SPINAL STENOSIS

Ethiopathogenesis, Diagnosis and Treatment

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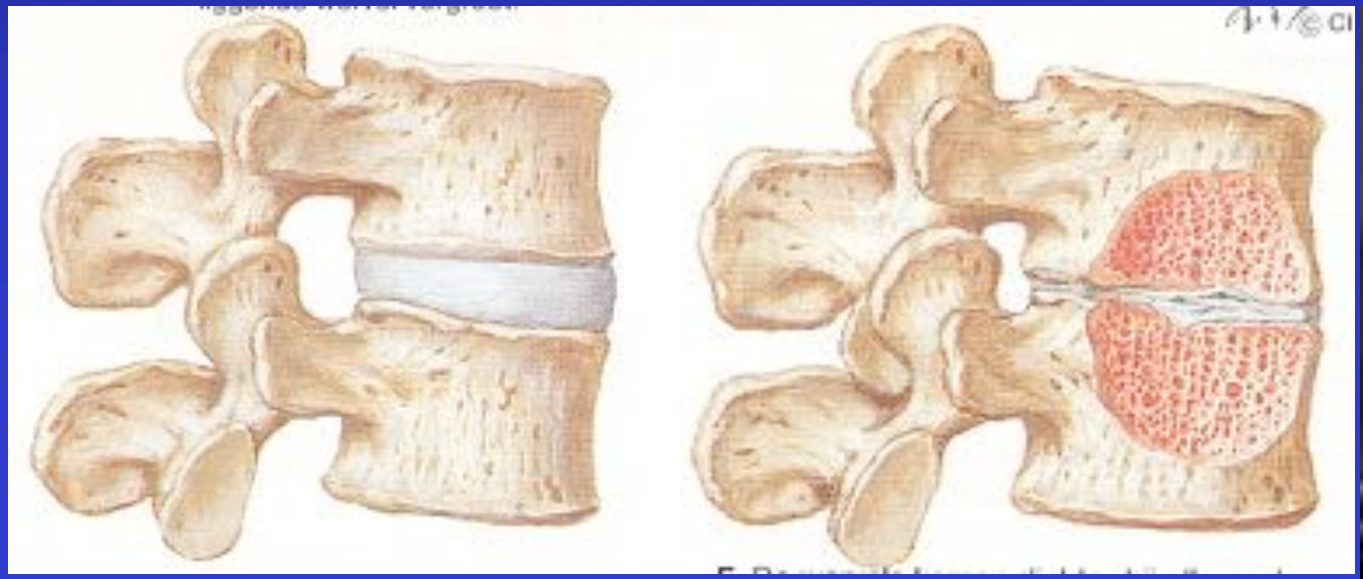
DEFINITION

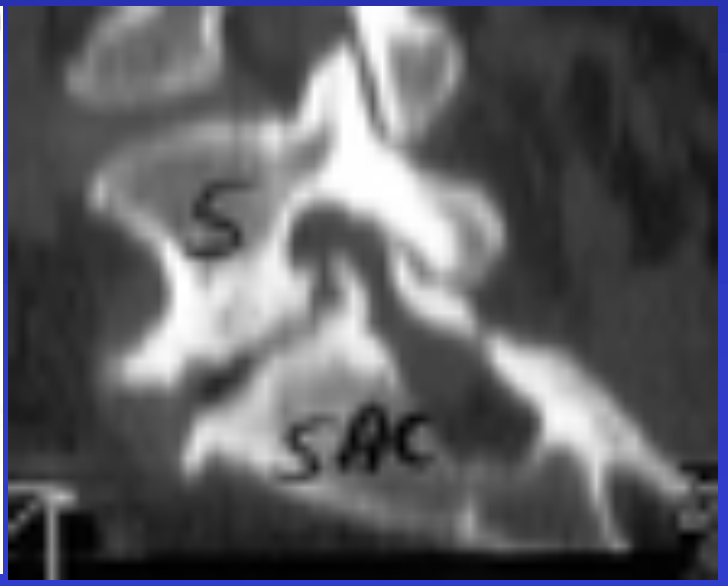
- DURA/CAUDA EQUINA COMPRESSED IN A NARROW CANAL = *"CENTRAL" STENOSIS*

DEFINITION

NERVE ROOT/DORSAL ROOT GANGLION OR SPINAL NERVE TRAPPED IN ITS PATHWAY

= *"<u>LATERAL</u>" STENOSIS*





ALWAYS A PATHOLOGY ?

UP T 21 % OF STENOSIS IN SYMPTOM-FREE INDIVIDUALS

Boden et al , JBJS 1990

Jensen et al, NEJM 1994

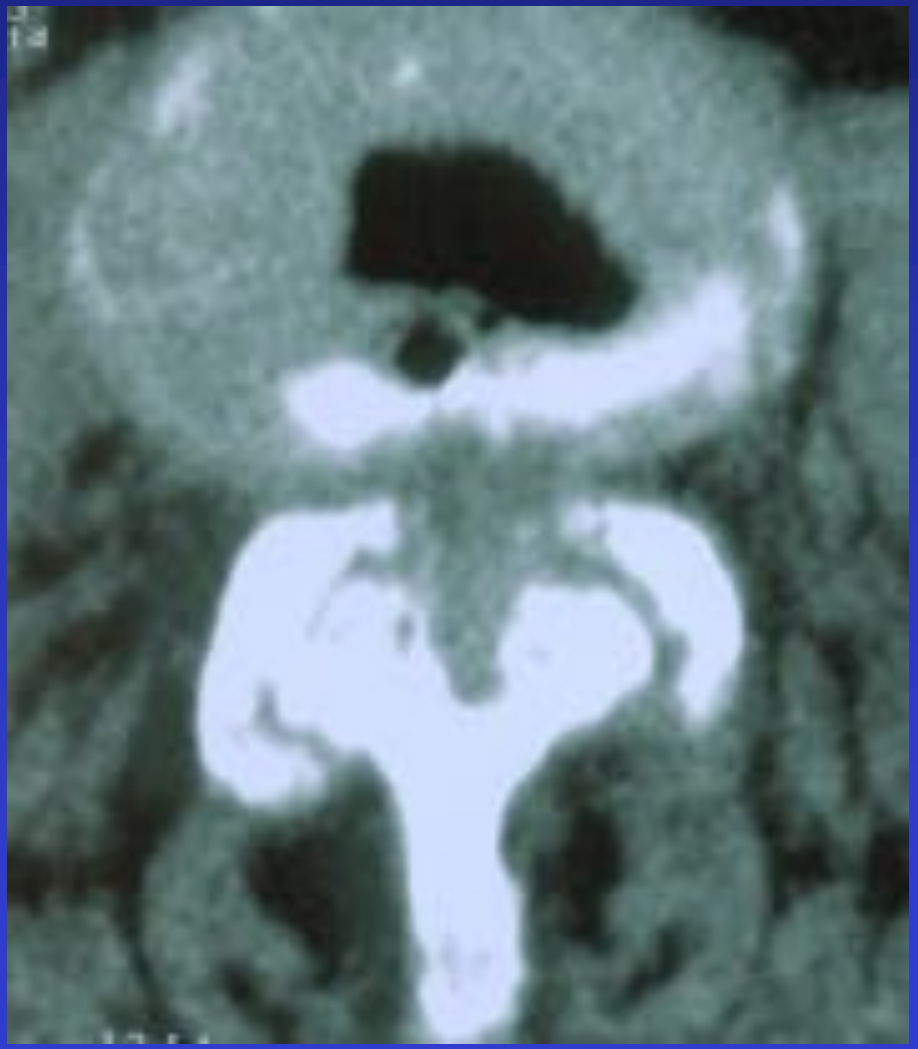
Wiesel et al, Spine 1984

STENOSIS = MORPHOLOGIC CONDITION

DOES NOT PER-SE IMPLY PATHOLOGY

- **Congenital**
- **Acquired** **(Facet Joint Hypertrophy / Degenerative Spondylolisthesis)**
- **Mixed**
- **Iatrogenic / Traumatic**

Acquired



Iatrogenic

CLINICAL PRESENTATION

- LOW BACK PAIN (LBP)
- NEUROLOGIC SIGNS AND SYMPTOMS
  - Neurogenic claudication
  - Radiculalgia
  - Cauda Equina Syndrom

Physical Signs

None really pathognomonic

CLINICAL PRESENTATION
NEUROGENIC CLAUDICATION

" Onset of pain, tension and weakness upon walking in one or both legs, progressively increasing until walking becomes impossible and subsequent disappearance of symptoms after a period of rest"

Verbiest 1976

CLINICAL PRESENTATION
NEUROGENIC CLAUDICATION

- Only during walking (not cycling)
- Sometimes pain without tension or weakness = "atypical leg pain"
- Restless legs (especially nocturnal)

CLINICAL PRESENTATION

NEUROGENIC CLAUDICATION

ΔΔ

ARTERIAL CLAUDICATION

Stenosis

- Must stop and stoop or sit
- Non smoker
- Palpation arteries
- Cycling goes well
- Downstairs more difficult
- Restless legs

Arterial

- Must stop
- Smoker
- No arteries to palpate
- Can not cycle better
- Stairs irrelevant
- No restless legs

CLINICAL PRESENTATION
LOW BACK PAIN

- Chronic LBP
- Progressive worsening
- Positional LBP
  - Increases during trunk extension, standing, walking
  - Decreases during trunk flexion

CLINICAL PRESENTATION
RADICULALGIA

- Radicular pain more frequent than claudication
- Possible radiculopathy: weakness, paresthesia...
- Positive straight leg raising (Lasègue)
- Variable pattern: uni- or bilateral, poorly defined
- Positional:
  - Appears in upright position
  - Increases during trunk extension
  - Decreases during trunk flexion

CLINICAL PRESENTATION
CAUDA EQUINA SYNDROME

- Intermittent or progressive
- Sensory-motor deficit
- Sphincter troubles
- Positional:
  - Related to upright position
  - Increases with walking

