ARABSPINE COURSE DIPLOMA

Module 1

Course Highlight Day-1

Lumbar Spine: Basic & Practice Essential

Lumbar Disc Herniation & Sciatica

Lumbar Canal Stenosis

Spondylolisthesis

Axial Back Pain/ Sacroiliac Join Pain

Facet Joint Pain, Evidence, Outcome & Clinical Pearls

NASSi ADVANCING GLOBAL SPINE CARE

ArabSpine

RCSI

Dubai, UAE

Dear Participant,

It is our great 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 with O-Arm Imaging.

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. Zoher Ghogawala
President
North American Spine Society

Prof. Richard Assaker
Chairman
ArabSpine Educational Committee

Prof. Ciaran Bolger
Head of Clinical Neuroscience
Royal College of Surgeons in Ireland (RCSI)

Prof. Abdul Karim Msaddi
Chairman
ArabSpine Course Diploma (ASCD)

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 hands-on training in spinal surgery.

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

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

We believe that the 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 & Degenerative 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 Care Related Physicians.

Prof. Richard Assaker
Chairman of Educational Committee (ASCD)

Continuing Medical Education (CME) Credit

This activity has been planned and implemented in accordance with the Essential Areas and policies of the Accreditation Council for Continuing Medical Education through the joint providership of the North American Spine Society and ArabSpine. The North American Spine Society is accredited by the ACCME to provide continuing medical education for physicians.

The North American Spine Society designates this live activity for a maximum of 13.5 AMA PRA Category 1 Credits™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

The American Medical Association has determined that physicians not licensed in the US to participate in this CME activity are eligible for AMA PRA Category 1 Credits™.

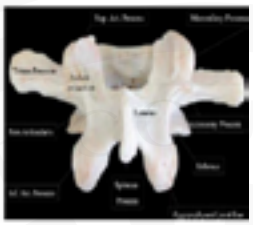
This activity is also accredited by Dubai Health Authority, designating 22.5 CME Credits for this Module.

CONTENTS

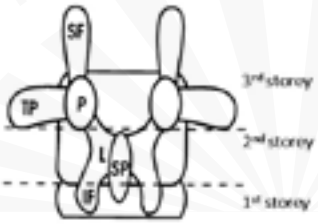
MODULE 1 - DAY 1

Surgical Anatomy of the Lumbar Spine

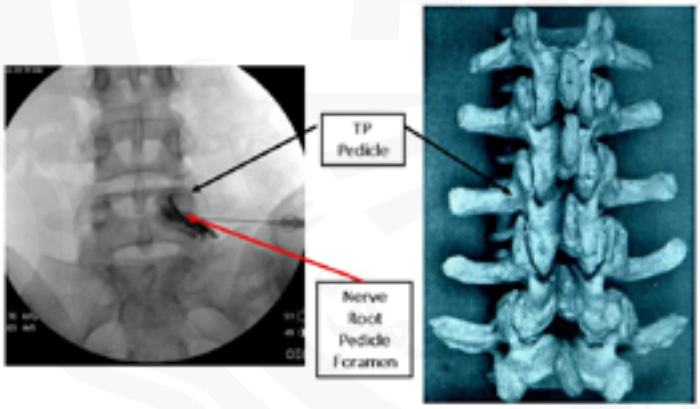
Principal Anatomic Landmarks
McCulloch "PALs"



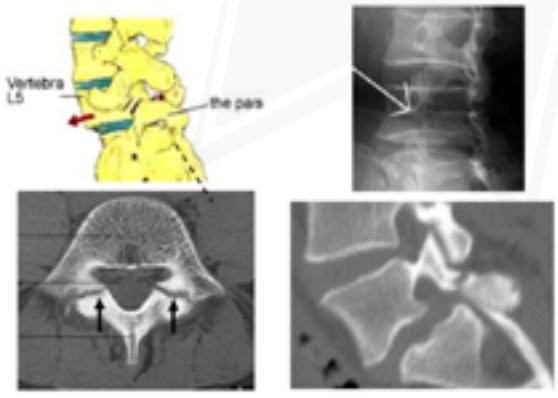
- Motion Segment=3 stories
  - Disc-1st storey
  - lower body/and foramen 2nd
  - Upper body/and pedicle 3rd
- Structural relations
  - Pedicle @ base TP
  - Pars Interarticularis
  - Foramen
  - Nerve Root



Pedicle at Base Transverse Process-TP
Root hug medial/inferior pedicle

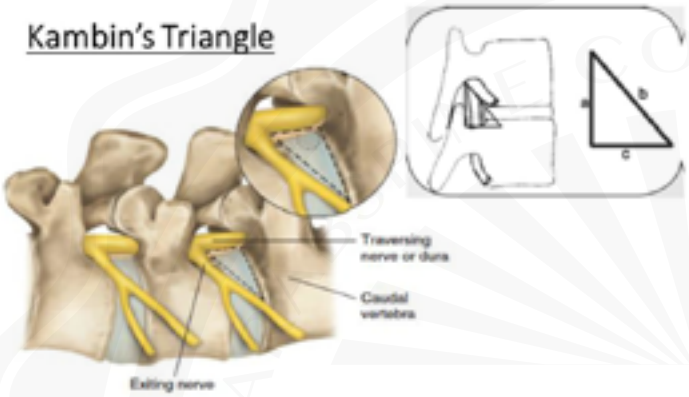


Pars Interarticularis
Spondylolysis/Spondylolisthesis



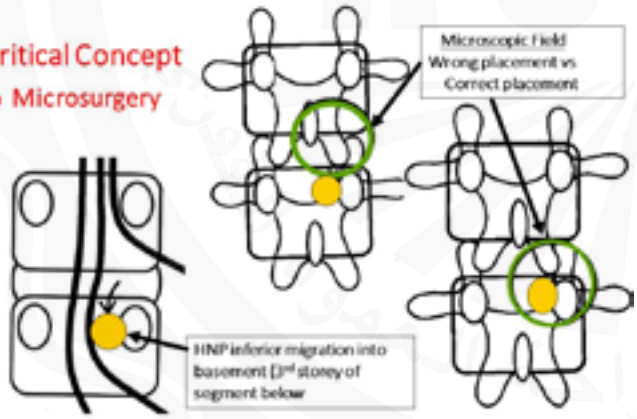
Endoscopic Surgery Key: Transforaminal Approach Safe Zone

Kambin's Triangle

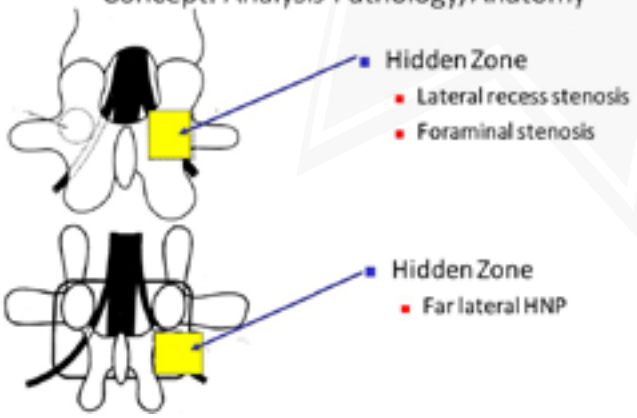


Localization of Pathology with limited surgical field

- Critical Concept
  - Microsurgery

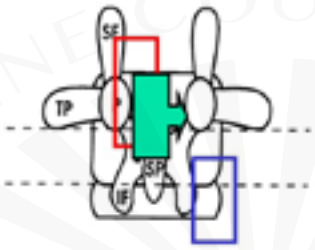


Dr. Ian Macnab "Negative Disc Exploration" Concept: Analysis Pathology/Anatomy



Microsurgical Anatomy

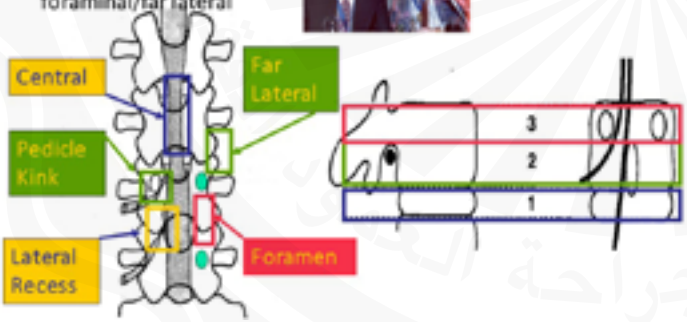
- Analysis of Pathology
  - Imaging
    - Grid
      - Macnab/McCulloch
        - Medial – Lateral
        - Inferior - Superior
- "PALs" for Windows
- (Principal Anatomic Landmarks)
  - Medial
    - Std Laminotomy
  - Laminaplasty
    - Bilateral decompression via unilateral window
  - Far Lateral
    - Intertransvers



Critical Concepts in Spine Anatomy/Pathology

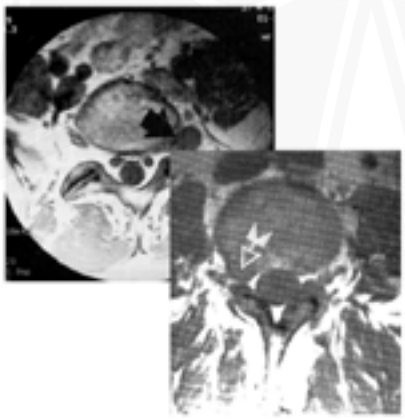
Ian Macnab
- Medial – lateral
- Central/lateral recess/ foraminal/far lateral

John McCulloch
- Inferior – superior
- 3 stories



Read Axial Images CT/MRI

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

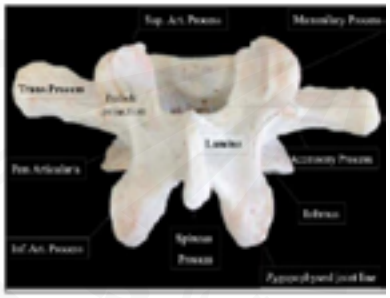


Screw Placement

- Facet
  - Inferior/lateral position
- L5S1
  - Careful of screw angle
  - Position S1 screw low
- Angle Top Threads
- Angle of Hex
- Place X-Links
- Interspinous Ligament
- Parallel Rods

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



Issues
Solutions/Tips

- Insertion
  - *Anatomic Pedicle Location*
    - Adjust Ball Ring Technology
      - 3 Dimensions
  - *Superior Facet Avoidance*
    - Rotate Away
- Assembly
  - *2D* vs 3D *Rod Bend*
    - Parallel Rods
    - Single Bend-Lordosis
    - Easy Cross Link Fixation
- *Spondylolisthesis Reduction*
  - Connector/Smooth Barrel
    - Avoid Large External Frame

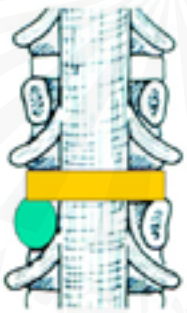



PALs for Windows

- Whenever you are lost, scared, frustrated or otherwise befuddled
  - "Always look to your PALs"
- Surgical PALs
  - Principal
  - Anatomic
  - Landmarks

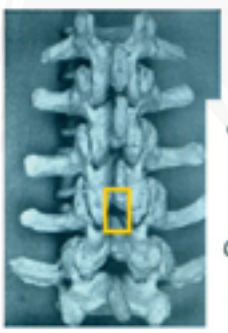
"PALs" for Windows Medial Laminotomy

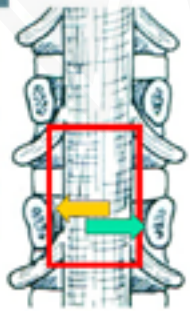
- External
  - Facet
  - Pars Interarticularis
  - Superior edge inferic lamina
- Canal
  - Pedicle
  - Disc



"PALs" for Windows Laminaplasty

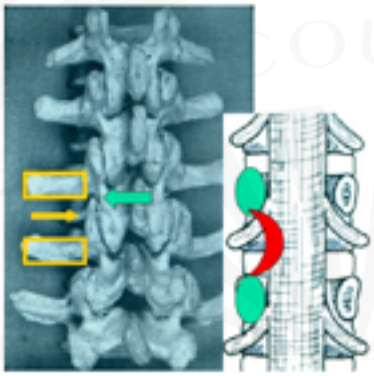
- External
  - Interspinous Lig
- Internal
  - Ipsilateral Pedicle
  - Opposite Pedicle





"PALs" for Windows Far Lateral

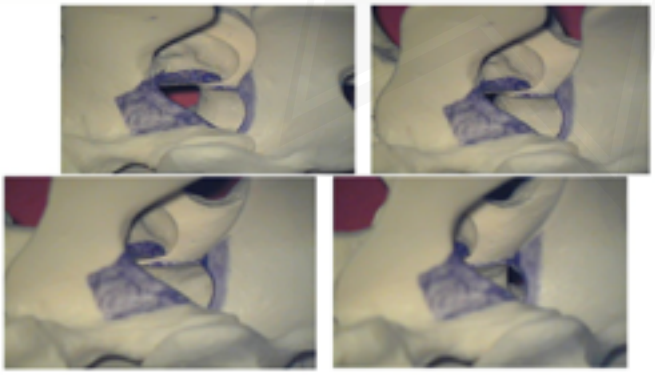
- External
  - Transverse Process
  - Pars Interarticularis
  - Superior Facet
- Internal
  - Pedicle
  - Pars Interarticularis



Bilateral Stenosis Decompression via a Unilateral Approach: Contralateral Sublaminoplasty

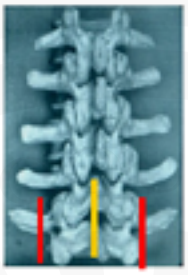
- Undercut contralateral rostral lamina
- Rostral to ligamentum flavum attachments
- ~50% of lamina

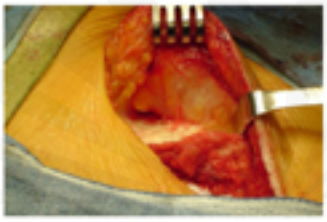
Ipsilateral Bone Resection for Opposite Side Foraminotomies with Rotate Scope foramen above/below



Bone Graft Harvest
Solutions/Tips

- Approach Posterior Iliac Crest-PSIS
  - Midline
  - Wiltse
  - Microscopic/Percutaneous
- Bone Graft
  - Interfascial Plane
    - Avoid Separate Incision
      - J/Hockey Stick Incision
    - Avascular
      - Few perforators
    - Avoid Cluneal Nerves
      - No Neuromas
    - Fat Graft





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- Toyoda H et al. Clinical Outcome of Microsurgical Bilateral Decompression via Unilateral Approach for Lumbar Canal Stenosis. Spine 2011;36:410-415.
- Merritt A et al. Gluteal Sparing Approach for Posterior Iliac Crest Bone Graft. Spine 2010;35:1396-1400.

Clinical Examination

Why is the Examination Important?

Physician Role: Put your hands on the patient

Build confidence in your patient
Build appreciation (2nd opinion)

Key to identifying various pathologies
Key in not missing underlying diagnoses
Fractures - Tenderness
Infection - Warmth
Neurological deficit
Cord compression

Some Spine-related diagnoses are completely clinical

Helpful in determining treatment pathway

Very useful in the evaluation of potential revision surgery patients for surgical planning

Reduce/Eliminate/Assist in Peer-Review Process

Observation

- Have every patient dressed in a gown, shoes off, socks off
- Keep your eyes open
  - Watch them walk in the hallway
    - Natural gait and posturing
    - Balance/spastic-UMN
    - Fast walk=subtle change strength/balance
- Note how they are sitting
  - Are they offloading one side?
  - Shifted in seated position
- Ask them to stand; Watch how they rise from a chair/table both physically and facial expression
- Gowers
- Muscle spasms

Look/Inspection

- Evaluate Standing Alignment
  - Where is the patient's head in relation to their pelvis?
  - Coronal Plane
  - Sagittal Plane
- Assess lordosis (posterior)/kyphosis(anterior)
- Note any significant deformity
- Shoulder / Pelvis level
- Rib hump
- Muscle atrophy
- Look for any prior incisions
  - Anterior, Flank, Posterior
    - If noted, question about surgery type and symptoms

Feel/Palpation

- Midline spine
  - Light vs. Deep (fracture)
  - Step Off (spondylolisthesis)
- Paraspinal Musculature
  - Guarding
  - Muscle spasm - Acute lumbar strain
- Fortin's sign
- Prior incisions – postoperative
- Painful hardware
- Fracture location
  - Acute versus chronic

Gait

- Ambulate across the room
  - Look for flexed posture
  - Look for compensatory muscle contractures
- Walk on tip toes/heels
  - Often pick up drop foot; gastroc weakness
- Note difficulty with weight bearing
  - Keep in mind differential diagnoses (not spine related)
- Tandem Gait evaluation

Range of Motion

- Note:
  - Pain with terminal motion
  - Pain with lateral bend and extension
    - forsminal impingement
    - laterality concordance
- Wadell Signs

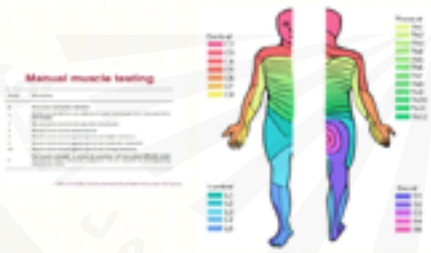
Waddell Signs

Category	Signs
Tenderness	▪ Superficial skin tender to light touch ▪ Non anatomic deep tenderness not localized to one area
Simulation	▪ Axial loading of spine over skull of standing patient elicits low back pain ▪ Rotation shoulders and pelvis rotate in the same plane elicits low back pain
Distraction	▪ Differences in supine straight leg raising and seated straight leg raising
Regional	▪ Weakness: many muscle groups give way readiness (patient does not give full effort on minor muscle testing) ▪ Sensory: sensory loss in stocking or glove distribution; non dermatomal
Overreaction	▪ Disproportionate facial or verbal expression (i.e., pain behavior)

Waddell G, McCulloch J et al. Nonorganic Physical Signs in Low Back Pain. Volvo Award in Clinical Science. Spine 1980;5:117-125.

Seated Neurologic Examination

- Seated on a table with legs dangling
- Inspection
  - Muscle atrophy
  - Prior extremity surgery, incisions, deformity
- Muscle Testing
  - HF, QUADS, TA, EHL, GS
- Dermatomal sensory testing
- Reflex testing
  - Patellar
  - Achilles



Seated Neurologic Examination

- Reflex testing
  - Difficulty with tandem gait, discoordination, off balance
    - Assess for hyperreflexia
    - Hoffman's
    - Inverted Brachioradialis Reflex
    - Clonus

CLINICAL INSIGHTS:

- Determine when to get cervical spine MRI
  - Identify cervical myelopathy
  - Don't want to miss cord compression
    - Wake up with new deficits
    - Remain symptomatic despite addressing pathology

Seated Neurologic Examination

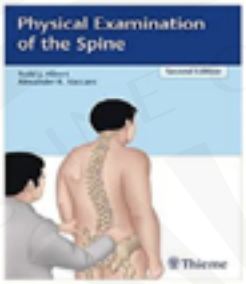
- Straight Leg Raise Testing
  - Seated or supine
  - Perform in non symptomatic extremity first
  - Looking for radiation of pain down the leg
  - Note the degree of extension at which symptoms occur
  - Pay attention to facial expression/grimace
  - Patient will sometimes raise from seat

Standing Neurologic Examination

- Single Leg Heel Rise
  - Dynamic testing Gastrocsoleus complex
- Single leg squat
  - Dynamic testing Quadriceps

Sacrolliac Joint Provocative Testing

Great References



Imaging Modalities of Normal Spine

To image *or not* to image?

- An imaging examination is needed for every patient that can get advantage from it
- The most suitable examination is needed for the suspected condition
- An accurate clinical examination is mandatory
  - Clinician must have enough time and skill to visit the patient, suspect a pathology and ask for the most suitable examination

To image *or not* to image?

J Gen Intern Med. 2001 Feb; 16(2): 120–131.
Evaluating and Managing Acute Low Back Pain in the Primary Care Setting. S.J. Atlas et al.

- A self-limited, nonspecific mechanical cause is found in most primary care patients
- Serious causes of low back pain are distinctly uncommon
- An accurate anamnesis and physical examination is mandatory to determine
  - the likely cause of the complaint
  - **whether diagnostic tests are needed**
  - which treatments are warranted

Table 1

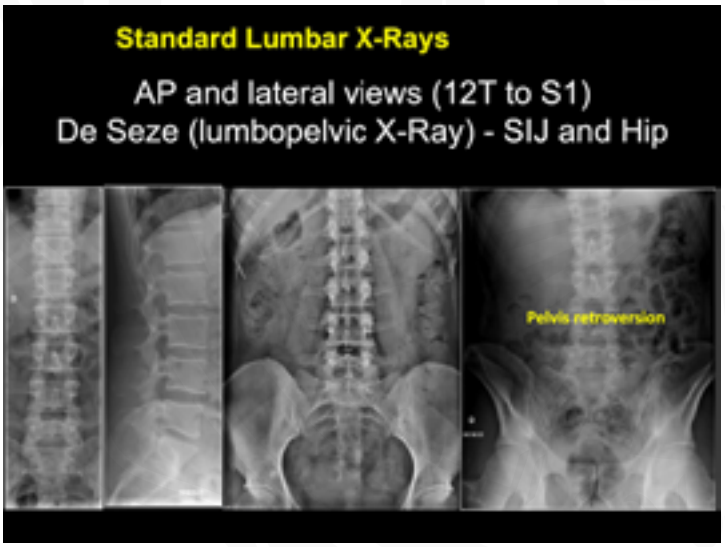
Differential Diagnosis of Low Back Pain*

J Gen Intern Med. 2001 Feb; 16(2): 120–131.
Evaluating and Managing Acute Low Back Pain in the Primary Care Setting.
S.J. Atlas et al.

Mechanical Low Back Pain	Nonmechanical Spine Disease	Visceral Disease
Lumbar strain or sprain†	Neoplasia	Pelvic organs
Degenerative disease	Metastatic carcinoma	Prostatitis
Disks (spondylosis)	Multiple myeloma	Endometriosis
Facet joints‡	Lymphoma and leukemia	Chronic pelvic inflammatory disease
Diffuse idiopathic skeletal hyperostosis‡	Spinal cord tumors	Renal disease
Spondylolysis‖§	Retroperitoneal tumors	Nephrolithiasis
Spondylolisthesis¶	Infection	Pyelonephritis
Herniated disk	Osteomyelitis	Perinephric abscess
Spinal stenosis	Septic discitis	Vascular disease
Osteoporosis with compression fracture	Paraspinal or epidural abscess	Abdominal aortic aneurysm
Fracture	Endocarditis	Aortoiliac disease
Congenital disease	Inflammatory arthritis	Gastrointestinal disease
Severe kyphosis	Ankylosing spondylitis	Pancreatitis
Severe scoliosis	Reiter's syndrome	Cholecystitis
Paget's disease	Psoriatic spondylitis	Perforated bowel
	Inflammatory bowel disease	
	Polymyalgia rheumatica	

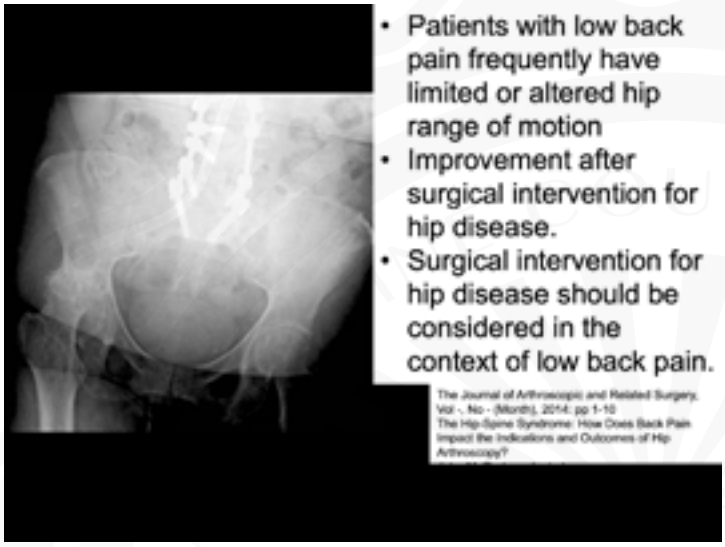
Lumbar spine X-rays

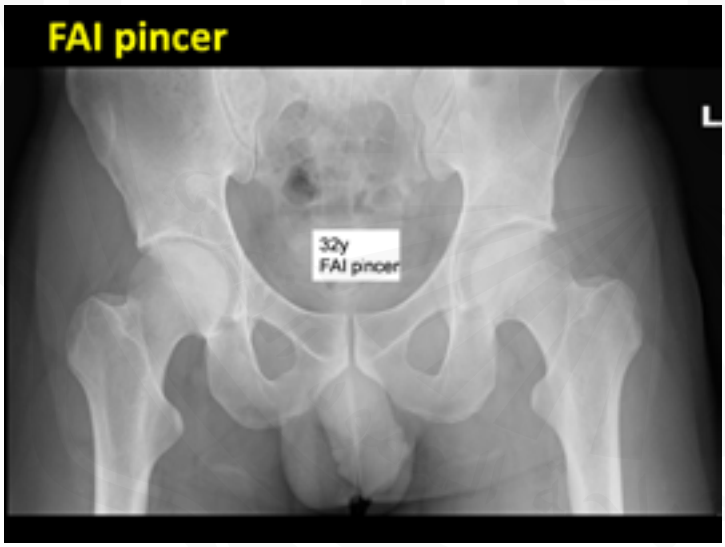
- **Pros**
  - Fast, no contraindications
  - Bony structures
  - **Panoramic**
  - **Cheap**
  - **Low radiation**
  - **Pathologies mimiking LBP as hip and SIJ**
- **Cons**
  - Poor soft tissues discrimination
  - Radiation exposure 1/10 than a 2 discs CT



Hip-spine syndrome

- The term was introduced by Offierski and MacNab in 1983
- Describes patients with coexisting hip arthrosis and lumbar spine disorders.
- The true prevalence of the hip- spine syndrome is unknown
- Frequently there is more than one condition contributing to a patient's pain, particularly in the area of the hip and lumbar

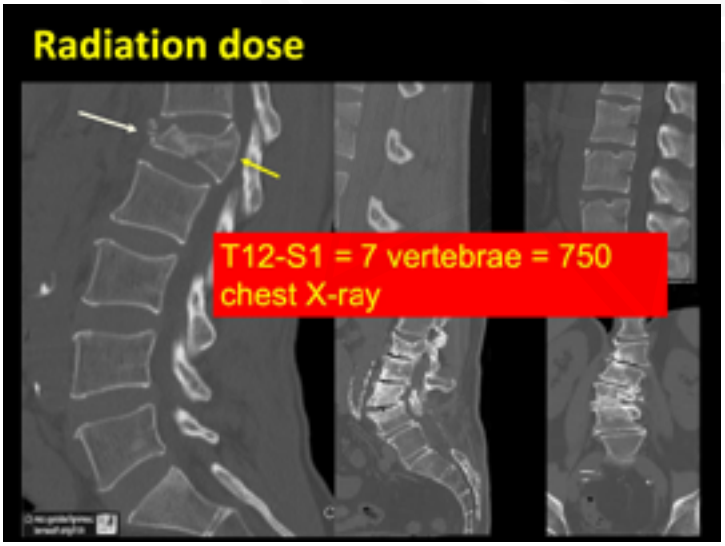

• Patients with low back pain frequently have limited or altered hip range of motion
• Improvement after surgical intervention for hip disease.
• Surgical intervention for hip disease should be considered in the context of low back pain.
The Journal of Arthroscopic and Related Surgery, Vol -, No - (Month), 2014: pp 1-10
The Hip-Spine Syndrome: How Does Back Pain Impact the Indications and Outcomes of Hip Arthroscopy?


