still do not understand basic information about the risks and benefits of their proposed treatment options.

Provider Factors:

- Lack of time for up-front patient education
- Overly complex or overly broad written materials
- Lack of support with interpreters
- Wrong assumptions about patient comprehension



Low Health Literacy — A Common Theme in Poor Clinician-Patient Communication

"It is likely the almost everyone has been, at some time, put off by densely worded forms, and confused by complex medical regimens, conflicting health care advice, poorly worded instructions, and medical speak that few on the receiving side of health care can understand".

m "What Did the Doctor Say?: Improving Health Literacy to Protect Patient Safety The Joint Commission, 2007 www.jointcommission.org



Low Health Literacy — A Common Theme in Poor Clinician-Patient Communication

- "Many leave the doctor's office with questions unspoken and unanswered..."
- "The communications gap between the abilities of ordinary citizens, and especially those with low health literacy and low English proficiency, and the skills required to comprehend everyday health care information must be narrowed".

From "What Did the Doctor Say?: Improving Health Literacy to Protect Patient Safety" The Joint Commission, 2007 www.jointcommission.org

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What's the Evidence that the Informed Consent Process is Not Working Well?

- Braddock et al 1999 ... found uninformed patients
- Audiotape recordings from 1057 physicianpatient encounters:
 - Only 9% of decisions were completely informed
 - Only 20% to 38% of the encounters met less stringent criteria for completeness



What's the Evidence that the Informed Consent Process is Not Working Well?

- Manthous et al 2003 ... found variability in use of informed
- National mailed survey of 117 intensivists and 56 internists:
 - Found heterogeneity in when physicians obtained informed consent
 - 74% to 93% for transfusion of blood products
 - 77% to 96% for common diagnostic procedures (e.g., lumbar puncture, paracentesis)
 Many physicians used a "blanket" consent forms to cover invasive medical procedures



What's the Evidence that Informed Consent Forms are Poorly Written?

- Bottrell et al 2000
- Analyzed 540 informed consent forms from

157 hospitals:

- Only 26% included all four elements (nature of procedure, risks, benefits, alternatives)
- Less than half of the forms provided specific information about risks
- Alternatives were noted only in 57% of forms



What's the Evidence that Informed Consent Forms are Poorly Written?

- Hopper et al. 1998
- 616 forms assessed by computer for readability
 - Average were written at grade level of 12.6
 - Just over half could be understood by patient with high school education
 - Only about 5% could be understood by patient with 8th grade reading level
- Lavelle-Jones et al 1993
- Interviewed 250 patients undergoing intrathoracic, intraperitoneal, or vascular surgery
 - 69% said they did not read the consent form before signing it



What are the Potential Consequences Lack of True Informed Consent

- Increased chance of a patient safety incident or medical error
- Increased chance for malpractice cases
- Violation of professional and ethical obligation to clinicians to communicate clearly



What's Needed for Informed Consent?

- The physician (not a delegated representative) should disclose and discuss:
 - The diagnosis, if known
 - The nature and purpose of a proposed treatment or procedure
 - The risks and benefits of proposed treatment or procedures
 - Alternatives (regardless of costs or extent covered by insurance)
 - The risks and benefits of alternatives
 - The risks and benefits of not receiving treatments or undergoing procedures

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How Much Needs to be Disclosed?

- Requires local interpretation, common sense
- Many states rely on a standard of what a "reasonable physician" would provide or what a "reasonable patient" would need
- Most laws describe the need to cover all "material" (i.e., significant) risks
- Information also needs to be tailored for each individual



What are the Main Barriers to **Effective Informed Consent?**

- Lack of clinician time
- Confusion among clinicians about when informed consent is needed
- Caution among physicians about giving too much information
- Perception of patients that the informed consent form is "just a legal release" for the doctor or hospital to proceed
- Patient unawareness that they can refuse the procedure or delay the decision



What are the Main Barriers to **Effective Informed Consent?**

- 6. Patient language and cultural issues
- Special patient circumstances
- 8. Poor quality of consent form and related educational materials
- 9. Patient inability to comprehend information on the informed consent form or related educational information about the proposed surgery or procedure
- ck

| 10. | Clinician | inability | to | detect | patient's | lac |
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What Can We Do to Improve **Our Informed Consent?**

- Redesign the informed consent process to include forms written in simple sentences and in the language of the patient
- Use 'teach back" during the informed consent discussion.
- Engage the patient in a dialogue about the nature and scope of the procedure



What Can We Do to Improve **Our Informed Consent?**

- Improve our written consent forms and related written educational materials:
 - Readability (5th grade level)
 - Layout/design
 - Language



What Can We Do to Improve Our Informed Consent?

- Improve our informed consent process:
 - Create the time for it
 - Simplify our language
 - Allow time for questions
 - Make sure the patient understands
 - Plan for language assistance in advance of appointment

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What Can We Do to Improve Our Informed Consent?

- Improve understanding of informed consent and the responsibilities and liabilities to health care organizations:
 - Train support staff, nursing, administrators, interpreters, etc.



What Can We Do to Improve Our Informed Consent?

- Improve your capacity to provide informed consent to patients with LEP:
 - Train interpreters to sight translate consent forms for patients with LEP
 - Assess whether interpreters have the ability to sight translate consent forms or informed consent discussions effectively
 - Assure the quality of translated consent forms



What Can We Do to Improve Our Informed Consent?

- Keep track of incidents related to informed consent process:
 - Use CQI processes to monitor incidents related to informed consent
 - Develop targeted remediation to identified problems

With Informed Consent..... It's Not About the Form

L.B.P. GUIDELINES



Outline

- Background
 - History
 - Call for development
- General Principles
 - Evidence Analysis
 - Levels of Evidence
 - Strength of Recommendation
 - Red flags
- Resources/Literature





Background

- Hazard R, Goal Achievement Model for LBP. Spine 2013;38:1431-5
 - 1996-2005 Med expenditure LB/neck
 - Social Security Disability Index LBP
 - · 1996- 20.6%
 - 2005 25.4%
- Nachemson A, LaRocca H. Editorial Spine 1987; 12:427
- Waddell G. A New Clinical Model for Tx LBP Spine1987;12:632





Low Back Pain Guidelines

- 1980's
 - AAOS/NASS
 - Algorithms
 - Consensus based
- 1994-AHCPR
- 2007-ACP/APS
- 2000's Workers Comp
- AAOS/NASS
 - Evidence based
 - · Coverage Recommendations
 - Appropriateness Criteria



American Academy Orthopaedic Surgeons North American Spine Society Algorithms / Red Flags



Critical Exclusionary Dx

(Red Flags)

- Cauda Equina Syndrome
- Severe Neuro Deficit
- Progressive Neuro Deficit
- Severe Progressive Symp
- Fracture
- Neoplasm
- Infection
- Previous Surgery-ongoing pain
- Chronic Pain Syndrome

CLINICAL GUIDELINES

Diagnosis and Treatment of Low Back Pain: A Joint Clinical Practice Guideline from the American College of Physicians and the American Pain Society

per Chou, M.O. Anno Quiseem, M.O. Ph.O. M.HA. Vincenza Snow, M.D. Dunald Casey, M.D. MFH, M.BA.; J. Th I Shakelle, M.D. Ph.O. and Douglas K. Owers, M.D. M.L. In the Chinald Efficacy Assessment Selectionselline Includes and Bis. American College of Physicians, Momentain Puls Society Lize Bick Flow Guidelines, Fanch'

Excommendation 1: Cinicans should conduct a focused history and physical examination to help place judicets, with low back pain into 1 of 3 linead categories, nonspecific few back pain, back pain potentially essential with readabagethy or spiral stenois, or back pain potentially essentially essentially with another specific spiral cause. The relative phocal include assessment of psychosocial risk factors, which projectly this for diverse disabling back pain titrong recommendation, moderate-quality endorse).

mountation 8: Clinitare should realisate patients with per-low lack pain and aigm or symplams of excludepility or storiess with magnetic resource imaging (perferred or what fromgaying only if they are potential considers for y or epidural stend injection for suspected subsculptuly



Low Back Pain Guidelines

Eur Spine J (2006) 15 (Suppl. 2): S192–S300 DOI 10.1007/s00586-006-1072-1

O. Airaksinen

J. I. Brox C. Cedraschi

J. Hildebrandt J. Klaber-Moffett

A. F. Mannion

S. Reis J. B. Staal H. Ursin

G. Zanoli

On behalf of the COST B13 Working Group on Guidelines for Chronic Low Back Pain

Chapter 4 European guidelines for the management of chronic nonspecific low back pain

Low Back Pain Guidelines Analysis

REVIEW

Josep M. Arnau Antoni Vallano Anna Lopez Ferran Pellisé Maria J. Delgado Nuria Prat

A critical review of guidelines for low back pain treatment



NASS Clinical Guidelines Available Products

- Clinical Guidelines
 - Clinical questions
 - Evidence analysis/tables
 - Strength of Recommendation
- Coverage Recommendations
 - Specific procedures
 - Evidence based
- Appropriateness Criteria
 - · Formal consensus methodology
 - Rand/Modified Delphi

| | | Levels of Evidence For Primary Research Question As Adopted by the North American Spine Society January 2005* | | | |
|---|-----------|--|---|--|---|
| | | Types of Mulici | | | |
| - | | Unexperies Studies— tereobjecting the proofs of technical | Prognostic Studies - to-cologisting the effect of a policies characteristic on the naturate of disease | Dispositic Stollers – Selectigating a disposite new | Economic soil Checonomic Anolyses — Developing as: as resemble or deconomic stooled |
| * | Leui | High quality randomized tool with interfacedly significant difference or no structurally significant difference that interfaced in the structural position of difference interpretable systems. Revolution of direct I BCTS could make growth proofs were histogramme. | High gooley proposition in a partial process of the process o | Tricking of pure wearly developed designation or constrain on consequence partners built an executify applied or freezest policy developed; Systematic review of Equal I shades | Senable cores and abstractives, values obtained them many studies, with auditious values and substance of control of Land Linkhar. |
| | Level II | Lever quelty NCI (e.g. 20% fidenous pur tribuding as amproper analysis of tribuding as amproper compositive attack). Prospective attack as a superpositive attacks with transmission positive. | Remogacitive study. Interested contents from an BCT Leavest speakly groups; the sample of a partners or subject, a partners or subject, a partners or subject, a partners or subject, and different prouts in flesh distance or subject, and the subject of the subject of Leavest II transfers of Leavest II transfers. | Chronisquant of diagnostic exteria on consumitive paramo both university applied relatency policy visualise] Systematic neversi- of Level III studies | Netratile costs and alternatives, relates stressed these limited medics; with auditory anothers Notestatic cortex* of Lavel II studies. |
| | Level III | Cest control study Extemporated comparation study Systematic tricks st Level III studies | Case control trody | thody of any- associatia prisons, without unassociaty applied reference "gold" manifed Nystemptic prisons of Lovel III Madies | Jandyses based on Sustain attenuatives and cores; and power estimates Systematic review ³ of Lanet III studies |
| | Level IV | Case Senso* | Case saties | Cine-cutril staty Post affermer emolycl | Audres with an acodony autyro. |
| | Lent V. | Espect Opsoning | Expert System | Digit Opinion | ExpertStreet |



NASS Clinical Guidelines Evidence Based

Grades of Recommendation for Summaries or Reviews of Studies

Good evidence (Level I Studies with consistent finding) for or against recommending

Fair evidence (Level II or III Studies with consistent findings) for or against recommending intervention.

Poor quality evidence (Level IV or V Studies) for or against recommending intervention.

There is insufficient or conflicting evidence not allowing a recommendation for or against intervention.



NASS Clinical Guidelines www.spine.org

Evidence Based Guidelines/

Tech Reports

- Lumbar Disc Herniation
- Lumbar Spinal Stenosis
- Degenerative Lumbar Spondylolisthesis
- Adult Isthmic Spondylolisthesis
- Cervical Radiculopathy
- Antibiotic Prophylaxis

NASS



Coverage Recommendations

- Cervical Epidural Steroid Injections
- Cervical Artificial Disc Replacement
- Cervical Fusion
- Cervical Laminoplasty
- Coccygectomy
- Electrical Stimulation for Bone Healing
- Endoscopic Discectomy
- Laser Spine Surgery
- Lumbar Fusion
- Interspinous Device with/without Fusion



NASS Appropriateness Criteria Formal Consensus/Rand Mod Delphi

- Cervical Fusion
 - Central Stenosis
 - Foraminal Stenosis
 - No Stenosis
 - Plate for ACDF
 - Posterior Decompression
 - Pseudoarthrosis
 - Soft Disc Herniation

State of Colorado **Dept of Labor & Employment Division of Workers Compensation**



Revised - October 15, 2013 Effective - January 1, 2014

Guidelines Task Force Chair: Dr Kathryn Mueller Methodologist/Evidence Development: Dr Ed Whitney

Low Back Pain Guidelines General Guidelines Principles

- Informed Decision Making
- Treatment Parameters Duration
 - Start date of Tx (not DOI)
- Positive Patient Response
 - Functional (not pain)-ROM,Strength,ADL
- Re-Evaluation of Treatment
 - 3-4 weeks
- Six Month time frame
 - Aim for RTW
 - Prognosis for RTW drops after 6 months



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Low Back Pain Guidelines General Guidelines Principles

- Surgical Interventions
 - "Cure... a misnomer"
 - Consider functional outcome (not pain)
- Return to Work
 - Considered therapeutic
 - Specific written physical limitations
 - Chronic pain not a contra-indication RTW
- Delayed Recovery
 - After Tx 6-12 wks /3-10% all WC pts
- Care Beyond MMI—not topic of guideline



Low Back Pain Guidelines Therapeutic Non Op

Specific indications/# Tx/time frame

- Acupuncture
- Biofeedback
- SI injections
- Radiofrequency Ablation

Not Recommended

- Prolo
- Intradiscal

Medications

Opiod Crisis



Low Back Pain Guidelines Imaging and Testing

- 1.5 T preferred
- Dynamic (flex-ext)not recommended
- Electrodiagnostics
 - EMG/NCS compliment imaging/Dx inj
 - Not recommend-surface EMG/SSEP
- Psych Eval
 - Consider @6-12 wks delayed recovery
- Discography
 - Pre-conditions
 - Needle damage disc? (Carragee 2009)





Low Back Pain Guidelines Therapeutic - Operative

Specific Indications

- Discectomy
- Fusion

Very Limited Indications

- Disc Arthroplasty
- Interspinous Spacers
- Kyphoplasty/Vertebroplasty
- Spinal Cord Stimulators

Not Recommended

- SI fusion
- Dynamic Neutralization
- Laser Discectomy/Percutaneous Disc
- IDET







References

- Dept. of Clinical Epidemiology and Biostatistics, McMaster University. How to read clinical journals. V. To distinguish useful from useless or even harmful therapy. CMAJ 1984;124:1156-1162.
- Hernan MA et al. Observational Studies Analyzed Like Randomized Experiments. Epidemiology 2008;19:766-779.