DIAGNOSIS
EMG

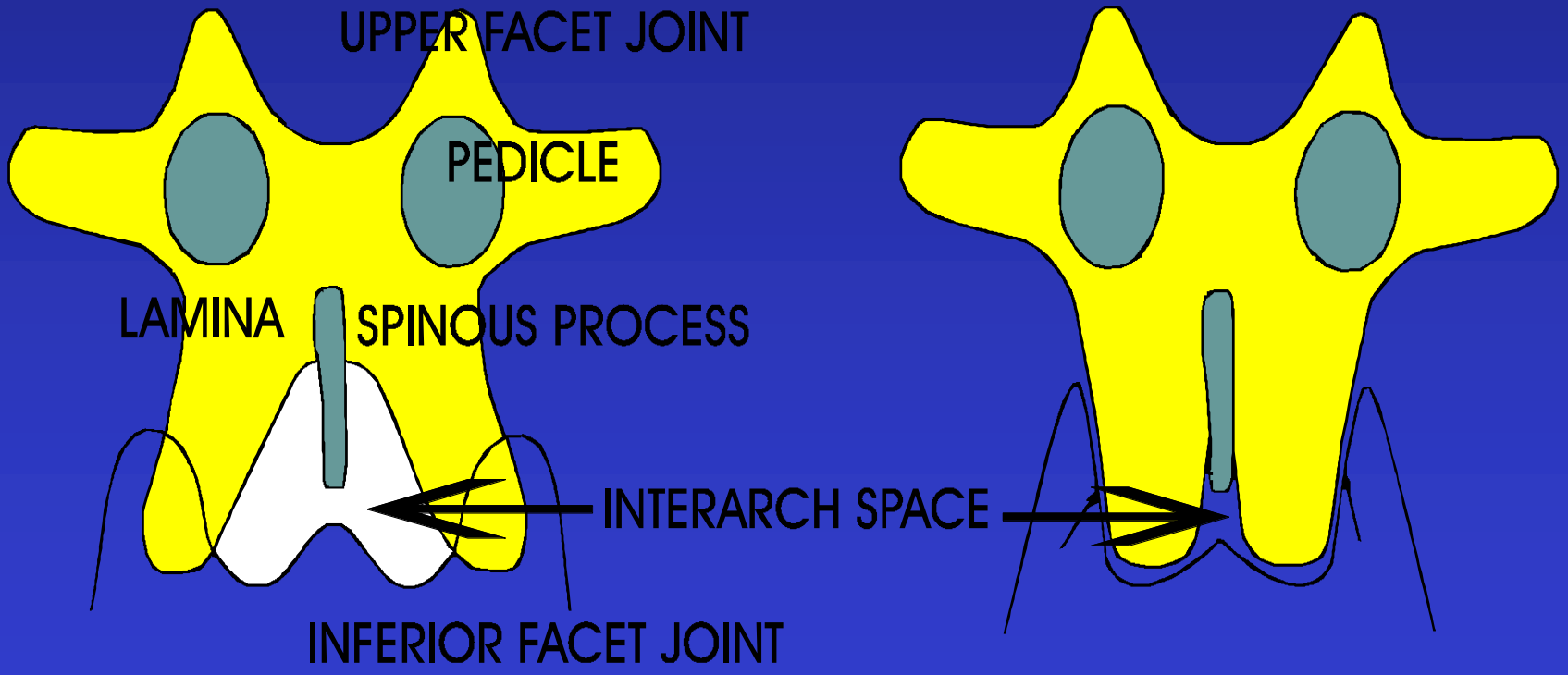
- **The Sensitivity and Specificity of Electrodiagnostic Testing for the Clinical Syndrome of Lumbar Spinal Stenosis (Haig et al, Spine 2005)**
- Electrodiagnostics has statistically significant, clinically meaningful specificity for spinal stenosis and detects neuromuscular diseases that may masquerade as stenosis.

- **yet**
- ***MANY STENOSIS CASES = NORMAL EMG***

DIAGNOSIS
PLAIN X-RAY

- Inter-pedicular distance
- Clothes-Peg Sign (Babin)
- Facet joint hypertrophy
- Disc space narrowing
- Oblique radiographs: neuroforamen Ø
  - Spondylolisthesis
  - Paget
  - …etc

BABIN "CLOTHES-PEG" SIGN

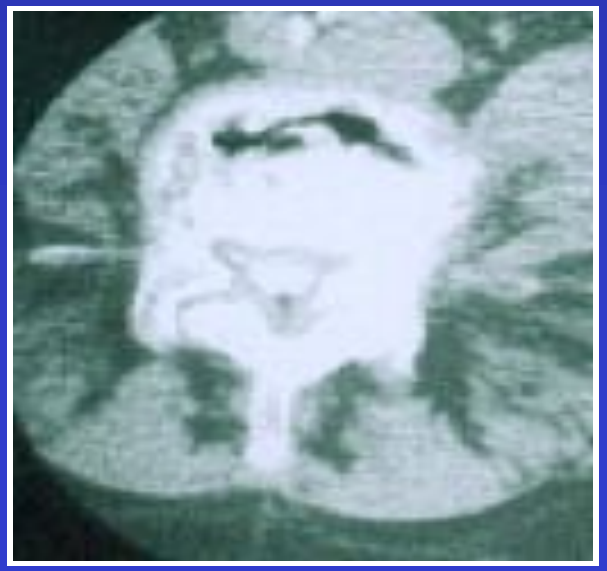


DIAGNOSIS
CT SCAN

- Precise evaluation of morphology (constitutional and acquired factors)
- Enables precise and reproducible measures

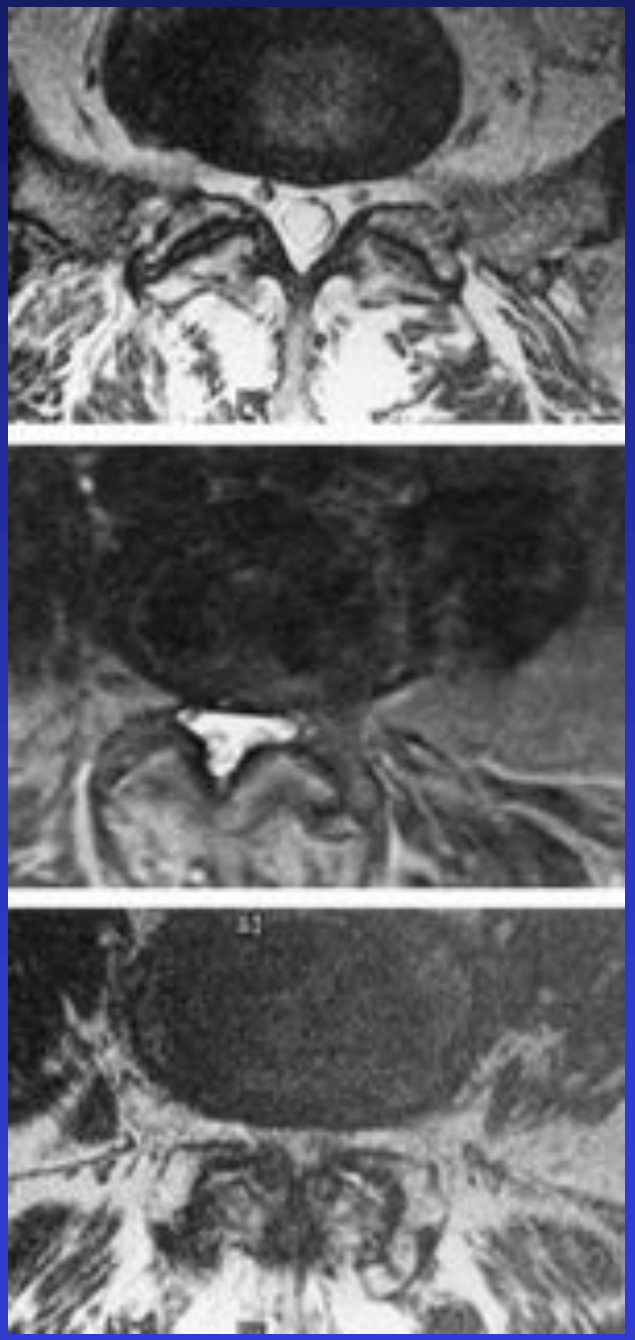
DIAGNOSIS
CT SCAN

- Enables good sagittal view with spiraled CT
- Enables Tri-D reconstruction
- BUT : *Supine position: underestimates stenosis which increases in upright position (10-30 %)*



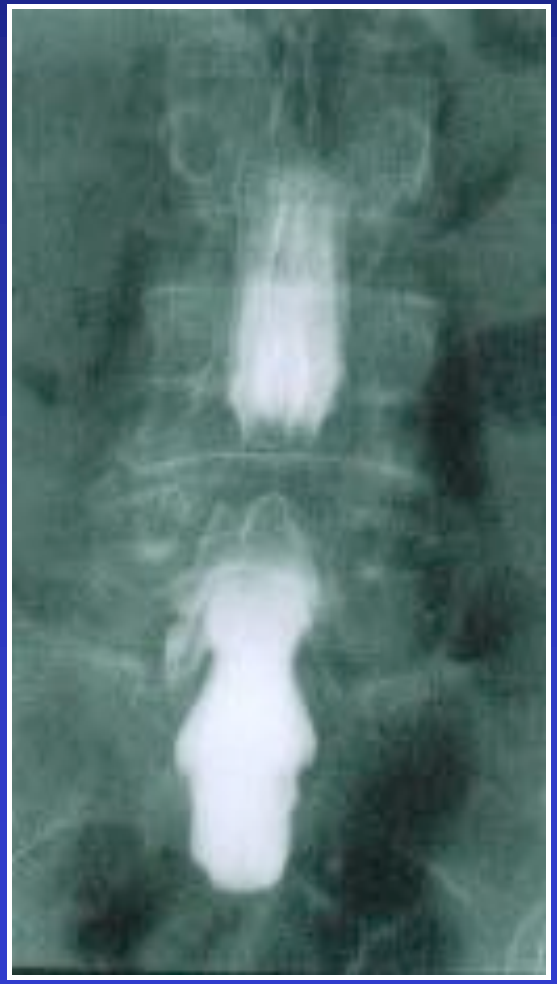
DIAGNOSIS
MRI

- Sagittal view enables to verify extension levels of stenosis
- Eliminates intra-dural pathologies
- BUT : *Supine position: underestimates stenosis which increases in upright position (10-30 %)*



DIAGNOSIS
MYELOGRAPHY

- Good assessment of anterior discal participation to the stenosis



DIAGNOSIS
MYELOGRAPHY

- Only test which enables investigation in loading postures and dynamic (flex-ext) views. (Nakstad et al 1983, Schumacher 1986,Wilmink & Penning 1983)
- Evaluates ‘instability’

DIAGNOSIS
MYELOGRAPHY

- Can be completed by myelo-scan

ORIGIN OF SYMPTOMS
RADICULALGIA

- Direct entrapment (lateral recess, foramen…)
- Increased compression by protruding disc and liamentum flavum during upright position

ORIGIN OF SYMPTOMS
LOW BACK PAIN

- Disc Degeneration
- Instability (?)
- Increased pressure on intracorporeal veins (Arnoldi 1976, Rothman & Simeone 1992)
- Muscle tension
- ……..