FAI pincer
32y
FAI pincer


Sacroiliac joints deseases

CT

- Facet arthritis
- Pars defects in axial or reformation images
- Stenosis
- Degenerative disc disease
- Bone and soft tissues setting

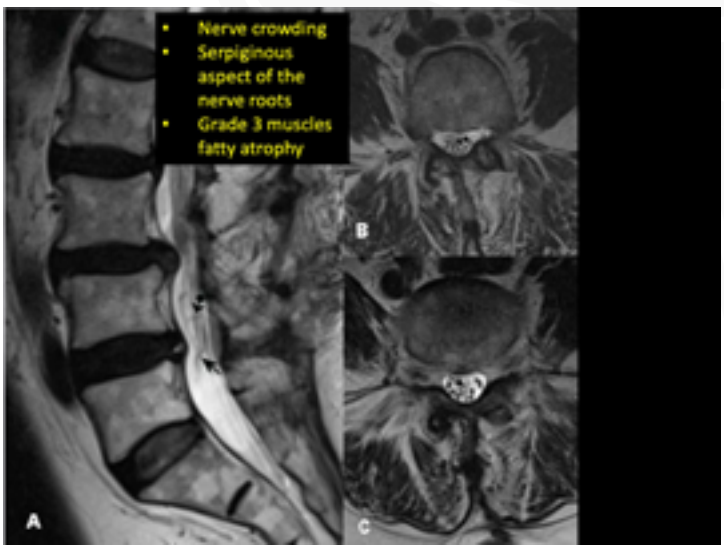


MRI

- Most sensitive and most specific to show:
  - –disc herniation,
  - –soft tissues or neurological lesions,
  - –tumours or infection
- Not specific to clinical presentation
  - –abnormal MRI scans were found in 30-40% of asymptomatic individuals (Boden 1990 - Jensen 1994)

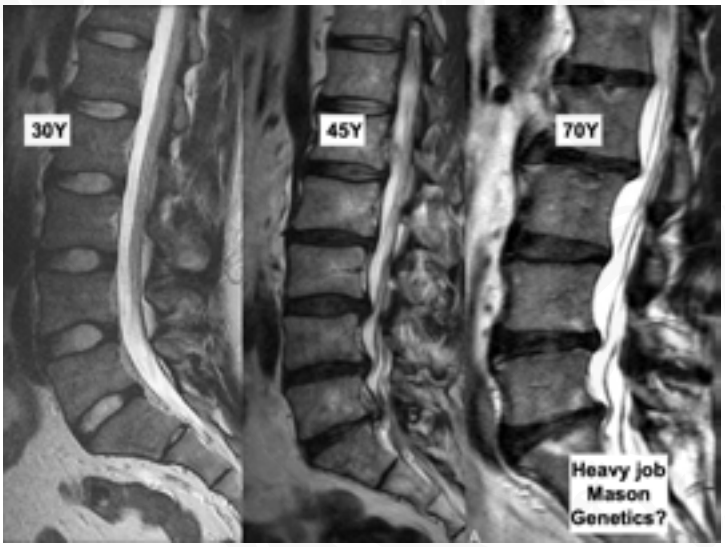
MRI findings of degenerative disease

- endplate changes
- decreased disc height
- disc signal changes
- disc herniation
- flava and longitudinal ligaments hypertrophy
- central or lateral stenosis
- facet joints arthritis



Low Back – Neck Pain

- Affects more frequently elder people
- Degenerative spine condition is the rule not the exception
- Most LBP and imaging signs resolve spontaneously
- Imaging always shows
  - **genetics**
  - age of the spine
  - the physical conditions
  - history of job and trauma of the patient



Appropriate Use of Diagnostic Imaging

Appropriate Use of Diagnostic Imaging in Low Back Pain: A Reminder That Unnecessary Imaging May Do as Much Harm as Good

T.W. Flynn et al.

Journal of Orthopaedic & Sports Physical Therapy, 2011 Volume:41 Issue:11 Pages:838–846 DOI: 10.2519/jospt.2011.3618

Appropriate Use of Diagnostic Imaging

Diagnostic imaging in individuals with LBP should only be used if the results of the image lead to a clinical decision that results in improved patient outcomes.

This statement appears both logical and obvious; however, data suggest that in the current US healthcare system this is not the guiding principle

Journal of the American College of Radiology:

- 26% of medical images ordered were inappropriate
- 53% inappropriate referral rate for CT
- 35% inappropriate referral rate for MRI

Appropriate Use of Diagnostic Imaging

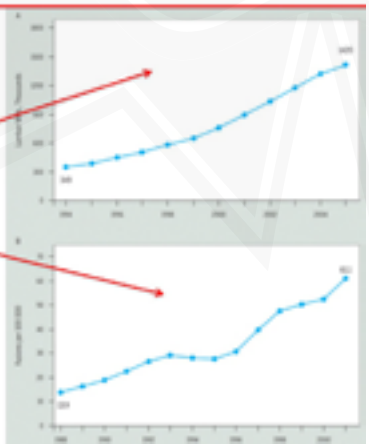
The potential harm associated with overimaging of lumbar spine in patients with LBP includes

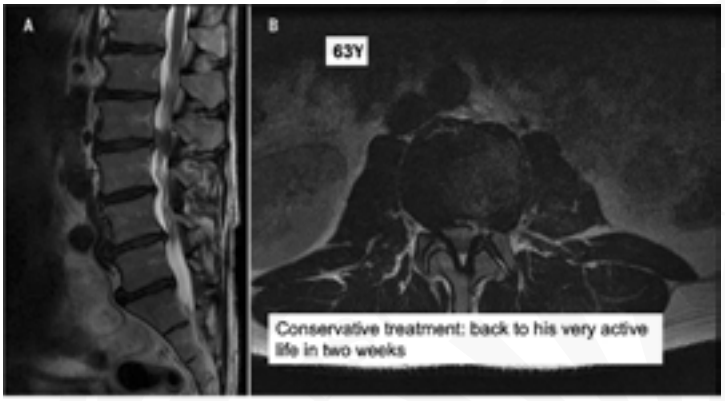
- radiation exposure (lumbar radiographs and CT)
- exposure to iodinated contrast (CT)
- increased risk of surgery (MRI)
- In 2007, 2.2 million lumbar CT scans were performed in the US.
- Based on the radiation exposure patients received, these CT scans were projected to cause
  - 1200 additional future cancers

Appropriate Use of Diagnostic Imaging

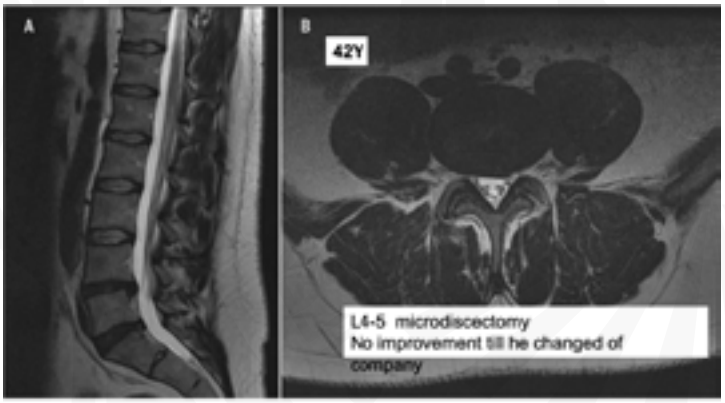
We are treating MRIs, not pathology adapting MRI to clinical findings

(A) Trends in lumbar MRIs
(B) lumbar fusions in the Medicare population.
Used with permission from Deyo et al.





(A) T2 sagittal magnetic resonance image demonstrating herniated nucleus pulposus at L2–3 with canal stenosis. (B) T2 transverse magnetic resonance image of L2–3 with severe central canal stenosis.



(A) T2 sagittal magnetic resonance image with degenerative disc disease in the lower lumbar spine and mild disc protrusion at L4–5. (B) T2 transverse magnetic resonance image with moderate broad based disc protrusion at L4–5.

Table 2

Prevalence of Potentially Serious Causes of Acute Low Back Pain in Primary Care*

Etiology	Estimated Prevalence, %
Compression fracture	4
Spondylolisthesis	3
Herniated disk	1 to 3
Neoplasia, primary or metastatic	0.7
Ankylosing spondylitis	0.3
Cauda equina syndrome	0.04
Infection	0.01
Spinal stenosis	Unknown

J Gen Intern Med. 2001 Feb; 16(2): 120–131.
Evaluating and Managing Acute Low Back Pain in the Primary Care Setting.
S.J. Atlas et al.

Conclusions

- **Start the imaging process…with an accurate anamnesis and clinical examination**
- X-ray imaging is the first step
- MR imaging is the second step for discs, cord, etc., assessment
- CT is the third step
  - ***Prescribing a CT you give radiation to the patients, be sure that it is necessary***

Conclusions

- **When used appropriately** diagnostic imaging is an important component of patient care in individuals with low back complaints.

- **The inappropriate use** of lumbar spine imaging
  - increases the risk of **patient harm**
  - contributes to the large **increase** in healthcare costs

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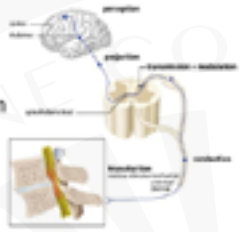
Pathophysiology of Neurologic Pain

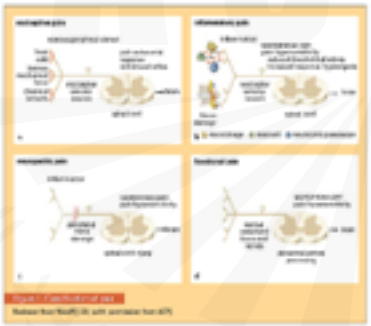
Pathways of spinal pain

- **Transduction** of the stimuli by nociceptors
- **Conduction** of the sensory input to central cord
- **Transmission** through the central nervous system
- **Projection** to brainstem, thalamaus and cortex
- **Perception** by the cortex



Pain classification

- Nociceptive (mechanical) pain
- Inflammatory pain
- Neuropathic pain
- Functional pain



Nociceptive versus Neuropathic Pain

Nociceptive pain	Neuropathic pain
• sharp, aching or throbbing quality • well localized • transient • good response to analgesic treatment	• burning, tingling, numbness, shooting, stabbing quality, or electric-like sensation • spontaneous or evoked • persistent or paroxysmal pain • resistance to non-steroidal anti-inflammatory drugs and limited or no response to opioids

Lumbar disc disease

- **Back** (axial) versus **Leg** (radicular) pain
- Segmental degenerative changes : axial pain
- Root compromise : radicular pain

Axial Pain

- Primarily located in the back
- **Specific** versus **non specific** back pain
- Evaluation of causal etiologies (disc, facet)
- Acute, subacute, chronic

Pathophysiology of specific back pain

- **Causal link between structural anatomy and the genesis of pain**
  - Discopathy, disc degeneration
  - Facet pathologies, effusion
  - Structural deformities, segmental instability

Pathophysiology of non specific back pain

- **No causal pathology**
- The flag system

Pathophysiology of Radicular pain

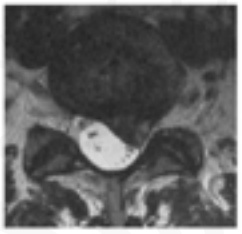
- **Nerve root compromise**
  - Mechanical compression
  - Inflammatory process

Radicular pain

- Less common than somatic pain
- The hallmark of radiculopathy any pathologic condition affecting the nerve roots
- Arises from the nerve roots or dorsal root ganglia
- Herniated disk is by far the most common cause

Pathophysiology of Radicular pain (I)
Mechanical compression

- Compression
- Decrease blood supply
- Oedema
- CSF decrease of nutritional fluid



Pathophysiology of Radicular pain (II)
Chemical inflammation

- Intrinsic inflammatory properties of the Nucleus pulposus
- Cytokines (TNFα)

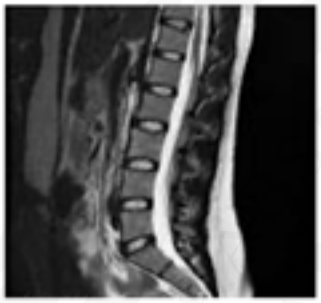
Neurologic assessment

- Authenticate the radicular syndrome
- Identify the affected root
- Detect any neurological deficit
  - Motor
  - Sensitive
  - Reflexes

LDH and Degeneration: Natural History & Differential Diagnosis

MRI

Normal

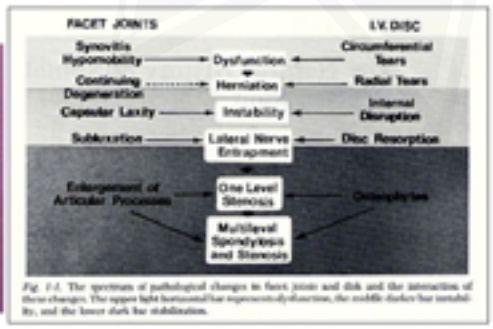


Degenerative

Canadian Triumvirate Wm.
Kirkaldy-Willis
Ian Macnab
Harry Farfan

Wm. Kirkaldy-Willis
(NASS Past President)
Managing Low Back Pain-1983

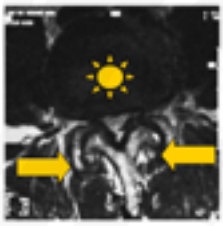
Three Phase Concept – "Degenerative Cascade"



Harry Farfan

International Society for the Study of the Lumbar Spine Founder

- 3 Joint Complex
  - Disc
  - 2 Facets
- Lumbo Sacral Stability
  - Seating L5 in Pelvis
  - Strength Ligaments
    - = L4-5 Level Degen Spondylo



Disc/2 Facets

L5 Shallow Seat

L5 Deep Seat

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

NEW ENGLAND SURGICAL SOCIETY

RUPTURE OF THE INTERVERTEBRAL DISC WITH INVOLVEMENT OF THE SPINAL CANAL*

Herniated Nucleus Pulposis

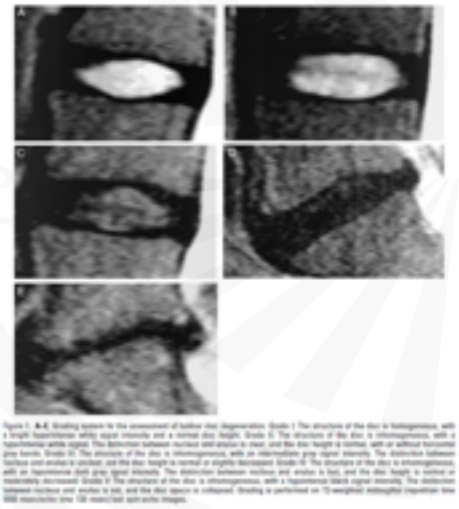
HNP

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

Pfirrmann Classification



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

Spine

RANDOMIZED TRIAL

Surgical *Versus* Nonoperative Treatment for Lumbar Disc Herniation

Eight-Year Results for the Spine Patient Outcomes Research Trial

- 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

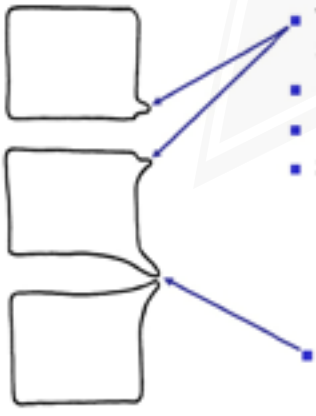
Risk Factors Recurrent HNP

JB&JS

Clinical Outcomes After Lumbar Discectomy for Sciatica: The Effects of Fragment Type and Anular Competence

	%	Re Herniation %	Re Operation %
Fragment Fissure	49.4	1.1	1.1
Fragment Defect	18.3	27.3	21.2
Fragment Contained	23.3	9.5	4.8
No Fragment Contained	8.8	12.5	6.3

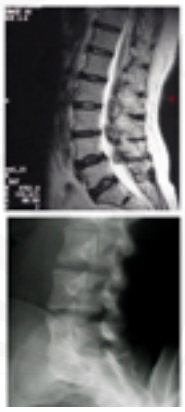
Dr. Ian Macnab & Degenerative Instability



- Traction Spur. JBJS 1971; 53A:663-670
- "Macnab Spur"
- Early segmental instability
- Start 1 – 2 mm off end plate
  - Annulus not insert cartilaginous epiphyseal plate
- Claw Osteophyte
  - Late Osteoarthritis

Dr. Ian Macnab and Spondylolisthesis

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



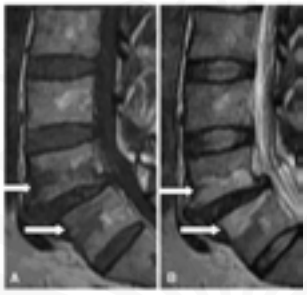
Degenerative Spondylolisthesis Flexion / Extension

Discogram L5-S1 Degeneration/Leak

Modic I
Hypointense T1, Hyper T2

- T1
  - Hypointense
- T2
  - Hyperintense

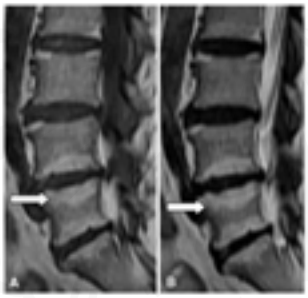
Inflammation
- 8% pts post discectomy
- 40% post chymopapain
- Assoc active LBP
- Instability



Type II

- T I
  - Hyperintense
- T2
  - Isointense/Hyper

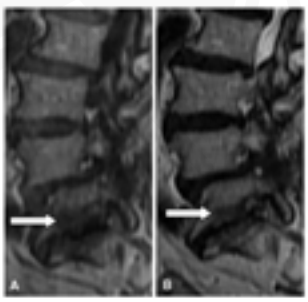
- Fatty replacement
- May develop from Type I
- Less assoc LBP
- More stable



Type III

- T1
  - Hypointense
- T2
  - Hypointense

- Sclerosis
- Nature and Pathologic significance – Unknown
- ? Bony sclerosis



Modic

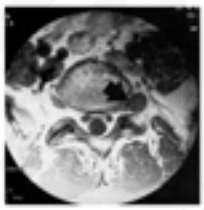
	Modic I	Modic II	Modic III
MRI T1	Hypo	Hyper	Hypo
MRI T2	Hyper	Hyper/Isodense	Hypo

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



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- Rahme R and Moussa R. The Modic Vertebral Endplate and Marrow Changes:Pathologic Significance

Medical Treatment for LDH

Lumbar Disc Herniation: Treatment

- Non-interventional conservative care
  - Activity modification
  - Medications
  - Bracing
  - Physical Therapy
  - Chiropractic care
  - Complementary and Alternative Medicine (CAM)
- Interventional Procedures
  - Epidural steroid injections
- Surgical Options

Conservative/Medical Treatment of Lumbar Disc Herniation

- **Non-interventional conservative care**
  - **Activity modification**
  - **Medications**
  - **Bracing**
  - **Physical Therapy**
  - **Chiropractic care**
  - **Complementary and Alternative Medicine (CAM)**
- Interventional Procedures
  - Epidural steroid injections
- Surgical Options

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: 96% 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.

Conservative/Medical Treatment of Lumbar Disc Herniation

- **Activity modification**
- Medications
- Bracing
- Physical Therapy
- Chiropractic care
- Complementary and Alternative Medicine (CAM)

Activity Modification

- Teach positioning and body mechanics
- Avoid bed rest (strong evidence)
- Encourage activity as tolerated (strong evidence)
- **Education and Reassurance**

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 spinal manipulative therapy
  - If no improvement after 8 wks of either, then treatment should be discontinued, re-evaluate

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

Exercise

North American Spine Society Lumbar Disc Herniation Guidelines Consensus:

"In the absence of reliable evidence, it is the work group's opinion that a limited course of structured exercise is an option for patients with mild to moderate symptoms from lumbar disc herniation with radiculopathy."

Conservative/Medical Treatment of Lumbar Disc Herniation

- Activity modification
- **Medications**
- Bracing
- Physical Therapy
- Chiropractic care
- Complementary and Alternative Medicine (CAM)

Medications

- NSAIDs or acetaminophen
  - short term for acute or chronic LBP
  - Systematic reviews of patients with OA consistently found NSAIDs superior to acetaminophen for pain relief
- Muscle relaxants
  - Short course (2 wks max) for acute LBP (cyclobenzaprine, methocarbamol)
  - Avoid carisoprodol and diazepam (high addiction potential and no benefit over less addictive meds)

Medications

- Antidepressants (TCAs preferred, not SSRIs)
- Antiepileptics (gabapentin, pregabalin, topiramate)
  - Select pts with radicular symptoms
  - Evidence mixed
- Opioids
  - Short term for acute LBP
  - For chronic, use with caution and close monitoring
- Insufficient evidence for many pharmaceutical options

Medications

- Poor Evidence:
  - NF-alpha inhibitors
- Insufficient evidence to make recommendations for or against (NASS 2020 guidelines):
  - IV glucocorticosteroids
  - 5-HT receptor inhibitors
  - Agmatine sulfate
  - Gabapentin
  - Amitriptyline

Conservative/Medical Treatment of Lumbar Disc Herniation

- Activity modification
- Medications
- **Bracing**
- Physical Therapy
- Chiropractic care
- Complementary and Alternative Medicine (CAM)

Bracing

- Systematic reviews of bracing for low back pain
- May reinforce awareness of a "back problem"
- No sufficient evidence to support the use of lumbar supports to treat low back pain
- Consistent use not recommended

Conservative/Medical Treatment of Lumbar Disc Herniation

- Activity modification
- Medications
- Bracing
- **Physical Therapy**
- Chiropractic care
- Complementary and Alternative Medicine (CAM)

Physical Therapy

- Limited evidence as a standalone treatment
- Therapy should be considered as part of a comprehensive treatment plan
- NASS 2020 guidelines:
  - "In the absence of reliable evidence, it is the work group's opinion that a limited course of structured exercise is an option for patients with mild to moderate symptoms from lumbar disc herniation with radiculopathy."

Physical Therapy

- Important to focus on active treatment, rather than passive treatment
- Active treatment modalities (e.g., exercise, education, activity modification) instead of passive treatments is associated with substantially better clinical outcomes.
- Large case series, 2007
  - Those adhering to guidelines for active rather than passive treatments incurred fewer treatment visits, cost less, and had less pain and less disability.
  - Success rates 44.7% among those adhering to the active treatment recommendations versus 36.5% for passive treatment.

Conservative/Medical Treatment of Lumbar Disc Herniation

- Activity modification
- Medications
- Bracing
- Physical Therapy
- **Chiropractic care**
- Complementary and Alternative Medicine (CAM)

Spinal Manipulative Therapy

- Performed by osteopaths, chiropractors, and physical therapists
- Techniques vary
- Overall some evidence for limited temporary benefit
- Spinal manipulation is an option for symptomatic relief in patients with lumbar disc herniation with radiculopathy (Grade C evidence)

Conservative/Medical Treatment of Lumbar Disc Herniation

- Activity modification
- Medications
- Bracing
- Physical Therapy
- Chiropractic care
- **Complementary and Alternative Medicine (CAM)**

Complementary and Alternative Medicine

- Massage
  - Limited evidence
  - Short term benefits, mostly with LBP (not radicular)
  - Most efficacious when combined with exercise
- Acupuncture
  - Evidence supports its use for chronic low back pain as an adjunctive treatment
  - More effective than placebo, sham
  - Little data for LDH or stenosis
- Yoga
  - Evidence supports its use for chronic LBP
    - Caution to avoid certain poses that may aggravate symptoms

Complementary and Alternative Medicine

- Tai Chi
  - Insufficient evidence
- Meditation
  - Insufficient evidence
- Traction
  - Insufficient evidence

*Insufficient evidence does not equal lack of benefit
*All have low inherent risk

Interventional Procedures – To be discussed in a separate lecture

- Epidural Injections
- Facet Joint Intraarticular injections
- SI joint injections
- Radiofrequency Ablation
- Spinal Cord Stimulation

Summary

- Understand natural course
- Wide variety of non-operative treatments available
- Weigh risks, benefits, and evidence

Interventional Tx - Lumbar Epidural Steroid Injections

Interventional Treatments for LDH

- Symptoms, imaging, and clinical evaluation all crucial in determining possible interventional treatment
- Epidural Steroid Injections are minimally invasive procedures performed under live x-ray

Epidural Steroid Injections

- Irritation can arise from narrowing, or stenosis from
  - Disc herniation
  - Foraminal Narrowing
- Treats pain from irritation of nerves
- Achieves high concentrations of steroid at the site of pain while minimizing systemic effects

Epidural Steroid Injections

- Pure mechanical compression of spinal nerves does not necessarily produce pain
- Degree of nerve root compression does not correlate to pain severity
- Various inflammatory markers or cells are required for the dorsal root ganglion to generate the painful discharges in radiculitis

Epidural Steroid Injections

- Radicular pain is inflammatory
  - Phospholipase A1
  - Prostaglandin E2
  - Leukotrienes
  - Cytokines
  - Nitric Oxide
  - Interleukin 6
  - Tumor Necrosis Factor alpha

Epidural Steroid Injections

- Steroids:
  - inhibit phospholipase 2
  - inhibit leukocyte aggregation
  - prevent degranulation of granulocytes, mast cells, and macrophages
  - prevent transmission of nociceptive C-fibers
  - stabilize ectopic discharge of neuronal membranes

Pathophysiology of Pain Relief

- Membrane stabilization
- Inhibition of neural peptide synthesis or action
- Blockade of phospholipase A_2 activity
- Prolonged suppression of ongoing neuronal discharge
- Suppression of sensitization of dorsal horn neurons.
- Local anesthetics have been shown to produce prolonged dampening of c-fiber activity
- Physical effects include clearing adhesions or inflammatory exudates from the vicinity of the nerve root sleeve

Contraindications

- Absolute
  - Local infection at site of needle entry
  - Systemic infection
  - Lack of patient consent or cooperation
  - Pregnancy (if fluoroscopy used)

Contraindications

- Relative
  - Allergies to the medications used
  - Abnormal clotting status/coagulopathy
  - Immunosuppression
  - Uncontrolled Diabetes (if using steroid)
  - Significant or unstable coexisting disease (esp. cardio-pulm)

Fluoroscopy

- Only way to verify the medication is getting to the targeted pathology
- Increases patient safety – detect inadvertent vascular uptake
- Minimizes patient discomfort and complications by using small gauge needles
- Numerous studies demonstrate that 25-35% of lumbar epidurals done without image guidance miss the epidural space
- Fluoro allows one to target a specific side and nerve root level

Risks of Epidural Steroid Injections

- <0.1% to 9.6%
- Most common complications are mild and self limiting
- Needle related
  - Vasovagal
  - Pain
- Medication related
  - Increased blood sugar
  - Facial Flushing
- Unique to procedure
  - Extremely rare (<0.1%)
  - Epidural hematoma (interlaminar ESI)
  - Embolic infarct (transforaminal ESI with particulate steroid)

How many are needed?

- Majority of patients need only 1 ESI, on average 1.7 ESI
- Assess results after each ESI
  - Can consider repeating if partial response (ie. 30% better)
  - Can consider repeating if response not durable (ie better for 1 week)
- No foundation for a routine series of 3
- Wait minimum of 2-3 weeks between therapeutic injections
- If more than 3-4 are needed in 6-12 months re-evaluate treatment plan

Why inject?

RCTs of oral, IV, or IM corticosteroids have unanimously found no benefit beyond placebo in treatment of symptoms of lumbar disc herniation and/or spinal stenosis.

RCTs	Active TX	Control TX	Results
Porsman	IM steroid	Placebo	No sig. diff.
Hedeboe	IM steroid	Placebo	No sig. diff.
Naylor	IM steroid	Placebo	No sig. diff.
Friedman	IM steroid	Placebo	No sig. diff.
Ghahreman	IM steroid	Placebo	No sig. diff.
Finckh	IV steroid	Placebo	No sig. diff.
Haimovic	PO steroid	Placebo	No sig. diff.

What to inject?

Transforaminal Injection:

- Dexamethasone 10mg/ml (preservative-free solution)
  - Only steroid acceptable for CJT TF ESI and first line LTF ESI

A nonparticulate steroid (e.g., dexamethasone) should be used for the initial injection in lumbar transforaminal epidural injections.
Particulate steroids should not be used in therapeutic cervical TF injections.

- Interlaminar Injection:
  - Particulate steroids (methylprednisolone, betamethasone, triamcinolone) thought so stay in the epidural space longer and thus work better
  - Most studies suggest equivalency
  - Risk of major complication independent of steroid selected
    - Intra-thecal preservatives can cause arachnoiditis

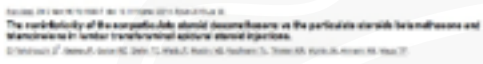
What to inject?

Steroids Available:

- **Dexamethasone 10mg/ml (preservative-free solution)**
- Betamethasone (Celestone® Soluspan®) 6mg/cc- recommended total dose 12-15mg 6decrease in diabetics i.e.= 9mg and others with co-existing medical conditions, etc.)
- Triamcinolone (Kenalog®) 40mg/cc (Box warning for ESI)
- Methylprednisolone

- Particulate steroids (methylprednisolone, betamethasone, triamcinolone) were thought so stay in the epidural space longer and thus work BETTER
- Particulate steroids have also been implicated in major complications related to TFESI*
  - Embolic infarct of spinal cord, paralysis

- Both groups demonstrated statistically significant improvements in pain and function at 2 weeks, 3 months, and 6 months.
- Progression to surgery was similar between groups (14.6% dexamethasone vs 18.9% triamcinolone)
- To achieve these outcomes: 7/41 (17%) patients in the dexamethasone group vs 1/37 (3%) in the triamcinolone group needed a third injection



- Retrospective observational study
- 2,634 patients with 2 month follow up
- Dexamethasone 10 mg vs Triamcinolone 80mg or betamethasone 12 mg
- Categorical outcomes:
  - No difference in rates of those achieving >50% improvement in pain
  - Dexamethasone favored with respect to proportion of patients achieving >40% improvement on RMDQ

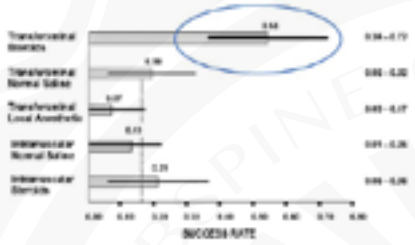
Epidural Steroid Injections: Evidence

Lutz, Arch Phys Med Rehabil Vol. 79, Nov. 1998. Fluoroscopic Transforaminal Lumbar Epidural Steroids An Outcome Study

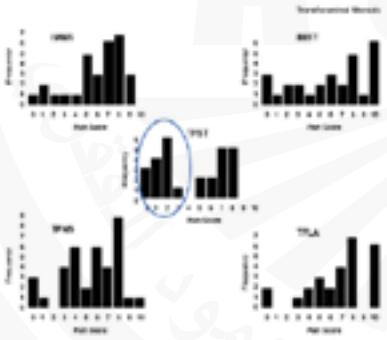
- Prospective case series of 69 patients with HNP/radiculopathy
- Injected Anes + steroid at level of pathology
- 75% successful long term outcome
- 78% of patients were satisfied with results

- Prospective randomized study for the treatment of lumbar radicular pain due to intervertebral disc herniation
- 5 arms
  - Transforaminal steroid
  - Transforaminal saline
  - Transforaminal anesthetic
  - Intramuscular steroid
  - Intramuscular saline
- Primary outcome 50% pain relief at 1 month

Results



Results



Results have been replicated

- Kennedy et al: Prospective randomized study comparing different steroids in patients with radicular pain due to single level disc herniation
- Primary outcome was decrease in leg pain

Surgical Sparing Effect

- In studies where patients enrolled were deemed surgical candidates but were offered TFESI first:
  - 79% avoided surgery (Winnr)
  - 71% avoided surgery vs 33% of those receiving epidural anesthetic injection (Riew)
  - 77% avoided surgery (Wang)
  - 83% avoided surgery (Kennedy)

The effectiveness of lumbar transforaminal injection of steroids: a comprehensive review with systematic analysis of the published data.