OUTCOME SCALES IN LUMBAR SPINE SURGERY

Introduction

- Integral part of spine surgery.
- Traditionally based on objective data and clinician subjective data.
- Recently shifted to patient reported outcome measures (PROM).

General Terms

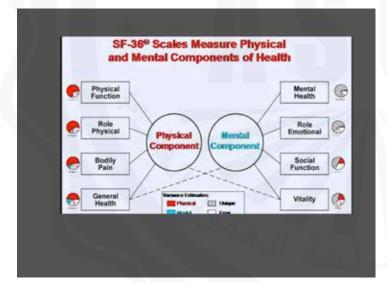
- Reliability: degree an outcome measure is free from measurement error. Cronbach's alpha 0.7-0.9
- · Validity:measure what it suppose to measure.
- Responsiveness:ability to detect change based on scoring.
- Minimal clinically important difference (MCID)

Categories

- · General quality of life
- Pain scale
- Disease specific

Short Form Questionnaire

- SF-36/12/6
- · Most commonly used general measure.
- · Good correlation with disease specific measures.
- · Global function status.
- · Powerful to compare different disease conditions.



EuroQol-5D

- · 1990 simple generic measure for both clinical and economical appraisal.
- scale 0-1

- · Solberg et al Eur Spine J 2005 useful for lumbar spine surgery
- · 150 languages
- · Revised 2005 to 5 levels to reduce ceiling effect.

| 121 |
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Pain Scales

- · Key sensory modality in back and leg pain
- · Numeric rating scale (NRS) 11 points.
- · Visual analog scale (VAS) 10 cm line.
- McGeary et al JBJS AM 2006 good predictive value for back pain.
- Parker et al J Neu Spine 2011 MCID VAS back 2.1-5.3/leg 2.1-4.7
- · Childs et al Spine 2005 MCID NRS 2 points.

Oswestry Disability Index (ODI)

- · 1976 John O'Brien.
- ISSLS 1981.
- · 4 versions most adapted Fairbank.
- · 10 subscales each 6 statements.
- pain/personal care/lifting /walking/sitting/ standing/sleeping/sex/social/travelling.

ODI

- 5 minutes scoring 2 min.
- · Well validated for back disability.
- · Translated many languages.
- · Copay et al Spine J 2008 confirmed responsiveness for lumbar surgery and MCID 12.8

The Oswestry Disability Index for Back Pain

Roland-Morris Disability Questionnaire (RMDQ)

- · 1983 assess physical disability with LBP.
- 24 items
- 0-24
- Jordan et al J Clin Epi 2006 MCID 2-3 or 30% reduction from baseline.
- · Weak in addressing psychosocial problems.

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RMDQ

- · Correlates well with other measures.
- · Cronbach's alpha 0.84-0.93 high internal consistency.
- · Complete 5 min.
- · Translations available.

When your back harts, you may find it difficult to do some of the things you normally do. Mark only the sentences that describe you today. It will be an estimates that disorder you takes.

[] I seek who are of the town because of my back and/or leg pain.

[] I seek more showly than social because of my back and/or leg pain.

[] I seek more showly than social because of my back and/or leg pain.

[] Secure of my back and/or leg pain. I see not delay any plat that is usually all around the back.

[] Measure of my back and/or leg pain. I see a should if your option.

[] Measure of my back and/or leg pain. I see also to see more when.

[] Measure of my back and/or leg pain. I because to half onto assembling to get out of a same of The decision of may be all more for against. I have to be that other committee to be perfect of all 1. The second of the committee of the committe 13) []] find it difficult to have over in find because of my back and/or leg pain

Summary

- · PROM are integral component of lumbar spine evaluation
- · Should include 3 categories.
- · Several tool available.
- · Best to use single measure to aid evaluation of treatment efficiency and disease severity.
- · Each measure has relative strength and weaknesses.
- established MCID.

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LUMBAR DISC HERNIATIOIN AND DEGENERATION: NATURAL HISTORY

Disclosures David A. Wong MD, MSc, FRCS(C)

Conflict of Interest:

- Stockholder
 - Denver Integrated Imaging
 - Huron Shores Investments LLC
- Research Funding (Group)
 - Mesoblast
- Consultant
 - United Healthcare
- Royalties
 - Lippincott



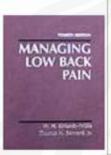
MRI Degenerative Normal

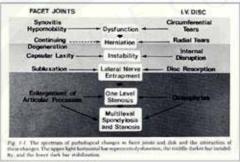




Wm. Kirkaldy-Willis Managing Low Back Pain-1983

Three Phase Concept - "Degenerative Cascade"





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Hernited Nucleus Pulposis

- Dynasty of the Disc (Mixter & Barr-1934)
 - 1930's 1940's
- Season of Stenosis
 - 1950's
- Era of Scoliosis
 - 1960's
- Reign of the Pedicle
 - 1980's



Herniated Nucleus Pulposis HNP



- 1% Pop/yr
 - (McCulloch 1996)
 - 10K/M pop/yr
 - (3M USA/yr)
- 2-4% Sx (Davis 1994)
 - 60-120,000 USA/yr
- Metro Denver
 - 2.9 million population
 - 29,000 HNP/yr
 - 580-1060 Sx/yr





Boden S et al. Abnormal MR Scans of the Lumbar Spine in Asymptomatic Patients. JBJS-A 1990; 72:403-408

| | Percentage of Subjects Who Had an Abnormal Finding | | | |
|-----------------------|--|----------------------------|----------------------------|--|
| | 20-39 Yrs. Old (N = 35) | 40-59 Yrs. Old (N = 18) | 60-80 Yrs. Old (N = 14) | |
| All abnormal findings | | | | |
| Reader 1 | 26 | 28 | 57 | |
| Reader 2 | 20 | 22 | 64 | |
| Reader 3 | 20 | 17 | 50 | |
| Average* | 22 (7) | 22 (3) | 57 (7) | |
| Herniated discs | 21 | 22 | 36 | |
| Spinal stenosis | 1 | 0 | 21 | |

Is Natural Hx of HNP to Shrink on Own? RCT Design/Reporting: **Effect of Crossover**

- Weber H. Lumbar disc herniation: a controlled prospective study with ten years of observation. Spine 1983;8:131-140.
- ISSLS Prizewinner
- Oft quoted indicating HNP treated non surgically does same as surgery at 10 years



RCT Herniated Disc Weber



- Worst patients operated on
- Removed from randomized group
- Crossover
 - Initial randomization –non op
 - Ultimately operated on did well
- Success non op Tx
 - Ultimately did well
- Failure of non op Tx
 - Clinically poor needed surgery





Effect of Crossover Intent to Treat Analysis

- - Crossovers to Sx/did well=non op success
- Bell recalculate
 - Crossovers = failure non op Tx i.e. as treated

| | Satisfactory |
|----------|--------------|
| 1 year | Non82/Sx91 |
| 4 years | Non90/Sx86 |
| 10 years | Non92/Sx93 |

Confirmed-Boos N, Spratt K. ISSLS 2003



Effect of Crossover Intent to Treat Analysis

- Weber
 - Crossovers to Sx/did well=non op success
- Bell recalculate
 - Crossovers = failure non op Tx i.e. as treated

| | Satisfactory |
|----------|--------------|
| 1 year | Non82/Sx91 |
| 4 years | Non90/Sx86 |
| 10 years | Non92/Sx93 |

Confirmed-Boos N, Spratt K. ISSLS 2003



RANDOMIZED TRIAL

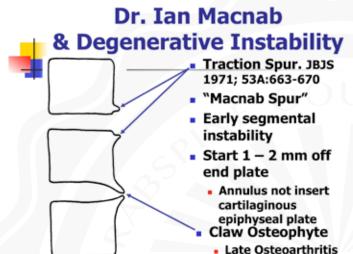
Surgical Versus Nonoperative Treatment for Lumbar Disc Herniation

Eight-Year Results for the Spine Patient Outcomes Research Trial

Jon D. Lurie, MD, MS, * Tor D. Tosteson, ScD, * Anna N. A. Tosteson, ScD, * Wenyan Zhao, PhD, * Tamara S. Morgan, MA, * William A. Abdu, MD, MS, * Harry Herkowitz, MD, † and James N. Weinstein, DO, MS*

- Crossover
 - 49% assign non op → surgery
 - 40% assign surgery→ non-op
- Intent to treat
 - Sx>non-op all measures x work/trend-NSD
- As Treated
 - Sx> non op all measures/statistically signif





Dr. Ian Macnab and **Spondylolisthesis**

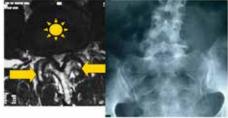
- Spondylolisthesis with an intact neural arch—the socalled pseudospondylolisthesis JBJS 1950;32B:325-333.
- Wiltse LL, Newman PH, Macnab I. Classification of spondylolisthesis. Clin Orthop 1976; 117:23-29.

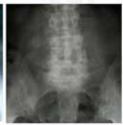






- 3 Joint Complex
 - Disc
 - 2 Facets
- Lumbo Sacral Stability
 - Seating L5 in Pelvis
 - Strength Ligaments
 - Level Degen Spondylo



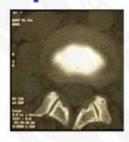


Degenerative **Spondylolisthesis** Flexion / Extension





Discogram L5-S1 Degeneration/Leak





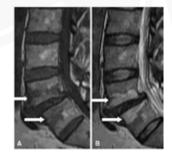
Modic I Hypointense T1, Hyper T2



- Hypointense
- T2
 - Hyperintense

Inflammation

- 8% pts post discectomy
- 40% post chymopapain
- Assoc active LBP
- Instability



Type II



- - Hyperintense
- - Isointense/Hyper
- Fatty replacement
- May develop from Type I
- Less assoc LBP
- More stable

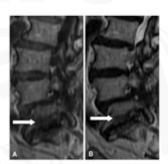


Type III

- - Hypointense
- - Hypointense



- Nature and Pathologic significance - Unknown
- ? Bony sclerosis



Modic

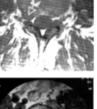
| | Modic I | Modic II | Modic III |
|--------|---------|----------------|-----------|
| MRI T1 | Нуро | Hyper | Нуро |
| MRI T2 | Hyper | Hyper/Isodense | Нуро |

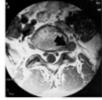
Identify Modic Type

- T2
 - Hypo = III
 - Hyper = I or II Look at T1
- T1
 - Hypo = I
 - Hyper = II

Foraminal/Far Lateral **Disc Herniation**

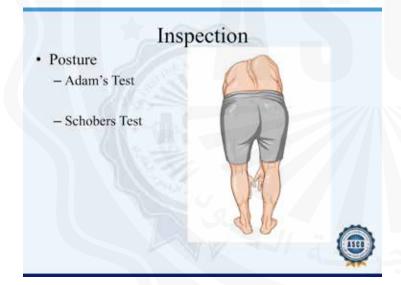
- Foraminal/Far Lateral Disc Herniation
 - Definition
 - Foraminal
 - Extraforaminal/Far Lateral
- Incidence
 - 5-10% surgical HD
 - McCulloch/Young
 - Essentials of Spinal Microsurgery

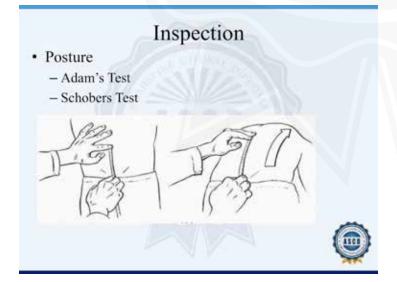




CLINICAL EXAMINATION

Disclosures/Disclaimer • Nothing to disclose





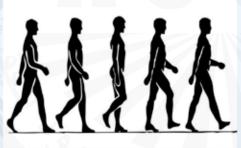
Inspection

- ROM
 - Forward Flexion 40-60
 - Extension 20-35
 - Lateral Bending 15-20
 - Rotation 3-18