ORIGIN OF SYMPTOMS
NEUROGENIC CLAUDICATION

- Abnormal nerve function: accumulation of metabolites and inadequate oxygenation: borderline function worsened by effort.
- Central stenosis at one level does not give neurogenic claudication nor does isolated lateral stenosis (Porter 1996)

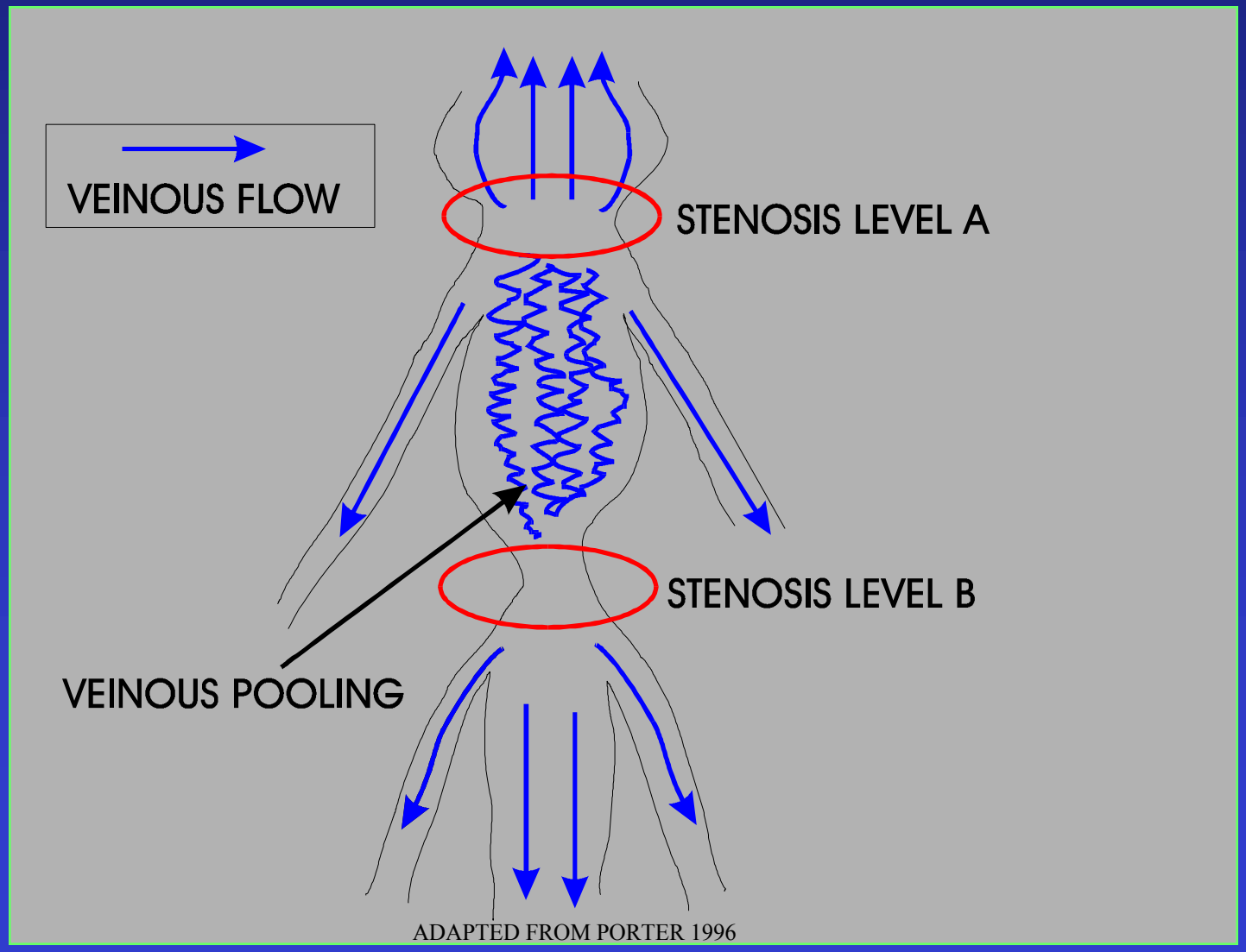
ORIGIN OF SYMPTOMS
NEUROGENIC CLAUDICATION

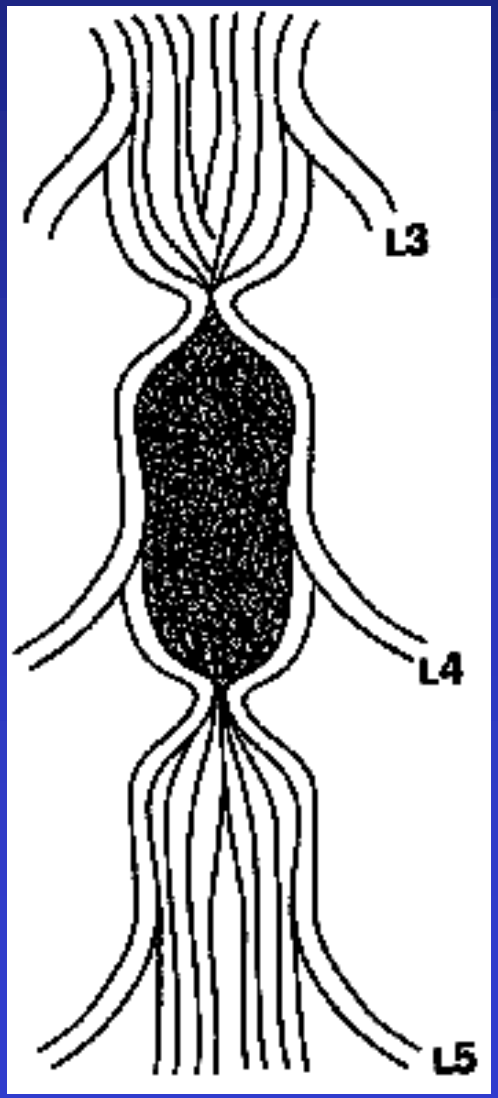
- Two-level compression below arterial pressure
  - Root veins vulnerable to congestion in uncompressed segment : veinous pooling

  - 2 C : bilateral claudication
  - 1 C - 2L: bilateral claudication
  - 1 C - 1L: unilateral cmaudication

VEINOUS POOLING

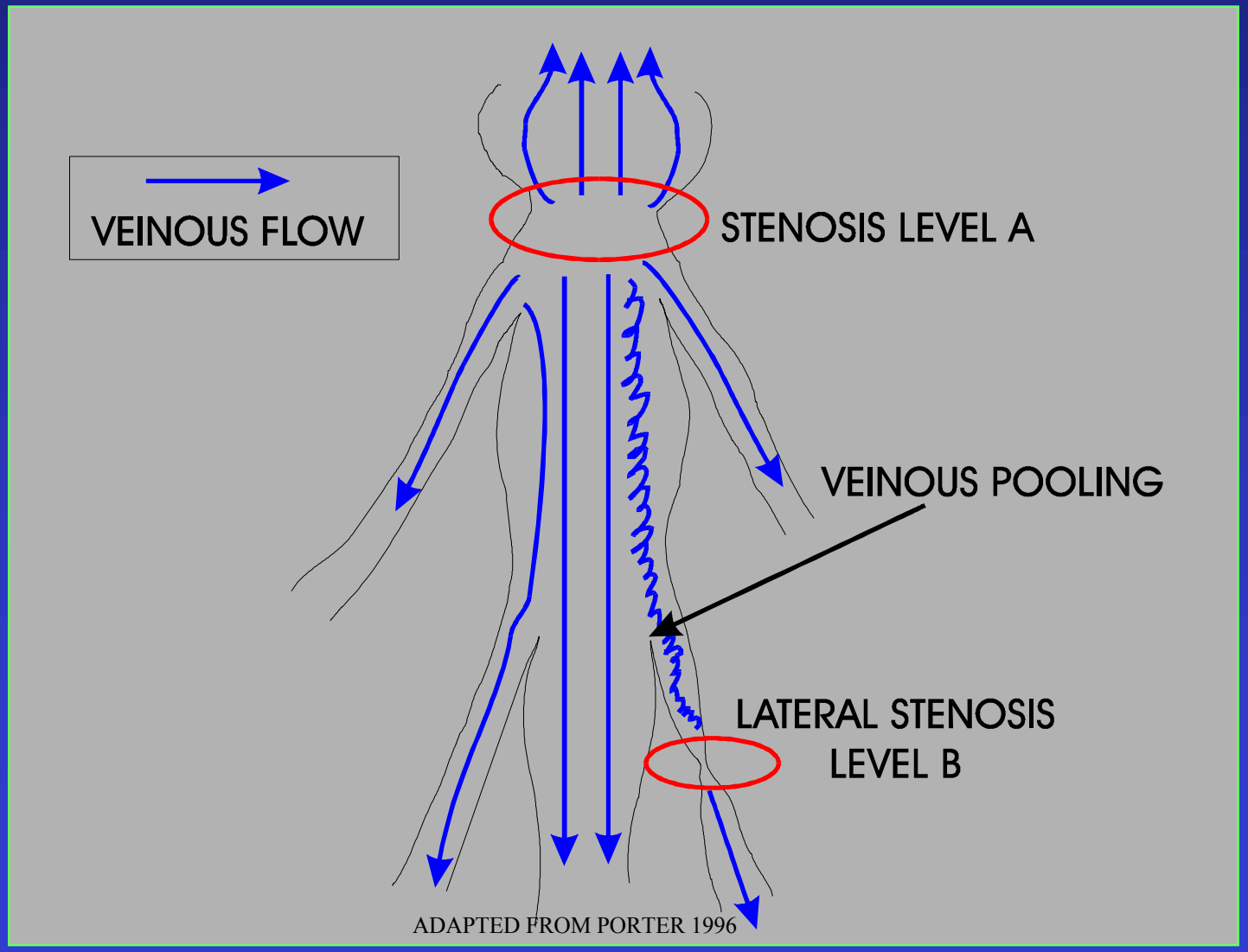
2 LEVEL CENTRAL STENOSIS

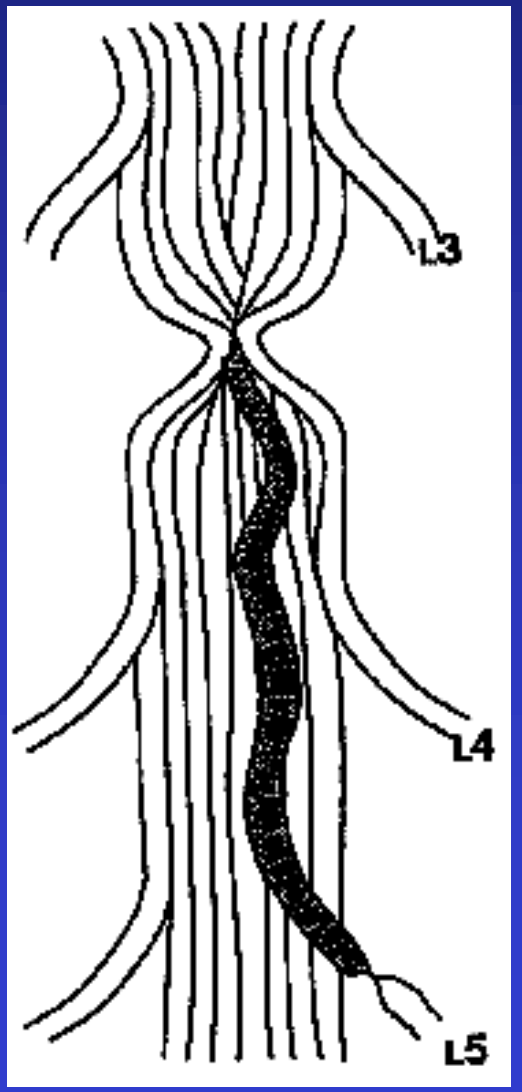




VEINOUS POOLING

CENTRAL + LATERAL STENOSIS





ORIGIN OF SYMPTOMS

NEUROGENIC CLAUDICATION

RELATION WITH WALKING ?