- The literature on TFESI for the treatment of radicular pain due to disc herniation is "abundant" and of "higher quality"
- About 60% of patients seems to achieve at least 50% relief of pain at between 1 and 2 months
- Only 40% maintain this outcome for 12 months
- Evidence is better for HNP
- Most only need 1 ESI
- Not effective for other indications such as low back pain

Evidence: Lumbar TFESI for Lumbar Radicular Pain

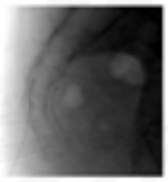
- Effective (more so in patients with contained disc herniations, low grade compression, and acute symptom duration
- Statistically more than placebo effects
- Reduce the burden of disease by improving function
- Reduce the need for surgery
- Cost effective

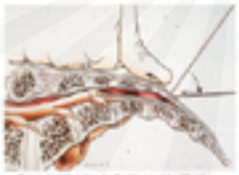
Epidural Steroid Injections

- Interlaminar epidural injection (ESI)
- Transforaminal epidural injection (TFESI)
- Caudal epidural injection

Caudal Epidural Steroid Injection

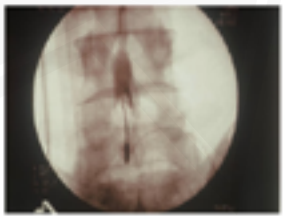
- Through the sacral hiatus
- Only Posterior Epidural Flow 68% of the time
- Medication does not typically spread above the L3-4 or L4-5 level (depending on volume injected)





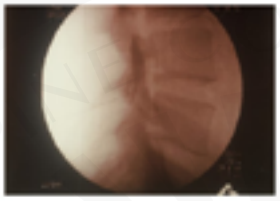
Interlaminar Injection

- Posterior Epidural Space between the dura and ligamentum flavum
- Could be done "blind" so have been around longer
- Diffuse spread of Injectate (along path of least resistance)
- Often fails to wrap all the way around to ventral epidural space



Interlaminar Injection

- Target just inferior/underneath the caudal aspect of the lamina
- Paramedian approach
- Uses LOR (loss of resistance) technique and LOR syringe
- Uses "blunt-tip" needles (Crawford or Touhy), typically 18 or 20g

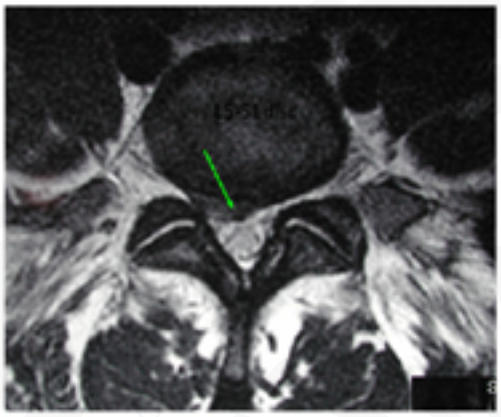


Transforaminal Injection

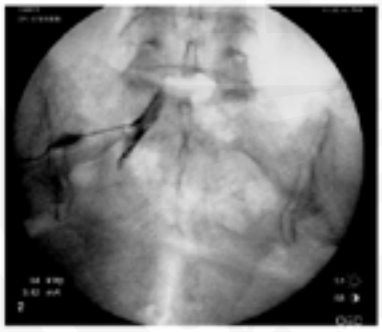
- Directly targets suspected spinal nerve in the neuroforaminal space
- Targets the dorsal root ganglion
- More likely to achieve ventral spread (which happens to be where the herniated disc lies)

Transforaminal Injection

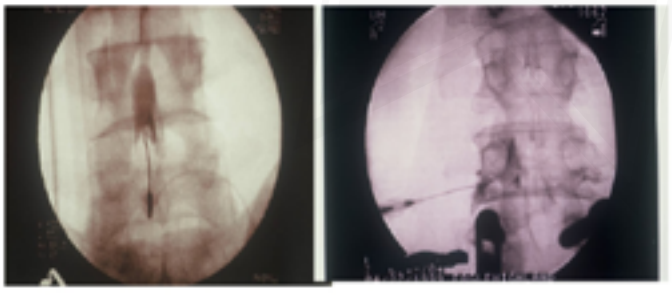
- Target the level and side of pathology
- Target the affective nerve(s), not necessarily the level:
  - Dx: Left L5 L radiculopathy due to a L4-5 paracentral HNP - A left L5-S1 transforaminal ESI is the most appropriate injection
  - Dx: Left L4 radiculopathy due to L4-5 foraminal HNP or Stenosis- A left L4-5 foraminal injection is most appropriate



S1 Transforaminal Epidural Injection



TF vs IL ESI
Is there a difference?



TF-ESI vs. IL ESI

- A prospective trial comparing fluoroscopically guided TF-ESIs to fluoroscopically guided IL corticosteroid injections demonstrated statistically significant benefit in the transforaminal group.

Ackerman WE, 3rd, Ahmad M. The efficacy of lumbar epidural steroid injections in patients with lumbar disc herniations. *Anesth Analg.* 2007;104:1217-22, tables of contents. This study

TF vs IL ESI: Is there a difference?

- Most studies that have compared the two have confirmed the superiority of TF over IL ESI.

Retrospective Cohorts
Schaufele - Pain Physician 2006 (n=80 HNP)
TF LSS > Interlaminar LSI
Smith - Pain Med 2010 (n=59 – LSS only)
TF LSI = Interlaminar LSI (trimonal)

Prospective RCTs
Thomas - Clin Rheumatol 2007 (n=70 HNP)
TF LSS > Med Interlaminar LSI
Kraemer* - Eur Spine J 1997 (n=133 HNP)*
Permeural > Interlaminar > placebo = All steroid
Lee - Clin J Pain 2009 (n=202 – LSS and HNP)
TF LSS > Interlaminar LSI (bilateral, not HNP)
Gharibo - Pain Physician 2011 (n=38 - Subacute HNP)
TF LSS > Interlaminar LSI
Rados - Pain Med 2011 (n=64 – Chronic HNP)
TF LSI > Interlaminar LSI

Conclusions

- Radicular pain is inflammatory mediated
- Evidence shows up to 70% success with TFESI for disc herniation
- Evidence for LSS is less robust but still shows effect
- Evidence is best for transforaminal approach
- Non-particulate steroids appear equal in effectiveness
  - Better safety profile

References

- [redacted]
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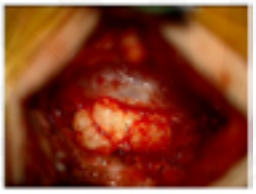
Open Microdiscectomy for LDH

Open Microdiscectomy Opportunity for Education/Teaching =Patient Safety

- Microscope
  - 2 heads direct visualization
  - Excellent Illumination
  - Wound Soft edges vs tube
    - Easy angulation of scope & Instruments to maintain optimum visualization
- Assistant watches surgeon
- *Surgeon can watch the assistant*



Techniques for Optimizing Outcome and Safety in *Micro Discectomy*

- Optimal Outcome
  - 3-D Analysis of pathology
  - Adequate decompression
    - Principal Anatomic Landmarks-PAL's
- Safety
  - High speed acorn burr
  - 3-0 curette
  - Ligamentum Flavum Anatomy
    - Broad Attach undersurface upper lamina
    - Attach upper edge lower lamina
  - Avoid Wrong Site Surgery (WSS)

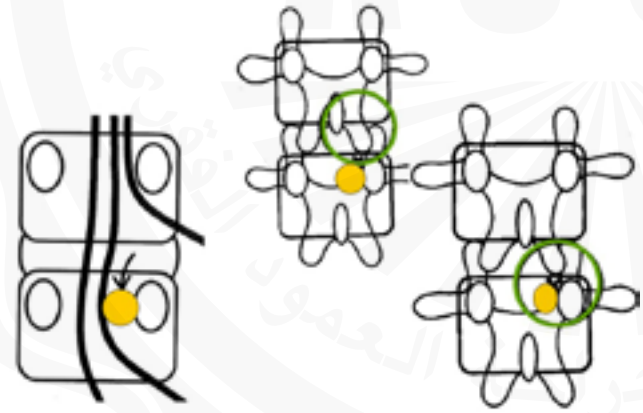
Lumbar Herniated Nucleus Pulposis

HNP

- Incidence Primary 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

Localization of Pathology

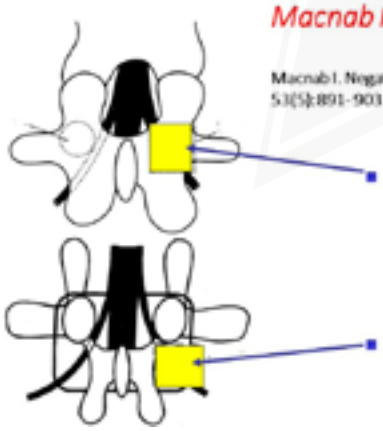
- Critical Concept Microsurgery/MISS



Patho-Anatomy – Medial to Lateral

Macnab HIDDEN ZONES

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

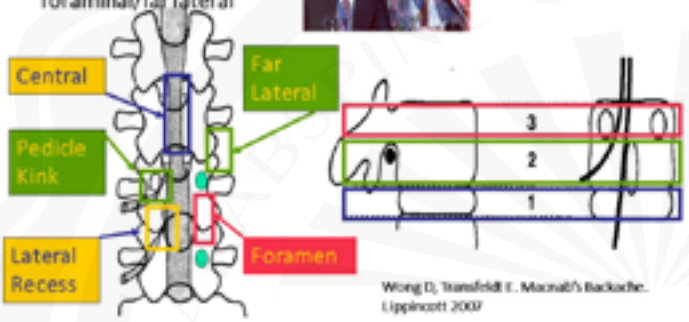


- Hidden Zone
  - Lateral recess stenosis
  - Foraminal stenosis
- Hidden Zone
  - Far lateral HNP

Critical Concepts in Spine Anatomy/Pathology — 3-D

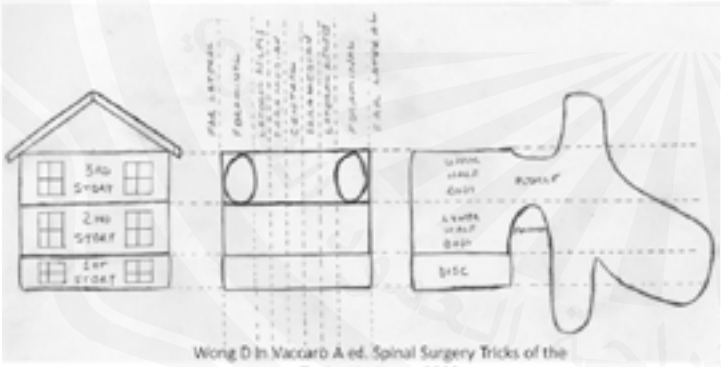
Ian Macnab
- Medial – lateral
- Central/lateral recess/ foraminal/far lateral

John McCulloch
- Inferior – superior
- 3 stories



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

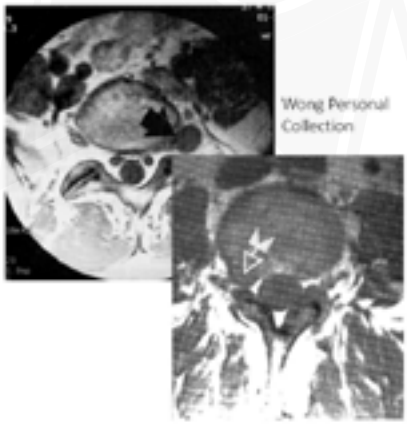
3-D Grid Orientation to Spinal Pathology



Wong D In Vaccaro A ed. Spinal Surgery Tricks of the Trade. Lippincott 2008

Read Axial Images CT/MRI

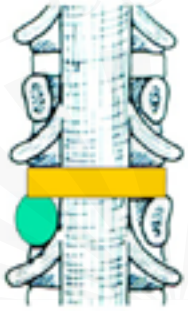
- Anterior
  - Disc density
  - Bone density
- Middle
  - Foramen – hole
  - Pedicle – bone
- Anterior
  - Disc = 1st storey
  - Bone = 2nd/3rd storey
- Middle
  - Foramen = 2nd storey
  - Pedicle = 3rd storey



Wong Personal Collection

"PALs" for Windows Medial Laminotomy

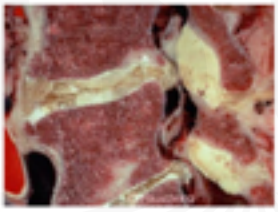
- External
  - Facet
  - Pars Interarticularis
  - Superior edge inferic lamina
- Canal
  - Pedicle
  - Disc

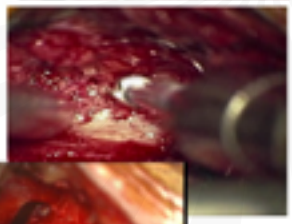


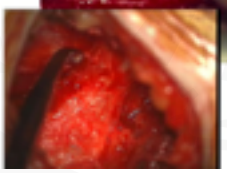
Wong D, Transfeldt E. Macnab's Backache. Lipponcott 2007

Key Technical Points

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



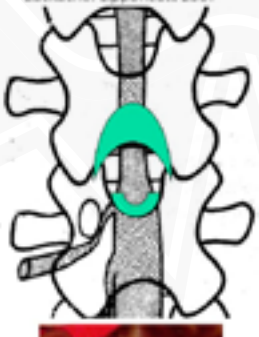




Micro-Discectomy

- 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 Backache. Lipponcott 2007



Koebler.com

Does Size Matter?

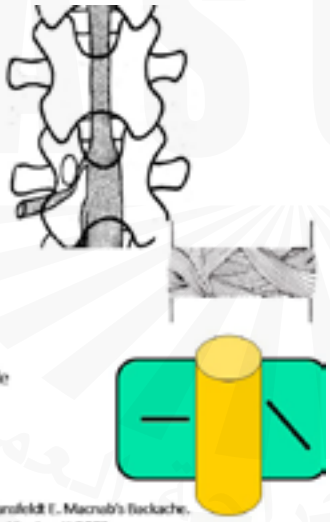
	All Patients	Fragment-Fissure Group	Fragment-Defect Group	Fragment-Contained Group	No-Fragment-Contained Group
No. of patients	180	80	33	42	16
Duration of postoperative sick leave*† (wk)	1.2 (0-8)	1.2 (0-8)	1.3 (0-6)	1.0 (0-4)	1.7 (0-4)
Postoperative Oswestry score* (points)	12.7 (0-51)	13.6 (0-28)	16.8‡ (2-48)	9.2 (0-33)	20.1# (0-60)
Stanford score* (points)	6.5 (2.8-8.0)	9.0‡ (4.1-10)	8.0 (3.9-10)	8.8 (6.0-10)	4.0# (2.8-9.5)
Rate of recurrent/persistent sciatica§	11.7% (21)	1.3%** (1)	27.3% (9)	11.9% (5)	37.5%# (6)
Rate of documented reherniation§	8.9% (16)	1.3%‡ (1)	27.3%‡ (9)	9.5% (4)	12.5% (2)
Rate of reoperation§	6.1% (11)	1.3% (1)	21.2%# (7)	4.8% (2)	6.3% (1)

*The data are given as the mean, with the range in parentheses. †The duration of postoperative work loss is given only for patients who eventually returned to work. §The data are given as the percentage, with the number of patients in parentheses. ‡p = 0.05 to 0.01. #p < 0.001. **p = 0.009 to 0.001.

Carragee E et al. Clinical Outcomes After Lumbar Discectomy for Sciatica: The Effects of Fragment Type and Anular Competence. JBJS-A 2003; 85:102-108

Discectomy Safety

- Canal Entry – Medial
  - Fat/trefoil – safer zone
- Identify
  - Pedicle - 3rd storey below (basement)
  - Traversing Root adjacent to pedicle
  - Disc above pedicle in 1st storey
  - Lateral border of dura
  - Pars – don't coagulate neurovasc bundle
- LOF Root flat over large HNP
  - ID Root everytime! – PAL = Pedicle
- Annulus incision – Slit/Oblique
  - Rate recurrent HNP
  - Anular Repair



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

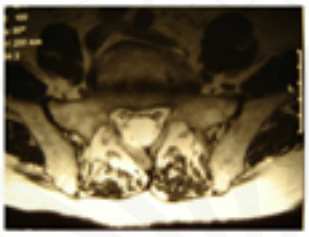
Spine Outcomes Research Trial-SPORT

Journal of the American Medical Association (JAMA)

- 2 Articles re HNP 2yr F/U
  - Randomized Control Trial
    - RCT
  - Observational Cohort
- 2 Editorials
  - Dr. Eugene Carragee
    - OrthoSpine – Stanford
  - Dr. David Flum
    - GenSurg – U Washington
    - CMS MCAC Panel Member
      - 11/30/06

SPORT
Findings/Statistical Analysis
Intent to Treat vs. As Treated

- Primary Measures
  - Trend favor surgery
    - Not statistically Significant
- Secondary Measures
  - Trend favor surgery
  - Statistically Significant Better outcome
    - Sciatica Bothersome
    - Self rated progress
- As treated
  - High Stat Signif for Sx
  - Primary and Secondary



Tubular Diskectomy vs Conventional Microdiskectomy for Sciatica
A Randomized Controlled Trial

JAMA 2009; 302:149

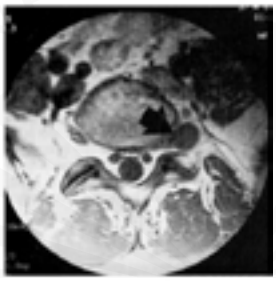
- 328 patients (tube 167/ micro 161)
- Outcome instruments
  - Roland Morris Disability Questionaire (RDQ)
  - VAS- Back and leg pain
  - Self reported reccovery
- All measures favor microdiscectomy
  - Good recovery Tube 69%/micro 79% - p=.05

Infection Rates?

- Rovner J, Schwender J et al. Comparison of Infection Rates in MIS vs Open TLIFS. TSJ 2008;S1;191-192S.
- RCT Open Vs MIS
  - Return to OR for washout
- 251 Open
  - 9 infections = 3.6%
- 196 MIS
  - 0 infections = 0%

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 X-Ray exposure
  - Higher than microdisc
  - C-Arm shots localize tube
    - Thyroid/Eye
    - Chest
    - Hand
  - Statistically significant



Neurosurgery. 2011 Oct;69(4):829-35; discussion 835-6.

Tubular diskectomy vs conventional microdiskectomy for the treatment of lumbar disk-related sciatica: cost utility analysis alongside a double-blind randomized controlled trial.

van den Akker ME, Arts MP, van den Hout WB, Brand R, Koes BW, Peul WC.

Cost Utility Analysis

Quality of Life
using Quality Adjusted Life Years (QALY)
calculated from US EuroQol–Utility scores
=No significant difference

Cost
Tube $460 higher

Wilco Peul

Surgical vs Nonoperative Treatment for Lumbar Disk Herniation

The Spine Patient Outcomes Research Trial (SPORT): A Randomized Trial

James N. Weinstein, DO, MSc

Surgical vs Nonoperative Treatment for Lumbar Disk Herniation

The Spine Patient Outcomes Research Trial (SPORT) Observational Cohort

James N. Weinstein, DO, MSc

- Similar outcomes
- RCT = Real Life Clinical

Percutaneous / Endoscopic Techniques for LDH

Percutaneous Techniques

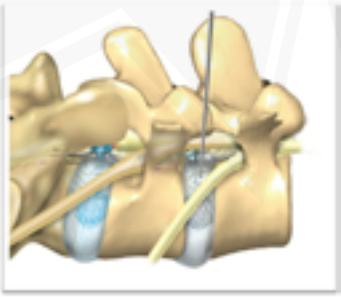
- Percutaneous access to the disc was first used in the 1950s to biopsy the disc using needles.
- Dissolving nuclear proteoglycans by the injection of chymopapain was the first percutaneous technique used to treat radicular pain caused by herniated nucleus pulposus, introduced in the 1960s by **Lyman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

Endoscopic discectomy

- 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.



Endoscopic discectomy

The Yeung Endoscopic Spine Surgery system

Endoscopic discectomy

- 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 canal.
  - Recurrent disc herniations with associated epidural scarring.
  - Moderate-severe central canal stenosis, and hard calcified herniations.

Risk of Complications

- 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 discectomy has reduced the rates of dysesthesia significantly.

- **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.
- The overall complication rate was 3.5%.

- **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 follow-up.
- The microdiscectomy group had a 79% success rate and the full endoscopic group had an 85% successrate with no leg pain at all.

Percutaneous Laser Disc decompression

- The use of laser energy to vaporize nuclear material was introduced in 1986 by **Peter Ascher** and **Daniel Choy**.
- Their first device used a Nd·YAG, through 18 gauge needle placed percutaneously through posterior or lateral approach.
- Different lasers have been investigated for laser discectomy including YAG, KTP, holmium, argon, and carbon dioxide lasers.
- The energy requirements and the rate of application differ among the lasers, but most use approximately 1200 joules of energy per disc.

Percutaneous Laser Disc decompression

- The principle of laser disc decompression is to vaporize a small amount of nucleus with laser energy and achieve decompression.
- Transient increase of temperature also spoils chemical factors and intradiscal nociceptors responsible for pain.
- Laser disc decompression produces high temperatures, and the risk of thermal damage to the adjacent vertebral end plates increases when the discal height is reduced.

Percutaneous Laser Disc decompression

- **Ahn et al** reported symptomatic improvement in 88% of his 111 case series.
- **Gronemeyer et al** reported a 73% success rate for eliminating or reducing back pain.
- **Choy et al** reported a 78% success rate at two to four year follow-up following laser decompression in 333 patients with contained herniated discs.

Automated percutaneous lumbar discectomy (APLD)

- APLD or the **Onik** method was popularised in the 1980s.
- This uses a posterolateral approach inserting instruments with a rotating cutting end through a cannula under radiology control into the disc and in combination with suction, removing fragments of nuclear material.
- Early results from the originators of the technique suggested a 70–85% success rate but a 1995 randomised controlled trial from Liverpool was halted just after half of the patients had been recruited because the results of APLD were so poor.
- Microdiscectomy patients had an 80% excellent or agood outcome compared to the APLD patients with a 30% excellent or good outcome.

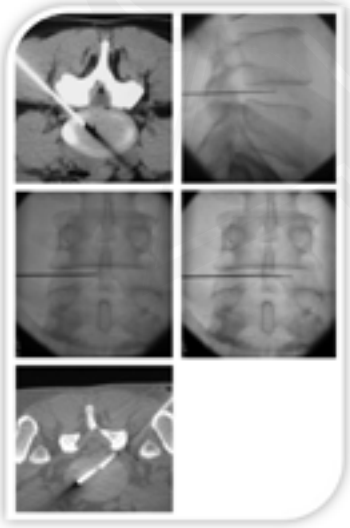
RADIOFREQUENCY NUCLEOTOMY (NUCLEOPLASTY)

- A bipolar radiofrequency electrode is inserted within the disc via a conventional percutaneous approach.
- The electrode ionizes the sodium atoms in the nucleus, leading to creation of a high-energy ionic plasma field disintegrating the intramolecular bonds in the nucleus.
- Does not rely on heat energy to ablate tissue and works in a much lower range of temperature compared with laser disc decompression, so thermal damage is avoided.
- Coblation® technology requires sodium to transmit energy. This process cannot work if the disc is dehydrated. Thus, pressure reduction is highly dependent on the degree of spine degeneration.

RADIOFREQUENCY NUCLEOTOMY (NUCLEOPLASTY)

- 17-gauge introducer needle is inserted into the disc via a conventional posterolateral approach and placed at the posterior annulus.
- Six to 10 channels are created in total, depending on the desired amount of tissue reduction.
- The gas produced by nucleus disintegration escapes from the disc via the introducer needle.
- Particular caution should be taken to keep the electrode parallel to the adjacent vertebral end plates to avoid touching them during the procedure.
- The ablation procedure is very fast, less than 2 minutes once the electrode is in position.

- Drawback of radiofrequency nucleoplasty is the cost of the electrode, which is significantly higher than the cost of the laser fiber.
- The 17-gauge introducer needle is very stiff and difficult to bend for complex L5–S1 approach; in this situation, the flexible laser fiber introduced coaxially through a bended 18-gauge spinal needle is more easily positioned into the disc.



- Indications of percutaneous disc decompression are radicular pain due to contained disc herniation determined by CT or MR imaging and failure of 6 weeks of conservative treatment including selective steroid injection.
- Contraindications include nerve paralysis, hemorrhagic diathesis, spinal stenosis or instability, severe disc collapse >50%, and infection.
- Previous surgery at the same level is considered as a relative contraindication.
- Extruded disc herniations and free discal fragments are not indicated for percutaneous treatment.

Technique of Disc Puncture:

- The disc puncture is performed with a posterolateral approach, under fluoroscopic guidance.
- To open up the posterior aspect of the disc space, pillows are positioned under the abdomen to place the lumbar spine in a semiflexed position.
- The C-arm fluoroscope first is rotated craniocaudally in the plane of the disc and then obliquely, so that the articular process projection is centered midway between the anterior and posterior aspects of the vertebral body ("Scotty dog view").

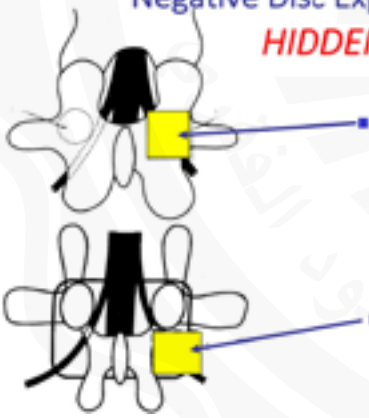
- Disc puncture is then performed in the axis of the X-ray beam, just lateral to the articular process. The needle must systematically slip along the articular process to avoid the nerve root in its extraforaminal course.
- For L5–S1, prominent iliac wings may block direct puncture and bended needle may be required. After puncturing the disc, both anteroposterior and lateral fluoroscopic projections are needed to confirm the proper positioning of the needle

Foraminal and Extra Foraminal Disc Herniation

Foraminal and Far Lateral HNP Surgical Options

- Traditional
  - Laminectomy/foraminotomy with resection of Pars Interarticularis (roof of the foramen) to perform discectomy/foraminotomy
  - Pars resection = destabilization of facet requiring fusion
- Minimally Invasive Microsurgical
  - Far lateral approach
    - Reflect intertransverse membrane expose foramen/exiting root/disc
    - Leave pars intact = no fusion

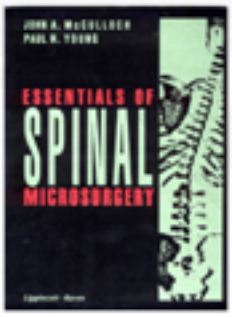
Pathophysiology-Foraminal/Extraforaminal
Dr. Ian Macnab
"Negative Disc Exploration"
HIDDEN ZONES



- Hidden Zone
  - Lateral recess stenosis
  - Foraminal stenosis
- Hidden Zone
  - Extra foraminal/ Far lateral HNP

Foraminal and Extra Foraminal Disc Herniations

- Lateral Disc Herniation
  - Definition foraminal anatomy
    - Entry Zone (lateral recess)
    - Mid Zone
      - under pars (roof)
      - Between pedicles (walls)
      - Above disc (floor)
    - Extraforaminal/Far Lateral
- Incidence foraminal/far lat
  - Only 5-10% of all surgical HD
  - McCulloch/Young



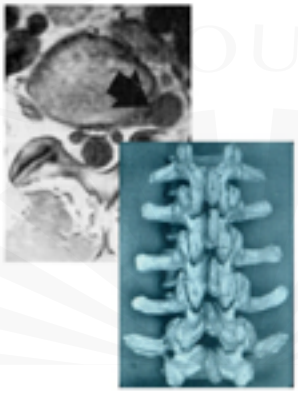
Analysis
3 Issues/3 Anatomic Factors

Issues

1. How lateral is it?
2. Associated foraminal stenosis?
3. What Approach?

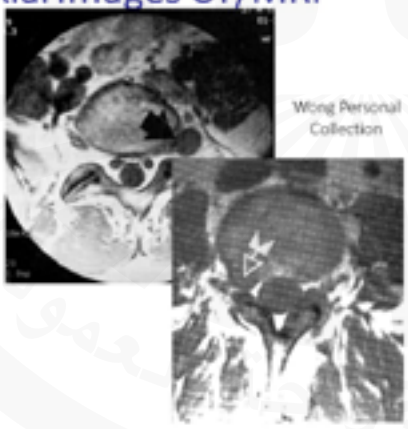
Anatomic Factors

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



Read Axial Images CT/MRI

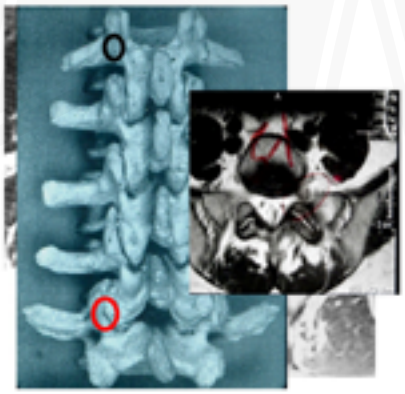
- Anterior
  - Disc density
  - Bone density
- Middle
  - Foramen – hole
  - Pedicle – bone
- Anterior
  - Disc = 1st storey
  - Bone = 2nd/3rd storey
- Middle
  - Foramen = 2nd storey
  - Pedicle = 3rd storey



Wong Personal Collection

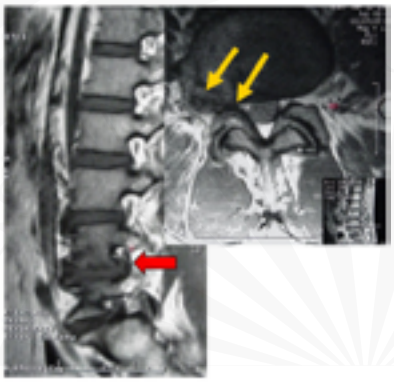
How Lateral Is It?