Inspection

- · Gait
 - Adaptive Equipment
 - Bracing
 - Genu Recurvatum
 - Genu Varus
 - Genu Valgus





Inspection

- Atrophy
 - Lumbar Paraspinal
 - Lower extremity atrophy
 - · Myotome Pattern



Palpation

- · Spinous Processes
- · Muscle and tendons
- · Joints



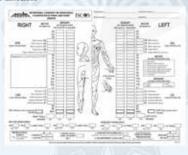
Neurologic Examination

- · Motor examination
 - ASIA Exam
- Sensory
 - Dermatome vs Peripheral Nerve distribution
- · Reflexes
 - -C5, C6, C7
 - L4, S1
- · Anal Reflexes



Neurologic Examination

- · Motor examination
 - ASIA Exam





Neurologic Examination

- · Motor examination
- · L1/L2: Hip flexion
- L2/L3/L4: Hip adduction, quadriceps
- · L4/L5: Hip abduction
- · L5: Great toe dorsiflexion
- · S1/S2: Foot plantarflexion
- · S2-S4: Rectal tone



Neurologic Examination

- · Sensory
 - Dermatome vs Peripheral Nerve distribution
- · Reflexes
 - -C5, C6, C7
 - L4, S1
- · Anal Reflexes



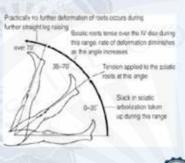
Test

- · Provocative Tests
 - SLR, CSLR
 - Slump
 - Facet Loading
 - FABER
 - Sacroiliac Joint Compression



Straight leg raise Herniated disc

- · Pain produced from 30-70 degrees
- · Sensitivity 91%
- Specificity 26%





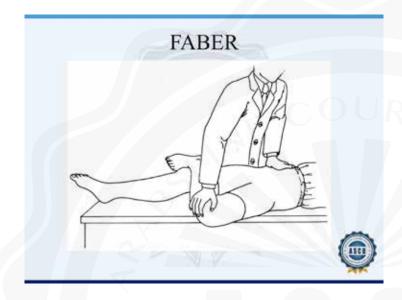
Facet Loading-Kemp Test

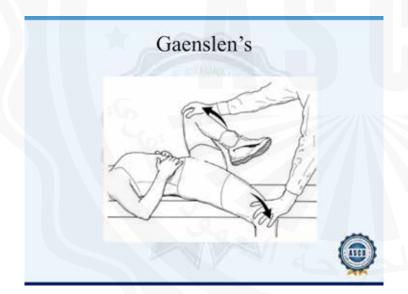


Sacroiliac Joint

- · FABER or Patrick's Test
- · Gaenslen's Test
- Compression









Conclusion

- · Complete examination is mandatory
- · Assist in organizing thought process
- Expands on differential
 - Many parts of the spine may be contributing to the complaint
 - Allows for provisional diagnosis





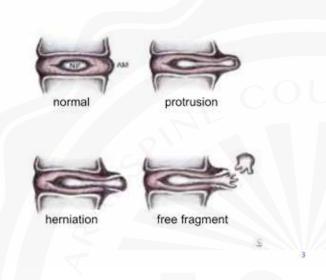
Lumbar Disc Herniation and Sciatica

IMAGING OF DEGENERATIVE SPINE DISEASE

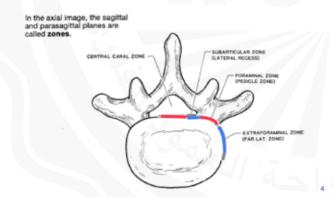
Description of a disc herniation

- Morphology
 - Bulging
 - Protrusion
 - Extrusion
 - Free fragment
- · Relation with PLL
 - Subligamentous
 - Transligamentous
- Volume
- Composition
 - Soft
 - Hard
- Location
 - Zones
 - levels

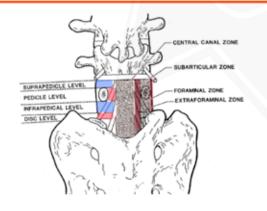
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Nomenclature zones and levels

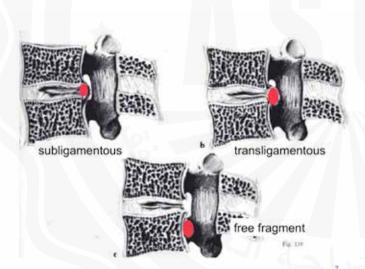


Nomenclature zones and levels



Relation with PLL complex

- · Subligamentous herniation
- · Translegamentous herniation (extrusion)
- · Free fragment

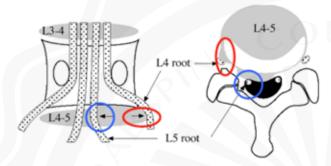


Axial disc herniation

- 1. Central herniation
- 2. Lateral recess (subarticular zone)
- 3. Foraminal or pedicle zone
- 4. Far lateral (extraforaminal)



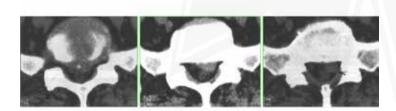
Far lateral herniation



Sagittal disc herniation

- · Herniation extends above the disc level (supraradicular Z)
- · Herniation extends below the disc level (infraradicular Z)
- · Free fragment

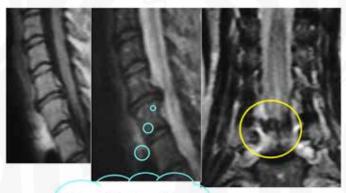
Migration below the disc level



Cervical disc herniation

- · Soft herniation
- · Hard herniation
- · Mixt herniation

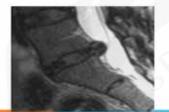
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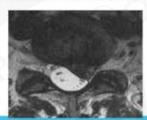


herniation? Osteophytes?

RADICULAR SYNDROME

In degenerative lumbar spine disorders Patients symptoms are related to back pain and/or Leg pain





Clinical presentation

30-50 y old

Acute back pain

Leg pain with or without sensory loss or motor weakness

(+) SLR right (NB: L5, S1 roots only)

(+) Crossed SLR right to left

Clinical prediction: S1 radiculopathy due to posterolateral lumbar disc prolapse

The goal of the history is

- 1. To evaluate the ratio of back/leg pain generating the discomfort of the patient
- 2. To analyze the characteristics of the pain, the distribution and if there is any true neurological weakness
- 3. To educate the patient re: diagnosis, natural history and treatment options

Neurological assessment will confirm

- 1. The peripheral syndrome (Versus central)
- 2. The root level according to the pain distribution; clinical examination is more sensitive and specific than nerve conduction studies
- 3. The presence of true neurological deficit
- 4. The monosynaptic reflex abnormalities
- Temporal characteristics (e.g. atrophy)
- 6. Consistency

ACUTE CAUDA EQUINA

True surgical emergency

"Triad"

bilateral sciatica

Urinary retention

saddle anesthesia

GU: retention, overflow incontinence

GI: constipation

Immediate imaging

Emergent decompression

48 hour data

40% with residual GU/ GI symptoms

Pathophysiology

- Mechanical compression: may be painless in the 1. absence of inflammation
- 2. Chemical neurotoxicity: Nucleus pulposus (TNFa) biochemical v. compressive:

continuous v. intermittent root tension burning dyesthesia

allodynia

| Root | Dermatome | Muscle | reflex | Diff Diagnosis |
|------|---|--|---|---|
| 12 | Inguiral ligament | Illopsoas | cremaster reflex | femoral palsy hip osteoarthritis pelvic disorder (i.e. psoas muscle) |
| is . | medial femoral and knee | femoral adductors, vastus medials of quadriceps muscle | adductor reflex | paralysis of obturator nerve pelvic disorder (aseptic necrosis of symphysis) hip osteoarthritis |
| 14 | lateral femoral and medial shank | vastus lateralis of quadriceps muscle | patellar reflex | paralysis of femoral nerve |
| LS | lateral shank | tibialis anterior muscle | tibialis posterior reflex | peroneal paralysis |
| 51 | dorsal shank, along heel into fifth digit of foot | gastrocnemius muscle | Achilles tendon roflex. | tibial paralysis tarsal tunnel syndrome |
| 52 | dorsal femoral | ischiocrural muscles | biceps femoris reflex | sciatic pain syndrome |
| 23 | proximal medial femoral | bulbocavemosus muscle and anal sphincter | bulbocavernosus and anal reflex | palsy of cutaneus posterior femoral nerve cucral plenus |
| 54-5 | * perineum | bulbocavemosus muscle and anal sphincter | bulbocavernosus and anal reflex | palsy of clunium medii palsy of anococcygei nerves (coccygea plexis) |

RECALL

Motor

Sensory

Reflex

Root tension

Hip-Spine

CES

Saddle anesthesia

Retention

Sciatica

NON OPERATIVE TREATMENT OF L.B.P. AND SCIATICA

Low Back Pain

- 60-90% of adults will have low back pain in their lifetime
- Of those, 55% o will have annual recurrences
- 2nd most common reason to see PCP

The Financial Bottom Line

- LBP accounts for \$25 billion in medical costs annually
- LBP contributes to another \$50 billion in non-medical costs each year

medical cost

non-medical cost

Low Back Pain Generators

- Muscles
 - Nerves
 - - DRG
 - dura
 - nerve root
- Facet jointsAnnulus
- Ligaments
 - -ALL
 - -PLL
 - -supra
 - -interspinous



Natural Course

- Most people improve, however a subset do not.
 - Radicular pain
 - 38 patients with symptoms and positive CT myelography: 58% symptom free within 30 days, 88% symptom free after 6 months
 - Retrospective study by the Saal brothers 52 patients: 95% good or excellent outcomes at 31 months
 - Consistent with radiologic follow-up 2/3 of herniated discs will resorb by greater than 50% within one year.
 - Acute axial pain
 - (n=973) After one year, 72% had fully recovered.
 - Factors associated with 28% persistence:
 - Older age
 - Greater baseline pain/dysfunction
 - Depression
 - Ongoing compensation claims

Ion-Operative Treatment of LBP and ciatica

- Non-interventional conservative care
 - Activity modification
 - Medications
 - Bracing
 - Physical Therapy
 - Chiropractic care
 - Acupuncture
- Interventional Procedures
 - Epidural steroid injections
 - Facet joint intra-articular injections
 - SI joint injections
 - Radiofrequency Ablation



- 1. Acute phase *
 - Management of Pain and Inflammation
 - Modalities
 - Patient education
- 2. Recovery phase
 - Flexibility
 - Strengthening
 - Body mechanics
 - Exercise

- Maintenance phase
 - Proper CV conditioning
 - Work-specific training
 - Ergonomic issues



Acute Phase-Low Back Pain

- Control Inflammation / Spasm
 - Relative rest
 - NSAIDs
 - Oral steroids for Radiculopathy
 - · Ice
 - Patient Education



Recovery Phase- Low Back Pain

- Teach proper Posture/Positioning/Body Mechanics
- Avoid Bedrest
- Encourage Activity
- Education and Reassurance

Recovery Phase-Exercise

- Medical practitioner directed active treatments have been shown to be effective for treatment of subgroups with LBP
- Yoga appears to be an effective non-physician directed exercise for LBP
- based on available evidence Structured exercise equally beneficial compared with
 - If no improvement after 8 wks of either, then treatment should be discontinued, reevaluate



Recovery Phase-Exercise

North American Spine Society Exercise Algorithm Task Force 2013

·Core stabilization

- Beneficial for subgroup of pts with clinical or radiographic instability
 Directional preference exercises (McKenzie / MDT)
 - Postural training and matched exercises in direction of preference
 - Beneficial for subgroup of pts with a directional preference

Cognitive functional motor control restoration

Beneficial for subgroup with maladaptive motor control patterns



Maintenance Phase- Low Back Pain

- Proper CV conditioning
- Work-specific training
- Ergonomic issues

Medications

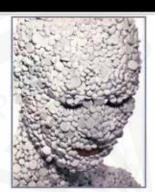
- NSAIDs or acetaminophen
 - short term for acute or chronic LBP
- Muscle relaxants
 - Short course (2 wks max) for acute LBP (cyclobenzaprine, methocarbamal)
 - Avoid carisoprodol and diazepam (high addiction potential and no benefit over less addictive meds)



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Medications

- Antidepressants (TCAs preferred, not SSRIs)
 - Chronic low back pain
- Antiepileptic (gabapentin)
 - Select pts with radicular symptoms
- Opioids
 - Short term for acute LBP
 - For chronic, use with caution and close monitoring



Bracing

- Recent systematic reviews of bracing for low back pain
- No sufficient evidence to support the use of lumbar supports to treat low back pain



Alternative Care

- Massage
 - Evidence supports its use for subacute and chronic LBP
 - Most efficacious when combined with exercise
- Acupuncture
 - Evidence supports its use for chronic low back pain as an adjunctive treatment
- Yoga
 - Evidence supports its use for chronic LBP
 - · Caution to avoid certain poses that may aggravate symptoms
- Tai Chi
 - Insufficient evidence
- Meditation
 - Insufficient evidence



Alternative Care

- Spinal Manipulative Therapy (SMT)
- Performed by osteopaths, chiropractors, and physical therapists
- Techniques vary
- Caution in pts with radicular symptoms
- Overall some evidence for limited temporary benefit



Nonpharmacologic Alternative

- Mindfulness Based Stress Reduction
 - Meditation
 - Yoga
 - Breathing
- Cognitive Behavioral Therapy
 - Training to change pain-related thoughts and behaviors
 - Key difference is that MBSR watch and disassociate yourself from thoughts and CBT you confront and address the content of the thoughts