- Normally arterial vasodilation accompanies exercise. Venous pooling may interfere with this mechanism causing failure of motor activity in the legs
- Arteriosclerosis (common in spinal stenosis age group) can cause a failed arterial response of cauda equina vessels

ORIGIN OF SYMPTOMS
NEUROGENIC CLAUDICATION

RELATION WITH WALKING ?

- Segmental rotation during walking reduces root canal space : specific to walking
- Impaired circulation of cerebro-spinal fluid may increase root vulnerability to venous congestion (Porter theory)

ORIGIN OF SYMPTOMS
NEUROGENIC CLAUDICATION

- Walking = upright posture = narrower canal
- Cycling = flexed posture = wider canal

Treatment

CONSERVATIVE TREAMENT

NSAI

Rest, Analgesics, Muscle relaxants

Physiotherapy

De-lordosing

Choropractic

EPIDURAL STEROIDS

Rationale: anti-inflammatory action of steroids (Benzon 1986)

EPIDURAL STEROIDS

Cost Utility Analysis of Lumbar Interlaminar Epidural Injections in the Treatment of Lumbar Disc Herniation, Central Spinal Stenosis, and Axial or Discogenic Low Back Pain

Manchikanti et al, Pain Physician 2017

Lumbar interlaminar epidural injections in patients nonresponsive to conservative management in the treatment of spinal stenosis in the lumbar spine shows the clinical effectiveness and cost utility of these injections of $1,976.58 for direct costs with a total cost of $3,301 per QALY

EPIDURAL STEROIDS

Transforaminal epidural steroid injection in lumbar spinal stenosis: an observational study with two-year follow-up

Davis et al, Br J Neurosurg 2017

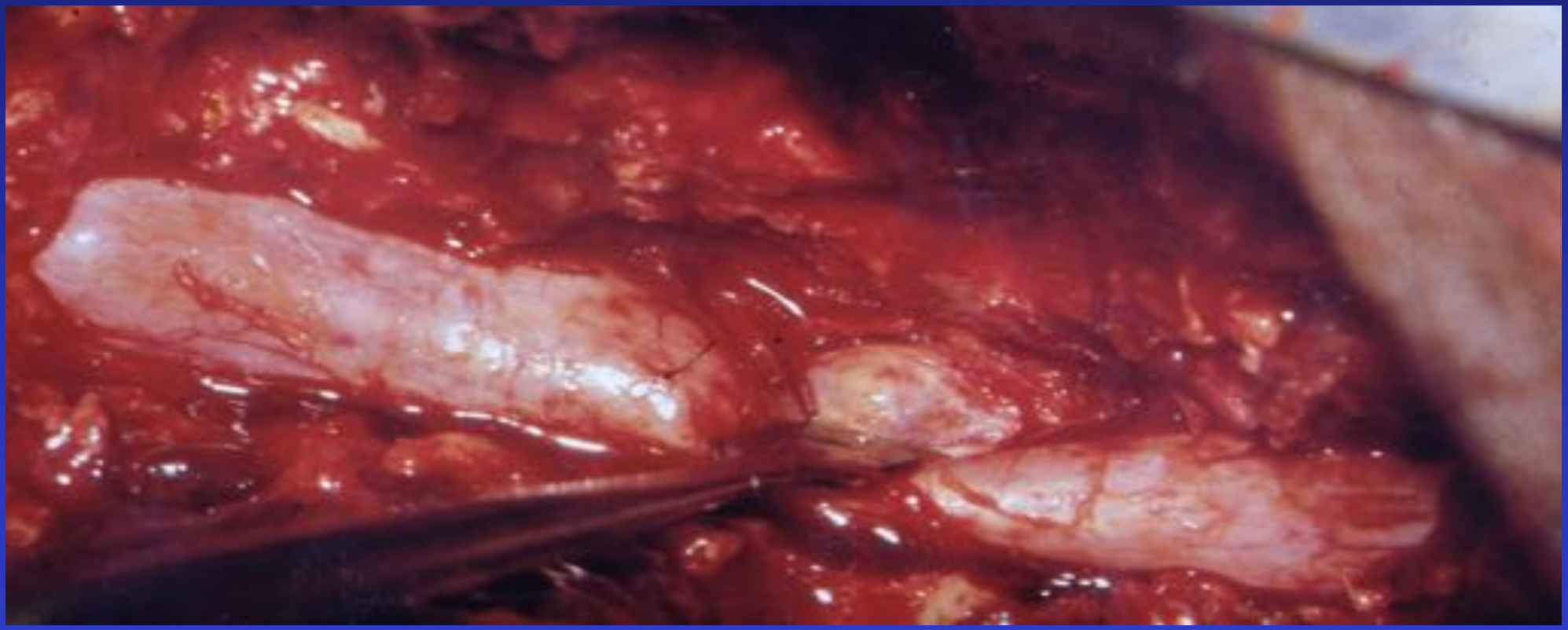
Considerably lower percentage patients opt for surgery than previously demonstrated by the available literature

Trans Foraminal Epidural Injection (FESI) is a reasonable treatment for lumbar spinal stenosis and can result in long-term relief from symptoms in a high proportion of patients

SURGERY

SURGICAL TREATMENT

Agressive bony resection to “unroof” the subarticular and foraminal zones leads to insufficiency of facet joints and pars with subsequent iatrogenic instability



SURGICAL TREATMENT

- Laminectomy/Flavectomy/Arthrectomy

multifidus is freed bilaterally from spinous process and lamina and retracted widely

supra- and interspinous ligaments are resected with inferior and superior halves of respective spinous proceses

paraspinal muscle denervation and atrophy

loss of supra-/interspinous ligament complex leads to instability

dead space potential for haematoma and scar formation

loss of median posterior furrow may be of cosmetic concern

SURGICAL TREATMENT

- ‘Recalibration’ (Senegas ‘88)
- ‘Laminarthrectomy’: sublaminar central canal decompression combined with bilateral foraminal and nerve root canal decompression with preservation of the midline structures (*Crock)*
- Endoscopic laser foraminoplasty

FRASER technique adapted from

Yong Hing and (1986)

Kirkaldi-Willis (1978), Crock (1985) and Cornish

LAMINOTOMY

with

PARTIAL ARTHRECTOMY

=

LAMINARTHRECTOMY

Standard prone position

Midline incision down to dorsolumbar fascia

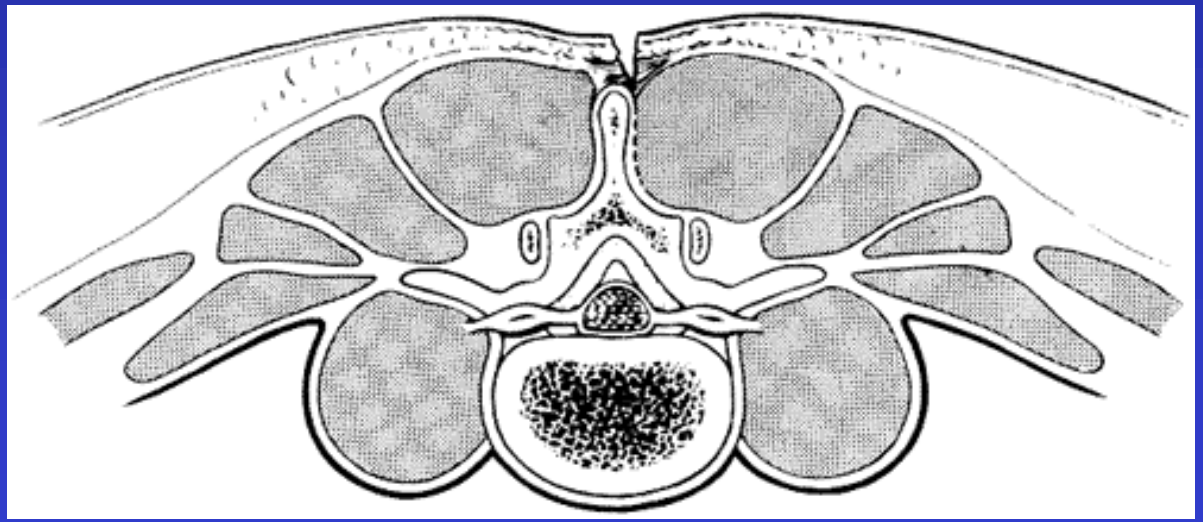
Incision of dorsolumbar fascia 5 mm off the midline to preserve supraspinous ligaments

Multifidus freed from spinous process and lamina, up to medial aspect of facet joint

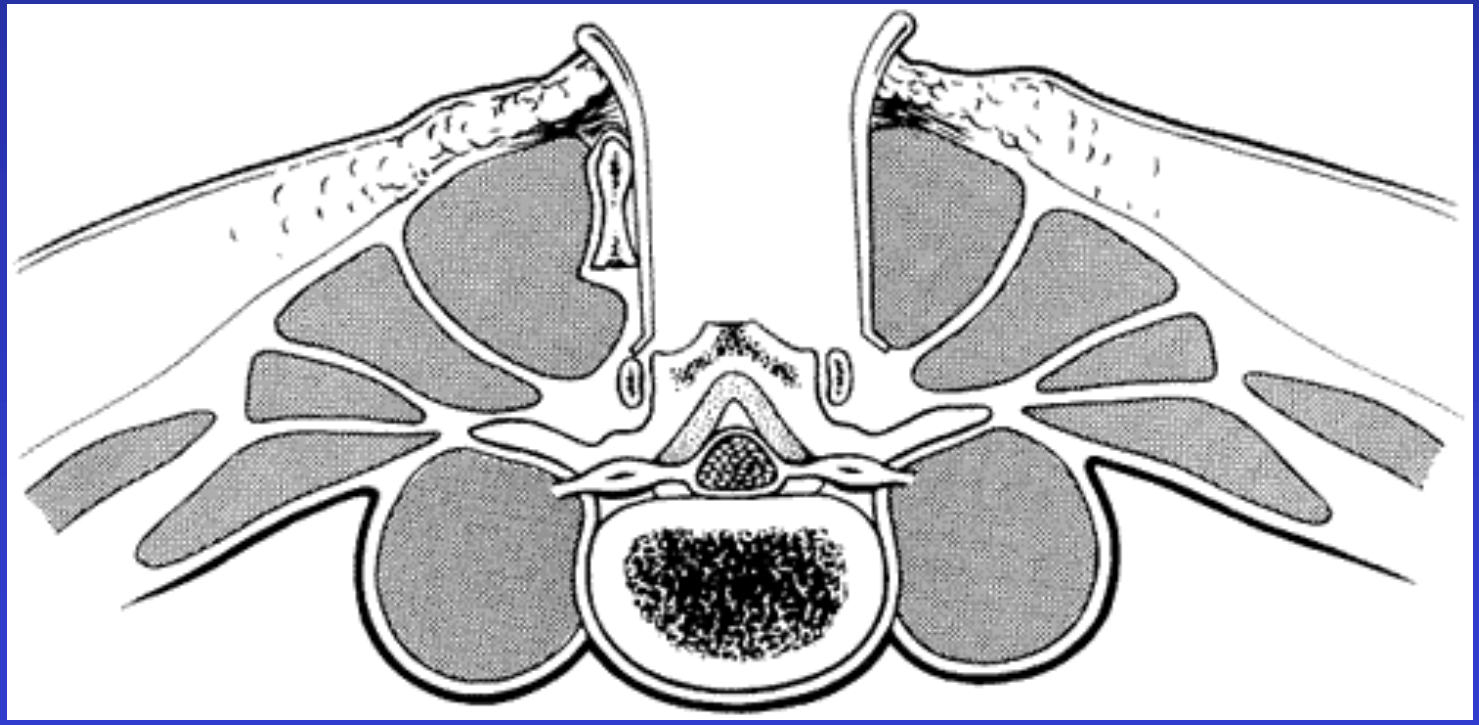
Osteotomy spinous processes just superficially to junction with lamina

Weiner BK, Fraser RD, Peterson M. Spinous process osteotomies to facilitate lumbar decompressive surgery.