- 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



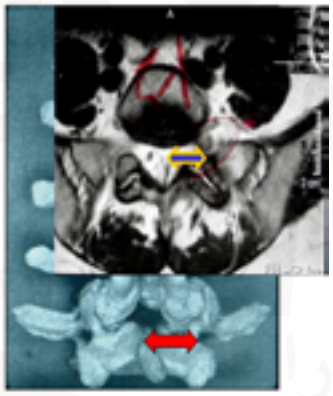
Associated Foraminal Stenosis?

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



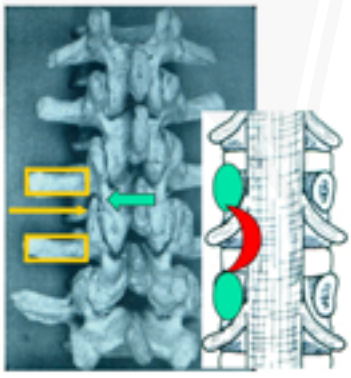
What Approach?

- Can I reach the disc?
  - Medial laminotomy
  - Only by 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

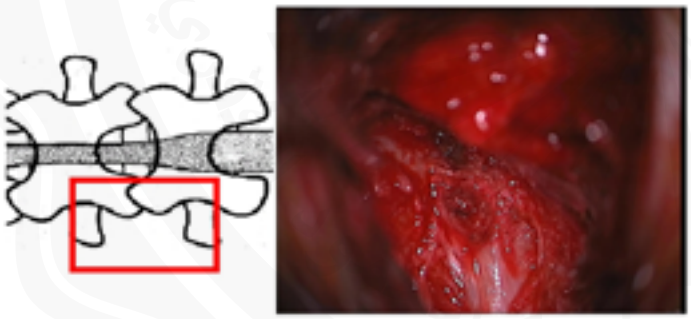
- External
  - Transverse Process
    - Superior/inferior
  - Pars Interarticularis
    - medial
  - Superior Facet
    - Hypertrophied tip obscure pars/foramen
- Internal- anterior to Intertransverse membrane
  - Pedicle
  - Pars Interarticularis



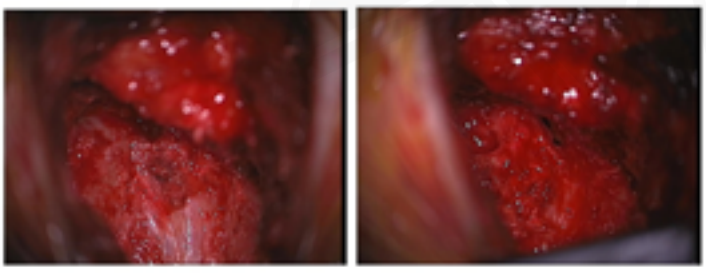
AP Lumbar

- AP Lumbar – Check for
  - Width of pars
  - Collapsed foramen
    - Narrow disc
    - Narrow interpedicular height
    - Scoliosis
  - Transitional level

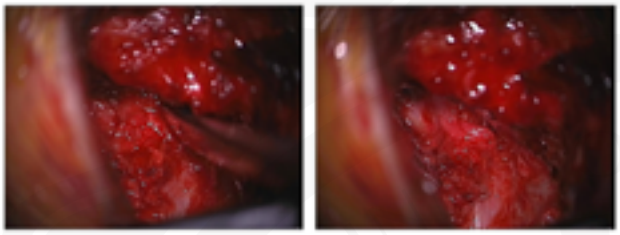
Intertransverse Membrane cleared. Facet medial



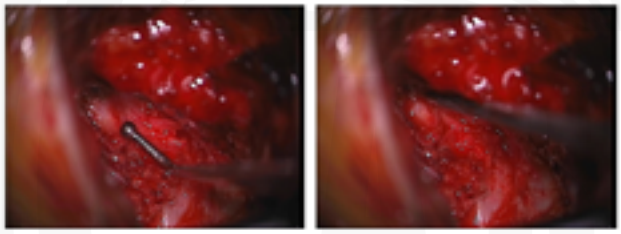
Intertransverse membrane intact then folded back



Pituitary in Disc Space

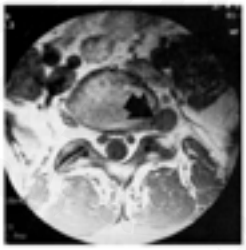


Probing Foramen with long Ball Tip



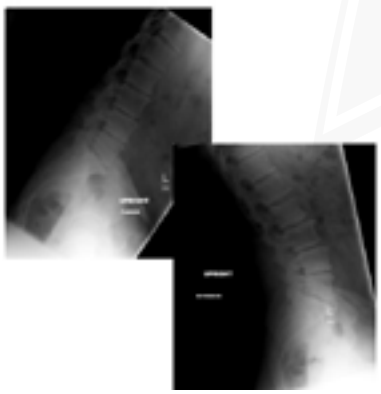
Tips, Tricks and Traps

- Root Ganglion – Cause Paresthesias
  - Lateral to foramen
  - Care for Gentle manipulation of root
  - Pre-treat-steroids/lyrica
- Very Vascular area
  - Bipolar/gelfoam/thrombin-no cautery
- Find
  - Pars medially
  - TP/Pedicle-
    - Exiting root hugs pedicle under upper TP
    - Disc above inferior pedicle/TP



Flexion Extension Laterals

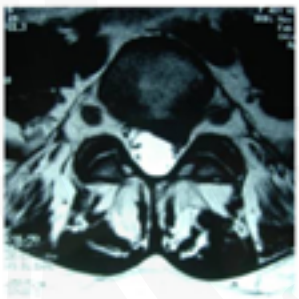
- Check for



Recurrent Disc Herniation

Recurrent Lumbar Disc Herniation

- 41yo female
- 4 week hx of LT leg pain
- Tried PT, NSAIDS, narcotics
- Weak S1 4/5
- +ve SLR

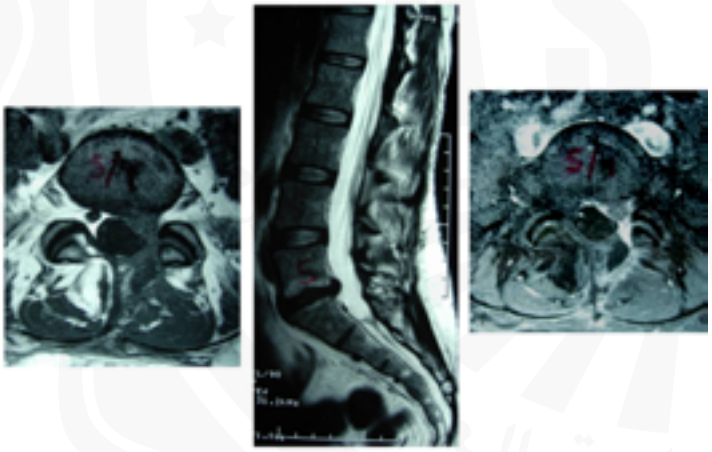


Operative Treatment

- Uneventful L5/S1 microdiscectomy
- Immediate relief of LT leg radicular pain
- S1 strength normal at 1 month postop

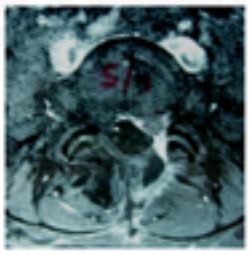
Recurrent Pain

- Presents in late March with increasing LT leg pain
- No weakness but +++ pain
- Some back pain, mechanical in nature
- No constitutional sx
- Wound ok



What is it?

- Disc at same level on the other side?
- Timing
- ⅓ occur within the first year

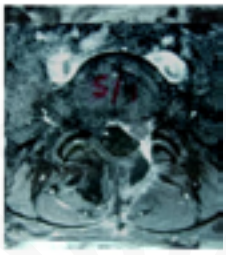


How Do We Diagnosis It?

MRI with gadolinium

- Scar displays immediate signal intensity, scar has heterogeneous enhancement
- Retraction of the thecal sac toward a soft tissue lesion also suggests scar
- The disc has no enhancement, the PLL and annulus can appear hypointense
- Timing of gadolinium administration important

Babar, Clin Radiol 2002



How Do We Diagnosis It?

Spine

CLINICAL CASE SERIES

Asymptomatic Same-Site Recurrent Disc Herniation After Lumbar Discectomy

Results of a Prospective Longitudinal Study With 2 Year Serial Imaging

- Serial imaging for 2 years
- ¼ had radiographic evidence of recurrence
- ¾ asymptomatic

How do we avoid it?

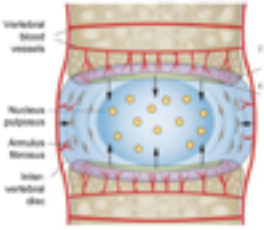
Risk Factors for Recurrent Lumbar Disc Herniation

A Systematic Review and Meta-Analysis

Weimin Huang, MD, Zhiwei Han, PhD, Jiang Liu, PhD, Lili Yu, MD, and Xiachun Yu, MD

Medicine • Volume 95, Number 2, January 2016

- Smoking
- Disc Protrusion
- Diabetes



How do we avoid it?

Disc Height and Segmental Motion as Risk Factors for Recurrent Lumbar Disc Herniation

Kyoung-Tae Kim, MD, Seung-Won Park, MD, PhD, and Young-Baeg Kim, MD, PhD

Factors associated with recurrence
- Greater disc height
- Sagittal Range of Motion

Does Surgical Technique Matter?

CLINICAL OUTCOMES AFTER LUMBAR DISCECTOMY FOR SCIATICA: THE EFFECTS OF FRAGMENT TYPE AND ANULAR COMPETENCE

- Size of annular defect
  - None, small, large
- Presence of free fragment
  - Yes, no

Does Surgical Technique Matter?

CLINICAL OUTCOMES AFTER LUMBAR DISCECTOMY FOR SCIATICA: THE EFFECTS OF FRAGMENT TYPE AND ANULAR COMPETENCE

- Recurrence rate highest with large annular defect (27%)

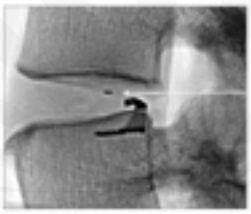
Does Surgical Technique Matter?

Clinical Study

Annular closure in lumbar microdiscectomy for prevention of reherniation: a randomized clinical trial

Claudius Thomé, MD*†, Peter Douglas Klassen, MD‡, Gerrit Jean Bouma, MD§, Adisa Kuršumović, MD‖, Javier Fandiño, MD¶, Martin Barth, MD#, Mark Arts, MD**, Wimar van den Brink, MD‡, Richard Bromelmann, MD‡, Aldemar Hegewald, MD‡, Volkmar Heidecke, MD‡, Peter Vajkoczy, MD†, Susanne Fröhlich, MD†, Jasper Wolfs, MD‡, Richard Assaker, MD‡, Erik Van de Kelft, MD‡, Hans-Peter Kübler, MD‡, Senol Eadik, MD‡, Sandro Eustacchio, MD‡, Robert Hes, MD‡, Frederic Martens, MD‡ on behalf of the Annular Closure RCT Study Group

- Symptomatic recurrence rate
  - 25% without closure
  - 12% with closure



Does Surgical Technique Matter?

Recurrent disc herniation and long-term back pain after primary lumbar discectomy: review of outcomes reported for limited versus aggressive disc removal.
McGirt MJ, Ambrossi GL, Datoo G, Sciubba DM, Witham TF, Wolinsky JP, Gokaslan ZL, Bydon A.
Neurosurgery. 2009 Feb;64(2):338-44; discussion 344-5.

- Incidence of recurrence after limited discectomy 7%
- Incidence of recurrence after aggressive discectomy 3.5%

CONCLUSION:

- Review of the literature demonstrates a greater reported incidence of long-term recurrent back and leg pain after AD but a greater reported incidence of recurrent disc herniation after LD.

How do we avoid it?

- Patient Risk Factors
  - Smoking
  - Diabetes
- Radiographic Risk Factors
  - Disc protrusion
  - Tall disc
  - Greater ROM
- Surgical Technique
  - Large annular defect
  - Limited Discectomy

Recurrent Disc Herniation

Management

- PT
- NSAIDs
- Epidural injections
- Time
- Surgery

Recurrent Disc Herniation

Surgical Options

- MIS revision discectomy
- Open revision discectomy
- Revision discectomy and fusion

MIS vs Open Revision Discectomy

Outcomes Equivalent (3 studies)

- Chen et al, *Neuro Int Res* 2015
  - Shorter duration of surgery
  - Less blood loss
  - Shorter hospital stay
  - Better immediate pain relief

Revision Discectomy vs Fusion

Long-term results of disc excision for recurrent lumbar disc herniation with or without posterolateral fusion.
(Fu , Spine 2005)

- N= 41, f/u 88 months, JOA Back Score
- 80.5% good- excellent overall
- 78.3% good- excellent discectomy alone
- 83.3% good- excellent discectomy and fusion

- Difference in post op back pain was insignificant

- Greater blood loss, OR time and hospital stay in fusion group

- DISC EXCISION ALONE IS RECOMMENDED

Revision Discectomy vs Fusion

Asian J Neurosurg. 2013 Jul-Sep; 8(3): 139–146.
doi: 10.4103/1793-5482.121685
PMCID: PMC3877500
PMID: 24403956

Recurrent lumbar disc herniation: A prospective comparative study of three surgical management procedures

Ayman A. El Shazly, Mohammed A. El Wardany, and Ahmad M. Morsi[1]

Discectomy vs TLIF vs PLF

- No difference
  - Postop JOA score
  - Resumption of previous activities
  - Pt satisfaction with result
- Discectomy
  - More back pain
  - More dural tears
  - More recurrences

Revision Discectomy vs Fusion

Comparison of Three Minimally Invasive Spine Surgery Methods for Revision Surgery for Recurrent Herniation After Percutaneous Endoscopic Lumbar Discectomy

Yuan Yao[1], Huiyu Zhang[2], Junlong Wu[1], Huan Liu[1], Zhengfeng Zhang[1], Yu Tang[1,A,#], Yue Zhou[1,A,#]

Endoscopic Discectomy vs Open Discectomy vs TLIF

- Discectomy
  - cheaper,
  - shorter hospital stay
  - more back pain
  - higher rate of recurrent surgery
- Clinical outcomes overall same at one year

Fusion Techniques for RLDH

Asian J Neurosurg. 2013 Jul-Sep; 8(3): 139–146.
doi: 10.4103/1793-5482.121688
PMCID: PMC3877600
PMID: 24403956

Recurrent lumbar disc herniation: A prospective comparative study of three surgical management procedures

Ayman A. El-Shafy, Mohammed A. El-Wardany, and Ahmed M. Morsi

TLIF vs posterolateral fusion (PLF)

- No differences between the fusion groups
  - Outcome scores
  - Fusion rates
- PLF cheaper

Surgery for RLDH

Recommendations

- Repeat disectomy alone gives reliable results
  - Slight increased incidence of back pain
  - ? higher recurrence rate
  - Slight increased chance of back pain
  - ? more difficult to decompress the nerve

Surgery for RLDH

Recommendations

- Fusion
  - Appropriate
  - Not routinely needed
  - Best for instability, deformity, persistent radiculopathy
  - Technique not important
  - ? Multiple revisions

Conclusion

- MRI with gadolinium is key to the diagnosis of recurrent disc
- Beware of aymptomatic recurrences seen on MRI
- Both patient groups have been shown to do well with discectomy alone, it is not definitively proven that those patients with concomitant back pain will benefit from fusion

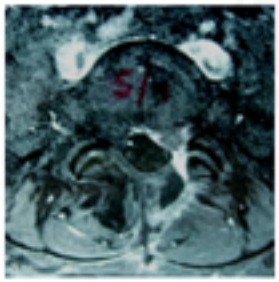
Recurrent Pain

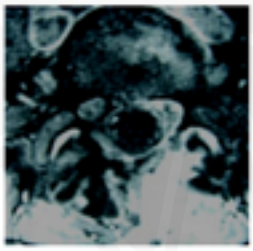
What would you do after a trial of conservative treatment and the pain persists?

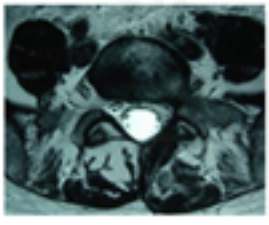
1) discectomy alone

2)discectomy and fusion

Case







Outcome

- Reduction in leg pain, not completely resolved
- Back pain persists and sometimes worsening

Complications in LDH - Avoidance and Management

MINIMIZING SIDE EFFECTS IN MICRODISCECTOMY

"TO ERR IS HUMAN" physicians are humans, and they do make mistakes.

Lumbar microdiscectomy is considered simple surgery but it may be associated with many complications, side effects and even death.

Malpractice Issues in Neurological Surgery:
Surgical Neurology,65, 2006

Background : A current study of *275 malpractice claims*

Spinal Surgery continues to dominate neurosurgical malpractice claims with 42% of the total, most from lumbar spine operations.

Spinal Surgery		Poor indications, inappropriate surgery	25
Lumbar	73	Increased pain/ disability, FBSS	
Cervical	30		
Thoracic	15	Cauda Equina/ nerve root, damage	20
Intracranial Surgery	18		
Trauma		Wrong level	16
Craniocerebral	27		
Spinal	21	CSF leak/ pseudomeningocele	5
Failed Diagnosis		Delay Surgery	3
Sentinel Bleed	10		
Cerebral Lesion	10	Vascular/ Bowel Injury (1 death)	3
Spinal Lesion	7	Diskitis	1
Aneurysm/ AVM	14		
Lung Cancer	1		
Infected Hip Wound	1		

MINIMIZING SIDE EFFECTS IN MICRODISCECTOMY

The two most important factors to improve outcome and avoid side effects and complications are:

Selection criteria

Concordance between clinical, radiological ± Neurophysiological findings

Absence of marked psychosocial economic problems,

Failure of well conducted medical treatment

Surgeons' expertise.

Pre-existing comorbid conditions must be stabilized and cleared before surgery

Anticoagulants, Aspirin-plavix must be stopped (at least 5 to 7days before surgery) to avoid excessive bleeding and possible post-op hematoma

MRI must be relatively recent (less than 3 months).

MRI needs to be repeated:

- In case of *new clinical signs*, (possible displacement of the herniated fragments or possible new disc herniation or new pathology has happened).

MINIMIZING SIDE EFFECTS STEP BY STEP

1. ANESTHESIA
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. SYMPTOMATIC EPIDURAL ADHESIONS
12. RECURRENT DISC HERNIATION
13. FAILED BACK SURGERY SYNDROME (FBSS)

1. ANESTHESIA

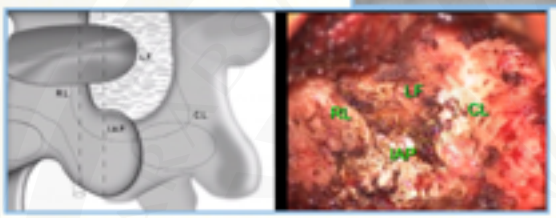
We do intubate elderly patients with the philadelphia collar in, or with fiber optics intubation to avoid neck hyperflexion and extension

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 postion as good as Wilson Frame.

It helps opening the posterior disc space and the inter-laminar 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.

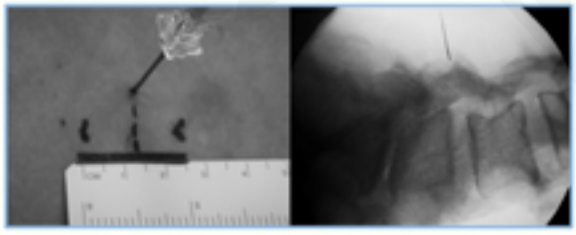
3. OPERATING WRONG LEVEL OR WRONG SIDE

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.



Online Survey study on *173 NASS members* (including both orthopedic surgeons and neurosurgeons):

Analysis of the Techniques for Thoracic and Lumbar *Level Localization* during Posterior Spine Surgery and the *Occurrence of Wrong Level Surgery*:

Wrong level exposure is documented in 0.32% to 15% of cases.
Fluoroscopy 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%).

Cause of localization errors

- Poor communication in the operating room,
- Failure to relocalize once the site is exposed
- Use of poor reference points
- Miscounting from a reference.

Plain radiographs are associated with more errors than fluoroscopy.

Recommendations

- 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

Check the patient for subtle coagulation problems or use of anti-platelets or others before surgery.

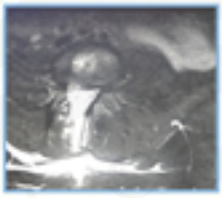
Secure good hemostasis

Use drain if needed.

5. DURAL TEAR AND CSF LEAK

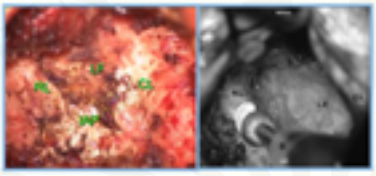
Work under magnification.

Keep ligamentum flavum intact during the bony work,



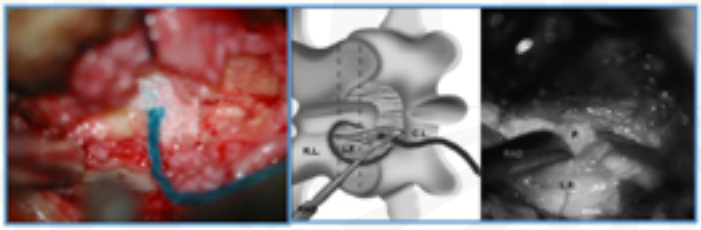
CSF Collection and leak

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



Godkin RS, Lasko CL. ***Unintended "incidental" durotomy during surgery of the lumbar spine: medico legal implications.*** *Surg Neurol 1995; 414-14.*

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.

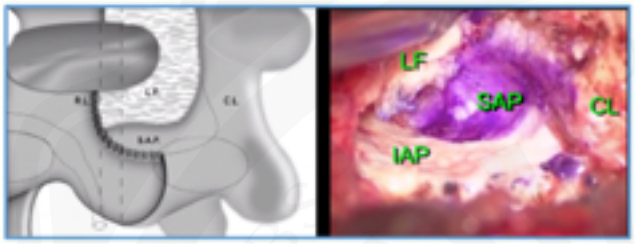
Use bilateral approach when very large central disc herniation, especially at L1-L2 and L2-L3 levels (risk of cauda equina)

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.

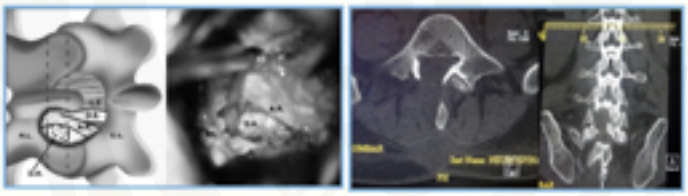
7. RESIDUAL STENOSIS



Lateral Recess Stenosis: Frequent cause of persisting symptoms after lumbar spine surgery

Removal of medial part of SAP

8. IATROGENIC INSTABILITY



Iatrogenic Instability (Excessive Facetectomy)

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.

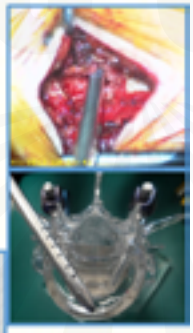
Consider prophylactic antibiotherapy especially in diabetic patients.

Avoid prolonging surgery.

Respect rules of sterilization.

Treat CSF leak or collection seriously and rapidly.

10. MAJOR VESSELS INJURY



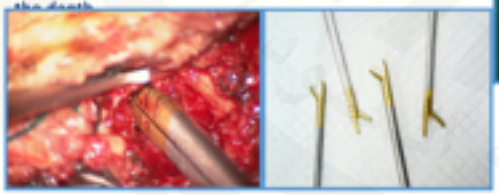
On pre-op. MRI see if anterior annulus rupture

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,

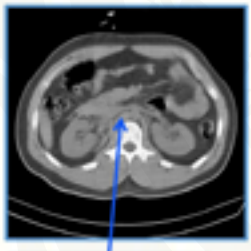
ask the anesthetist to insert more lines and to be ready for possible massive blood transfusion. Finish fast the actual Microdiscectomy, start the transfusion during the turning of the patient onto his back.

It is expected to have another acute B.P. drop when turning the patients' to Supine position.

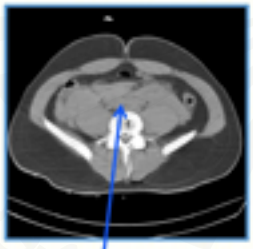
Be ready with ultrasound and radiologist inside the operating room.

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.



Normal Vessels and Retroperitoneal Space



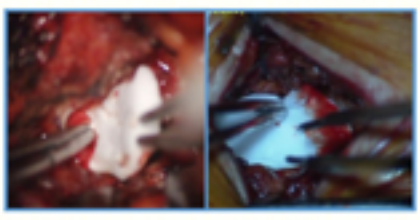
Fullness of pre vertebral shadow masking the outline of the Aorta and IVC due to retroperitoneal hematoma

11. SYPMTOMATIC EPIDURAL ADHESIONS

Avoid excessive coagulation,

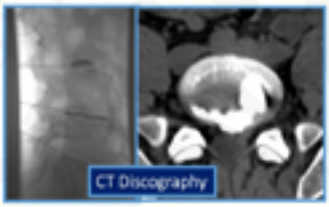
Cover the nerve root and the exposed dura by the available anti adhesive products (many are available in the market) or use fat from the same incision (still controversial).

Avoid residual or post-operative bleed



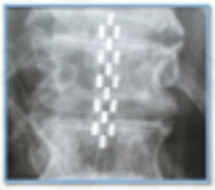
12. RECURRENT DH

- 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



13. 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

CONCLUSION

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 +++

WHO SSI Prevention Guidelines 2016 CDC SSI Guidelines 2017

GLOBAL GUIDELINES FOR THE PREVENTION OF SURGICAL SITE INFECTION

SSI GUIDELINES: CDC

- World Health Organization-WHO
  - https://wwwwho.int/gpsc/ssi-prevention-guidelines/en/
- Centers for Disease Control-CDC
  - Berrios-Torres S. JAMA Surg 2017;152(8):784-791

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Cauda Equinna Syndrome

Cauda Equina Syndrome

per Medscape

Cauda equina syndrome refers to a characteristic pattern of neuromuscular and urogenital symptoms resulting from the simultaneous compression of multiple lumbosacral nerve roots below the level of the conus medullaris. These symptoms include low back pain, sciatica (unilateral or, usually, bilateral), saddle sensory disturbances, bladder and bowel dysfunction, and variable lower extremity motor and sensory loss

Cauda Equina Syndrome

Clinical Issues

- Diagnosis
  - "classic presentation" = Complete
    - LE weakness/numbness/paresthesias
    - Saddle anesthesia
    - Urinary retention
      - Look out for – overflow urine loss
    - Stool loss
      - Decrease rectal sphincter tone
  - "Incomplete/ Atypical"
  - Differential Dx-Conus Medullaris Synd
- Timing of Surgery
  - ?surgical emergency? vs. urgent

Cauda Equina Syndrome

Incomplete vs. Complete

Table 2. Practical Working Definition of Cauda Equina Syndrome and Most Common Associated Cardinal Clinical Features

Types of Cauda Equina Syndrome	Definition	Most Common Associated Clinical Features of Both Types
Incomplete CES or	Patient has urinary difficulties: - diminished urinary sensation - loss of desire to void - poor urinary stream - need to strain to urinate	- severe low back pain - unilateral/bilateral radicular pain - unilateral/bilateral sensory or motor radiculopathy - perianal or genital dysesthesia - fecal retention or incontinence - sexual dysfunction
Complete CES or	painless urinary retention and overflow incontinence	

Cauda Equina Syndrome-CES
vs.
Conus Medullaris Syndrome-CMS

	Conus Medullaris Syndrome	Cauda Equina Syndrome
Presentation	Sudden and bilateral	Gradual and unilateral
Reflexes	Knee jerks preserved but ankle jerks affected	Both ankle and knee jerks affected
Radicular pain	Less severe	More severe
Low back pain	More	Less
Sensory symptoms and signs	Numbness tends to be more localized to perianal area; symmetrical and bilateral; sensory dissociation occurs	Numbness tends to be more localized to saddle area; asymmetrical; may be unilateral; no sensory dissociation; loss of sensation in specific dermatomes in lower extremities with numbness and paresthesia; possible numbness in pubic area, including glans penis or clitoris
Motor strength	Typically symmetric, hyperreflexic distal paresis of lower limbs that is less marked; fasciculations may be present	Asymmetric areflexic paraplegia that is more marked; fasciculations rare; atrophy more common
Impotence	Frequent	Less frequent; erectile dysfunction that includes inability to have erection, inability to maintain erection, lack of sensation in pubic area (including glans penis or clitoris), and inability to ejaculate
Sphincter dysfunction	Urinary retention and atonic anal sphincter cause overflow urinary incontinence and fecal incontinence; tend to present early in course of disease	Urinary retention; tends to present late in course of disease

Cauda Equina Syndrome-CES
vs.
Conus Medullaris Syndrome-CMS

CMS

- Compression Conus Medullaris (Usual T12-L2)
  - Tumor
  - Vascular/infarct
  - Trauma
  - Infection
  - Disc Herniation

CES

- Compress LS Roots
  - Massive Central HNP
    - Lumbar Stenosis
    - Tethered Cord Syndrome
  - Tumor
  - Infection
    - Abscess/compression
    - Inflamation/demyelination
  - Trauma
  - Spinal Epidural Hematoma
    - Post op
    - Post injection

Acute Cauda Equina Syndrome Caused by a Disk Lesion
Is Emergent Surgery the Correct Option?
Karthik Mahadevappa , MBBS , * Adriano Persi , BSc. Pharm, DC , † and Shanker Nesathurai , MD, MPH, FRCP(C) ‡
Spine 2015;40:636-638

- Cauda equina syndrome (CES) is characterized by low back pain, leg dysaesthesiae, and leg weakness as well as 1 or more of the following symptoms: urinary incontinence, fecal incontinence, and/or sexual dysfunction.