Mindfulness- Based Stress Reduction

- Studied for over two decades
- Currently used in over 200 hospitals and medical centers to complement medical management of chronic pain
- Encourages patient centered care
- Patient engagement in daily self management of pain
- Recognizes that psychosocial factors play key role in how a person
- reacts and responds physically to pain
 Patients living with chronic pain feel that mind and body are in a
 constant battle with each other. This battle creates/ exacerbates
- Stress leads to increased
 - Inflammation muscle tension
 - Spasm
 - hypersensitivity to pain Increased heart rate

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- Guided imagery- imagination takes mind to a relaxing place. Helps to increase self confidence by patients imagining themselves being succesful at a task and reaching their
- Biofeedback- targets biologic components of stress
- hypnosis

Mindfulness- Based Stress Reduction

- MBSR techniques teach people to deal with this stress and address adverse life experiences by increasing awareness of breathing, thoughts and body sensations and learning how to observe and not react to them from a detached perspective
- Thought is that detachment creates objectivity which may lead to a deeper awareness of how mind and body interact to create life's experiences
- MSBR cultivates a greater awareness of the relationship between mind and body and how our negative thinking and emotions adversely impact our actions and our health This awareness leads to avoidance of mental and physical
- behaviors creating those adverse outcomes thereby reducing pain and stress

Mindfulness- Based Stress Reduction

- Hypnosis
- Progressive Muscle Relaxation
- Progressive Focused Breathing
 - Attention focused on timing and movement of
 - modulates activity in the Sympathetic nervous system
 - · Decreases levels of stress hormones

Cognitive Behavioral Therapy

- Psychosocial therapeutic method where behavior change is initiated by a therapist
- Explores the relationship between thoughts, emotions, actions, and pain.
- View is that an individuals interpretation, evaluation and beliefs about his health condition and his coping mechanisms, with respect to pain and disability, will affect the degree of emotional and physical disability associated with the pain condition
- Can be traced to Freud's exploration of the unconscious mind
- Origins began with Albert Ellis is the 50's. Termed it rational emotive behavioral therapy

Cognitive Behavioral Therapy

- Aaron Beck modified and Pioneered these concepts in the early 1960's and is regarded as the father of Cognitive Behavioral Therapy
- His theories are widely used in the treatment of clinical depression(<u>Beck Depression Inventory (BDI)</u>, <u>Beck Hopelessness Scale</u>, <u>Beck Scale for Suicidal Ideation (BSS)</u>, <u>Beck Anxiety Inventory (BAI)</u>, and <u>Beck Youth Inventories</u>).
- He found that depressed patients experienced streams of spontaneous negative thoughts. He termed these "automatic thoughts," and discovered that their content fell into three categories: negative ideas about themselves, the world, and the future.
- He helped patients identify and evaluate these thoughts and found that by doing so, patients were able to think more realistically, which led them to feel better emotionally and behave more functionally.
- He discovered key ideas in CBT, explaining that different disorders were associated with different types of distorted thinking which has a negative effect on behavior and that successful interventions will educate a person to understand and become aware of their distorted thinking, and how to challenge its effects.

Cognitive Behavioral Therapy

- Thoughts and behaviors affect ones ability to adapt to chronic pain and can change how your body responds to pain
- Control how your mind manages the pain as negative thoughts lead to anxiety, depression and increased pain
- Patients are taught how to identify negative thoughts and behaviors, monitor these and replace them with positive thoughts, and practice using positive thoughts and develop healthy thinking
 - Stress coping skills
 - Thought process correction(Correcting dysfuncional/negative thoughts and replacing with positive thoughts)
 - There is no standard protocol but a descriptor for a family of treatments

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Cognitive Behavioral Therapy

- Helps patients accept their chronic pain
- Sets realistic goals for management
- Teaches patients self management tools that significantly improve quality of life by keeping them active longer and restoring their sense of self fulfillment
- Management of pain is trending away from addictive medications and more toward mindfulness and cognitive behavior
- Concentrate on the emotional mental and social aspects of chronic pain as well as physical

Studies

- Rolving, Nielson, Christnesen out of Denmark
 - Does a preoperative cognitive behavioral intervention affect disability pain behavior, pain and return to work the first year after lumbar spinal fusion surgery—spine vol 40 number 9 2015
 - · Randomized clinical trial 90 patients at one year there was no statistical difference in control vs cbt group on oswestry index score however the cbt group at 3 months had significant reduction 15 point p=.003) did not translate into faster return

Studies

- Hanscom et al. Global Spine Journal Dec 2015 review of literature
 - Overview define the role of CBT in treating chronic low
 - Evidence that psychosocial factors negatively affect outcomes is irrefutable yet few surgeons assess or treat these issues
 - Methodologies need to be developed and documented to ensure that these factors and any mental health disorders are defined and treated prior to élective spine procedures especially in more invasive procedures sucha as fusions
 - CBT should be discarded as a term as it covers such a wide range of therapies

Injections

- Epidural Injections:
 - Interlaminar, Caudal and Transforaminal
- Facet Joint Injections
- Medial Branch Blocks
- Facet Joint Denervation
- Sacroiliac injections and arthrography
- Lumbar Disc Stimulation and Discography

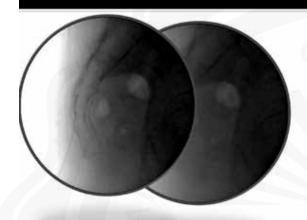
Fluoroscopy

- Only way to verify the medication is getting to the targeted pathology
- Increases patient safety
- Minimizes patient discomfort
- Numerous studies demonstrate that 25-35% of basic lumbar epidurals done without fluoro-"blind" miss the epidural space
- Fluoro allows one to target a specific side and nerve root
- Must be used for all diagnostic injections

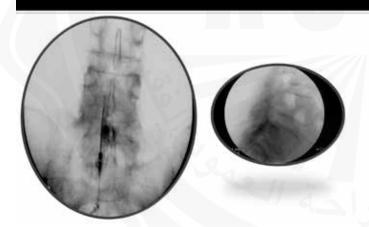
Epidural Steroid Injections

- Therapeutic Injections
- Diagnostic Injections

Caudal Epidural



Lumbar Interlaminar Epidural Injection



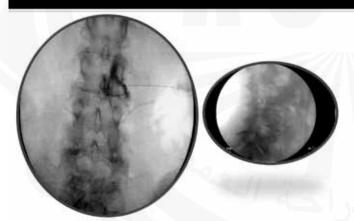
Diagnostic Injections

- Spinal Nerve Root Block/Transforaminal Epidural injections
 - By anesthetizing one nerve, can provide diagnostic information to guide eventual surgery (which level to decompress)

Diagnostic Blocks

- Help to determine or verify the etiology and location of a patient's pain
- The information gathered can then be used
 - Include or exclude a certain diagnosis
 - Guide treatment programs
 - Provide information for medical or legal issues
 - Expedite the diagnosis and treatment of specific injuries

Lumbar Transforaminal Injection



Do Epidurals Work?

- At Times, pending:
 - 1) Patient Selection and Diagnosis
 - 2) Appropriateness and Accuracy of injection
 - 3) May take > 1 injection

Epidural Injections: Summary

- Assess results after each ESI before proceeding (maximum of 3 in 6 weeks).
- No foundation for a routine series of 3 injections without regards to the prior results
- Fluoroscopic Guidance is a must!
- Literature supports the effectiveness of transforaminal ESI's for radicular pain but the literature is not or is much less supportive for the use of interlaminar ESI's.

Interventional Treatments for acet Mediated Pain

- Therapeutic
 - Intra-articular Facet Joint Injections
 - Radiofrequency Neurotomy
- Diagnostic
 - Medial Branch Blocks



Pathophysiology/Proposed **Etiologies**

- Hyperextension with DDD increases z-joint capsular loads
- Mechanical deformation may stimulate capsular nociceptors
- Micro-trauma, not seen on radiographic studies, may cause pain
- Osteoarthritis can cause pain

Interventional Treatments for Facet Mediated Pain

- Facet Joint Injections
 - Therapeutic and may be useful for acute or subacute LBP (i.e. traumatic arthritis)
- Medial Branch Blocks
 - Level I evidence for medial branch blocks for diagnostic accuracy in the lumbar spine and can help guide possible surgical intervention, level II evidence in the cervical spine
- Radiofrequency Neurotomy
 - Several studies: after appropriate diagnostic blocks, RFA leads to significant and sustained pain relief

Radiofrequency Ablation

- Radiofrequency ablation is indicated for pain with constant and limited distribution
- Interrupts nociceptive pathways
- Limited indications for neuropathic pain
- Tendency for recurrence 1-2 years; can be repeated



L2-L3 facet arthrogram



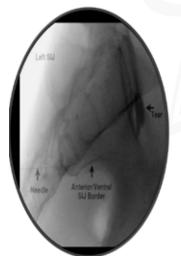
Sacroiliac joint Pain: Historical

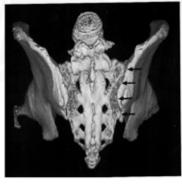
- Can it hurt?
- The SIJ was shown to be a potential source of lower back and buttock pain after pain was produced in asymptomatic volunteers via capsular distension

(Fortin JD, Spine 1994; 19:1475-1482)

Historical Background

The joint can <u>only</u> be reliably anaesthetized by intra-articular injection of local anesthetic





Sacroiliac joint injections

- SI joint injections under flouroscopy
- Both diagnostic and therapeutic
- Evidence to support short term benefits
- · ?PRP



Sacroiliac joint ablation

- Radiofrequency ablation 2008 RCT Cohen: 28 patients
- - L4 and L5 primary dorsal rami and S1-3 lateral branch RF ablation
 - 1,2,6 months
 - 79% (1 mo), 64% (2 mos), 57% (6mos) >50% relief vs 14% and o in control at 1, 2 mos 2012 RCT Patel: 51 patients
- - L5 primary dorsal rami and S1-S3 lateral branch ablation
 - · Treatment group showed improvements at 3 months, with benefits beyond 9 months



Patient Selection

- LPB that is maximal below L5
- With or without somatic referred LE pain
- When other diagnoses are not obvious
- Consider SIJ Block to confirm

PERCUTANEOUS TECHNIQUES FOR LUMBAR DISC HERNATION (LDH)

Lumbar Disc Herniation: Non Surgical V/s Surgical Treatment

Both may provide a successful outcome Nonsurgical: initial treatment of choice

70-90% improvement of symptoms with conservative management

Urgent indications for surgery are rare (cauda equina syndrome)

Surgery is associated with risks.

Consider:

MRI: 20-30%

LDH in asymptomatic patients

MRI: disc subsides over time (Matsuba 1995)

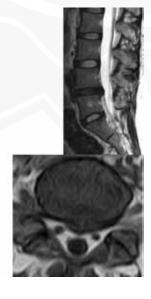




"There is a general trend in spine surgery towards minimally invasive techniques with minimized incisions, minimized length of surgery, short length of stay and cost reduction"

Contained DH:

may benefit from percutaneous intradiscal decompression techniques such as Nucleoplasty, Mechanical or automated Nucleotomy, PLDD and others



Involves injecting substances into the disc, evaporating or ablating components

- Chemonucleolysis 75,000 cases in USA in 6 months → Complications++
- · PLDD Percutaneous Laser Disc Decompression
- · Targeted Disc Decompression
- Nucleoplasty
- · Automated lumbar discectomy
- · Intradiscal Ozone Therapy ?
- IDET no more approved as technique...!!!

Success Factors

· Decompression (tissue removal as much as possible especially in large contained DH over 4 mm) -> Automated Nucleotomy

(shaver technique)

- Denervation effect on the annulus? In PLDD, Nucleoplasty, TDD, ???

Exclusion Criteria

- · Severe degenerative disc
- · Sequestrated and migrated disc
- LCS
- Instability
- · Infections and tumours

| 1 | _ | - |
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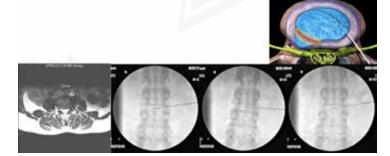


Technique

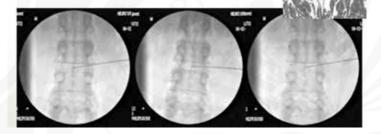
- · Needle placement: posterolateral
- · electrode or working canula is advanced behind anterior wall 5-7 mm
- · Make 8-10 channels 35º rotation each step, clockwise, ablate in and out (Nucleoplasty)
- · Navigate inside the nucleus with the curved tip (of the TDD Catheter)
- · Aspirate-shave disc material: different depths, different dissections

TARGETED DISC DECOMPRESSION

Focal decompression at the site of the herniation in contained disc herniation



- · 35 y. old male, 3 month history of Lt.leg pain with minimal LBP, failed conservative treatment including epidural infiltration.
- · MRI: Lt.contained disc herniation
- · Targeted disc decompression
- · 24months post-op. still doing fine

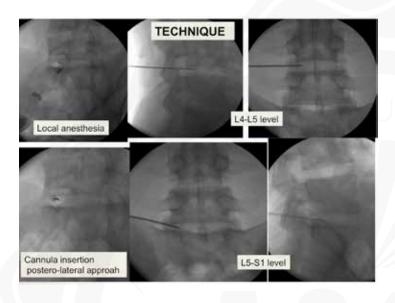


Percutaneous Nucleoplasty

- · For patients with discogenic low back and/or radicular pain from contained disc herniation
- · Coblation (controled plasma ablation)
- · Reasonable treatment for carefully selected patients
- · Quick, relatively safe, minimallyinvasive, no scar







Nucleoplasty

- · For treatment of chronic discogenic pain
- · Vijay Singh et al. Pain Physician , Volume 5, No. 3, pp 250-259. 2002
 - Results on 67 patients at 1 yr, 80% of patients improved.
 - · His conclusion: Effective procedure for patients presenting with discogenic back and/or leg pain who have failed conservative therapies and are not considered candidates for open surgical intervention.