Spine 1999;24:62-66



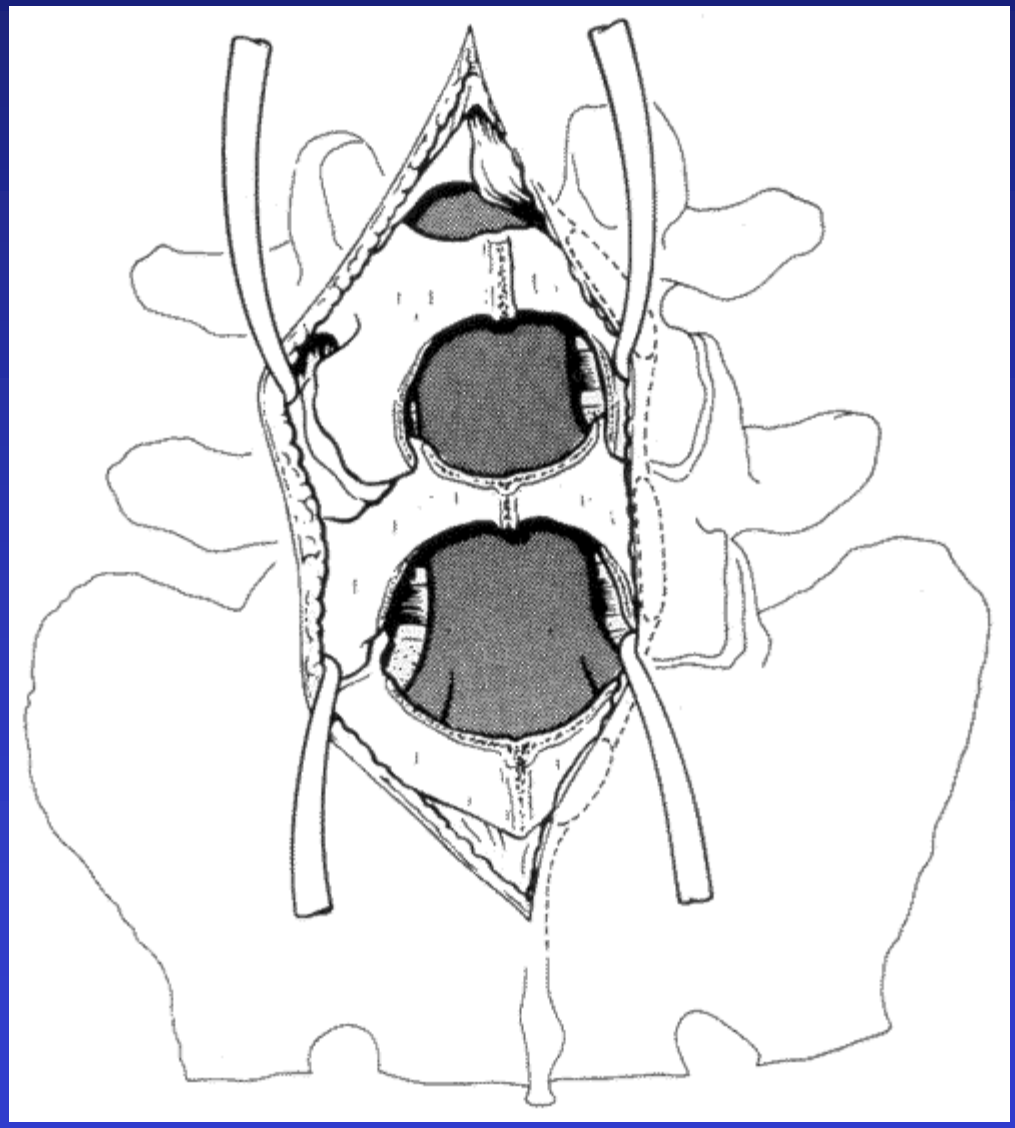
Self-retaining retractor (Keon-Cohen) through interspinous notch on the contralateral side and multifidus ipsilaterally