- Division of Physical Medicine andRehabilitation, School of Medicine, McMaster University, Hamilton, Ontario, Canada; and ‡ Department of Physical Medicine and Rehabilitation, Hamilton Health Sciences, St. Joseph's Healthcare Hamilton, and School of Medicine,McMaster University, Hamilton, Ontario, Canada.

Cauda Equina Compression by Hydrogel Dural Sealant After a Laminotomy and Discectomy:Case Report
Mike Mulder, MBChB (UCT), J. Crosier, FRCS (Edin), FCS(SA) Orth, and R. Dunn, MMed (Orth), FCS(SA) Orth
SPINE 2009;34:E144–E148

- Check package insert
  - % expansion=mass effect
    - Vary 10 → >100%
- FDA warning
  - Gelfoam

Eurospine

Copenhagen September 2-4/15

Blade D et al. Timing of Treatment of Cauda Equina Syndrome at a National Treatment Center. ESJ 2015;24:S723

- Royal Victoria Hospital
  - Belfast, Northern Ireland
  - Tertiary care unit
    - Emergency Spine Surgery all NI
    - 1.86 M population/Belfast 580,000

Blade D et al. Timing of Treatment of Cauda Equina Syndrome at a National Treatment Center. ESJ 2015;24(supp):723

- All referrals 2008-2014
- 344 pts possible CES
  - 205 NO CE compression on Imaging
  - 137 CE compression
  - 2 metastatic
- CES/CES Incomplete/CES Urinary
- Sx <48hrs CES-I improved
- Sx CES-U no diff under/over 48hr

Blade D et al. Timing of Treatment of Cauda Equina Syndrome at a National Treatment Center. ESJ 2015;24(supp):723

Conclusions

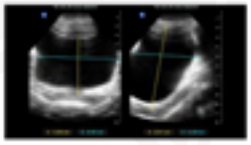
- Try to operate <48hrs onset
  - Best results
    - Back and leg pain
    - Paresthesias
    - Weakness
  - Bladder and Bowel - CES-U
    - No difference rates of recovery +/- 48h
    - Clinical improvement less than CES-I
  - Sx before CES-I converts to CES-U

Cauda Equina Syndrome What Type of Surgery?

- 3-D analysis of Pathology
  - Disc/facet-central/foraminal
  - Other-hematoma/tumor/infection
  - Usually bilateral/? Number levels
- Laminectomy
- Bilateral laminotomies
- Bilateral microdecompression via unilateral approach
- Open/micro/tube
- +/- fusion

Tips, Tricks and Traps

- Clinical
  - Cauda vs other Diagnoses
    - Urinary spotting (esp. women)
      - *Overflow from paralyzed bladder*
      - Weak pelvic floor post partum
      - Weak bladder/short urethra
      - UTI
    - Urinary retention (esp. men)
      - Prostate disease
      - Anesthesia/opioids



Tips, Tricks and Traps

- Clinical
  - B&B can function with unilateral innervation
- Imaging
  - Severe Central/bilateral stenosis
  - Look for enlarged bladder
- Technical
  - Canal entry apex of trefoil
  - Very thin shoe kerrison

Cauda Equina Syndrome Summary: Surgical Timing

- Traditional Approach
  - "the sun should not set on a significant cauda equina syndrome"
- Practical Approach
  - As soon as possible/practical
    - <48hrs
      - Improvement CES incomplete
      - No chg outcome bladder involve

Other References

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Natural History

Narrowing of the spinal canal/lateral recess/ intervertebral foramen

Verbiest (1954) first established LCS as a clinical entity

By the age of 65 yrs, myelographic evidence of LCS is present in 17–60% of adults; Up to 80% aged >70 years.

LCS most commonly involve L4-L5 level , followed byL3-L4 level.

The natural history of lumbar canal stenosis is frequently benign, and many patients respond to conservative treatment.

Surgery should be reserved for when medical treatment fails and leg symptoms are severe and functionally disabling.

Johnsson, K. e. Acta Orthop. Scand. 66, 403–405(1995) Sasaki K (1995) Eur Spine J 4:71–6

CLASSIFICATIONS

Etiological Classification

Primary stenosis

- Idiopathic stenosis
- Achondrodysplasia

Secondary stenosis

- Degenerative
- Ossification of the ligamentum flavum & OPLL
- Metabolic or endocrine causes
- Infections
- Neoplastic
- Rheumatological conditions
- Posttraumatic or postoperative stenosis

A patho-morphological classification

considers the underlying pathology such as:

- Hypertrophy of the ligamentum flavum
- Hypertrophy of the facet joints
- Osteophyte formations (spurs)
- Disc herniation
- Synovial facet joint cysts
- Vertebral displacements (anterior/lateral)

Symptoms of LCS

- Standing/ walking provokes symptoms
- Pain/weakness in the legs
- Patients lean forward while walking to relieve symptoms
- Sitting or bending forward relieves symptoms

Cardinal symptom

Neurogenic claudication

- Numbness, weakness and discomfort in the legs while walking or prolonged standing,
- Regression of symptoms during sitting and rest .
- Distance decreases with increasing severity of the degenerative changes

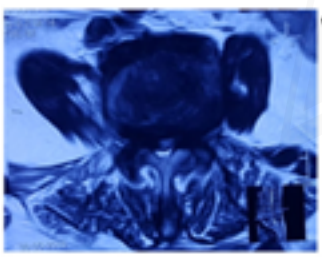
Radicular claudication

- Symptoms can be provoked during walking and prolonged standing but are localized to a nerve root dermatome

Less frequent symptoms

- Mechanical low-back pain (worse on activity)
- Atypical leg pain (non-radicular distribution)
- Cauda equina syndrome (very rare)

CENTRAL Stenosis



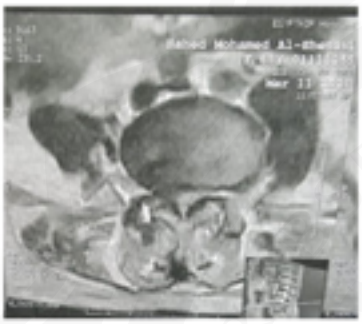
Varied presentation

Classically with neurogenic claudication

Some may only have back pain

Rarely painless progressive weakness

FORAMINAL Stenosis



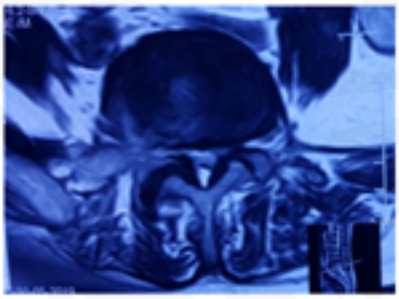
Root symptoms

Unilateral

No claudication

Acute or chronic

LATERAL RECESS Stenosis



Claudication

Radicular pain

Weakness is rare

Acute or chronic

PHYSICAL FINDINGS

The most frequent physical findings

- Limited lumbar extension 66–100%
- Sensory deficit 32–58%
- Muscle weakness 18–52%
- Straight leg raising 10–90%
- Absent knee reflexes 10–50%
- Absent ankle reflexes 50–68%

Katz JN, et al. Rheum. Dis. Clin. North Am. 20:471-483, 1994

A reliable assessment of the **walking distance** is an important parameter for determining the outcome of surgical treatment.

LCS

- **Common disease of the spine.**
- **Increased in the past few decades**
  - **Population ageing**
  - **Accuracy of diagnostic methods**
- **The number of detected cases of LCS have increased**

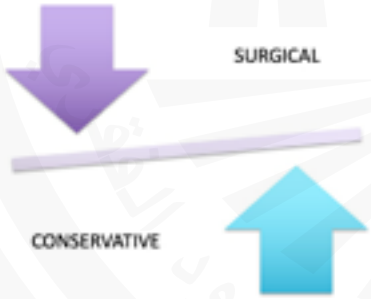
LCS

- LSS is one of the **most common reasons** to perform spinal surgery in elderly
- SURGERY
  - ✓ Rate of success ranges from 57-95%
    - Turner JA, Spine, 1992
    - Thome C, J Neurosurgery, 2005
  - ✓ Rate of revision surgery 6.5-27%
    - Javid MJ, J Neurosurg, 1998
    - Martin BI, Spine, 2007
    - Jannson K, Eur Spine J, 2005
    - Caputy AJ, J Neurosurg, 1992
  - ✓ The outcome of **revision** surgery is less than index surgery

- 20% of asymptomatic individuals over 60 y/o have LCS on imaging
  (Boden, J of Bone and Joint Surgery, 1990)
- No direct relationship between the extent of the stenosis and clinical Sx
  Herno A, Spine,1994, 1999
- This fact remains unexplained

- Most of the elderly population exhibit radiological findings of spine degeneration on spine imaging
- 80% of subjects aged over 70 years has stenotic findings on MRI
  - Sasaki K 1995, Eur Spine J 4:71–76

- **knowledge of the natural history of LSS is crucial.**



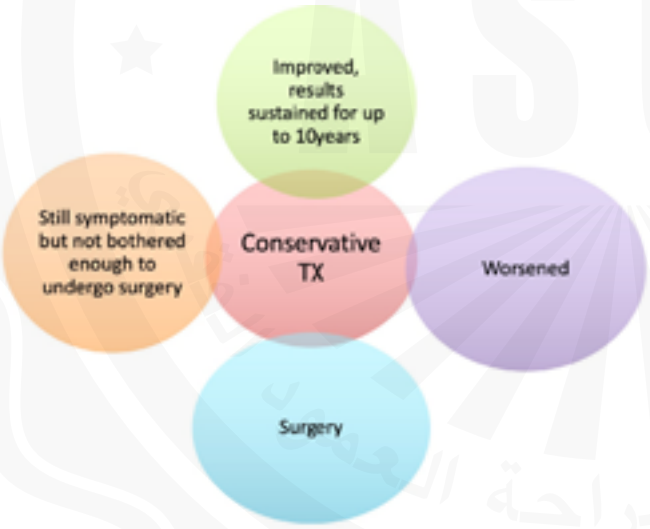
ANECDOTAL REPORTS

- no scientific value but indicate that some patients do not deteriorate with time and are able to tolerate their disability without surgical decompression.

STUDIES

- No well conducted studies
  - ✓Not randomized, retrospective, no clear or various inclusion criteria
  - ✓Small number of patients precluding definite conclusions
- Follow-up between 3 to 10 years

NO DEFINITE CONCLUSIONS OR GUIDELINES TO RECOMMEND SURGICAL VS CONSERVATIVE TX



FACTS

- Overall results of surgery are better than those of medical treatment.
- Faster resolution of pain
- Increased chance to improve an eventual neurological deficit
- Earlier return to work and lower costs for society

OUTCOME AFTER LCS SURGERY

- LITERATURE SURVEY
- ✓ Success rate after initial decompression 80-85% (90%)
- ✓ The results after surgical decompression deteriorates with time
- ✓ Further degenerative changes and bone re-growth carries a risk of restenosis
- ✓ Marked improvement is in walking distance and standing time and less in Back pain.
- ✓ Success rate of redo surgery 50%

PREDICTOR FACTORS FOR WORSENING AND NEED FOR SURGERY

- Severe stenosis / complete block
- Multilevel stenosis
- Scoliosis
- Spondylolisthesis

- SEVERE UNREMITTING PAIN
- IMPAIREMENT OF FUNCTIONAL STATUS
- NEUROLOGICAL DEFICIT

SURGICAL PROCEDURE

- **Advanced age** does not increase the morbidity,
- nor does it decrease patient satisfaction
- or lengthen the return to activity
  - Fredman et all, Eur Spine J 11:571 – 4
  - Ragab et all, Spine 28:348 – 53
- **Elderly patients with spinal fusion have increased complication rate**
  - Stromqvist, Acta Orthop Scand 72:99 – 106
  - Ciol MA, J Bone Joint Surg Am 74:536 – 43
  -
- **Therefore less invasive surgical approaches may be of particular interest.**

LCS - TAKE HOME MESSAGE

- Treatment should start with well-organized and closely monitored conservative therapy.
- If the pain remains mild or moderate with no major disability, conservative care can be continued with fair chances of stability or even improvement.
- If the low-back and leg pain remains or becomes severe, surgery offers a good chance of stable improvement.
- Overt stenosis, Spondylolisthesis, Scoliosis probably better with surgery

Clinical Assessment

Lumbar Spinal Stenosis: Clinical Background

- Known Clinical Entity only since 1800s
  - Portal 1803 –recognized patho-anatomy of stenosis of lumbar canal - describing increasing compression of neural sac as a function of decreasing canal volume
  - Charcot 1858 – described clinical sequential exercise pain-rest cycle=neurogenic claudication
  - Verbeist and Ehni 1950 recognized connection between anatomic narrowed canal and symptoms of neurogenic claudication
    - suggested term Lumbar Spinal Stenosis
- routinely recognized/treated only 70 years

Consensus on the clinical diagnosis of lumbar spinal stenosis: Results of an International Delphi Study

- international consensus on the clinical diagnosis of LSS, and suggests that within six questions clinicians are 80% certain of diagnosis

Spine (Phila Pa 1976). 2016 August 1; 41(15): 1239–1246.

Questions (In Order)	Percent (%) of respondents who asked this question	Number and percent (%) of times asked as Question 1	Number and percent (%) of times asked as Question 2	Number and percent (%) of times asked as Question 3	Total Times Asked
1. Does the patient have leg or buttock pain while walking?	78	156 (56)	39 (16)	16 (6.5)	211
2. Does the patient flex forward to relieve symptoms?	58	35 (13)	83 (33)	66 (26)	184
3. Does the patient feel relief when using a shopping cart or bicycle?	50	30 (11)	49 (20)	57 (23)	136
4. Does the patient have motor or sensory disturbance while walking?	38	28 (10.5)	32 (13)	44 (18)	104
5. Are the pulses in the foot present and symmetric?	16	1 (1)	18 (7)	25 (10)	44
6. Does the patient have lower extremity weakness?	15	6 (2.5)	13 (5)	23 (9)	42
7. Does the patient have low back pain?	11	5 (2)	10 (4)	15 (6)	30

Lumbar Spinal Stenosis
Clinical Assessment
Outline

- Differential Diagnosis – Leg pain,weakness, paresthesias
  - Neurogenic Claudication
  - Vascular Claudication
  - Peripheral Neuropathy
- Sources of Referred Pain
  - Hip
  - Sacro Iliac Joint
  - Piriformis Syndrome

Lumbar Spinal Stenosis
Clinical Assessment
Outline

- Who Needs Supplementary testing
  - MR
  - EMG/NCS
  - ESI/SRB

Lumbar Spinal Stenosis
Clinical Assessment
"The Big Three" Differential Diagnosis

- DDx
  - Stenosis/neurogenic claudication
  - Vascular/vascular claudication
  - Peripheral neuropathy
- Dr. Ian MacNab-Toronto Canada
  - Conceptual thinker
    - Emphasize history and physical exam
  - "if you ask the right questions, the patient will tell you their diagnosis"

Working Diagnosis

Chief Complaint = "Leg pain/weak/numb"

System Directed Questions

	Neurogenic Claudication	Vascular Claudication	Peripheral Neuropathy
Location	Leg/Foot	Calf	Leg/Foot
Nature	N/T/Wk	Cramp	N/T/W
Onset	Variable Dist	Specific	Constant
Relief	Minutes	Immediate	None
Relief Posit	Flex	Sit/Stand	None
Symmetry	Uni/Bilat	Uni/Bilat	Bilat

Working Diagnosis

Chief Complaint = "Leg pain/weak/numb"

System Directed Physical Exam

	Neurogenic Claudication	Vascular Claudication	Peripheral Neuropathy
Weakness	+/- Radic	No	+/- Distal
Numbness	+/- Radic	No/cold	Stocking
Reflexes	Variable	Variable	Variable
SLR	Negative	Negative	Negative
Pulses	+/-	Absent	+/-
Appearance	OK	Edema/Stasis	Atrophy/Ulcer

Lumbar Spinal Stenosis
Sources of Referred Pain

SPINE • VOLUME 8 • NUMBER 3 • 1983

Hip–Spine Syndrome

C. M. OFFIERSKI, MD, and I. MACNAB, M.B., Ch.B.

- Sacro-Iliac Joint
  - Flexion-Abduction-External Rotation (FABER)
  - Posterior Hip Thrust
- Piriformis Syndrome
  - Local tenderness
  - Hip Adduction / internal rotation

Lumbar Spinal Stenosis
Differential Diagnosis

- Diabetic Mononeuropathy
  - Sometimes pain > numbness
- Anticholesterol medications
  - Myalgias
- Multiple Sclerosis (MS)
  - Weak/balance/vision/fatigue
  - Plaques on MRI
- Amyotrophic Lateral Sclerosis
  - ALS/Lou Gehrig Disease
  - Fasciculation/cramp/spastic/weak

Lumbar Spinal Stenosis
Differential Diagnosis
North America – Hikers/Backpack

- Lyme Disease
  - Bacteria Borrellia/tick borne
  - Target Rash/fever/fatigue/joint swell
  - Nerve pain/weakness
- Rocky Mountain Spotted Fever
  - Bacteria Rickettsia/tick borne
  - Rash/headache/nausea/myalgia/fever
- West Nile Disease
  - Viral/mosquito borne
  - Usually mild/fever nodes
  - Severe/encephalitis/myalgia/paralysis

Epidural Lipomatosis
Exogenous Steroids

- Mean daily dose
  - 30-100 mg prednisone
- Mean Duration
  - 5-11 yr (6mo-25yr)
- Youngest reported
  - Age 6 yrs
- Borre Classify % canal fat
- Roy-Camille R, Mazel C et al. Symptomatic Spinal Epidural Lipomatosis Induced by a Long-Term Steroid Treatment. Spine 1991;16:1365-1371.

Spinal Stenosis from Epidural Lipomatosis

Other Etiologies
- Epidural Steroids
- HIV - Protease Inhibitors

Location
- Thoracic
- Lumbar

Diagnosis – MRI
- Fat layer >7mm/>40% X-sec

Who Needs an MR?

- Red Flags
  - Cauda Equina/B&B
  - Progressive neuro
  - Acute incapacitating symptoms
- 6 wks failed cons care
- Leg symptoms vs LBP
  - Leg
    - Radiculopathy on Px
  - LBP Differential Dx
    - Infection /Tumor

Who Needs Radiographs?

- Everyone
- Stenosis Issues
  - Transitional vertebrae
  - Congenital stenosis/short pedicles
  - Spondylolisthesis/spondylolysis/scoli
- Differential Diagnosis
  - SI fusion/inflammation-sclerosis
  - Hip arthritis/dysplasia
  - Tumor/Fracture/retropulsion

Who needs an EMG?

- Clinical Indications
  - DDx
    - Neuropathy
    - Peripheral nerve
      - Peroneal nerve at knee
    - MS
    - ALS/Lou Gehrig Dis
    - Previous surgery
      - Acute vs. chronic
- Anatomic Indications
  - ? Levels
  - scar

Who needs an Epidural Steroid Injection?

- Canal diameters
  - 16-18 mm Normal
  - 10 mm dura
  - 8-10-Mild SS
  - 6-8 – Moderate
  - 5-6 – severe
  - <5 - critical
- Best ESI candidates
  - None/minor neuro chg
  - Mild/mod SS on MR
    - Severe/ critical no help

Epidural Steroid Injections Lumbar Spinal Stenosis

- Radcliff K et al. Epidural steroid injections are associated with less improvement in patients with lumbar spinal stenosis. Spine 2013; 38:279-291.
- Weinstein JN et al. Surgical versus non operative treatment for lumbar spinal steno four year results of the spine patient outcomes research trial. Spine 2010;35: 132 1338.
- Surgery generally preferred treatment

Who needs an Diagnostic Injections?

- Help define symptomatic levels in cases of multilevel stenosis

Who needs a Surgical Referral?

- Clinical
  - Neurogenic claudication
    - Failed non op care
  - Cauda Equina Syndrome
- Physical Exam
  - Radiculopathy
  - ASIA Motor
    - V – Normal
    - IV- some resistance +/-
    - III- full motion vs gravity
    - II- motion short of gravity
    - I – none/flicker

Imaging of LCS

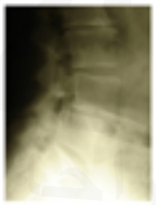
Evolution of Spine Imaging

- Radiographs
- Myelogram
- Epidural Venogram
- CT Scan
- Myelo-CT
- Magnetic Resonance Imaging MRI



Lumbar Spinal Stenosis Imaging

- Critical Investigation
  - Reinforce H&P findings
  - Confirm diagnosis
  - Surgical planning
    - Levels
    - Right vs Left or both
      - HNP/Lateral recess/foramen/far lateral
    - Spondylolisthesis/instability
    - Scoliosis
  - Decompression/fusion/instrument

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  - Hip arthritis/dysplasia
  - Tumor/Fracture/retropulsion



Lumbar Spinal Stenosis Imaging and Surgical Planning

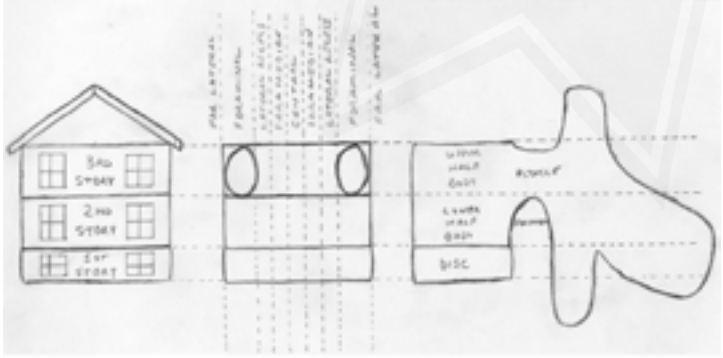
- Minimally Invasive Surgery-MIS
  - 3-D analysis of canal pathology
    - Extent of decompression proximal/distal each segment
    - Extent of decompression media/lateral
      - Lateral recess/foraminal/far lateral
  - Stability/spondylolisthesis
  - Deformity/Scoliosis

Concepts in Spine Anatomy/Pathology

Ian Macnab
- Medial – lateral
- Central/lateral recess/ foraminal/far lateral

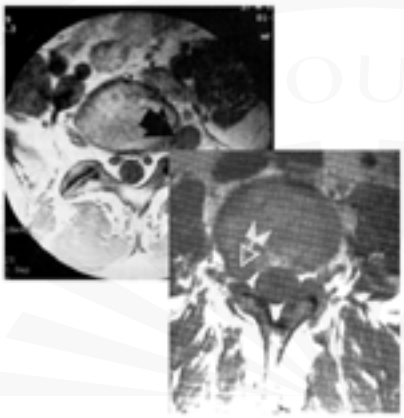
John McCulloch
- Inferior – superior
- 3 stories

Grid Orientation to Spinal Pathology



Read Axial Images CT/MRI

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



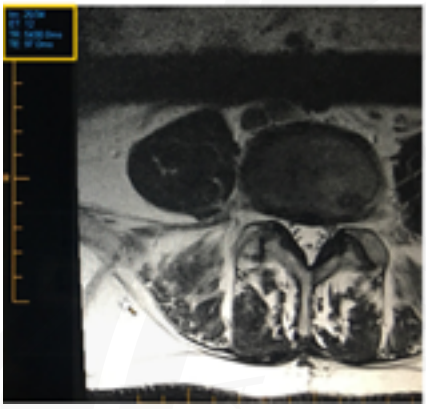
Magnetic Resonace Imaging (MRI) Principles

- Every MRI scanner is a magnet which creates a static magnetic field i.e. it's always on
- Placing a person, in part or whole, into the magnet, will effect the orientation and spin characteristics of tissues at the atomic, molecular and macromolecular level
- The patient is then subjected to additional magnetic gradients or RF signal using electromagnets turned on and off, which change the previous orientation and spin induced by the static magnetic field of the scanner

Magnetic Resonance Imaging (MRI)

- TE (Time to Echo)=apply pulse
  - Time flip proton 180°
- TR (Time to Recover)
  - Pulse interval
- Sequences
  - T1 (TE dominant)TE>50/TR<500
  - T2 (TR dominant)TE>50/TR>1000
- Signal average=slice thick+gap

MRI
T1 vs. T2 Sequences

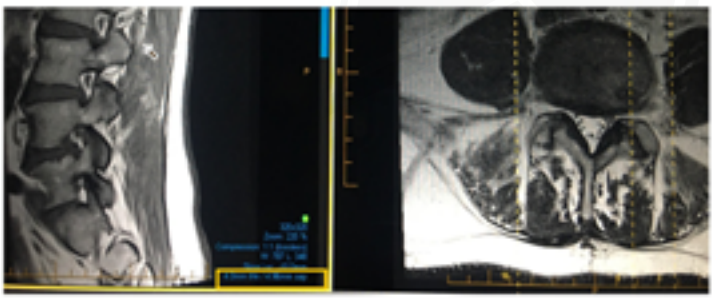


- T1 (TE dominant)
  TE>50/TR<500
- T2 (TR dominant)
  TE>50/TR>1000

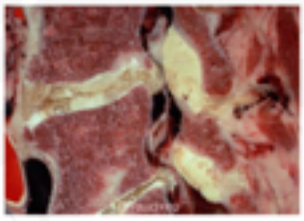
Magnetic Resonance Imaging (MRI)

- T1
  - Better for Bone detail
  - Fluid appears black
  - White=Fat/Blood/Melanin
  - Best for eval foraminal stenosis
- T2
  - Better for soft tissue/less bone detail
  - Fluid appear white i.e.replace myelogram
- Stir (fat suppression)
  - MS Plaque/tumor vs. edema

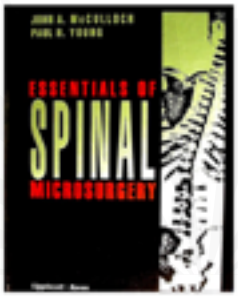
Signal Averaging
Slice Thickness + Gap



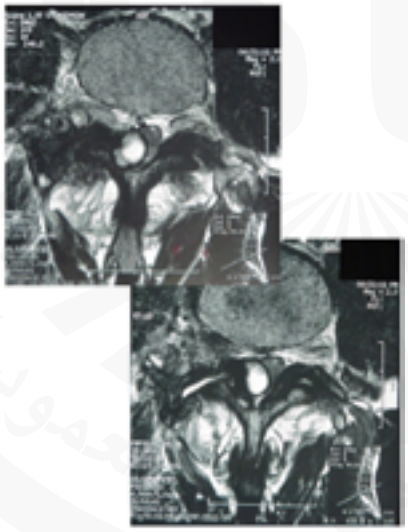
Overview: Pathology



- Spinal Stenosis is a *First Story* disease.
  - John A. McCulloch



MRI 1st Story Stenosis

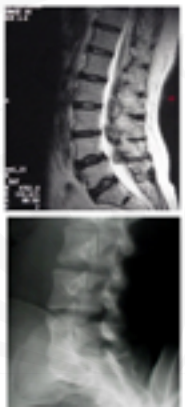


Who Needs an MR?