Reference from Journal of Neurosurgery

Neurowarg Focus 13 (3):Acticle 7, 2002, Clink hore to return to Table of Cost

Alternative strategies for lumbar discectomy: intradiscal electrothermy and nucleoplasty

WILLIAM C. WILCH, M.D., AND PETER C. GERSZYEN, M.D., M.P.H.

monts of Neurological Surgery and Orthopundic Surgery, and the School of Rehabilizative n. University of Pintsburgh Medical Conner-Beatth System, Presbyterian University Hospi rgk, Pennyshania

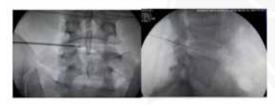
PLDD

- Same indications as Nucleoplasty, mainly contained DH
- Heat effects are more





Automated Nucleotomy





Percutaneous Automated Intradiscal Mechanical Nucleotomy (Shaver concept)





Post-operatively

- · Rest one day (muscle spasm if multi-levels: pain and muscle spasm is more ++)
- · No prolonged sitting for two (2) weeks
- Lumbar belt
- · They get better in few days (many get better in few hours)

| _ | |
|--------|----------|
| OM | ications |
| COILID | ILALIONS |

Related to needle placement:

trauma to neural, vascular or retroperitoneal structures

Thermal injury: could be avoided with proper needle placement and awake technique

Late complications: Discitis, epidural abcess and meningitis.

Guidelines for Intradiscal Treatment for Contained HNP/Discogenic Pain

- Absence of progressive neurological deficit
- · No cauda equina syndrome
- · Annular integrity (no sequestration or migration) results in better outcomes

(Ahlgren BD, et al: Spine 2000)

Predictors for a Good Post-Operative Status

- 1. Clinical picture
 - a. Radicular pain below the knee
 - Positive root tension signs (SLR, CSLR, FT)
 - Corresponding neurological signs
 - Asymmetrical depressed reflex
 - Decreased sensation in dermatomal distribution
- Proven LDH on Rx studies
- Preoperative interval < 3-4 months 3.
- High psychosocial status 4.
- Applied appropriate technique

Operator must be part of multidisciplinary team or must be a neuro-spine surgeon able to offer the correct technique to the corresponding pathology.

| 1 | 60 |
|---|----|
| | n |

Intradiscal Injection Techniques

<u>Advantages</u>

Disadvantages

TDD

Easy placement
Safe
Radicular pain in
contained disc herniation
?replace some microdiscectomy.

Focal decompression small treatment area,

LASER NUCLEOPLASTY Good decompression Effect on radiculopathy and contained DH Temperature control ?

AUTOMATED

Wide effective Decompression Not able to target Local herniation

Percutaneous Techniques: Results

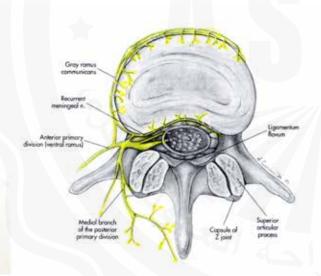
In our experience, in more than 150 patients: success may approach 75% for central or paracentral contained DH, results are better on leg pain than LBP

In foraminal and far lateral contained disc herniation the success rate didn't exceed 50%

Conclusion

- Percutaneous techniques helpful for contained DH in carefully selected patients
- · Safe, minimally invasive and cost effective
- Nearly all these techniques reported an average of 70% good results
- Techniques require meticulous selection criteria and good experience.
- Poor patient selection is by far the main cause of bad results of surgery for degenerative disc disease
- Failure of conservative treatment doesn't mean successful surgery





ENDOSCOPIC DISCECTOMY

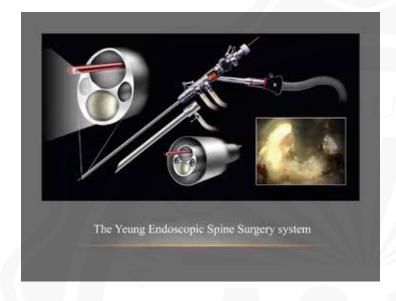
| When recommending surgery for lumbar disc herniation causing sciatica, the surgeon should be aware of general accepted concepts. | |
|--|------|
| Lumbar disc herniations are common ,1% of general population per year. McCulloch 1996 | |
| Approximately 2-4% of patients with disc herniations have indications for | JROA |
| surgical intervention. Davis et al 1994 | |
| 80-90% of the patients who experience a disc hemiation improve with conservative care. | |
| Saall 1989,Maige et al1992 | |
| Magnetic resonance image will reveal a disc herniation in approximately 20% of asymptomatic patients aged less than 60 years. Boden 1990 | |
| | |
| | |
| | |
| | |
| Surgical intervention will improve the short term outcomes for patients with | |
| sciatica ,But long term studies show little difference between groups of patients treated surgically and patients treated conservatively. | |
| Weber 1983,Atlas et al 2001 | |
| Surgical intervention for disc hemiation causing sciatica rarely is indicated before 6 weeks from onset of symptoms and should not be delayed to beyond 3-4 months from the onset of the symptoms. | |
| McCulloch 1996,Postacchini 1996 • The aging process ,which affects all lumbar discs will continue long after the | |
| patients undergo therapy. | |
| Scar tissue will result wherever the surgeon creates a wound. McCulloch 1996 | |
| | |
| | |
| | |
| | |
| | |
| Patients requiring lumbar disc herniation surgery may experience a long period of inactivity before surgery, which in turn may cause decreased muscle strength, impairment of the voluntary neural activation rate, impaired lumbar | |
| proprioception ,and postural control. Leinonen et al 2001 , Leinonen et al 2003 | |
| Back muscle injury after the posterior lumbar surgery has been demonstrated by computer tomography, electromyographic abnormalities, and by histological and | |
| enzymatic analysis (creatine phosphokinase MM isoenzyme). Kawaguchi et al in 1996,Nakagawa et al 2003 | |
| | |
| and the same of th | |
| | |

· From these widely accepted concepts, it is easy to comprehend the limited role of discectomy and, when indicated, the necessity to design a least-invasive, cost- effective approach (surgery carries with it a high rate of initial success [90% satisfactory outcomes] with limited risk to the patient and can be performed at a reasonable cost) to the surgical management of a lumbar disc herniation.

- Percutaneous access to the disc was first used in the 1950s to biopsy the disc using needles.
- Dissolving nuclear proteoglycans by the injection of chymopapain was the first percutaneous technique used to treat radicular pain caused by herniated nucleus pulposus, introduced in the 1960s by Lyman Smith.

ENDOSCOPIC DISCECTOMY

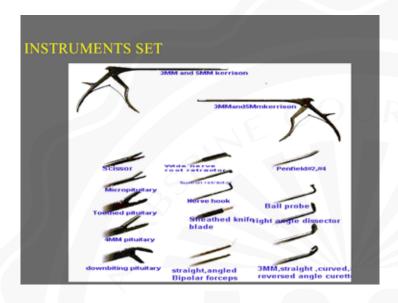
- Percutaneous access to the disc using endoscopic techniques was developed in the 1970s by Hijikata in Japan using a 7 mm cannulae placed into the center of a disc by a posterior-lateral approach and manually removing nuclear material.
- · Kambin in the United States developed arthroscopic techniques to access and remove posterior herniated fragments through a scope that included both working and viewing channels (biportal technique).
- · Anthony Yeung developed the first working channel endoscope to become widely available.

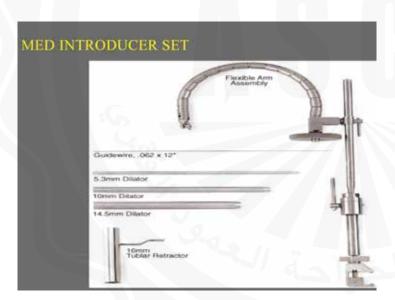


APPROACH:

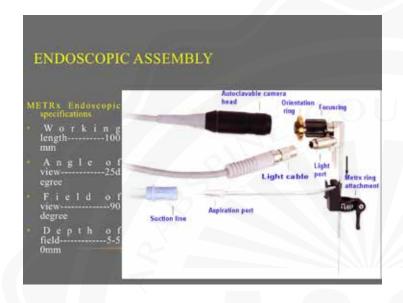
- Paramedian (interlaminar).
- Transforaminal.



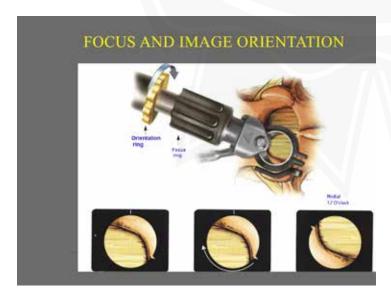


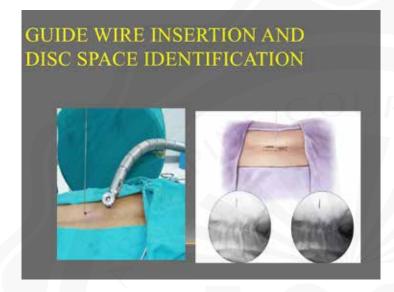














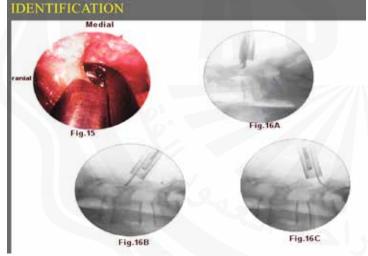


INSERTION OF THE ENDOSCOPE INTO THE TUBULAR RETRACTOR

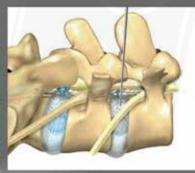




LAMINAR AND INTERLAMINAR SPACE



- Posterolateral endoscopic lumbar surgery is performed through what has been named the triangular working zone, or Kambin's triangle.
- The exiting nerve root is the hypotenuse of the triangle, the superior endplate of the caudal vertebral body/sacrum is the base (width), and the traversing nerve root/dura is the height of the triangle.



- The ideal lesions for posterolateral selective endoscopic discectomy are the foraminal and extraforaminal disc herniations but certainly, all contained disc herniations are appropriate for endoscopic decompression and any herniation contiguous with the disc space not sequestered and migrated is amenable to endoscopic disc excision if the anatomy permits an unobstructed approach.
- Current techniques and equipment include 30 and 70 degree fiberoptic endoscopes, shavers to decompress the lateral recess and foramen, and specialized suction shavers to quickly remove nucleus.

CONTRA-INDICATION:

- Infection.
- Cauda Equina syndrome or newly developed signs of neurological deficit.
- Uncontrolled coagulopathy and bleeding disorders.
- Relative contraindications (dependent on the surgeons' technical experience and comfort level):
 - Some sequestered and migrated disc herniations (migrated extent greater than the measured height of the posterior marginal disc space on T2 imaging [MRI]).
 - larger herniations occupying greater than 50% of the spinal
 - Recurrent disc herniations with associated epidural scarring.
 - Moderate-severe central canal stenosis, and hard calcified herniations.
 - The risks of serious complications or injury are low, approximately 3%. The usual risks are infection, nerve injury, dural tears, bleeding, and scar tissue formation.
 - There is potential for nerve irritation(dysesthesia) or overt nerve damage. Dysesthesia occurrence is 5% to 15% and is almost always transient. Routine injection of steroid medication at the conclusion of the endoscopic significantly.
 - The prolonged surgical time remain as matters of serious

- Yeung has reported his initial results using the YESS system in his first 307 patients with disc herniations who were candidates for open microdiscectomy.
- The study included intracanal and extracanal herniations. Recurrent herniations and patients with previous surgery at the same level were not excluded.
- Results were reported with 1-year follow-up. Overall patient satisfaction was found to be 91%. The same percentage of patients said they would undergo the procedure again if faced with the same diagnosis.

- Tsou and Yeung separated out a subgroup of 219 patients with noncontained herniations and reported results at 1 year. Patient satisfaction was 91%. These initial results demonstrated that endoscopic surgery could provide equivalent results to reported results of open microdiscectomy, even with noncontained herniations.
- Hermantin performed a prospective randomized study with 30 patients in each group (open and endoscopic). The mean duration of follow-up was 31 months. Patient satisfaction was 93% in the open surgical group and 97% in the endoscopic group.
- The endoscopic group had shorter duration of narcotic use and shorter time out of work compared with open discectomy.

- In 2008 Ruetten compared traditional microdiscectomy with full endoscopic discectomy. There were 178 patients (87 microdiscectomy and 91 endoscopic) with 2-year
- · The microdiscectomy group had a 79% success rate and the full endoscopic group had an 85% successrate with no leg pain at all.
- Our study of endoscopic discectomy performed on 30 patients who were candidates of discectomy without instability, spinal canal stenosis, recurrent disc prolapse or cauda equina syndrome with the results as follow:

- · Mild occasional leg pain was found in 20% of patients
- Residual LBP was found in 70% of patients (100%).
- Mild gait disturbance was found in 3.3% of patients
- No patient had positive straight leg raising postoperative
- 13.33% of the patients still had mild sensory deficit postoperatively (66.7%).
- Postoperatively 3.3% (one patient) still had mild motor weakness, another patient (3.3%) had severe motor disturbance patient had severe motor weakness preoperatively (50%).