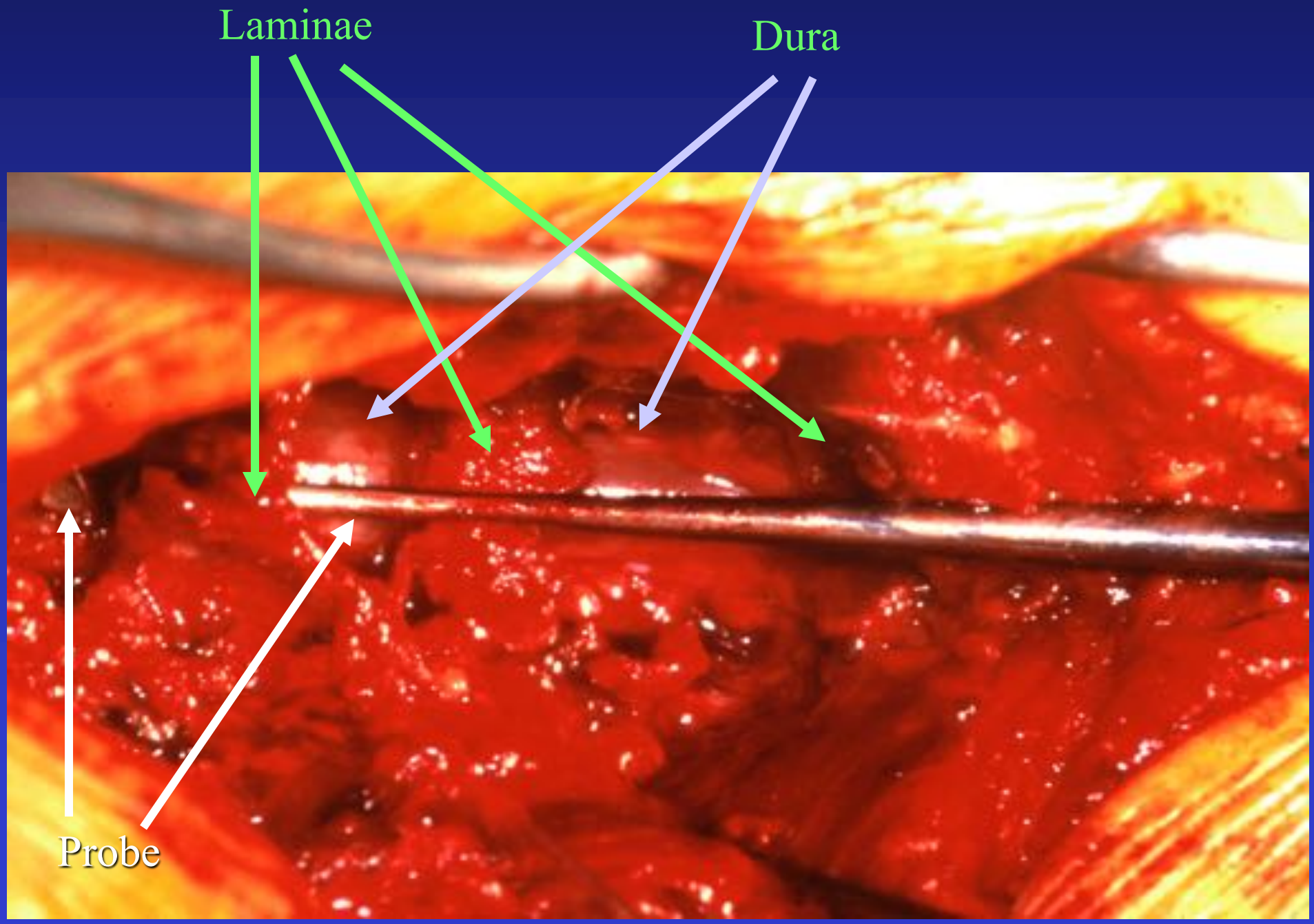


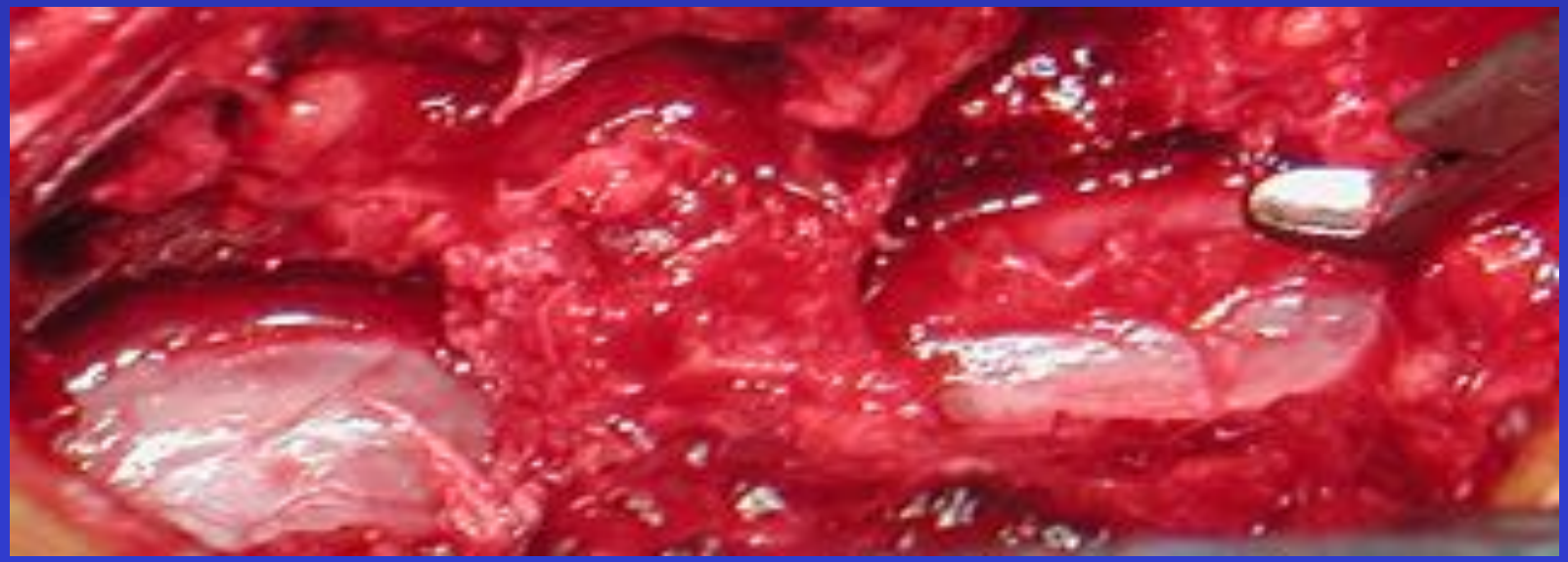
Flavectomy

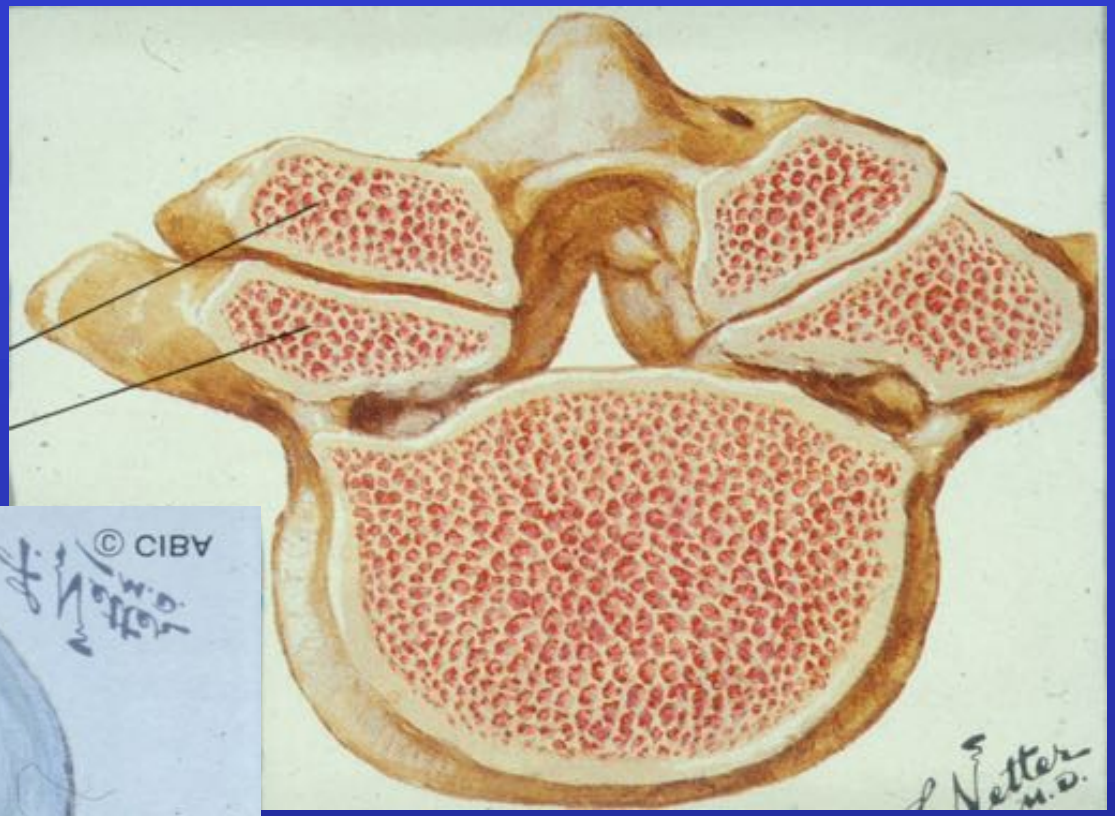
Partial laminectomy (1/2 superior, 1/4 inferior lamina)

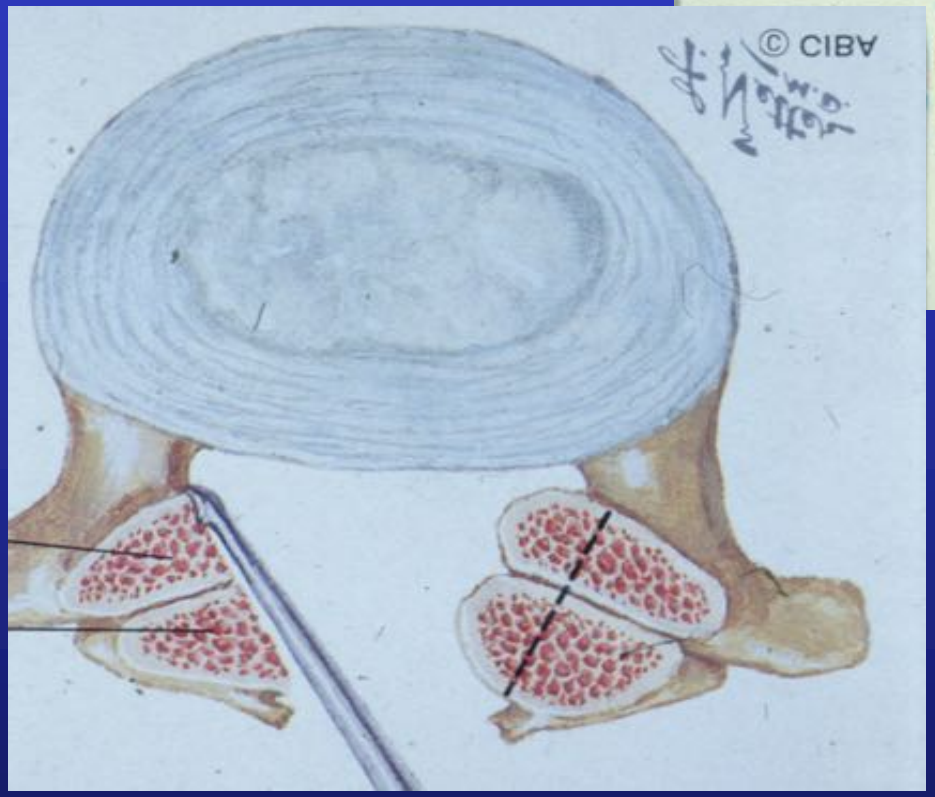
Decompression of subarticular and foraminal zones in an undercutting and trumpeted fashion




Laminae
Dura
Probe



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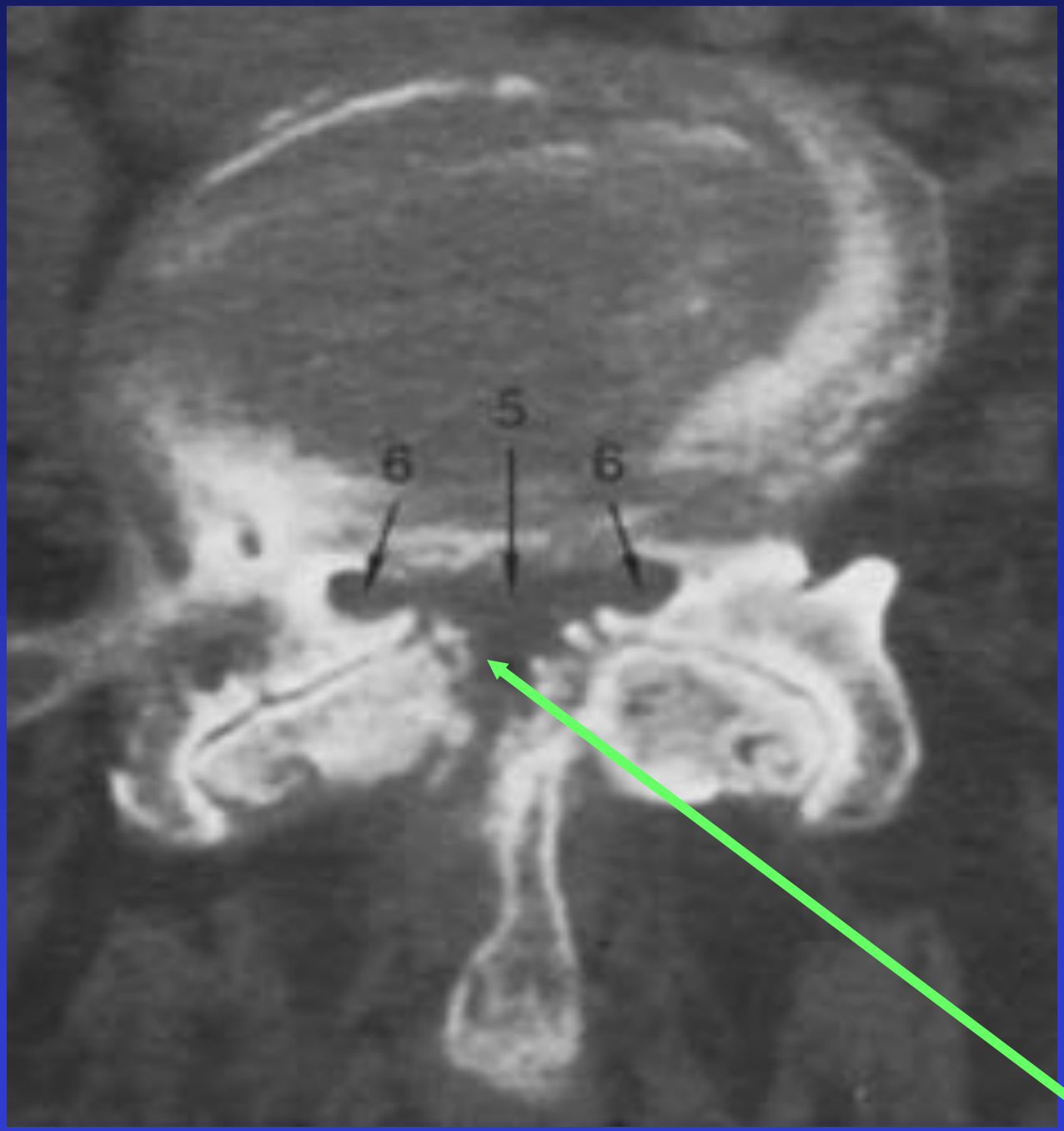