- Red Flags
  - Cauda Equina/B&B
  - Progressive neuro
  - Acute incapacitating symptoms
- 3-6 wks failed cons care
- Leg symptoms vs LBP
  - Leg
    - Radiculopathy on Px
  - LBP Differential Dx
    - Infection /Tumor

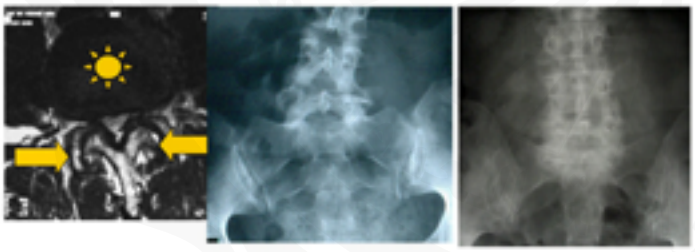
Dr. Ian Macnab and Spondylolisthesis

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

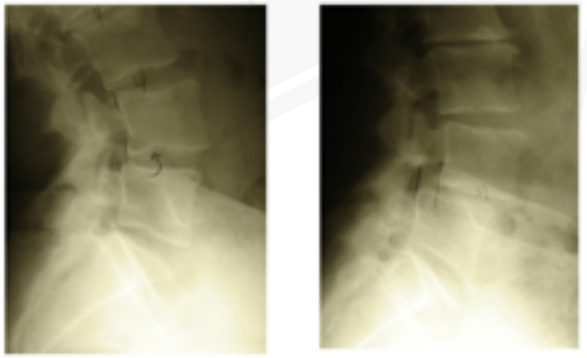


Harry Farfan

- 3 Joint Complex
  - Disc
  - 2 Facets
- Lumbo Sacral Stability
  - Seating L5 in Pelvis
  - Strength Ligaments
    - Level Degen Spondylo L4-5



NASS Guideline Spinal Stenosis with Degenerative Spondylolisthesis;
Instability >4mm motion Flexion Extension

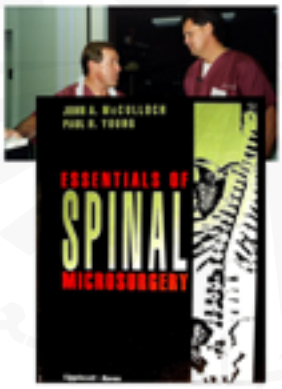


Laminectomy vs. Laminaplasty

- Laminectomy
  - Post Struc/2° Stabilizers Sacrifice
  - Extent dissection
    - Recovery
    - Blood loss
  - Foraminal Decomp
- Laminaplasty
  - 2° Stabilizers Intact
  - Minor Dissection
  - Ipsilateral Foramen

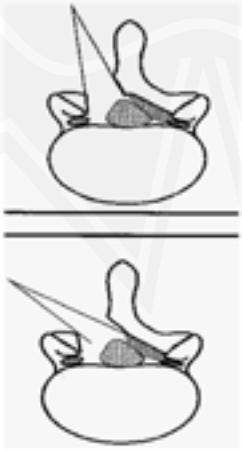
?Bilateral Decompression via Unilateral Laminotomy?

- Paul Young
  - Neurosurgeon
  - St. Louis, Mo
  - Director PAWS (Practical Anatomy WorkShop)
    - 1st AAOS cadaver
  - Co-author
    - Essentials of Spinal Microsurgery



Surgical Issues

- Laminectomy
- Micro Decompression
  - Laminotomy
  - Laminaplasty
- Lam + Fuse
  - Posterior only
    - + PLIF
  - 360°



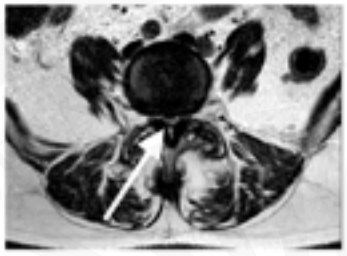
Imaging Issues Contributing to Surgical Decision Making

- Stenosis No Spondylolisthesis
  - Degenerate/Congenital
  - =decompression
- Stenosis + Spondylo
  - Grade I
    - Few mm/↓ disc height/Stable flex/ext/scoliosis <20°
  - =decompress +/- fusion
- Stenosis + Spondylo
  - Unstable spondylo >4mm translate flex/ext
  - Scoliosis >20°
  - Lateral Listhesis
  - =decompress likely fusion

Medical Treatment of LCS

Spinal Stenosis

- Narrowing of the central canal
- Combination of:
  - Facet hypertrophy
  - Ligamentum Flavum Hypertrophy
  - Disc bulge/herniation



Spinal Stenosis

- Bilateral symptoms
- Mostly radiating
- Worse with ambulation or standing
- Improved with sitting
- "shopping cart" sign
- Neurogenic claudication can mimic vascular claudication

Spinal Stenosis - Treatment

- Non-interventional conservative care
  - Activity modification
  - Medications
  - Bracing
  - Physical Therapy
  - Chiropractic care
  - Complementary and Alternative Medicine (CAM)
- Interventional Procedures
  - Epidural steroid injections
- Surgical Options

Spinal Stenosis - Treatment

- **Non-interventional conservative care**
  - **Activity modification**
  - **Medications**
  - **Bracing**
  - **Physical Therapy**
  - **Chiropractic care**
  - **Complementary and Alternative Medicine (CAM)**
- Interventional Procedures
  - Epidural steroid injections
- Surgical Options

Conservative/Medical Treatment of Lumbar Stenosis

- **Activity modification**
- Medications
- Bracing
- Physical Therapy
- Chiropractic care
- Complementary and Alternative Medicine (CAM)

Activity Modification

- Teach positioning and body mechanics
- Avoid bed rest (strong evidence)
- Encourage activity as tolerated (strong evidence)
- Walker for safety/ambulation
- **Education and Reassurance**

Conservative/Medical Treatment of Lumbar Stenosis

- Activity modification
- **Medications**
- Bracing
- Physical Therapy
- Chiropractic care
- Complementary and Alternative Medicine (CAM)

Medications

- NSAIDs or acetaminophen
  - short term for acute or chronic LBP
  - Systematic reviews of patients with OA consistently found NSAIDs superior to acetaminophen for pain relief
- Antiepileptic (gabapentin, pregabalin, topiramate)
  - Select pts with radicular symptoms
  - Evidence is mixed
- Antidepressants (TCAs, SNRI not SSRIs)

Medications

- Insufficient evidence for Calcitonin, Prostaglandin E2
- Opioids
  - Short term for acute LBP
  - For chronic, use with caution and close monitoring
- Insufficient evidence for many pharmaceutical options

Conservative/Medical Treatment of Lumbar Stenosis

- Activity modification
- Medications
- **Bracing**
- Physical Therapy
- Chiropractic care
- Complementary and Alternative Medicine (CAM)

Bracing

- Increased walking distance and decreased pain with lumbar corset
- May reinforce awareness of a "back problem"
- Consistent use not recommended

Conservative/Medical Treatment of Lumbar Lumbar Stenosis

- Activity modification
- Medications
- Bracing
- **Physical Therapy**
- Chiropractic care
- Complementary and Alternative Medicine (CAM)

Physical Therapy

- Limited Evidence as stand alone treatment for Spinal Stenosis
- PT should be considered in comprehensive treatment plan

Conservative/Medical Treatment of Lumbar Lumbar Stenosis

- Activity modification
- Medications
- Bracing
- Physical Therapy
- **Chiropractic care**
- Complementary and Alternative Medicine (CAM)

Spinal Manipulative Therapy

- Performed by osteopaths, chiropractors, and physical therapists
- Techniques vary
- Overall some evidence for limited temporary benefit
- Spinal manipulation is an option for symptomatic relief in patients with lumbar disc herniation with radiculopathy (Grade C evidence)

Conservative/Medical Treatment of Lumbar Stenosis

- Activity modification
- Medications
- Bracing
- Physical Therapy
- Chiropractic care
- **Complementary and Alternative Medicine (CAM)**

Complementary and Alternative Medicine

- Massage
  - Limited evidence
  - Short term benefits, mostly with LBP (not radicular)
  - Most efficacious when combined with exercise
- Acupuncture
  - Evidence supports its use for chronic low back pain as an adjunctive treatment
  - More effective than placebo, sham
  - Little date for stenosis, neurogenic claudication

Complementary and Alternative Medicine

- Yoga
  - Evidence supports its use for chronic LBP, unclear for stenosis
    - Caution to avoid certain poses that may aggravate symptoms
- Tai Chi
  - Insufficient evidence
- Meditation
  - Insufficient evidence
- Traction
  - Insufficient evidence

*Insufficient evidence does not equal lack of benefit
*All have low inherent risk

Interventional Procedures – To be discussed in a separate lecture

- Epidural Injections
- Spinal Cord Stimulation

Summary

- Understand natural course
- Wide variety of non-operative treatments available
- Weigh risks, benefits, and evidence

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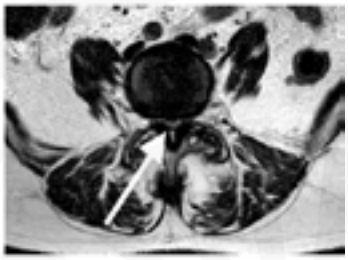
Interventional Treatment of LCS – Epidural Steroid Injections

Interventional Treatments for Lumbar Spinal Stenosis

- Symptoms, imaging, and clinical evaluation all crucial in determining possible interventional treatment
- Epidural Steroid Injections are minimally invasive procedures performed under live x-ray
- Other percutaneous Procedures
  - PILD
  - Interspinous spacer



Epidural Steroid Injections

- Irritation can arise from stenosis from
  - Disc herniation
  - Ligamentum Flavum Hysertrophy
  - Facet Joint Hypertrophy
- Treats pain from irritation of nerves
- Achieves high concentrations of steroid at the site of pain while minimizing systemic effects

Epidural Steroid Injections

- Pure mechanical compression of spinal nerves does not necessarily produce pain
- Degree of nerve root compression does not correlate to pain severity
- Various inflammatory markers or cells are required for the dorsal root ganglion to generate the painful discharges in radiculitis

Contraindications

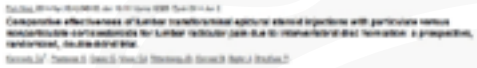
- Absolute
  - Abnormal clotting status/coagulopathy
  - Local infection at site of needle entry
  - Lack of patient consent or cooperation
- Relative
  - Pregnancy
  - Allergies to the medications used
  - Systemic infection, fevers or immunosuppression
  - Anticoagulants (prefer INR< 1.4, off Ticlid 14days, Plavix 7 days, etc.)
  - Uncontrolled Diabetes (if using steroid)
  - Significant or unstable coexisting disease (esp. cardio-pulm)

Fluoroscopy

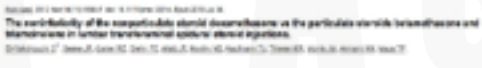
- Only way to verify the medication is getting to the targeted pathology
- Increases patient safety
- Minimizes patient discomfort and complications by using small gauge needles
- Numerous studies demonstrate that 25-35% of lumbar epidurals done without image guidance miss the epidural space
- Fluoro allows one to target a specific side and nerve root level
- Must be used for all diagnostic injections

Risks of Epidural Steroid Injections

- <0.1% to 9.6%
- Most common complications are mild and self limiting
- Headache
- Flare in pain
- Syncope
- Dural Tear*
- Other serious complications (e.g. SCI, epidural hematoma, infections, etc.)



- Both groups demonstrated statistically significant improvements in pain and function at 2 weeks, 3 months, and 6 months.
- Progression to surgery was similar between groups (14.6% dexamethasone vs 18.9% triamcinolone)
- To achieve these outcomes: 7/41 (17%) patients in the dexamethasone group vs 1/37 (3%) in the triamcinolone group needed a third injection



- Retrospective observational study
- 2,634 patients with 2 month follow up
- Dexamethasone 10 mg vs Triamcinolone 80mg or betamethasone 12 mg
- Categorical outcomes:
  - No difference in rates of those achieving >50% improvement in pain
  - Dexamethasone favored with respect to proportion of patients achieving >40% improvement on RMDQ

A Randomized Trial of Epidural Glucocorticoid Injections for Spinal Stenosis

- New England Journal of Medicine: Randomized controlled trial 2014
  - 400 patients
  - Roland Morris Disability Questionnaire and Numeric Pain Scale
  - Multicenter trial
  - Follow-up at 3 and 6 weeks
  - Compared glucocorticoid + lidocaine with lidocaine alone
  - Lots of press

The NEW ENGLAND JOURNAL of MEDICINE

A Randomized Trial of Epidural Glucocorticoid Injections for Spinal Stenosis

- New England Journal of Medicine: Randomized controlled trial 2014
  - At 3 weeks, statistically significant differences btwn groups, with glucocorticoid-steroid group greater improvement in RMDQ and NRS pain
  - At 6 weeks, significant differences in pt satisfaction
  - At 6 weeks, both groups improved in both pain and function, no difference between the two

The New York Times

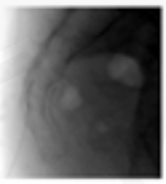
NYT: July, 2, 2014: Common Back and Leg Pain Treatment May Not Help Much, Study Says

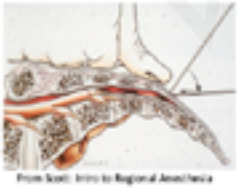
Epidural Steroid Injections

- Interlaminar epidural injection (ESI)
- Transforaminal epidural injection (TFESI)
- Caudal epidural injection

Caudal Epidural Steroid Injection

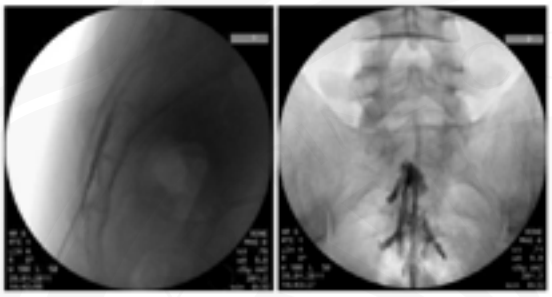
- Through the sacral hiatus
- Only Posterior Epidural Flow 68% of the time
- Medication does not typically spread above the L3-4 or L4-5 level (depending on volume injected)





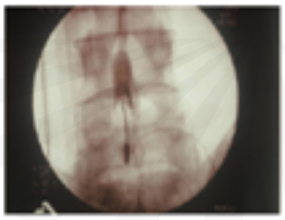
From Scott: Intro to Regional Anesthesia

Caudal Epidural Steroid Injection



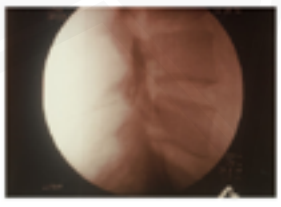
Interlaminar Injection

- Posterior Epidural Space between the dura and ligamentum flavum
- Could be done "blind" so have been around longer
- Diffuse spread of Injectate (along path of least resistance)
- Often fails to wrap all the way around to ventral epidural space

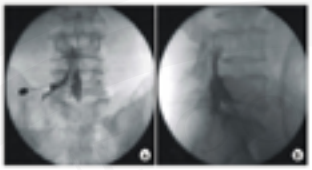


Interlaminar Injection

- Target just inferior/underneath the caudal aspect of the lamina
- Paramedian approach
- Uses LOR (loss of resistance) technique and LOR syringe
- Uses "blunt-tip" needles (Crawford or Touhy), typically 18 or 20g



Transforaminal Injection



- Directly targets suspected spinal nerve in the neuroforaminal space
- Targets the dorsal root ganglion
- More likely to achieve ventral spread (which happens to be where the herniated disc lies)

TF-ESI vs. IL ESI

- A prospective trial comparing fluoroscopically guided TF-ESIs to fluoroscopically guided IL corticosteroid injections demonstrated statistically significant benefit in the transforaminal group.

Ackerman WE, 3rd, Ahmad M. The efficacy of lumbar epidural steroid injections in patients with lumbar disc herniations. *Anesth Analg.* 2007;104:1217-22, tables of contents. This study

Percutaneous Image Guided Lumbar Decompression(PILD)

- Steps:
  - 1. Epidurogram
    - Contralateral oblique view
  - 2. Insert portal with fluoro and secured with stabilizer, depth guide placed
  - Insert bone sculptor for superior and inferior lamina to improve access
  - Insert tissue sculptor and debulk posterior ligamentum flavum
  - Confirm improved epidurogram

Percutaneous Image Guided Lumbar Decompression(PILD)

- Steps Cont.
  - Insert tissue sculptor and debulk posterior ligamentum flavum
  - Confirm improved epidurogram

Interventional Procedures

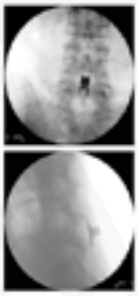
- Vertiflex- superion
- Interspinous spacer Device
  - Indications
    - Symptomatic 1 or 2 level moderate spinal canal stenosis
    - Zurich Claudication Questionnaire greater than or equal to 2.0
    - 6 month non-operative care
- Contraindications
  - Cauda equina
  - BMI>40
  - >grade 1 spondy
  - Prior surgery
  - Severe osteoporosis
  - Allergy to titanium

Interspinous Spacer Device

- Steps
  - Small midline incision between spinous process
  - Place Dilator then secondary dilator
  - Ream to remove soft tissues
  - Measure interspinous space
  - Deploy interspinous device

Interspinous Spacer Device

- Data
  - Prospective, multicentered, single blinded, randomized controlled trial comparing Superion (S) to X-stop
    - N: 60
    - 24 month follow up
    - 5 year durability study
      - Success
        - Zurich claudication questionnaire 84%
        - Leg Pain 86%
        - ODI 83%
- Complications
  - 16% spinous process fracture*



Interventional Procedures

- Considerations
  - Anticoagulation
    - Shared risk assessment
  - Bleeding disorders
  - Diabetes/HTN
  - Infection
  - Prior Surgeries

Conclusions

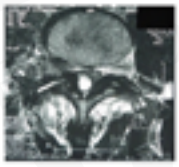
- Evidence for LSS is less robust but still shows effect
- Variety of minimally invasive treatments available.
- Weigh risks, benefits, and evidence

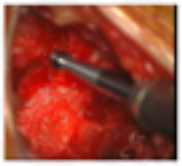
Surgical Treatment of LCS

4 Key Skills

2 Cognative/2 technical

- 3D Anatomic Analysis of Pathology
- Spinal Canal
  - Entry
  - Orientation
  - Identification structures
    - Nerve root
- Skilled use of side-cutting burr
- Skilled use small 3-0 angled curette

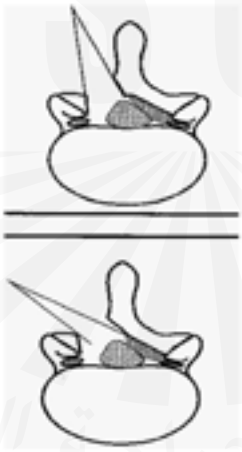




Wong Personal Collection

Surgical Issues
Posterior Approach

- Traditional
  - Laminectomy
- Minimally Invasive
  - Micro Decompression
    - Laminotomy
    - Laminaplasty
  - Endoscopic
- +/- Fusion
- Options dictated by Analysis of Pathology

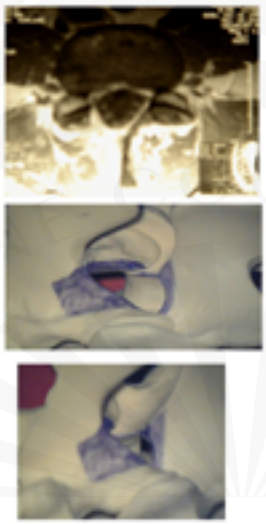


Laminectomy
vs.
Laminaplasty

- Laminectomy
  - Positive Considerations
    - Better Foraminal Decompression
      - Able Reach entry and mid zones bilaterally
      - Easy enter canal midline with severe stenosis
  - Negative Considerations
    - Post Structure/2° Stabilizers Sacrificed
      - Higher risk develop instability
    - Extent dissection
      - = Longer Recovery
      - Additional Blood loss
    - Risk stress fracture pars
    - Fusion necessary for spondylolisthesis

Laminectomy vs. Laminaplasty

- Ipsilateral Laminotomy/ Contralateral Laminaplasty
  - Positive Considerations
    - 2° Stabilizers Intact
    - Minor Muscle Dissection
  - Negative Considerations
  - Limited view/decompress
    - Ipsilateral Foramen
      - Reach entry zone
    - Contralateral foramen
      - Reach entry and mid zones
    - Bilateral Exit Zone/far lateral
      - Reachable far lateral approach only



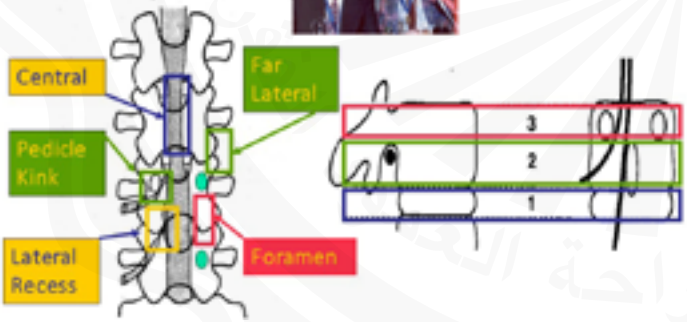
Concepts in Spine Anatomy/Pathology

Ian Macnab

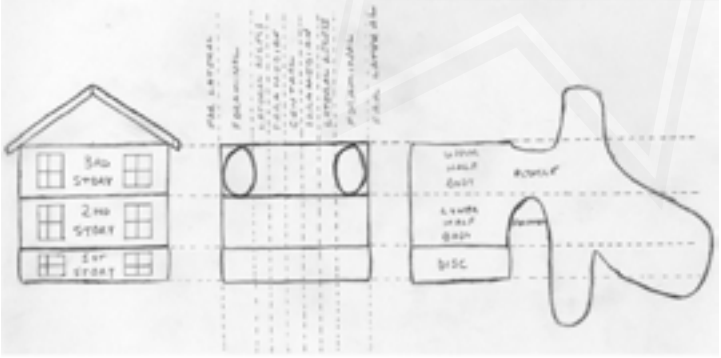
- Medial – lateral
- Central/lateral recess/ foraminal/far lateral

John McCulloch

- Inferior – superior
- 3 storeys

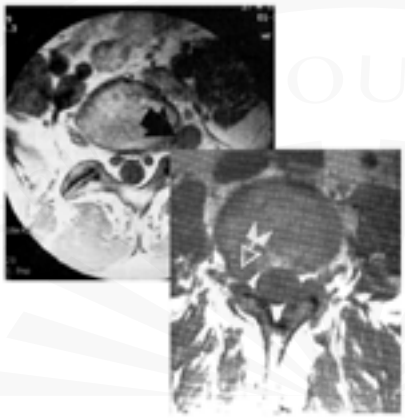


Grid Orientation to Spinal Pathology



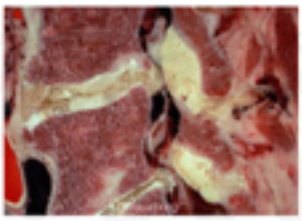
Read Axial Images CT/MRI

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



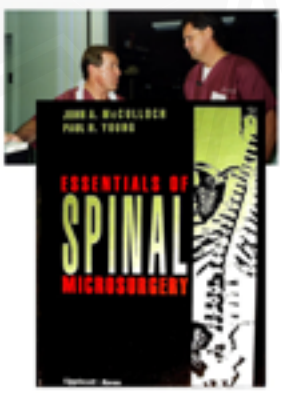
Overview: Pathology

- Spinal Stenosis is a *First Storey* disease.
  - John A. McCulloch



?Bilateral Decompression via Unilateral Laminotomy?

- Paul Young
  - Neurosurgeon
  - St. Louis, Mo
  - Director PAWS (Practical Anatomy WorkShop)
    - 1st AAOS cadaver
  - Co-author
    - Essentials of Spinal Microsurgery



Overview: Sx Options

- Stenosis No Spondylo
  - Congenital
  - Lipomatosis
  - Degen-Analysis Pathol
- Stenosis + Spondylo
  - Grade I
    - Few mm
    - ↓ disc height
    - Stable F/E
  - Scoliosis
    - 10° - 15°
  - Lateral Listhesis
    - 1-2 mm/stable

"PALs" for Windows Medial Laminotomy

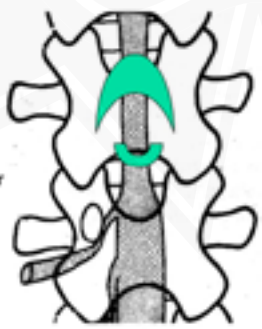
- External
  - Facet
  - Pars Interarticularis
  - Superior edge inferior lamina
- Canal
  - Pedicle
  - Disc

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

Tight Stenosis Canal Entry

- 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 Backache. Lipponcott 2007



Koebler.com

Background Context
Slip Progression

- Normal pre-op align
  - Midline laminectomy
  - 31% slip
- Pre-Op Degenerative Spondylo Grade I
  - Midline laminectomy
  - 73% slip progression

Mardjetko SM, Connolly PJ, Shott S. Degererative lumbar spondylosis: A meta-analysis of the literature 1970–93. *Spine* 1994;19:2256S–65S.

Background Context
Clinical Outcome - SPORT

- SS+Spondy 601 pt/369 (61%) Sx
  - Sx incl fusion 347/94% (78% metal)
- SS 634 pt/394 (62%) Sx
  - Sx incl fusion 43/11% (53% metal)
- Baseline same exc spondy more Female
- Both groups better with Sx vs non Sx
- Spondylo outcome better vs SS

Pearson A et al. Degenerative Spondylolisthesis Versus stenosis. Does a Slip Matter? Comparison of Baseline Characteristics and Outcomes (SPORT). Spine 2010; 35:298-305.

Stability with
MIS Decompression

- Finite element analysis remove posterior elements
  - Laminectomy
  - MIS
- Extension vs intact
  - Lam 4X/MIS 2X
- Flexion
  - Lam 3.6X/MIS 1.6X

Bresnahan L, Fessler R et al. A Biomechanical Evaluation of Graded Posterior Element Removal for Treatment of Lumbar Stenosis. Spine 2008;34:17-23.

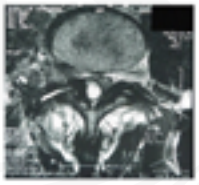
Stability with MIS Decompression

- McCulloch/Young approach
- 57 pts 27m/30f av age 69.6
- F/U 5 yr min/mean 6 yrs (5-8)
- 27 SS/20 spondylo/10 scoli
- Slip progression
  - 1.2% +/- 3.1% SS
  - 2.4% +/- 4.7% Spondylo
  - 0.0% +/- 0.0% Scoli
- Clinical outcome NSD

Toyoda H et al. Clinical Outcome of Microsurgical Bilateral Decompression via Unilateral Approach for Lumbar Canal Stenosis. Spine 2011;36:410-415.

Synovial Cyst

- Inflammatory/adherent
  - Incorporated with ligamentum
- Sufficient exposure key
  - Superior
  - Inferior
  - Medial
- Separate from dura
  - 3-0 curette
  - Small McCulloch hook
  - *Patience!*



MIS of Lumbar Stenosis

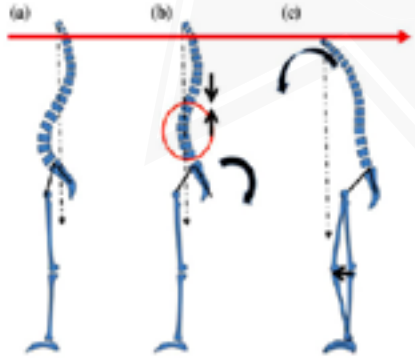
Lumbar stenosis

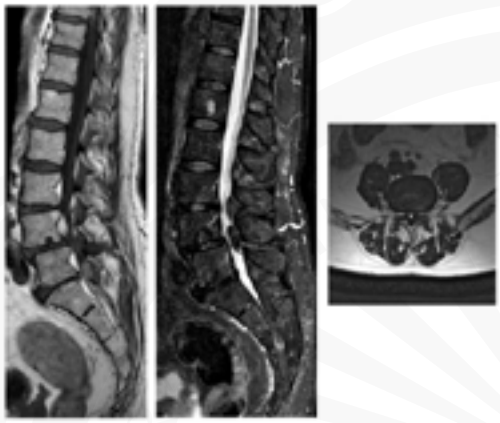
- Most common spine disease in the elderly
- Patients > 65y
- Pathophysiology:
  - Acquired canal stenosis
  - Increase in hyperlordosis

Aging spine

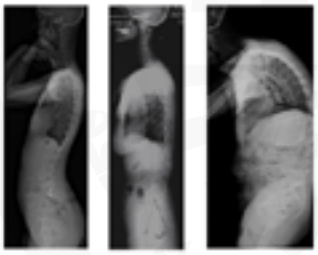
- Sagittal aging profile
  - C7 Plumbline anteriorly displaced
  - Lumbar kyphosis
  - Prevalence 68% > 65ans
- QoL & Sag Profile
- **Lumbar stenosis**
- Osteopenia/osteoporosis
  - Risk of adjacent fractures
  - Implants hold !!!!

Effect of aging on sagittal alignement of the spine





Sag Balance & lumbar decompression



Limit the iatrogenic destabilisation

- Decompress
- Decompress and fuse
- Deformity correction

Spine

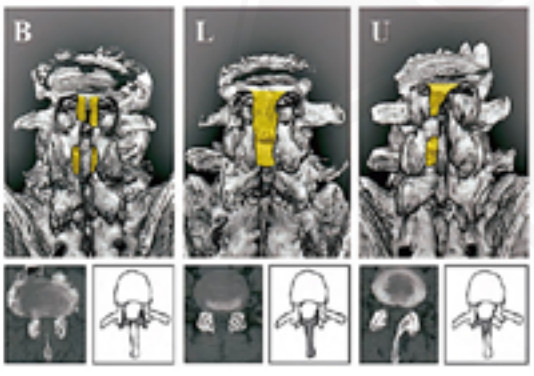
HEALTH SERVICES RESEARCH

Nationwide Trends in the Surgical Management of Lumbar Spinal Stenosis

...the rate of simple fusion surgery has increased for treatment of LSS compared with decompression only...