LUMBAR MICRODISCECTOMY FOR LDH



Lumbar Microdiscectomy

For

Lumbar Disc Herniation









Disclosures David A. Wong MD, MSc, FRCS(C)

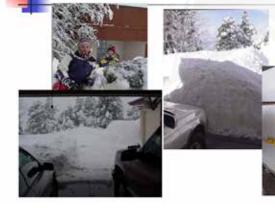
Conflict of Interest:

- Stockholder
 - Denver Integrated Imaging
 - Huron Shores Investments LLC
- Research Funding (Group)
 - Mesoblast
- Consultant
 - United Healthcare
 - Travena
 - Spine Stabilization Technoloies
- Royalties
 - Lippincott



Denver

St. Patrick's Blizzard 2003



Techniques for Optimizing Outcome and Safety in

"MIS" Discectomy

- Optimal Outcome
 - Analysis of pathology
 - Adequate decompression
 - Principal Anatomic Landmarks PAL's
- Safety
 - High speed burr
 - 3-0 curette
 - Ligamentum Flavum Anatomy
 - Wrong Site Surgery (WSS)
 - Radiation



Lumbar Herniated Nucleus Pulposis

HNP



- 1% Pop/yr(McCulloch 1996)
 - 10K/M pop/yr (3M USA/yr)
- 2-4% Sx (Davis 1994)
 - . 60-120,000 USA/yr

Incidence in UAE

- 5M population
 - =50,000 HNP/yr
 - =1,000 4,000 surgeries/yr

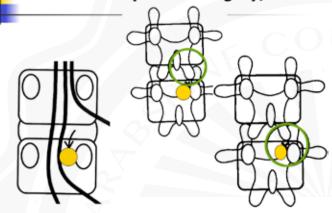








Critical Concept Microsurgery/MISS



Patho-Anatomy -**Medial to Lateral**

Macnab HIDDEN ZONES

Macnab I. Negative Disc Exploration. JBJS-A. 1971; 53(5): 891-903

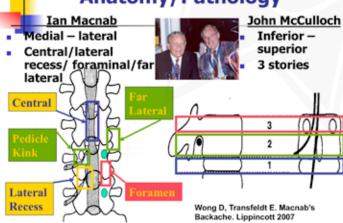
Hidden Zone

- Lateral recess stenosis
- Foraminal stenosis

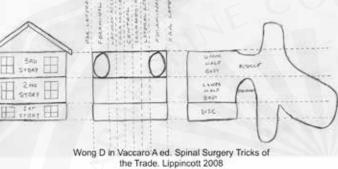
Hidden Zone

Far lateral HNP

Critical Concepts in Spine Anatomy/Pathology



Grid Orientation to Spinal Pathology



Read Axial Images CT/

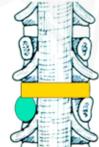
- Anterior
 - Disc density
 - **Bone density**
- Middle
 - Foramen hole
 - Pedicle bone
- Anterior
 - = 1st story Disc
 - Bone = 2nd/3rd story
- Middle
 - Foramen = 2nd story
 - Pedicle = 3rd story

"PALs" for Windows **Medial Laminotomy**



- Facet
- Pars Interarticularis
- Superior edge inferior lamina
- Canal
 - Pedicle
 - Disc





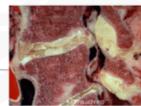
Wong Personal

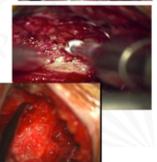
Collection

Wong D, Transfeldt E. Macnab's Backache, Lipponcott 2007

Key Technical Points

- Ligamentum Flavum
 - Attach superior
 - Undersurface of lamina
 - Attach inferior
 - Abut leading edge lamina
- Dural tears
 - Epid fat/ligamentum attenuate
 - Dura adhere to bone
- High speed burr
 - Side cutting AM-8
 - Align 90° to dura
- Ligamentum Flavum
 - Protect Dura





Micro-**Discectomy**

Ligamentum Flavum Anatomy

- Attach-Sup Undersurf/Inf Abut
- Hypertrophied Mushroom Cap
 - Separate hypertrophied layers from inferior
 - Resect
 - Keep last layer for dural protect
- Burr Sup Lamina 1st
 - Protect dura
 - Keep Ligamentum tension
 - Release upper first
 - Curette under to release point



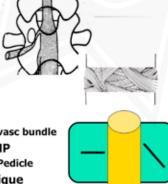
Wong D, Transfeldt E. Macnab's



Koebler.com

Discectomy Safety

- Canal Entry Medial
 - Fat/trefoil safer zone
- Identify
 - Pedicle 3rd Story below
 - Root adjacent to pedicle
 - Disc 1st Story
 - Lateral border of dura
 - Pars don't coagulate neurovasc bundle
- LOF Root flat over large HNP
 - ID Root every time! PAL = Pedicle
- Annulus incision Slit/Oblique
 - Rate recurrent HNP
 - Wong D, Transfeldt E. Macnab's Backache. Lippincott 2007 Anular Repair



Tubular Diskectomy vs Conventional Microdiskectomy for Sciatica A Randomized Controlled Trial



JAMA 2009; 302:149-158



tube 167/ micro 161

Wrong site surgeries

- Tube 1
- Micro 5

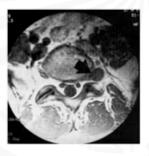


Spine (Phila Pa 1976). 2011 Feb 1;36(3):255-60. Radiation exposure to the surgeon during open lumbar microdiscectomy and minimally invasive microdiscectomy: a prospective, controlled trial.

Mariscalco MW, Yamashita T, Steinmetz MP, Krishnaney AA, Lieberman IH, Mroz TE.

MIS exposure

- Higher than microdisc
 - Thyroid/Eye
 - Chest
 - Hand
- Statistically significant



MINIMIZE SIDE EFFECTS IN LUMBAR DISC SURGERY

| MINIMIZING SID | E EFFECTS IN MICRODISCECTOMY | | |
|---|---|--------------------------|--|
| "TO ERR IS HUMA | AN" physicians are humans, | | |
| and they do ma | | OURSE | |
| Lumbar microdi | scectomy is considered | | |
| | out it may be associated | | |
| with many com | plications, side effects and | | |
| even death. | | | |
| Malpractice | issues in Neurological Surgery; Surgical Neurology, 65, 2006 | | |
| | by of 275 malpractice claims of dominate neurosurgical malpractice claims with a lumbar spine operations. | th | |
| Spinal Surgery Lumbar Cervical 30 Thoracic 15 Intracranial Surgery 18 Trauma Craniocerebral 27 Spinal 21 Failed Diagnosis Sentinel Bileod 10 Cerebral Lesion 10 Spinal Lesion 7 Aneuryam/ AVM 14 Lung Cancer 1 Infected Hip Wound 1 | Poor indications, inappropriate surgery increased pain/ disability, FBSS Cauda Equina/ nerve root, damage Wrong level CSF leak/ pseudomeningocele Delay Surgery Vascular/ Bowel Injury (1 death) Diskitis | 25 20 16 5 3 | |
| The two most impor and avoid side effect Selection criteria | tant factors to improve outcome ts and complications are: | | |
| Neurophysiologic Absence of marke Failure of well con | | | |
| Surgeons' expertise. | المراك المراك الم | | |

| Pre-existing comorbid conditions must be stabilized and | |
|---|----------|
| cleared before surgery | |
| Anticoagulants, Aspirin-plavix must be stopped (at least 5 | |
| days before surgery) to avoid excessive bleeding and | |
| possible post-op hematomas | KS_{E} |
| M- ASCH - IK | |
| MRI must be relatively recent (less than 3 months). | |
| MRI needs to be repeated: | |
| In case of clinical changes with New clinical signs, (possible displacement of the herniated fragments or possible new disc herniation or new pathology has | |

Minimizing Side Effects Step By Step

1. ANESTHESIA

happened).

- 2. RELATED TO THE POSITION
- 3. OPERATING THE WRONG LEVEL OR THE WRONG SIDE
- 4. EPIDURAL HEMATOMA
- 5. DURAL TEAR AND CSF LEAK
- 6. NERVE ROOT INJURY
- 7. PERSISTING OR RECURRENT SCIATIC PAIN

- 8. IATROGENIC INSTABILITY
- 9. INFECTION
- 10. MAJOR VESSELS INJURY
- 11. SYPMTOMATIC EPIDURAL ADHESIONS.
- 12. RECURRENT DISC HERNIATION
- 13. FAILED BACK SURGERY SYNDROME

1. ANESTHESIA

We do intubate elderly patients with the philadelphia collar in, or with fiber optics intubation to avoid neck hyperflexion and extension

In some patients it is done under Intraoperative Monitoring (especially if myelopathy or severe cervical stenosis)

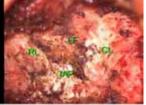
2. RELATED TO THE POSITION

We do use Wilson frame insuring free abdominal breathing. Chest-Knee position as good as Wilson Frame.

It helps opening the posterior disc space and the interlaminar space which facilitate the surgical access to the disc







All pressure points are covered with protection pads.

Neck position is verified to avoid bad posture and especially in elderly.

Eyes protection is verified.

Ulnar nerve compression (the most common) can be avoided by placing protection pads.

Peroneal nerve injury is prevented by avoiding hyper flexion and compression of the popliteal fossa mostly in knee-chest position.

Brachial plexus stretch injury: Avoid arms abductuin >90.

3. OPERATING WRONG LEVEL OR WRONG SIDE

More with single level

OR nurse repeat the oral confirmation: the side and level

Perform fluoroscopy before skin incision.

For higher levels L3-L4 and above: repeat the fluoroscopy before opening the ligamentum flavum and entering the canal.



| Analysis of the Techniques for Thoracic and Lumbar Level | |
|--|----------|
| Localization during Posterior Spine Surgery and the | |
| Occurrence of Wrong Level Surgery: | |
| Results from an online Survey study on 173 NASS members (including both orthopedic surgeons and neurosurgeons). | |
| (including both of those of surgeons and neurosurgeons). | R |
| W 2004 | |
| Wrong level exposure is documented in 0.32% to 15% of cases. | |
| Flouroscopy was the most commonly used imaging technique | |
| in lumbar surgeries (86%), radiographs (58%). | |
| 76 surgeons reported using both plain radiographs and plain fluoroscopy. The facet joint with corresponding pedicle was | |
| the most commonly used anatomic landmark for localization | |
| in lumbar surgeries (59%) followed by the spinous process (52%). | |
| (3270). | |
| | |
| | |
| | |
| | |
| Cause of localization errors | |
| Poor communication in the operating room, | |
| Failure to relocalize once the site is exposed | |
| Use of poor reference points URS | |
| Miscounting from a reference. | |
| Plain radiographs are associated with more errors than fluoroscopy. | |
| A COD | |
| Recommandations | |
| Using a localization time out, improving standard guidelines specific to spine localizations, and increased awareness of | |
| common sources of error. | |
| Pathologic level and fixed reference point must be visualized on the same radiograph. | |
| Real time fluoroscopy can be used continuously with direct or oblique | |
| projections that allow the surgeon to count "live" from a fixed reference point. | |
| | |
| | |
| | |
| | |
| | |
| 4. EPIDURAL HEMATOMA | |
| 4. ELIDONAL HEMATOWA | |
| a militar | |
| Check the noticet for subtle and subtles we blown | |
| Check the patient for subtle coagulation problems | |
| before surgery. | |
| Secure good hemostasis | <u>/</u> |
| Secure good helitostasis | |
| Use drain if needed. | |
| College of | |
| | |
| | |
| | |
| | |
| | |

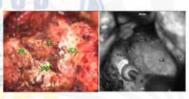
5. DURAL TEAR AND CSF LEAK

Work under magnification. Keep ligamentum flavum intact during the bony work,



CSF Collection and leak

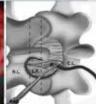
Use blunt dissector or upward curved fine currettes, when dissecting the dura from under the ligament and lamina and before using the Kerrison

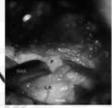


Godhi-RG, Laite LL. Unintended "Incidental" durotomy during surgery of the Is medica legal implications. Surg Neurol 1995, 43:4-14.

Protect the dura with patties especially if case of stenosis.







Repair any dural tear with 5/0 non-absorbable stitches using round needle,

Cover the dura with fat graft and glue Avoid drainage if possible

Maintain flat position 24 hours if possible

6. NERVE ROOT INJURY

Avoid excessive retraction on the root and dural sac.

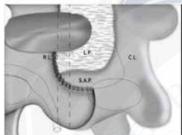
Use bilateral approach when very large central disc herniation, especially at L1-L2 and L2-L3 levels (risk of cauda equina)

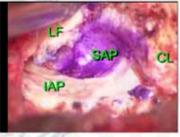
On pre-operative X-rays rule out spina bifida occulta and calcified disc herniation (don't hesitate to perform facetectomy and stabilize to avoid harmful retraction).

Avoid excessive coagulation nearby the root, use cooling irrigation.

Enter the disc rongeur in closed position while performing the discectomy.