Adequate decompression also of lateral recess

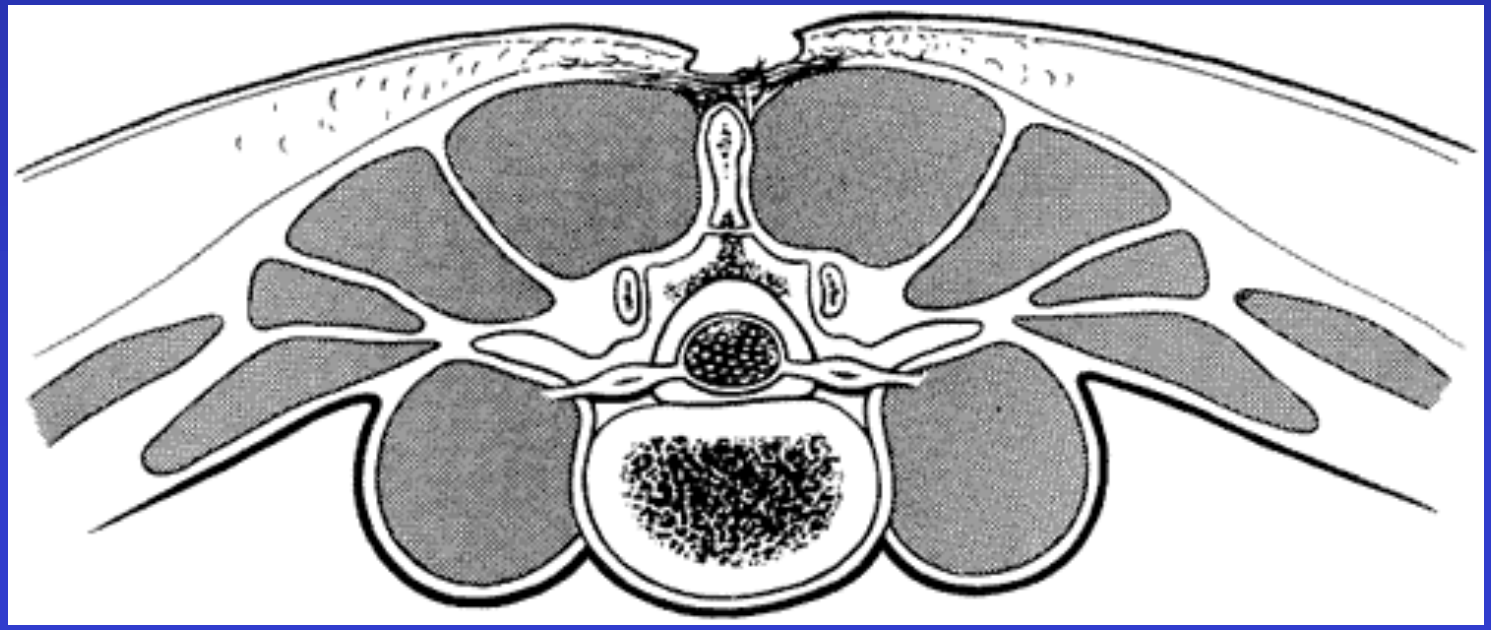
Kerrison Rongeur


Codman

Removal of retraction

Resuturing dorsolumbar fascia to supraspinous ligament with osteotomized spinous processes resuming their native positions

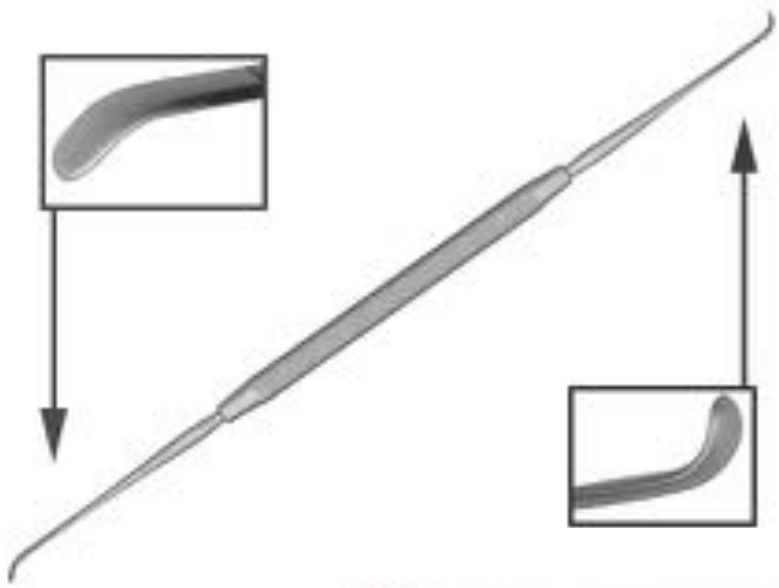
RESTITUTIO AD INTEGRUM

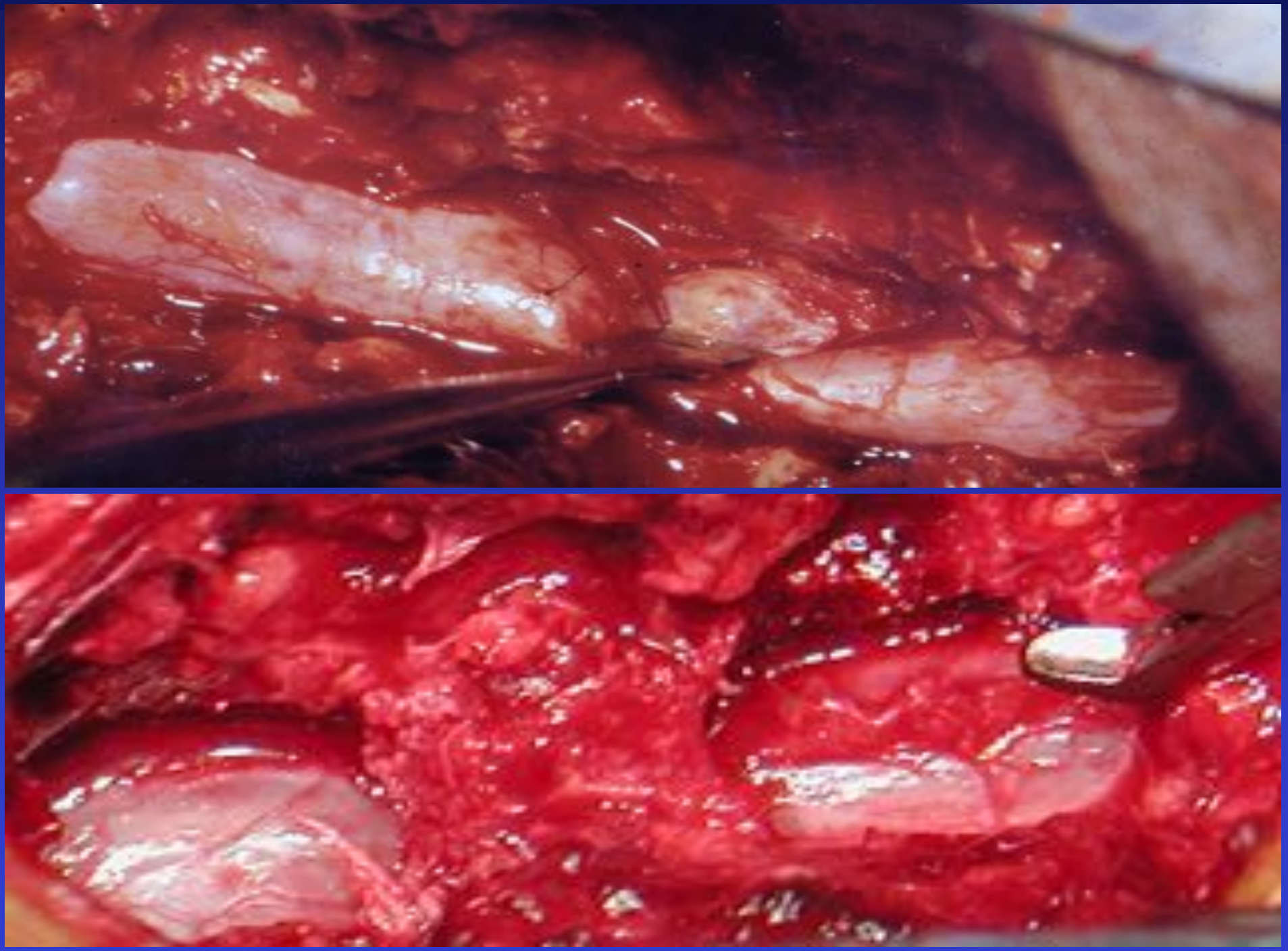


- Average blood loss 250 ml
- Only one suction drain
- Resumption of walking: day 1 post-op
- Resumption of work: 6-12 weeks

- Blunt disector
- Kerrison rongeurs of different lenghts, widths and angulations
- (Power drill)
- Retraction with plastic suction tip


JAKOBI





Clinical and Psychofunctional Measures
of
Conservative Decompression Surgery
for
Lumbar Spinal Stenosis:
A Prospective Cohort Study

R. Gunzburg, T.S. Keller, M. Szpalski, K. Vandeputte, K.F Spratt

- January ‘96 & January ‘98
- 36 consecutive patients
- Clinically & Radiologically spinal stenosis
- Failed conservative Tx/ min 1 year
- No previous spinal surgery
- No added fusion
- No spondylolisthesis
- Single surgeon (R.G.)

Pre-Surgery: clinical features

- Clinical examination by Independant Orthopaedic surgeon observer (K.V.)
- NOS non-organic physical signs (Waddell)

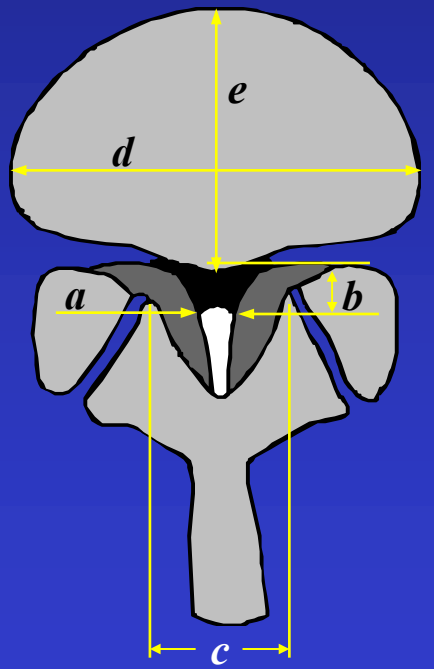
Pre-Surgery: outcome assessments

- Disability index (WDI) **Waddell**
- Oswestry Low Back Disability Questionnaire (ODI) **Fairbank**
- Low Back Outcome Score (LBOS) **Greenough**
- General questionnaire

Pre-Surgery: trunk dynamometer testing

- Isostation B200
- Dynamic flexion-extension velocity was measured at 25% & 50% of maximum torque in sagittal plane

Pre-Surgery: CT-scan imaging



Follow-up

- Identical clinical evaluation by an independant orthopaedic surgeon observer
- Isostation B200 Trunk Function Analysis
- Self-administered questionnaires
- CT-scan (operated level only)

Questions at Follow-up

- **Were you happy with the care you received during your hospital stay?**
- **Were you happy with the operation itself?**
- **Would you have the same operation again?**