Surgical options

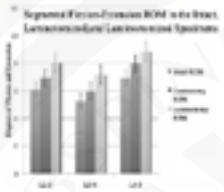
- Classic open Laminectomy
- Classic open laminectomy & fusion
- bilateral laminotomies
- MI unilateral laminotomy



The Effect of Bilateral Laminotomy *Versus* Laminectomy on the Motion and Stiffness of the Human Lumbar Spine

A Biomechanical Comparison

Michael J. Lee, MD,* Richard J. Dmitriev, MD,† Carlo Bellabarba, MD,‡ Jens R. Chapman, MD,† Amy M. Cohen, BE,† Richard M. Harrington, MD,‡ and Randal P. Craig, PhD†



...These results suggest that laminectomy may be more prone to the development of postdecompression instability than bilateral laminotomy...

Spine

Clinical Case Series

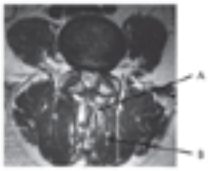
A Comparison of Unilateral and Bilateral Laminotomies for Decompression of L4–L5 Spinal Stenosis

- Clinical outcomes evaluated with VAS and ODI were not different between unilateral and bilateral laminotomies.
- Unilateral laminotomy can be done with **less bleeding and short operation time.**
- Less translational motion change occurs in the unilateral laminotomy; thus, **unilateral laminotomy is in favor of radiologic stability.**

Spine

Clinical Case Series

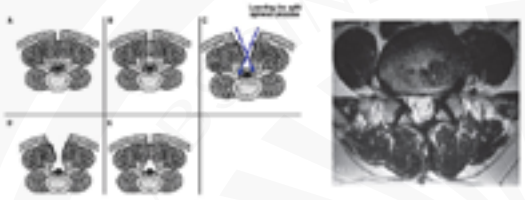
Modified Marmot Operation *Versus* Spinous Process Transverse Cutting Laminectomy for Lumbar Spinal Stenosis



Spine

Clinical Case Series

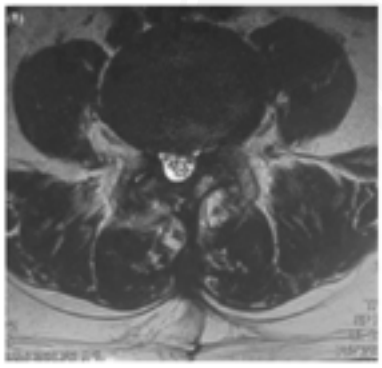
Modified Marmot Operation *Versus* Spinous Process Transverse Cutting Laminectomy for Lumbar Spinal Stenosis



Spine

Surgery

Modified Unilateral Laminotomy for Bilateral Decompression for Lumbar Spinal Stenosis



J Neurosurg (Spine 2) 95:213–217, 2001

Bilateral decompression of lumbar spinal stenosis involving a unilateral approach with microscope and tubular retractor system

Sylvain Palmer, M.D., Robert Turner, M.D., and Rosemary Palmer, R.N.

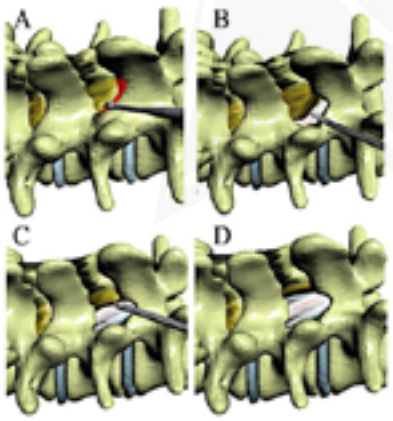
Mission Hospital Regional Medical Center, Mission Viejo, California

J Neurosurg Spine 9:570–580, 2001

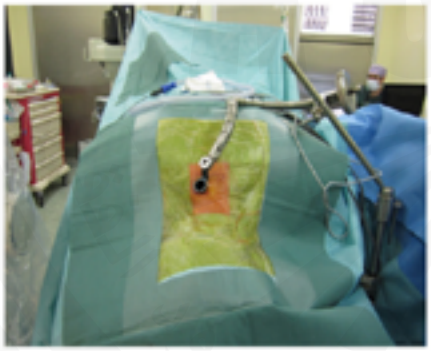
Degenerative lumbar spinal stenosis: analysis of results in a series of 374 patients treated with unilateral laminotomy for bilateral microdecompression

Francesco Costa, M.D.,[1] Marco Sassi, M.D.,[2] Andrea Cardia, M.D.,[2] Alessandro Ortolina, M.D.,[2] Antonio Di Santis, M.D.,[2] Giovanni Luccarelli, M.D.,[2] and Maurizio Fornari, M.D.[2]

[1]Department of Neurosurgery, Università degli Studi di Milano, Istituto IRCCS Galeazzi; and [2]Department of Neurosurgery, Istituto IRCCS Galeazzi, Milan, Italy



Complications rate	2.4%
Post op instability	0.8% (No surgery)

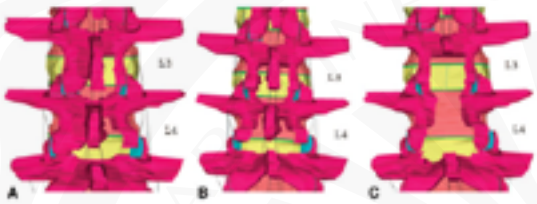


Rational for MI decompression

- Muscle preservation technology
- Post-op pain
- Quicker return to normal activities
- Avoid iatrogenic « instability » ????

A Biomechanical Evaluation of Graded Posterior Element Removal for Treatment of Lumbar Stenosis

Comparison of a Minimally Invasive Approach With Two Standard Laminectomy Techniques



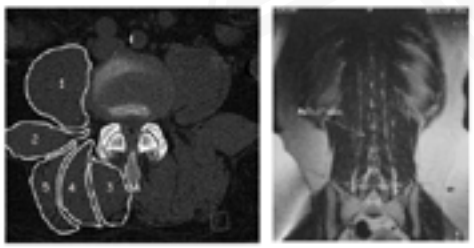
12% 18% 25%

Key points

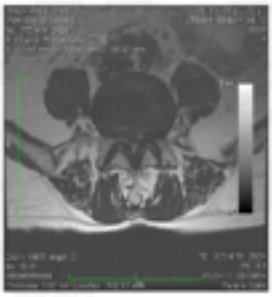
- Open laminectomy produces the greatest change in segmental motion during flexion, extension, left and right axial rotation.
- Following a minimally invasive procedure, postoperative segmental motion is similar to the intact spine.
- Preservation of the posterior spinal elements associated with minimally invasive surgery could minimize rates of developing *de novo postoperative* changes in spinal alignment.

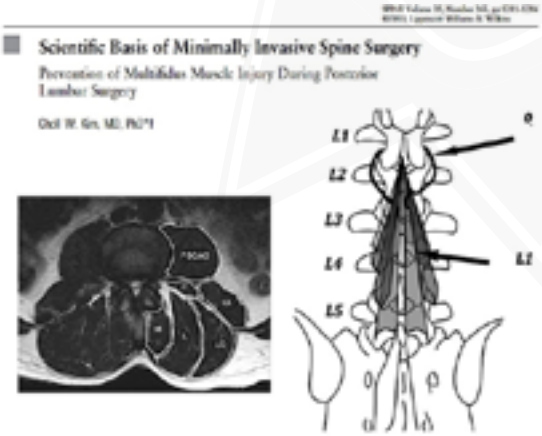
MAST

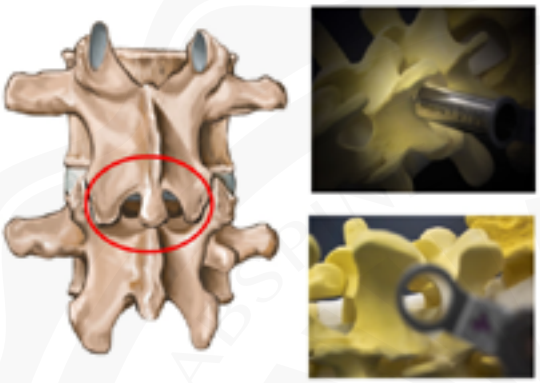
Muscle preservation approach

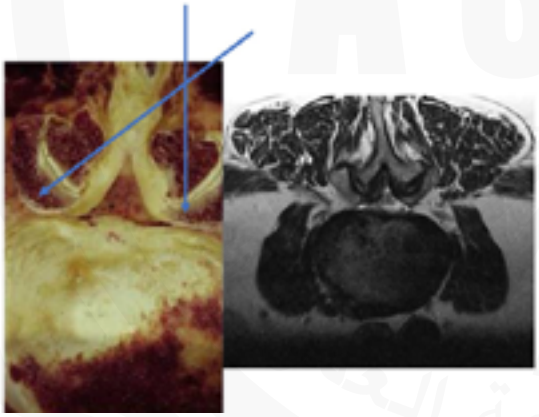


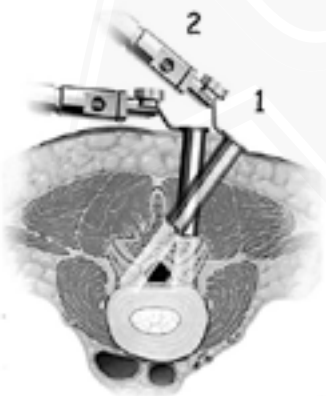

Multifidus




Scientific Basis of Minimally Invasive Spine Surgery
Prevention of Multifidus Muscle Injury During Posterior Lumbar Surgery
L1
L2
L3
L4
L5
L1



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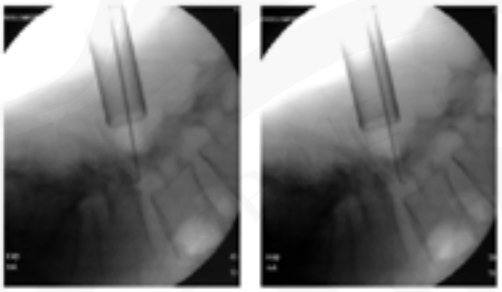
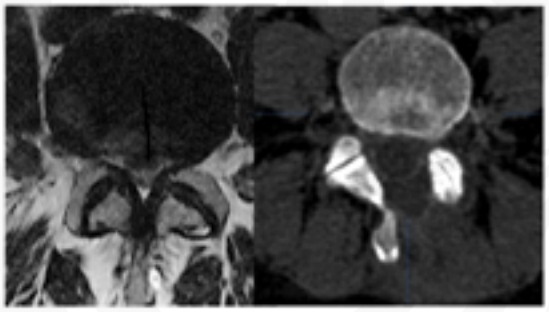
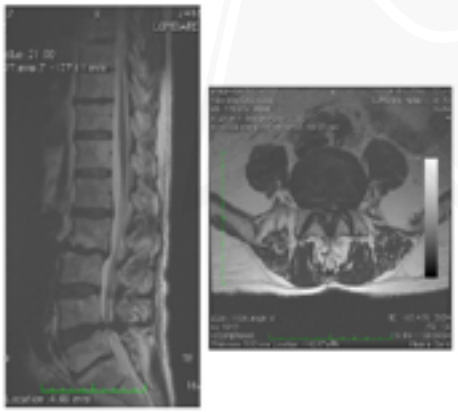
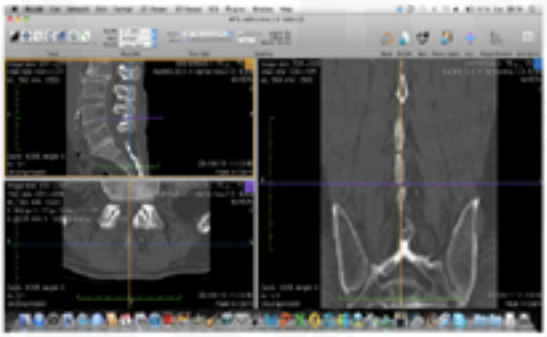


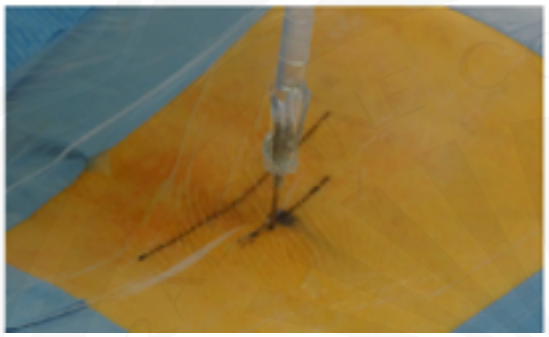


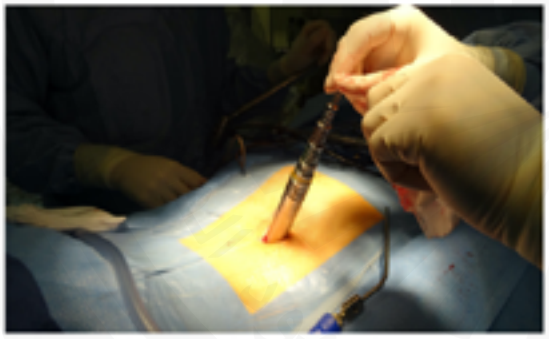
H 76 ans
Claudication neurogène
Sténose L4L5

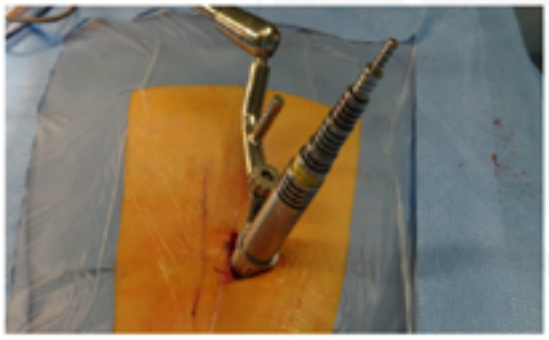
Hospitalisation 3J
Retour à domicile

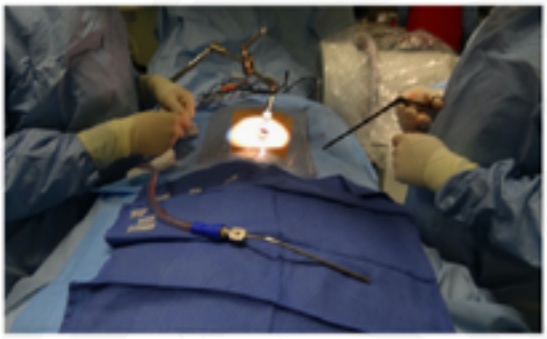


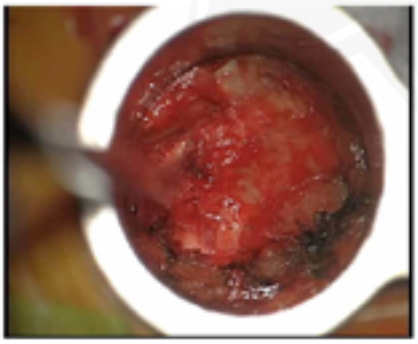


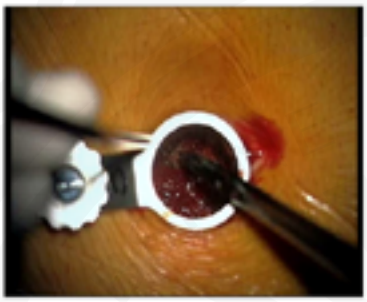


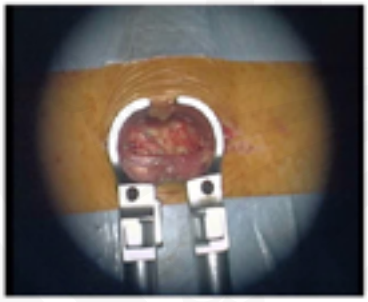


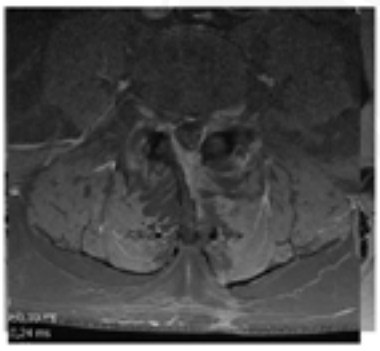












MI Laminotomies Advantages

- Limit the iatrogenic disruption of lig and muscle
- Better confort, less pain, less opioid...
- Quicker rehab & out of bed
- Decrease hospital stay

Complications are mainly due to bed rest....

MI Laminotomies limitations

- Longer surgery
- 45 to 60 min per level
- Radiation exposure
- Dural tear
- Learning curve

LCS : Stabilize or Not

Lumbar Canal Stenosis

When to fuse
and How to fuse

Aging spine

- Sagittal aging profile
  - C7 Plumbline anteriorly displaced
  - Lumbar kyphosis
  - Prevalence 68% > 65yrs
- QoL & Sag Profile
- **Lumbar stenosis**
- Osteopenia/osteoporosis
  - Risk of adjacent fractures
  - Implants hold !!!!!

Prevalence of spinal deformity
elderly volunteers over 60%

Adult degenerative scoliosis: evaluation and management

Fernando E. Silva, M.D.,[1] and Lawrence G. Lenke, M.D.[2]

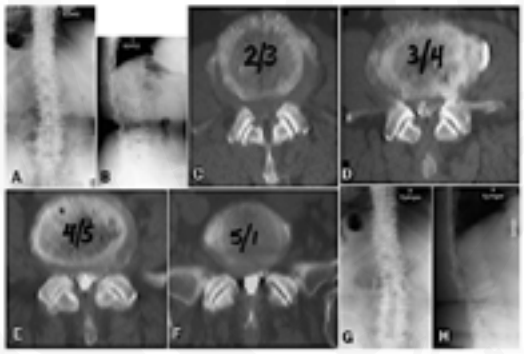
[1]North Medical Fort Worth, Neurological Surgery, North Texas Neurological and Spine Center, Fort Worth, Texas, and [2]Orthopaedic Surgery, Washington University School of Medicine, St. Louis, Missouri

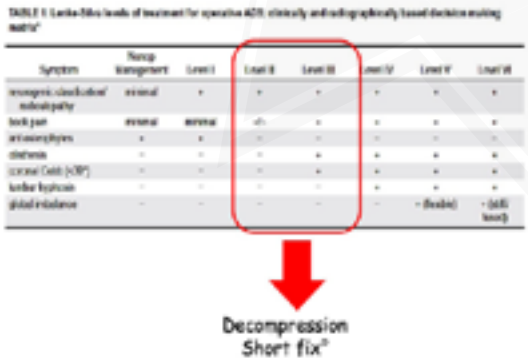
Clinical parameters: Radicular vs Back pain

Radiological parameters: Deformity and sag profile (and coronal)
Olisthesis
Cobb

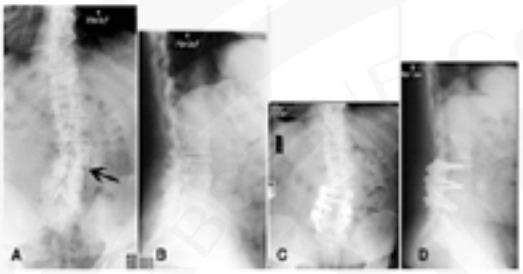
Angle

Decompression only





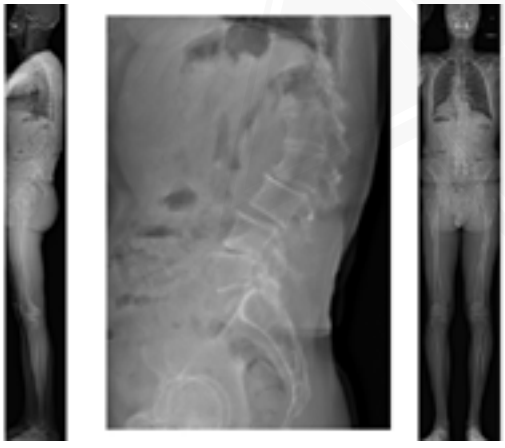
Decompression
Short fix*

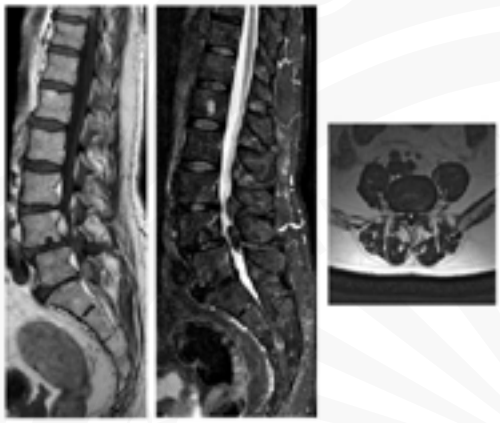


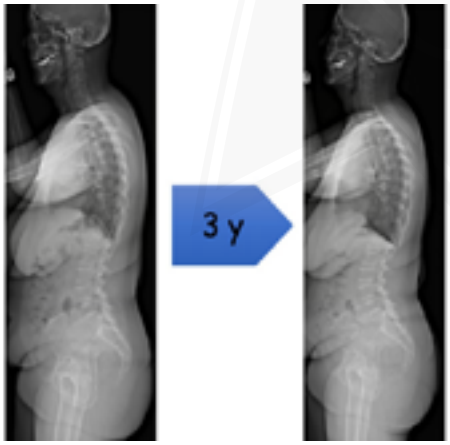
When to fuse

Sagittal Alignement
Segmental instability

- Acceptable sag Balance/ Segmental instability
  - Decompression & Short segment fix*
- Sagittal umbalance
  - Decompression and long segment fix*



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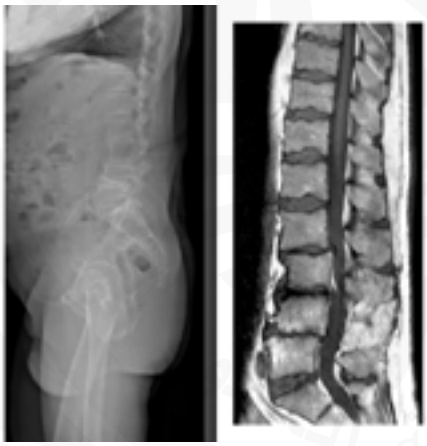
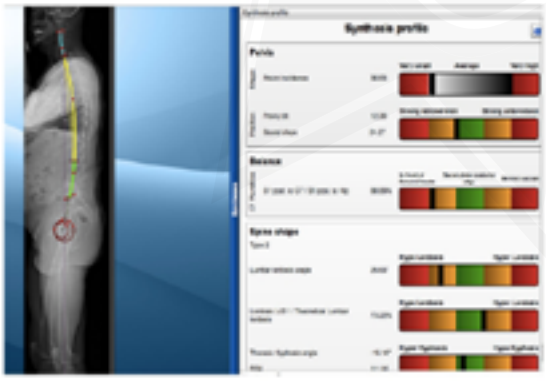
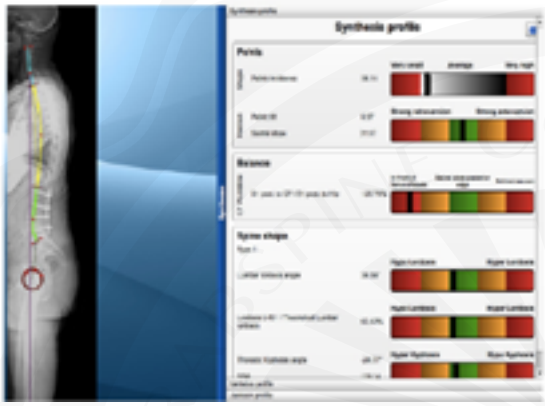
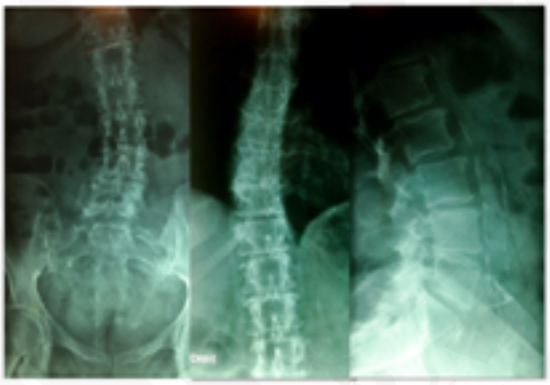
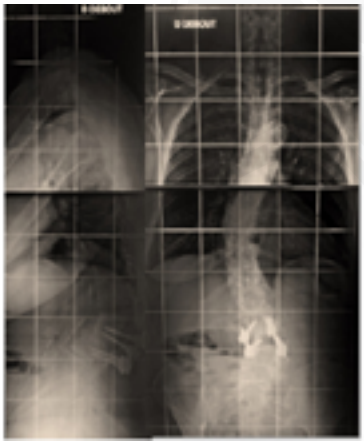
When and How to fuse



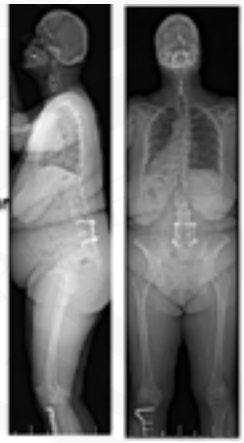



Synthesis profile
Pelvis
Balance
Spine shape

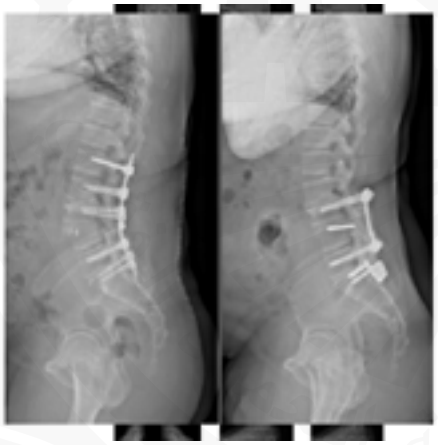


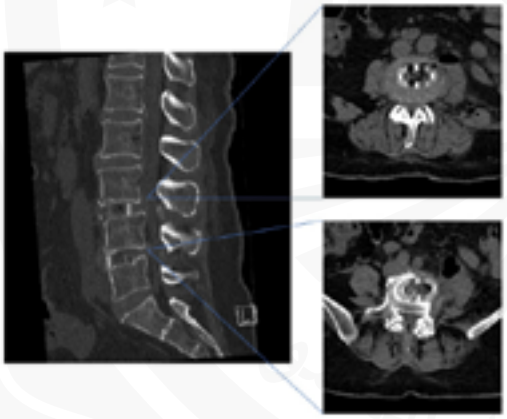


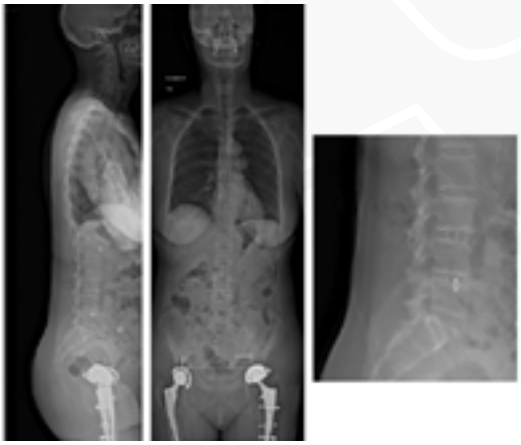
- F 62y old
- Disc herniation L4L5
- Recurrence: discectomy & fusion
- LBP, FBSS
- Revision: L4S1

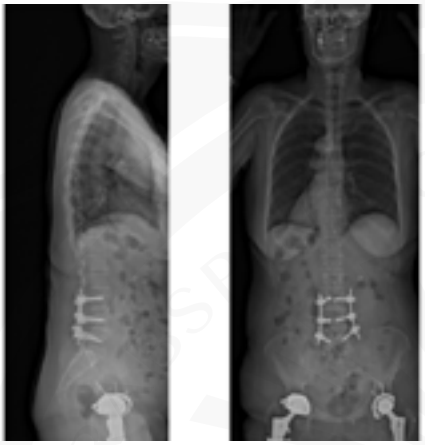


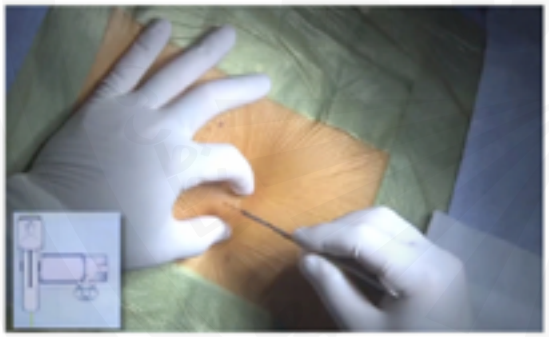

69yM
99 & 2004 Surgery for LBP
FBSS
2013











Cores Messages

- Decompression only
  - Radicular pain > BP
  - Acceptable sag (and coronal) profile
  - No lateral listhesis
- Decompression and short fusion
  - Radicular and BP
  - Acceptable Sag profile
  - Lateral listhesis > 6mm
  - Cobb>30°