7- Residual stenosis





Lateral Recess Stenosis: Frequent cause of persisting symptoms after lumbar spine surger Removal of medial part of SAP

8. IATROGENIC INSTABILITY

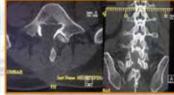
Stabilize if induced instability:

Massive discectomy in borderline degenerative spondylolisthesis or if

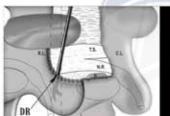
Excessive facetectomy or if

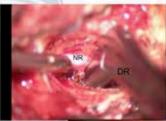
Over thinning or excision of the pars





Removal of foraminal disc to help decompression of exiting nerve root using curved disc rongeurs (D.R.) and right angled or curved dissector to avoid complete facetectomy





Foraminal disc removal to avoid instability by excessive facetectomy

9. INFECTION

Surgery must be delayed if there is any active infection.

Consider prophylactic antibiotherapy especially in diabetic patients.

Avoid prolonging surgery.

Respect rules of sterilization.

Treat CSF leak or collection seriously and rapidly



10. MAJOR VESSELS INJURY

On pre-op. MRI see if anterior annulus rupture

Avoid massive discectomy,

Use high magnification when working inside the disc. Keep feeling end-plate with the disc rongeour.

If possible use graded/color disc rongeur which indicate the depth



Think about abdominal vessel injury if:

Sudden unexplained drop in blood pressure

Abnormal bleed coming from the disc space.

If stable G.C. anterior perforation can be confirmed by exploring the disc space under microscope,

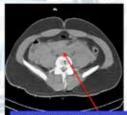
ask the anesthetist to insert more lines and to be ready for possible massive blood transfusion. Finish fast the actual Microdiscectomy, start the transfusion during the turning of the patient onto his back. It is expected to have another acute B.P. drop when turning the patients' to Supine position.

Be ready with ultrasound and radiologist inside the operating room.

Get an access surgeon or better the vascular surgeon inside the operating room at the same time (if you cannot manage a possible vascular injury)

If the ultrasound is not conclusive and the patient's general condition and B.P. are stable, do abdominal C.T. Scan (keep patient ventilated) and check for possible retroperitoneal bleed, if confirmed, proceed with the vascular repair.





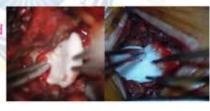
ullness of pre vertebral shadow masking he outline of the Aorta and IVC due to etroperitoneal hematoma

11. SYPMTOMATIC EPIDURAL ADHESIONS

Avoid excessive coagulation,

Cover the nerve root and the exposed dura by the available anti adhesive products (many are available in the market) or use fat from the same incision (still controversial).

Avoid residual or post-operative bleed



12. RECURRENT DH

- · Confirm recurrency, operation for scar alone is not helpful
- · MRI with Gado is the exam. of choice
- · If needed invasive investigation may be done: CT discography or CT myelography





FAILED BACK SURGERY SYNDROME (FBSS)

All previously mentioned complications are factors of failed back surgery syndrome. Patient selection is more important than most of the technical problems in FBSS.

Correct assessment is needed to get an accurate diagnosis, and if we find any treatable cause, such as recurrent disc herniation or instability, you do treat this pathology. If there is no treatable cause, spinal cord stimulation may help improving patient's pain and functions.

Spinal Cord Stimulation

CONCLUSIONS

Maximizing good results and minimizing side effects can be only obtained by the combination of

careful selection of the patient in association to

microsurgical expertise

Avoid operating in careless way +++

MIS FOR FORAMINAL AND EXTRA FORAMINAL **DISC HERNIATION**





Pathophysiology-Foraminal/Extraforaminal Dr. Ian Macnab

Negative Disc Exploration"



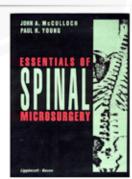
- **Hidden Zone**
 - Lateral recess stenosis
 - Foraminal stenosis



Extra foraminal/ Far lateral HNP

Foraminal and Extra Foraminal Disc Herniations

- Lateral Disc Herniation
 - Definition
 - Foraminal
 - Extraforaminal/Far Lateral
- Incidence
 - 5-10% surgical HD
 - McCulloch/Young



| 1 | Λ | - |
|-----|---|---|
| - 1 | 9 | |
| | | |



Analysis 3 Issues/3 Anatomic Factors

- How lateral is it?
- Associated foraminal stenosis?
- What Approach?

Anatomic Factors

- **Grid Reference** 1.
- **Hypertrophy Sup Facet**
 - Narrow disc
- Measure MiP/MAp Distance
 - Midline-Pars
 - Midline-Apex HNP





How Lateral Is It?

- Grid
- Foraminal
 - Far Lateral
- Level
 - Mid/Upper Lumbar
 - · L4-5 (50-60%)
 - · L3-4 (25-35%)
 - Lower Lumbar
 - · L5-S1(5-10%)
 - Foramen covered Relation
 - Pedicle
 - Pars





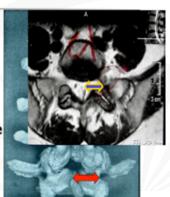
Associated Foraminal Stenosis?

- Hypertrophy **Superior Facet**
- Narrow disc
- **Pedicular Kink**
- Surgical Plan
 - Foraminotomy
 - Lateral
 - Open capsule
 - Tip superior facet
 - Medial



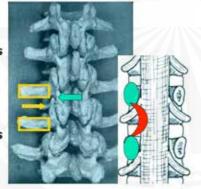
What Approach?

- Can I reach the disc?
 - Medial laminotomy
 - Far lateral
- Measure MiP Distance
 - Midline-Pars
 - Plain films
- Measure MAp Distance
 - Midline-Apex HNP
- Compare MiP/MAp
 - Pars intact 6-8mm



"PALs" for Windows Far Lateral

- External
 - Transverse Process
 - Pars Interarticularis
 - Superior Facet
- Internal
 - Pedicle
 - Pars Interarticularis





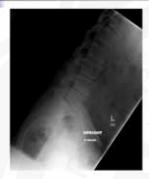
AP Lumbar

- AP Lumbar
- Minor degenerate scoiosis with collapse Left L4-5 foramen



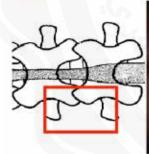


Flexion Extension Laterals



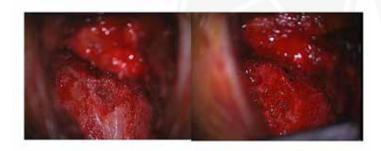


Intertransvers membrane cleared. Facet medial





Intertransverse membrane intact then folded back





Pituitary in Disc Space





Probing Foramen with long Ball Tip

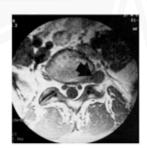


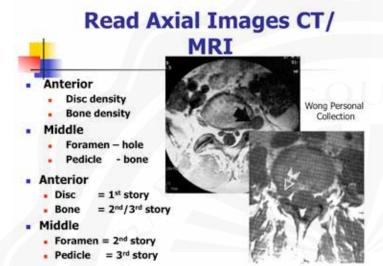




Tips, Tricks and Traps

- Ganglion Paresthesias
 - Lateral to foramen
 - Gentle manipulation of root
 - Pre-treat- steroids/lyrica
- Vascular
 - Bipolar vs. gelfoam/trombin
- Find
 - Pars medially
 - Exiting root hugs upper pedicle/TP
 - Disc above lower pedicle/TP





LUMBAR TDR AND DYNAMIC STABILIZATION

Rationale for TDR

- Adjacent disc Disease?
- AS Degeneration vs AS Disease
- Natural history ASDeg 3 to 4 % per year (Hassett

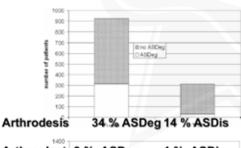
Lumbar Adjacent Segment Degeneration and Disease After Arthrodesis and Total Disc Arthroplasty

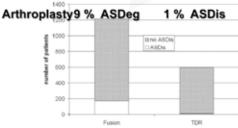
James S. Harrop, MD,* Jim A. Youssef, MD,† Mitch Maltenfort, PhD,* Peggy Vorwald, BS,† Pascal Jabbour, MD,* Christopher M. Bono, MD,‡ Neil Goldfarb, BS,§ Alexander R. Vaccaro, MD,* and Alan S. Hilibrand*

Study Design. Systematic review of published incidence of radiographic adjacent segment degeneration (ASDeg) and symptomatic adjacent segment disease (ASDis) after arthrodesis or total disc replacement.

1996-2006

"lumbar spine," "adjacent level degeneration," "adjacent level deterioration," "adjacent level disease," "spinal fusion," "total disc arthroplasty," "artificial disc"





J Neurosurg Spine 8:13-16, 2008

Patient selection for lumbar arthroplasty and arthrodesis: the effect of revision surgery in a controlled, multicenter, randomized study

Fred H. Geisler, M.D., Ph.D., Richard D. Guyer, M.D., Scott L. Blumenthal, M.D., Paul C. McAfee, M.D., Andrew Cappuccino, M.D., Fabien Bitan, M.D., and John J. Regan, M.D.

...clinical outcomes of patients enrolled in the CHARITÉ IDE trial who underwent revision surgery after primary TDR with CHARITÉ or ALIF...

The 7.1% of patients who underwent a secondary stabilization procedure had poor clinical improvement. This finding may indicate that if the alternative treatment had been the initial treatment, these patients would not have benefited, and further implies a 7.1% rate of imprecision in preoperative evaluation



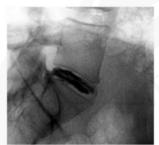




Loss of integrity of the disc cause LBP

A degenerated disc might be the source of pain

Supra segmental control of the Pain!



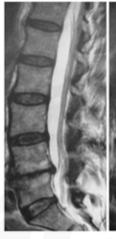


2009 ISSLS Prize Winner: Does Discography Cause Accelerated Progression of Degeneration Changes in the Lumbar Disc

A Ten-Year Matched Cohort Study

Eugene J. Carragee, MD,* Angus S. Don, FRACS,* Eric L. Herwitz, DC, PhD,† Jason M. Cuellar, MD, PhD,‡ John Carrino, MD,§ and Richard Herzog, MD¶

- · Discography using modern small needle disc puncture resulted in accelerated disc degeneration over 10-year follow-up compared to matched controls.
- Qualitative MR findings of new disc herniation, new endplate changes, and progression of disc degeneration grade were all found more frequently in discs exposed to disc injection.
- · Quantitative MR findings of disc height loss and nuclear signal loss were also greater in the discs exposed to disc injection.
- New MR findings for disc herniation were disproportionately found on the side of the disc injection compared to the contralateral side.
- · Careful consideration of risk and benefit should be used in recommending procedures involving disc puncture for diagnostic or therapeutic interventions.





BMI Multidisciplary evaluation Conservative treatments Facet evaluation (CT) information

Discogenic Lumbar pain

Treatment Goal:

- -Resect the pain source
- Reconstruct the segment
 - Rigid reconstruction: Fusion
 - · Dynamic reconstruction: Arthroplasty

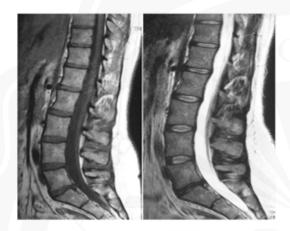
Rationale for arthroplasty

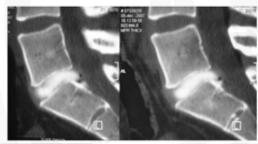
- Avoids stress being transmitted to AS
- · Counteracts early degeneration of AS

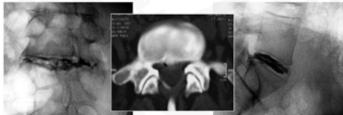




Ideal candidate









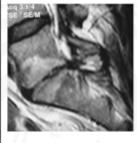


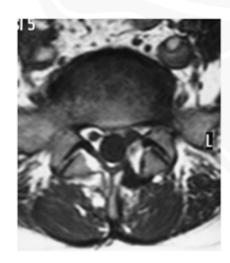
Controversies

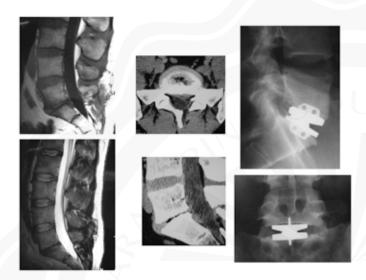
Post discectomy syndrome Multilevel TDR











Multilevel disc disease







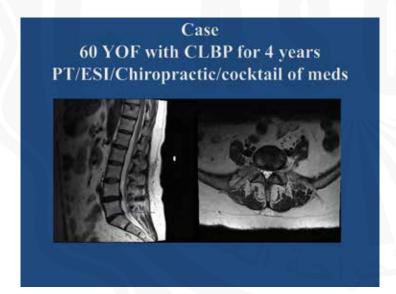


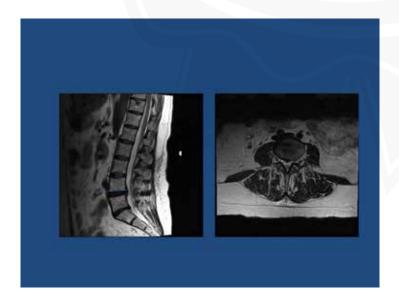
Conclusion

- · Patient's selection
- TDR could be an option (20% of DBP)
 - Discogenic, modic1, no facet arthritis, no deformity
 - Socio psychological parameters
- · Don't think fusion vs TDR!
- Surgeon part of multidisciplinay team
- · Patient has to deserve the surgery!