Defining successful outcome: 4 variables

- VAS
- Self reported functional status (LBOS)
- Reduction of pain while walking
- Reduction of leg pain

At least 3 out of 4 improved

Statistical Analysis

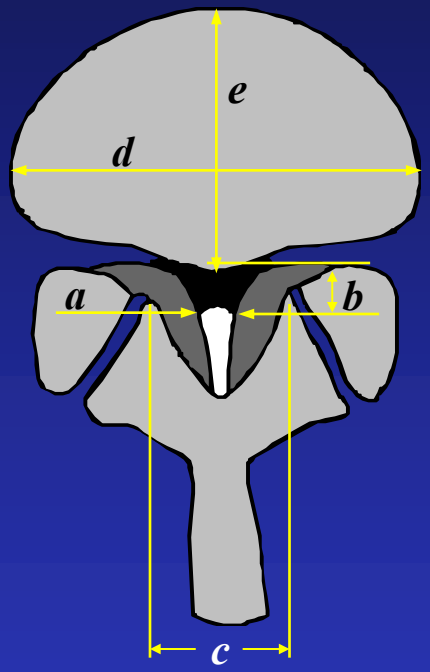
Treatment Efficacy

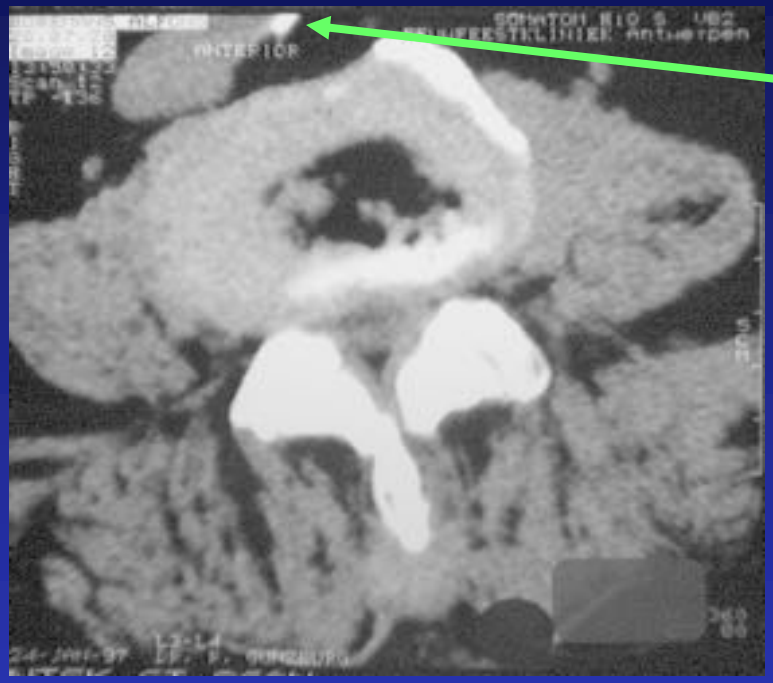
Patient age, gender and variables such as the number of operative levels were considered in conjunction with changes in health status following surgery.

Treatment efficacy was evaluated within a three variable crossed factorial design considering *number of operative levels*, and *changes in outcomes* from pre- to post-operative assessment using mixed model analysis of variance (ANOVA) techniques.

RESULTS

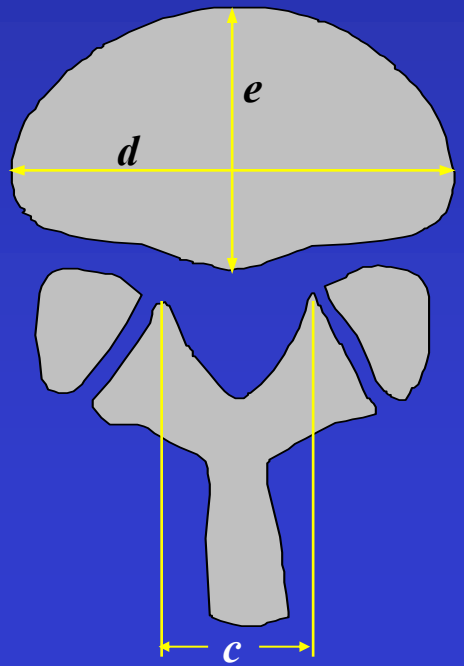
- 17 males, 19 females
- mean age at surgery: 60 years
- 18/36 had aortic calcifications
- 10 smokers
- average follow-up 1.7 years





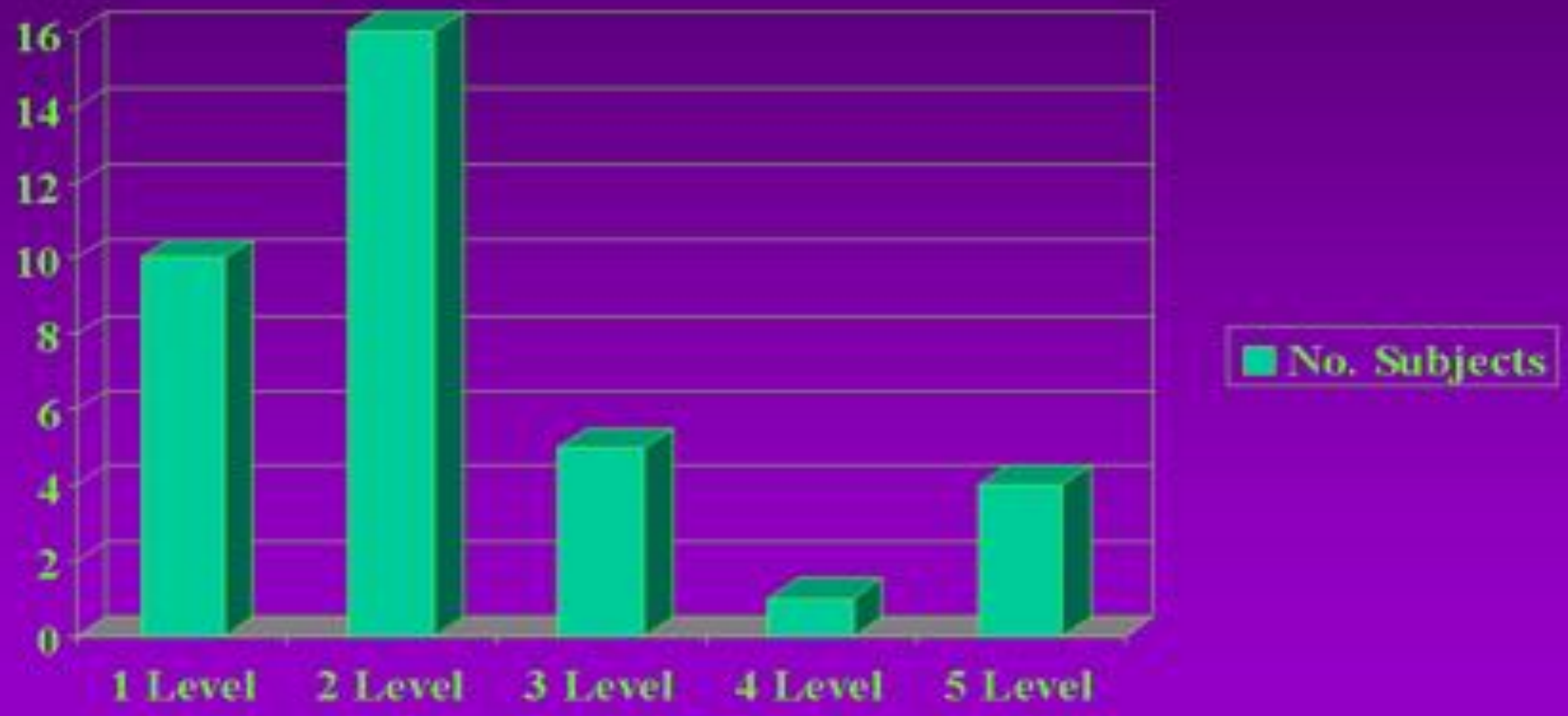
Aortic calcification

Pre-op



Post-op

Operated Levels



RESULTS

- Average duration of operation = 68 ± 33 min
- Length of hospital stay averaged = 6.0 ± 4.9 days

$\Rightarrow$ There were no significant differences in hospital stay relative to number of operative levels or gender.

RESULTS

- **34 patients responded to satisfaction questionnaire**
- **94% were happy with the *care* administered during hospital stay**
- **97% reported satisfaction with the *operation itself***
- **65% indicated they *would undergo the same operation again***

RESULTS

- No statistically significant differences for subgroups based on gender, operative age or number of operative levels
- However, of the patients who had a *one level decompression*, 89% would have the operation again compared to 37% of patients who had *multilevel decompressions*

RESULTS

Four self-reported outcomes were considered to evaluate improvement after surgery

All demonstrated statistically significant pre- to post-operative changes consistent with improved health status

VAS (**66** ± 21 pre to **36** ± 31 post, $p < 0.004$)

ODI (**42** ± 14 pre to **31** ± 19 post, $p < 0.0031$)

WDI (**6.0** ± 1.9 pre to **3.6** ± 2.3 post, $p < 0.0034$)

LBOS (**28** ± 10 pre to **40** ± 17 post, $p < 0.005$)

Predicting successful Outcome

14/36 improvement on all four criteria

7/36 improvement on three/four

Therefore 21/36 (**58.3%**) successful outcomes

12/36 improvement on two/four

3/36 improvement in one/four

- VAS
- Self reported functional status (LBOS)
- Reduction of pain while walking
- Reduction of leg pain

Conclusion

Conservative surgical decompression

- maintains spinal stability
- minimizes tissue disruption
- no violation of the laminae, facet joints and interspinous ligaments

Conclusion

General function and disability questionnaires instruments designed for and commonly used in low back pain can be used to assess outcome of surgical treatment of spinal stenosis

Surgical decompression

+

Fusion

=

Controversy

Comparison of surgical procedures for degenerative lumbar spinal stenosis: a meta-analysis of the literature from 1975 to 1995

Niggemeyer et al., Eur Spine J 1997

- We found that in patients suffering degenerative spinal stenosis for up to 8 years, decompression without fusion showed the best results

Effectiveness of surgery for lumbar spinal stenosis: a systematic review and meta-analysis
Machado et al., PLoS One 2015

- MEDLINE, EMBASE, AMED, CINAHL, Web of Science, LILACS and Cochrane Library
- Decompression plus fusion is not more effective than decompression alone

Fusion or Not for Degenerative Lumbar Spinal Stenosis: A Meta-Analysis and Systematic Review

Shen et al, Pain Physician 2018

- 5 electronic databases (PubMed, EMBASE, MEDLINE, Cochrane Library, and CENTRAL)
- Only randomized controlled trials (RCTs) assessing the comparison between decompression and fusion surgery for DLSS were included.
- Additional fusion surgery seems unlikely to result in better outcomes for patients with DLSS
- But it may increase additional risks and costs