Spondylolisthesis Classification – Natural History

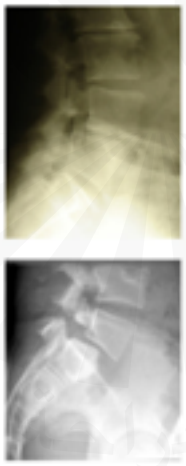
Concepts Spondylolisthesis Classification

Analysis for each patient

- Type
  - Wiltse, Newman, Macnab
- Grade I-V
  - Mayerding
- Stability
  - Flexion extension x-rays
  - ≥4 mm horizontal translate =unstable

Concepts Spondylolisthesis Natural History

- Historical Perspective/Timeline
  - Concepts which stand test of time
    - Macnab 1950
      - Pseudo spondylolisthesis intact neural arch
      - Today known as degenerate spondylo
    - Farfan 1970
      - Average L5 sits relatively deep in pelvis between iliac wings with additional stability from ileo-transverse ligaments
      - Reason degenerative spondylolisthesis most common at L4-5
    - Wiltse, Newman, Macnab 1976
      - Classification Spondylolisthesis used today

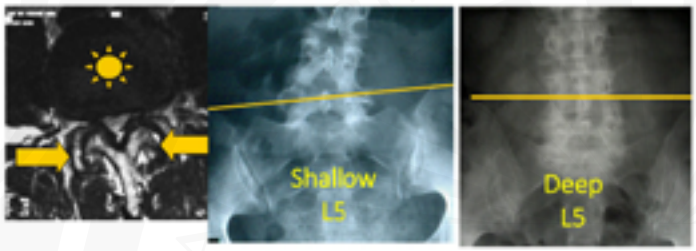


Dr. Ian Macnab Toronto, Canada

- Conceptual thinking
  - Pathoanatomy
    - Natural history
    - instability
  - Classification
    - Spondylolisthesis
      - Degenerate 1950
      - Traction Spur 1971
      - Wiltse et al 1976

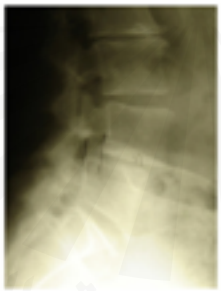
Harry Farfan
Montreal Canada

- 3 Joint Complex
  - Disc
  - 2 Facets
- Lumbo Sacral Stability
  - =depth Seating L5 in Pelvis
  - Deep=more/strong Ligaments
    - Thus Level Degen Spondylo=L4-5



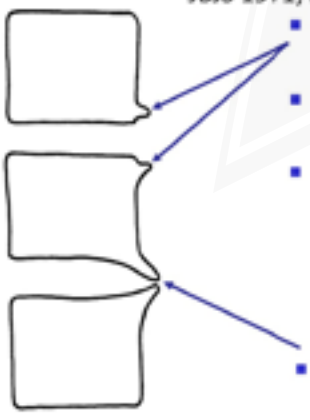
Instability/Spondylolisthesis Macnab 1950

- Macnab I. Spondylolisthesis with an intact neural arch— the so-called pseudospondylolisthesis JBJS 1950;32B:325-333.
- = degenerative spondylolisthesis



Dr. Ian Macnab 1971

The Traction Spur: An Indicator of Segmental Instability.
JBJS 1971; 53A:663



- Traction Spur
  - "Macnab Spur"
- Sign Early segmental instability
- Start 1 – 2 mm off end plate@annulus attachment
  - Annulus not insert cartilaginous epiphyseal plate
- Claw Osteophyte
  - =Late Osteoarthritis

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

Type I	Dysplastic		
Type II	Isthmic	a. Lytic	Slip associated with a displaced pars articularis
		b. Elongation	Repeated pars stress fractures have healed with elongation and attenuation. A defect may not be present
		c. Acute fracture	Rare
Type III	Degenerative		
Type IV	Traumatic		
Type V	Pathological		

Wiltse, Newman, Macnab Classification: Impact on Clinical Evaluation, Treatment and Surgical Decision Making

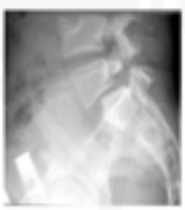
e.g. Dysplastic Type

=Failure formation end neural tube - May be associated with

- Pedicle dysplasia *
  - Thin cortex, small diameter
  - =Poor fixation pedicle screw
- Spina Bifida/SBO
- Facet dysplasia/tropism
- Asymmetric laminae
- Sacral dysplasia
- Hip dysplasia/shallow cup
- Other systems-GU,GI,vascular

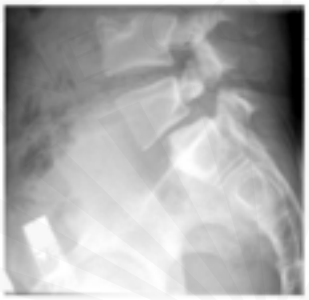
Spondylolisthesis Meyerding Classification

- 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)



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°



Instability
NASS Lumbar Stenosis/Spondylo Guideline

- Comprehensive Literature Review
- Hours of debate
- Definition Instability
  - ≥4mm horizontal translation
    - Standing Flexion / Extension X-Rays

Background Context
Slip Progression

- Normal pre-op align
  - Midline laminectomy
  - =31% pts develop spondylo
- Pre-Op Degenerative Spondylolisthesis Grade I
  - Midline laminectomy
  - =73% slip progression

Mardjetko SM, Connolly PJ, Shott S. Degenerative lumbar spondylosis: A meta-analysis of the literature 1970–93. *Spine* 1994;19:2256S–65S.

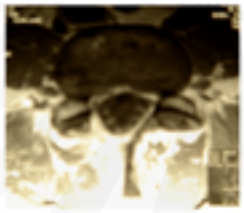
Spondylolisthesis Progression with Laminectomy

- 45 patients
  - 25 stenosis no slip
  - 20 Gr I Spondylolisthesis
- Progressive Spondylolisthesis
  - 5/25 stenosis -=25%
  - 13/20 Gr I slip = 65%
- Clinical Outcome progressive slip
  - 7/13 good

Johnsson KE et al. Postoperative instability after decompression for lumbar spinal stenosis. *Spine 1986;11:107–10.*

Stability with MIS Decompression

- Finite element analysis remove posterior elements
  - Laminectomy vs MIS intact arch
- Extension motion vs intact arch
  - Lam 4X /MIS 2.5X normal motion
- Flexion motion vs intact arch
  - Lam 3.6X/MIS 1.5X normal motion



Bresnahan L, Fessler R et al. A Biomechanical Evaluation of Graded Posterior Element Removal for Treatment of Lumbar Stenosis. Spine 2008;34:17-23.

Bilateral Decompression via Unilateral Laminotomy/contralateral Laminaplasty

- John McCulloch
- Paul Young
  - PAWS (Practical Anatomy WorkShop)
    - St Louis MO
    - 1st AAOS cadaver
  - Co-authors

McCulloch JA, Young PH. Essentials of Spinal Microsurgery. Lippincott-Raven. Philadelphia 1998

Stability with MIS Decompression

- McCulloch/Young approach
- 57 pts 27m/30f av age 69.6
- F/U 5 yr min/mean 6 yrs (5-8)
- 27 SS/20 spondylo/10 scoli
- Slip progression
  - 1.2% +/- 3.1% SS
  - 2.4% +/- 4.7% Spondylo
  - 0.0% +/- 0.0% Scoli
- Clinical outcome NSD

Toyoda H et al. Clinical Outcome of Microsurgical Bilateral Decompression via Unilateral Approach for Lumbar Canal Stenosis. Spine 2011;36:410-415.

Background Context
Clinical Outcome - SPORT

- SS+Spondy 601 pt/369 (61%) Sx
  - Sx incl fusion 347/94% (78% metal)
- SS 634 pt/394 (62%) Sx
  - Sx incl fusion 43/11% (53% metal)
- Baseline same exc spondy more Female
- Both groups better with Sx vs non Sx
- Spondylo outcome better vs SS

Pearson A et al. Degenerative Spondylolisthesis Versus stenosis. Does a Slip Matter? Comparison of Baseline Characteristics and Outcomes (SPORT). Spine 2010; 35:298-305.

Classic Reading
Instability/Spondylolisthesis

- Macnab I. Spondylolisthesis with an intact neural arch— the so-called pseudospondylolisthesis JBJS 1950;32B:325-333.
- Macnab I. The Traction Spur: An Indicator of Segmental Instability. JBJS 1971; 53A:663
- Macnab I. Negative Disc Exploration. JBJS 1971;53A:891
- Wiltse LL, Newman PH, Macnab I. Classification of spondylolysis and spondylolisthesis. *Clin Orthop. 1976;117:23–29.*
- Offierski C, Macnab I. Hip-Spine Syndrome. Spine 1983; 8:316
- Fraser R. The Formation of ISSLS and its Influence on Lumbar Spine Research. Spine 2004; 29:1059

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.

Additional Bibliography

- Kirkaldy-Willis WH, Farfan HF. Instability of the lumbar spine. Clin Ortho Relat Res.1982;165:110–23
- Farfan HF et al. The effects of torsion on the lumbar intervertebral joints:the role of torsion in the production of disc degeneration. J Bone Jt Surg 1970;52:468-497

Surgery for Grade I – II (Spondylolisthesis)

Type	Description
Type 1 Dysplastic (congenital)	With a defect in the upper sacrum or arch of L5
Type 2 Isthmic	Pars problem
Type 2A	Lytic (defect in the pars)
Type 2B	Elongation of the pars
Type 2C	Acute traumatic pars fracture
Type 3 Degenerative	Disc & facet degeneration, leading to segmental instability & gradual slippage
Type 4 Post-traumatic	Fracture of neural arch other than pars
Type 5 Pathologic	Weakening of neural arch due to disorders of bone
Iatrogenic	Excessive removal of bone following spinal decompression

Surgical Indications

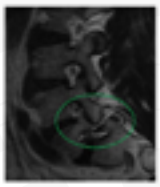
- Failure to respond to non op treatment
- Progressive or profound neuro deficit
- Symptomatic slip progression (rare)

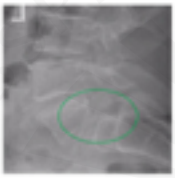
Surgical Goals

- Decompression
  - Direct
  - Indirect
- Stabilization
  - Alignment
    - Translation?
    - Angulation?
      - Segmental lordosis
      - Global sagittal alignment
  - Fusion

Decompression

- Foraminal
- Direct
  - Laminoforaminotomy
- Indirect
  - Interbody fusion





Fusion Options

- Posterolateral
- Posterolateral with instrumentation
- Posterolateral with instrumentation with IB
- Anterior with instrumentation
- Anterior with instrumentation + posterior

Fusion

- Goals
  - Alignment
    - Lordosis
    - Pelvic incidence (global sagittal alignment)
    - Translation ?
  - Avoid pseudarthrosis

Anterior

- Optimizes fusion rate
  - Thorough discectomy, large graft (BMP on label)
- Less subsidence – bigger footprint
- Improved lordosis (sagittal alignment)
- Reduced posterior dissection
  - Reduced nerve post op nerve dysesthesia

Posterior

- Familiar
- Do not need an approach surgeon
- Direct decompression
- Complication profile different

- RCT. Exercise (34), fusion (37), and fusion with instrumentation (40)
- 9 year f/u (91% capture)
- Both surgical groups had similar clinical outcomes better than non operative
- Radiographic outcomes not evaluated

PLF vs. PLIF

- Clinical outcomes similar
- Fusion rates similar in most studies, occasionally better with PLIF.
  - Ekman P. Spine. 2007
  - Lee G. Spine. 2014
  - Musulman A. JNS Spine. 2011
  - Ye Y. Arch Orthop Trauma Surg. 2013.
  - Farrokhi M. J Neurotrauma. 2012


Spine

LITERATURE REVIEW

What is the Optimum Fusion Technique for Adult Spondylolisthesis—PLIF or PLF or PLIF Plus PLF?

- Based on 4 RCTs and 6 observational studies, moderate evidence that PLIF more effective than PLF for clinical outcomes, fusion rate, reduction of complications, and reoperation
- Based on 7 observational studies, low quality evidence that PLF and PLIF + PLF were similar for all parameters.
- Did not compare PLIF to PLIF + PLF.

TLIF (or PLIF) vs. ALIF (+ posterior instrumentation)

- Some MIS and some open
- Clinical outcomes similar
- Lordosis (radiographic outcomes) better for ALIF
- One study showed ASD 2x greater in PLIF at 4 yrs
  - Kim J. JSDT. 2009
  - Jiang S. J Orthop Trauma Surg. 2012.
  - Min J. JNS Spine. 2007
  - Hsieh P. JNS Spine. 2007.

Arab Orthop Trauma Surg (2014) 1:77–784
DOI 10.1007/s40602-014-0005-9

ORTHOPAEDIC SURGERY

Fusion techniques for adult isthmic spondylolisthesis: a systematic review

Shun-Jin Wang · Ying-Chao Huo · Xiao-Ming Liu · Bin Ma · Wei-Dong Zhao · De-Sheng Wu · Jun Tan

Abstract
Introduction Various fusion techniques have been used to treat lumbar spine isthmic spondylolisthesis (IS) in adults, including anterior lumbar interbody fusion (ALIF), posterior lumbar interbody fusion (PLIF), transforaminal lumbar interbody fusion (TLIF), posterolateral fusion (PLF), and circumferential fusion. The objective of this study was to evaluate which fusion technique provides the best clinical and radiological outcome for adult lumbar IS.
Materials and methods A systematic review was performed. MEDLINE databases and reference lists of selected articles were searched. Inclusion criteria stated that the studies had to be controlled and that they compared clinical and radiological outcomes of various fusion techniques for treating adult IS. Exclusion criteria were use of two studies compared ALIF and TLIF, and five studies compared PLIF and PLF. ALIF was superior to other techniques regarding restoration of disc height, segmental lordosis, and whole lumbar lordosis. TLIF had lower complication rates. ALIF combined with PLF showed lower nonfusion rates than other techniques. However, there were no significant differences in clinical outcomes between any two techniques.
Conclusion Compared to other fusion techniques, TLIF shows fewer complications, ALIF shows better sagittal alignment, and circumferential fusion showed better fusion rates. It was difficult to make recommendations about the optimal approach because of the methodological variance in the publications.

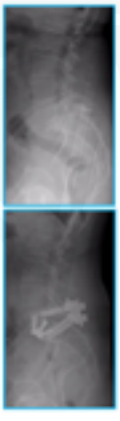
Surgical Goals

- ALIF
  - Decompression
    - Direct
    - Indirect - Yes
  - Stabilization
    - Yes
    - Alignment
      - Translation?
      - Angulation? - Better
    - Fusion – Equal

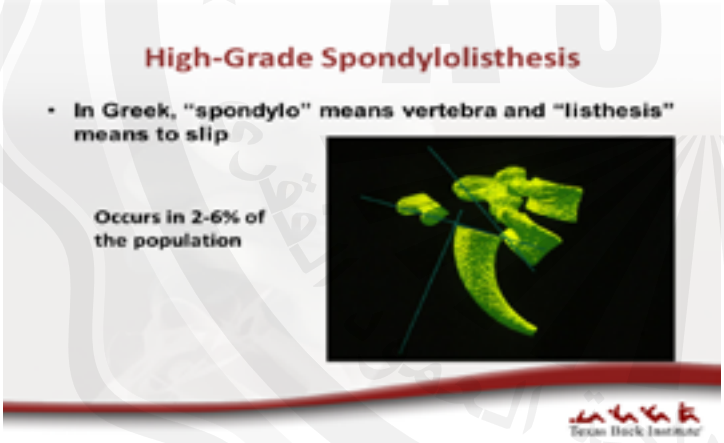
- TLIF / PLIF
  - Decompression
    - Direct Yes
    - Indirect
  - Stabilization
    - Yes
    - Alignment
      - Translation?
      - Angulation?
    - Fusion – Equal

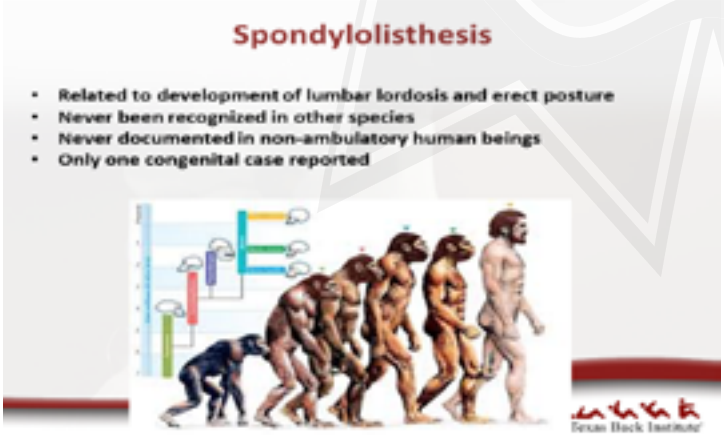
Anterior vs. Posterior Summary

- For low grade slips
  - Technical results favor anterior
  - Clinical outcomes similar
  - ASD maybe decreased with anterior
  - Fusion rates similar
  - Reduction of translation not necessarily important, but addressing PI (angular correction) is
  - My opinion – For IS, addition of interbody graft important to optimize fusion rates and post op mobilization.



Surgical treatment of high grade spondylolisthesis





Wiltse, Newman, McNab

I Dysplastic
II Isthmic A. Lysis; elongation; Acute pars fracture
III Degenerative 20%
IV Traumatic (vertebral #s other than the pars)
V Pathological (neoplastic or metabolic, Paget's, OI)
VI Post-surgical

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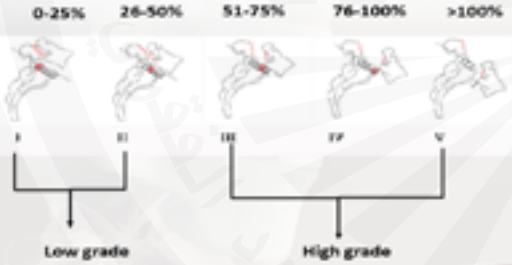
Spondylolisthesis – Spondylosis
Meyerding 1931



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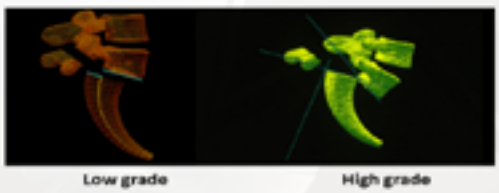
High-Grade Spondylolisthesis



High-grade spondylolisthesis is a defined as Meyerding grade III, IV, or V with an increased L5-S1 kyphosis / slip angle

Bridwell, Neurosurg Clin N Am, 2006

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Spondylolisthesis – Spondylosis Anatomy

Part of vertebra located between the interior and superior articular processes of the facet joint

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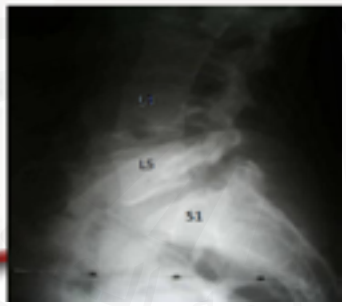
Spondylolisthesis - Spondylosis

- Most common level is L5-S1, although spondylolisthesis can occur at L4-5 and rarely at higher levels

L5-S1	87%
L4-5	10%



Risk Factors for Spondylolisthesis and Spondylolysis

- Etiology is multifactorial
- Genetic risk factors
  - Higher rate in certain family
  - Higher rate in some race (Eskimos)
  - Greater rate in males
- Mechanical risk factors
  - Higher occurrences in gymnasts, football players, and heavy laborers
  - Repetitive stress/injuries to the pars
  - Increased shear force from high pelvic incidence and sacral slope

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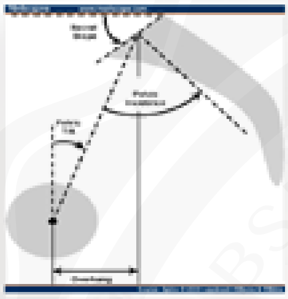
Spinopelvic Alignment



- Pelvic incidence is the angle between the perpendicular to the sacral endplate at its midpoint and a line connecting the same point to the center of the femoral heads
- Increase PI is associated with increased sacral slope and verticalization of S1 end plate
- Verticalization of L5-S1 disc space and increase shear force

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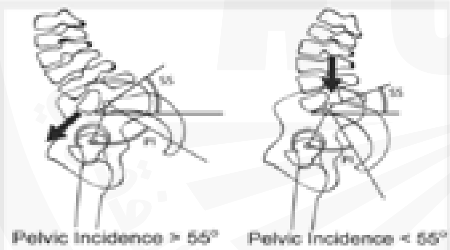

A Pelvic Incidence > 55° Sacral Slope > 40° B Pelvic Incidence < 55° Sacral Slope < 40°

Figure 3. Schematic representation of two possible etiologies of spondylolysis that are determined by sagittal alignment. **A**, The essential lesion to be the vertical orientation of the lumbosacral junction, a high value for the sacral slope and the pelvic incidence, and excessive traction on the pars. **B**, The theory of posterior process impingement as the essential lesion in association with a low value for sacral slope and pelvic incidence.

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Sagittal Alignment of the Spine and Pelvis in the Presence of L5–S1 Isthmic Lysis and Low-Grade Spondylolisthesis

Pierre Roussouly, MD,* Sohrab Gollogly, MD,* Eric Berthonnaud, PhD,† Hubert Labelle, MD,‡ and Mark Weidenbaum, MD§

Parameter	Label	Normal Average	Average	Minimum	Maximum	SD
Spondylolisthesis	%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pelvic incidence	PI	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sacral slope	SS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pelvic tilt	PT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L5 incidence	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L5–S1 extension	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Thoracic kyphosis	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Lumbar lordosis	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
No. of lordotic vertebrae	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L5 wedge	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L4–S1 extension	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L4 wedge	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

*Statistically different (P < 0.05).

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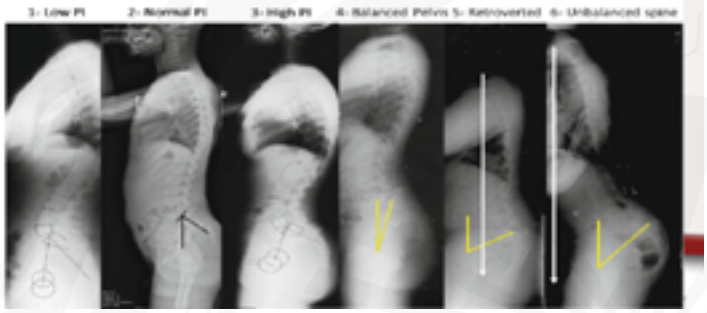
SDSG Classification

SDSG Classification: 6 types

Low grade High grade



Clinical Presentation of Spondylolisthesis/Spondylolysis

- Back pain
- L5 radiculopathy
  - Motor or sensory changes
  - Foot drop
  - Difficulty walking

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Clinical Work-Up

- Lumbar spine X-rays
  - Flexion / extension views to determine instability
  - See femoral heads to measure spinopelvic parameters
- MRI
  - Determine degree of neural compression
  - Eliminate other pathologies
- 36-in long-cassette X-rays
  - Measure spinopelvic parameters
  - Determine sagittal balance
  - Apply parameters of adult spinal deformity surgery
    - Restore C7 plumb line; goal SVA < +5cm
    - Restore spinopelvic alignment
      - Goal PT <20 degrees
      - Goal LL = PI ± 9 degree

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Treatment Options

- Low grade spondylolisthesis
  - Observation
  - Medical treatment of pain symptoms
  - Surgical can be indicated with failure of conservative treatment
- High grade spondylolisthesis
  - Surgery is recommended for all high grade spondylolisthesis

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Surgical Options

- Decompression only
- Decompression and in-situ fusion
- Decompression with instrumented fusion with or without reduction
- Bohlman's procedure
- Gaines procedure

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Decompression Only

- Decompression only (Gill's laminectomy)
- No generally indicated or recommend in the modern era
- Risk of instability
  - Slip progression
  - Progressive pain
  - Progressive radiculopathy

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Decompression and In-Situ Fusion

- No reduction
- High rate of pseudoarthrosis
- Requires casting or other rigid immobilization

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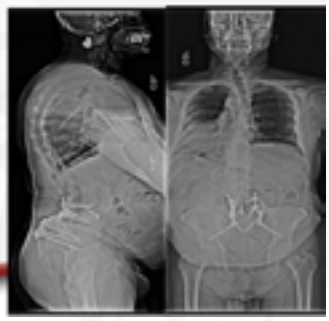
Decompression and Fusion with Instrumentation

- Provide immediate stability
- Improves fusion rate
- Allows for slip reduction
- Allows for early post-operative mobilization
- Discectomy and interbody fusion can be improve reduction as well as fusion



Bohlman's Procedure

- Described in 1982
- Provides anterior column support
- Provides resistances to shear across lumbosacral junction

Gaines Procedure

- A stage procedure

1. Anterior approach for L5 Vertebrectomy
2. Posterior approach with instrumentation, reduction of L4 onto S1, and posterolateral fusion

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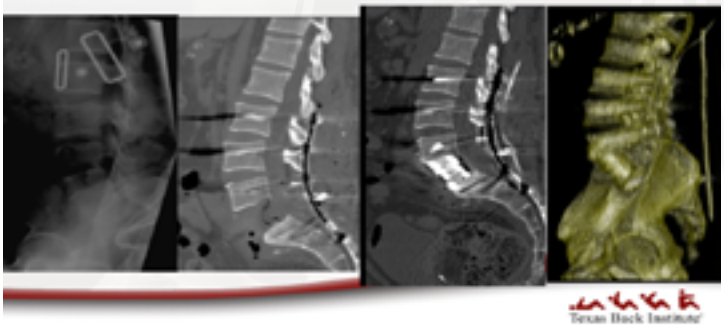
Case Example

- 41M fell off a cliff and suffered multiple leg fractures and lumbar fractures
- Placed in bedrest for 2 months
- Had preserved DF/PF and bladder/bowel functions



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Reduction vs. No Reduction

No Reduction

- Pro
  - Straightforward operation
  - Decrease neurological risks
- Con
  - No improvement in slip angle or pelvic tilt
  - Overall lack of global sagittal alignment improvement

With Reduction

- Pro
  - Improve spinopelvic parameters
  - Improve global sagittal alignment
- Con
  - Increased surgical complexity
  - Significant risk of L5 nerve injury

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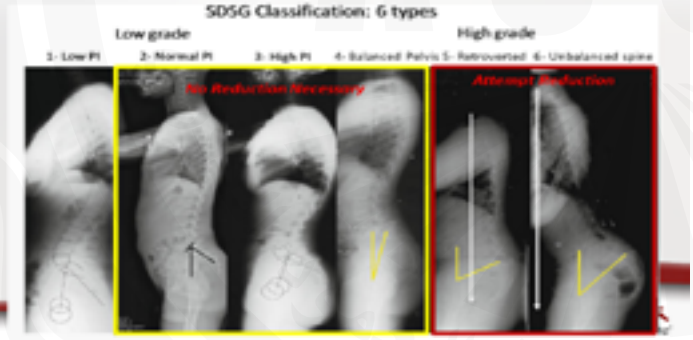
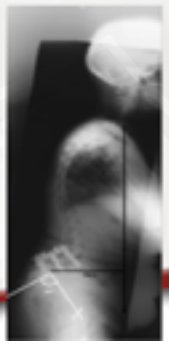
When to Reduce?



Failure to Reduce

- Persistent lumbosacral kyphosis
- Sagittal imbalance
- Mismatched spinopelvic parameters



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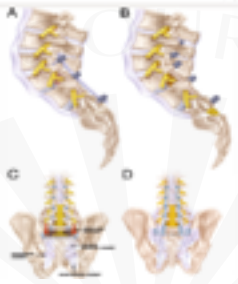
A novel approach to sagittal balance restoration following iatrogenic sacral fracture and resulting sacral kyphotic deformity

Technical note

- Fixed kyphosis requires an osteotomy for correction
- Sacral osteotomy to correct the L5-S1 angle and pelvic incidence
- Change of PI to match altered lumbar lordosis



Sacral PSO for Fixed Lumbosacral kyphosis

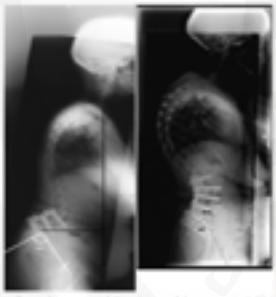


TABLE 1

*Comparison of pre- and postoperative spinopelvic parameters in a 52-year-old woman with a sacral fracture**

Parameter	Preop Angle (°)	Postop Angle (°)	Normal Values (°)†
pelvic incidence	86	65	54.8 ± 5.3
sacral slope	65	49	39.7 ± 4.1
pelvic tilt	21	16	13.1 ± 3.2
lumbar lordosis	68.5	61.4	62.7 ± 5.4
L-5 incidence angle	71	51	NR

* NR = not reported.
† Normal values obtained from Labelle et al.

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Summary

- Spondylolisthesis is a common condition among ambulatory human beings
- Low-grade spondy can be managed conservatively
- Surgical treatment is recommended for high-grade spondylolisthesis
- Spinopelvic and sagittal alignment parameters are critical for treatment planning and success
- Reduction should be considered with alterations in spinopelvic parameters or sagittal imbalance but the risk to the L5 nerve root should be weighted

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Please refer to Book of

DAY- 2 (Module 1)

for continuation...

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