Lumbar Disc Herniation and Sciatica

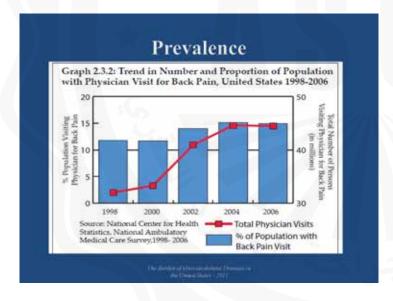
LUMBAR FUSION OPTIONS





Introduction -- LBP

- A major public health problem
- The leading cause of disability for people < 45
 </p>
- 2nd leading cause for physician visits
- 3rd most common cause for surgical procedures
- 5th most common reason for hospitalizations
- Lifetime prevalence: 49%–80%



Epidemiology

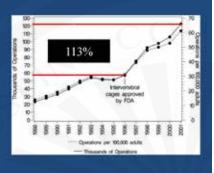
> High cost of low back pain 1996-\$33 Billion in direct medical expenses Much greater if indirect expenses counted Waddell, Spine 1996

2002-\$55 Billion in direct medical expenses

Pauza, ISIS 2002

Deyo et al. 2005, Spine

■ USA: 113% increase in number of lumbar fusion compared with 13-15% increase in THA & TKA between 1996 and 2001



Lumbar Fusion

Zdeblick. Spine 1993, p983-91, 124 patients entered into prospective study. Diagnosis included isthmic and degenerative spondylolisthesis, degenerative disc disease, degenerative scoliosis with spinal stenosis, repair of previous lumbar pseudoanthrosis.

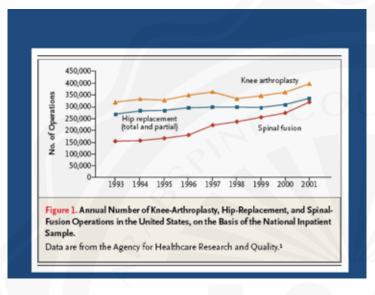
Group I: PL fusion without instrumentation.

Group II: PLF + semigrid pedicle screw system

Group III: PLF + rigid pedicle screw system

Lumbar Fusion

| Zdeblick: Spine 1993: Results | | Clinical outcome | | |
|-------------------------------|--------|------------------|------|-----------|
| | Fusion | exc | good | Fair/poor |
| Group I (no instr) | 65% | 49% | 22% | 29% |
| Group II (semirig) | 77% | 60% | 29% | 11% |
| Group III (rigid) | 95% | 70% | 24% | 5% |



Practice Guidelines

- Resnick D et al. Guidelines for the performance of fusion procedures for degenerative disease of the lumbar spine, J Neurosurg Spine, 2005 Jun;2(6):637-740
- Van Tulder M et al., European guidelines for the management of chronic nonspecific low back pain, European Commission Research Directorate General Cost Action B 13 Low Back: Guidelines for Its Management, 209 pages

Red Flags

- Older age
- Significant trauma
- Neurologic deficit
- Weight loss (unexplained)
- Substance abuse
- Ankylosing spondylitis
- Malignancy Hx
- Systemic steroids
- Fever (≥ 100)
- Persistent pain
- Compensation Issues

Yellow Flags (Prognostic Factors)

- ► Inappropriate attitudes and beliefs about back pain (e.g., back pain is harmful, or a high expectation from passive treatment)
- ► Inappropriate pain behavior (e.g., fear-avoidance and reduced activity levels)

Kendall et al 1997

Yellow Flags (Prognostic Factors)

- Work related problems or compensation issues (e.g., poor work satisfaction)
- ► Emotional problems (such as depression, anxiety, stress, tendency to low mood and withdrawal from social interaction)

Kendall et al 1997

Controversies in Lumbar DDD

- Etiology
- Diagnosis
- □ Treatment

Low Back Pain - Disorders

Mechanical Referred Rheumatologic Hematologic Infectious Neurologic Neoplastic Psychiatric Miscellaneous Endocrinologic

on D. Wood S. Bolon S. Lee Buck Part. Medical Disgreen, and Comprehensive Management, 1995

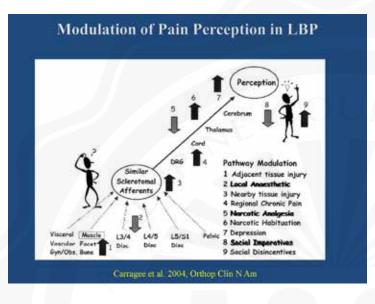
LBP

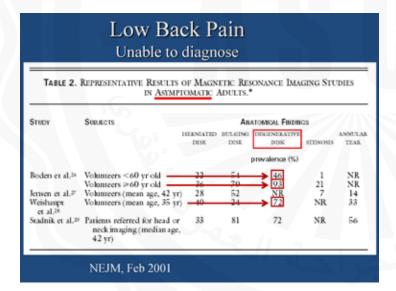
Natural History

- 443 LBP subjects postal questionnaire 12 months
- > 15 general practices Amsterdam, Netherlands
- 269 completed survey less pain answered less often
- 7 weeks-median time to recover
- At 12 weeks-35%, 52 weeks-10% had LBP
- > 75% had 1 or more relapses during study
- Pain and disability were less during relapses
- Time to relapse-median 7 weeks, duration-median 6 weeks

Low Back Pain Unable to diagnose

 "Up to 85% of pts cannot be given a definitive diagnosis because of weak associations among symptoms, pathological changes, and imaging results."





Anatomical Considerations

- Intervertebral Disks
- Facet Joints
- Musculoligamentous Sturctures: ALL, PLL and paraspinal muscles
- Neural Structures

MRI - High Intensity Zone "HIZ" Aprill and Bogduk 1992

- High T2 signal in the posterior or posterior-lateral annulus in discs that caused pain during a subsequent discogram
- Purported to be highly specific for discogenic LBP illness (PPV=90%)

HIZ Annular fissure with high-intensity signals L5

2000 Volvo Award Winner in Clinical Studies Lumbar High-Intensity Zone and Discography in Subjects Without Low Back Problems Expece J. Carrigue, MD, Steve J. Paragioudokis, MD, and Sargey Khurana, MD

- MRI (looking for HIZ) then discography
- 109 discs in 42 symptomatic patients vs 143 discs in 54 asymptomatic group
- % of HIZ:
 - 59% in symptomatic, 25% in asymptomatic
- % of HIZ lesions positive in discography:
 - 73% in symptomatic vs 70% in asymptomatic
- Not pathognomonic as advertised

Treatment Options

General

Bed Rest NSAIDs

Anti-depressants Physical Therapy
Orthotics Chiropractic Muscle Relaxents
Prolo-therapy IIIII

Referral for Surgery

Clinical question: what are the indications for referral for surgery based on the effectiveness of surgical treatments compared with non-surgical treatment or no treatment on pain, functional disability or psychological distress?

Treatment Options Surgery

Surgical:

- · Fusion vs Arthroplasty vs Dynamic Stabilization
- Fusion: ? approach, ? graft, ? instrumentation
 - Open vs MIS
 - Approach: ALIF, PLIF, Circumferential, TLIF
 - · Graft: allograft, autograft
 - Instrumentation: need? type?
- · Arthroplasty: Total Disc vs Nucleus Pulposus
- · Dynamic Stabilization

Rationale of Fusion

■ To eliminate pathologic segmental motion and its accompanying symptoms, especially low back pain

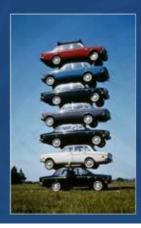


What Does The Literature Say?

Cochrane Review - Surgery for Degenerative **Lumbar Spondylosis** Gibson & Waddell, August 2005

- Surgery for back pain: 8 RCTs
 - 2: surgery vs no surgery
 - 3: intra-discal electrotherapy
 - 3 RCT: arthroplasty
- No pooled data because of heterogeneity of procedures

VOLVO and Spine Fusion



2001 Volvo Award Winner in Clinical Studies: Lumbar Fusion Versus Nonsurgical Treatment for Chronic Low

A Multicenter Randomized Controlled Trial From the Swedish Lumbar Spine Study Group

- 294 patients, 19 centers, over 6 yr
- Strict criteria: LBP > leg pain, > 2 yr, no nerve root compression, and failure of non-surgical treatment
- "equivalent" major disability) for at least 1 yr
- Randomized into 4 groups: 72 conservative, 222 had one of 3 fusion sx (PLF, PLF+instrument, ALIF or PLIF)
- 98% follow-up at two years.

Fritzell et al. 2001, Spine 2 yr Results

- Excellent or Good: 46% of surgery vs 18% of conservative (P=0.0001)
- More surgical patients rated their results as 'better' or 'much better' (63% versus 29%) (P=0.0001)
- Significantly greater improvement in pain (VAS) and disability (ODI) in surgery groups
- The "net back to work rate" was significantly in favor of surgery (36% versus 13%) (P=0.002)
- No significant differences in any of these outcomes between the three surgical groups.

Critcisim to the Fritzel Paper

- Surgery
 - · Imaging studies were not unified
- Physical therapy
 - Not structured/specific

Lumbar Fusion

FAIRBANK, J. ET AL, 2005

- 349 participants aged 18-55
- Chronic low back pain of at least one year's duration who were considered candidates for spinal fusion.
- The primary outcomes were
 - after randomization.
 - > The SF-36

- 176 to surgery and
- 173 to rehabilitation.
- 284 (81%) provided follow-up data at 24 months.
- ODI changed favorably from
 - Surgery 46.5 to 34.0)
 Rehab 44.8 to 36.1

 - The estimated mean difference between the groups was 4 1(95% confidence interval 8 1 to 0.1, P = 0.045) in favor of surgery.

Lumbar Fusion

BROX, LETAL, 2003 NORWEGIAN TRIAL

- 64 patients (25–60 years)
 - Low back pain lasting longer than I year
 - Evidence of disc degeneration at L4-L5 and/or L5-S1
 - Randomized to either.
 - Lumbar instrumented fusion and postoperative physiotherapy
 - or cognitive intervention and exercises
- Results:
 - The ODI was reduced from

 - 42 to 30 after cognitive intervention and exercises (P 0.33)
- Conclusion: The main outcome measure showed <u>equal</u> <u>improvement</u> in patients with chronic low back pain and disc degeneration randomized to cognitive intervention and exercises, or lumbar fusion

Brox et al, 2003

- No significant differences in any of the main outcomes of independent observer rating, patient rating, pain, disability or return to work
- Radiating leg pain improved significantly more after
- At one-year follow-up, the conservative group had significantly:
 - · Less fear-avoidance beliefs
 - · Better forward flexion
 - · Better muscle strength and endurance

Lumbar Fusion

IBRAHIM, T. ET AL, O., 2008

- One meta-analysis of Spinal Fusion vs. non-surgical treatment

 3 RCTs using ODI as the main outcome measure.
- Showed overall benefit of surgery when compared to other treatments for those with severe pain lasting longer than 1 year.
- The meta-analysis, showed a benefit from surgery of 4.87 (95%C1 1.62 to 8.12 P=0.003) as measured on the ODI.

Conclusion

- Spinal fusion should be reserved for:
 - A small group of selected individuals
 - combined physical and psychological intervention
 - > Where referral for an opinion on spinal fusion may be appropriate.

Lumbar Fusion

MIRZA, S. ET AL 2007

- One systematic review reviewed the efficacy of lumbar fusion surgery for chronic back pain treatment.
- RCTs comparing
 - surgical to nonsurgical treatment for discogenic back pain
- Comparators were non-surgical treatment, such as physical therapies, cognitive interventions and intensive rehabilitation, and outcome measures included VAS, ODI.

- Result:
 - Surgical procedures may be more efficacious
 - > When compared to unstructured nonsurgical
 - Not so when compared to structured cognitive behavior

Cochrane Review - Surgery for Degenerative **Lumbar Spondylosis**

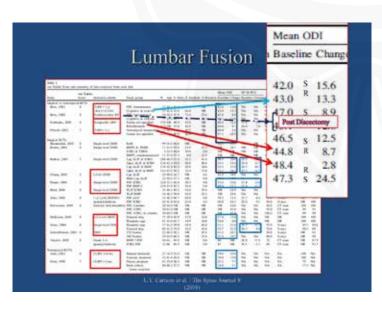
Gibson & Waddell, August 2005

- Comparison of fusion techniques: 15 RCTs, very heterogeneous
 - 8: instrumentations
 - 4: approach
 - 3: electrical stimulation to enhance fusion

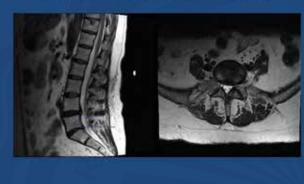
Cochrane Review - Surgery for Degenerative **Lumbar Spondylosis**

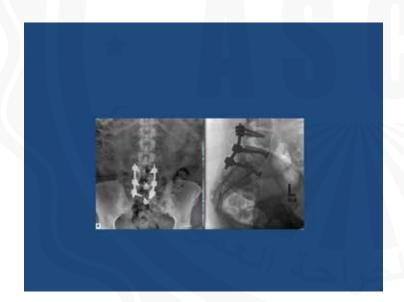
Gibson & Waddell, August 2005

- Most of RCTs report short-term, technical, surgical outcomes rather than patient-centered outcomes
- Although high fusion rate, but not necessarily longterm good pain control
- Authors' conclusions: Limited evidence is now available to support some aspects of surgical practice



Case 60 YOF with CLBP for 4 years PT/ESI/Chiropractic/cocktail of meds





Summary > LBP - 80-90% of people experience > High cost to society - and rising \$33 - 55 Billion in direct costs alone > Can be difficult to diagnose, psychosocial overlays





Please refer to Book of DAY-2 (MODULE-1) for continuation...





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