DIAGNOSIS AND TREATMENT OF CERVICAL SPONDYLOTIC MYELOPATHY

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History of Cervical Spondylosis

- Earliest references to cervical disorders causing neurological deterioration
  - Strumpell 1888
  - Marie 1898
    - (Marie-Strumpell Disease=Ankylosing spondylitis)
  - Von Becktren 1899
- Horsely in 1892 performed first surgical intervention for myelopathy
  - C6 laminectomy
  - Patient had full recovery within one year

- Spurling and Scoville (1940) described foraminal decompression.
- Brain et al (1952) define the etiology pathophysiology of CSM.
- Robinson and Smith (1955), Cloward (1958) described anterior cervical discectomy and fusion.
- Bailey and Badgley (1960) published onlay strut grafting.
- Hirabayashi et al- Open door laminoplasty.

Epidemiology of Cervical Spondylosis

- Prevalence in males
  - Age 30, 13%
  - Age 70, 100%
- Prevalence in females
  - Age 40, 5%
  - Age 70, 96%
- Cervical spondylotic myelopathy is the most common cause of spastic paraparesis or quadriparesis.

Pathophysiology of Cervical Spondylosis

- Reduction in spinal canal diameter is the primary degenerative process.
- Disc Degeneration.
  - 3rd decade begins a progressive decline in water content of disc due to loss of glycosaminoglycans
  - 90% water at age 20, 70% at age 80
  - Loss of water, protein, mucopolysaccharides with age allow the nucleus pulposus to become smaller and more fibrous.
- The annulus fibrosis takes on more weight bearing responsibility.
- Loss of disc height occurs.
  - Annulus begins to bulge
  - Disc becomes an indistinct mass of fibrocartilage.

Pathophysiology of Cervical Spondylosis

- Osteophytic bars form likely to stabilize adjacent vertebrae by increasing the weight bearing of the endplates.

- Uncinate process hypertrophy occurs, encroaching on the intervertebral foramina.

Pathophysiology of Cervical Spondylosis

- Disc herniation
  - Layers of annulus fibrosis are thinner dorsally, leading to tears and disc material herniating posteriorly into the canal.
- Spondylotic Spurs
  - Annulus dissects away from the PLL and endplates, leaving exposed bone.
  - Bare edges of dorsal vertebral bodies form reactive bone (subperiosteal reaction).
  - Extend along the ventral aspect, encroach on nervous tissue.

OPLL

- It is a misnomer
- Ossification is an entity by itself of ossific process.
- Commonly involves cervical spine in middle & elderly age.
- Cytokine related abnormal bone growth, HLA related genotype aberration, diabetes, Vit-D deficiency, genetic recessive transmission.


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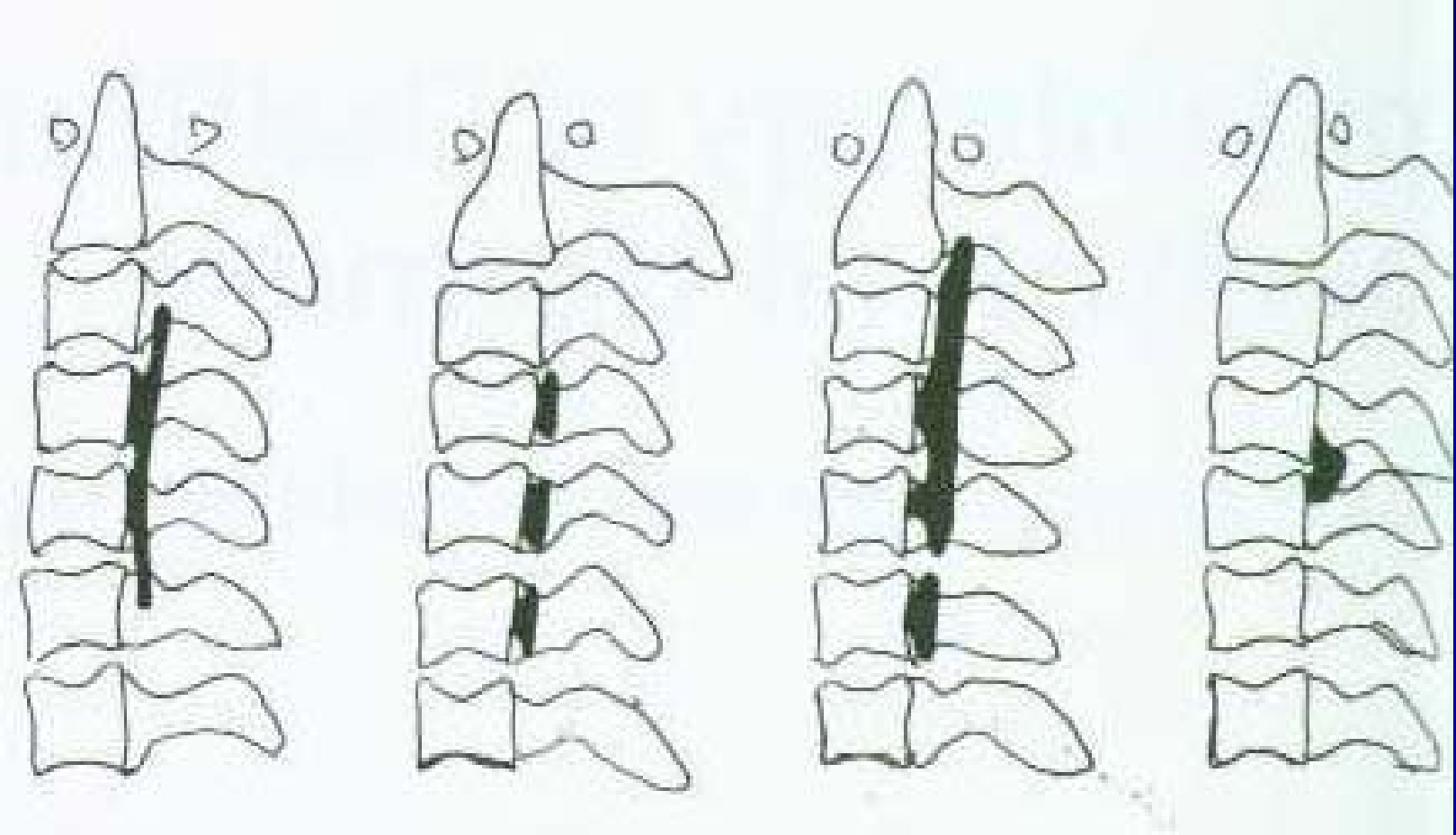
- OPLL
  - Most common in Japan
    (burning candle variety)
  - Not rare in India
  - Overall incidence is 5%.



Physiological Measurements of the Cervical Spine

- Pavlov's Ratio:

  ≥1 is normal.

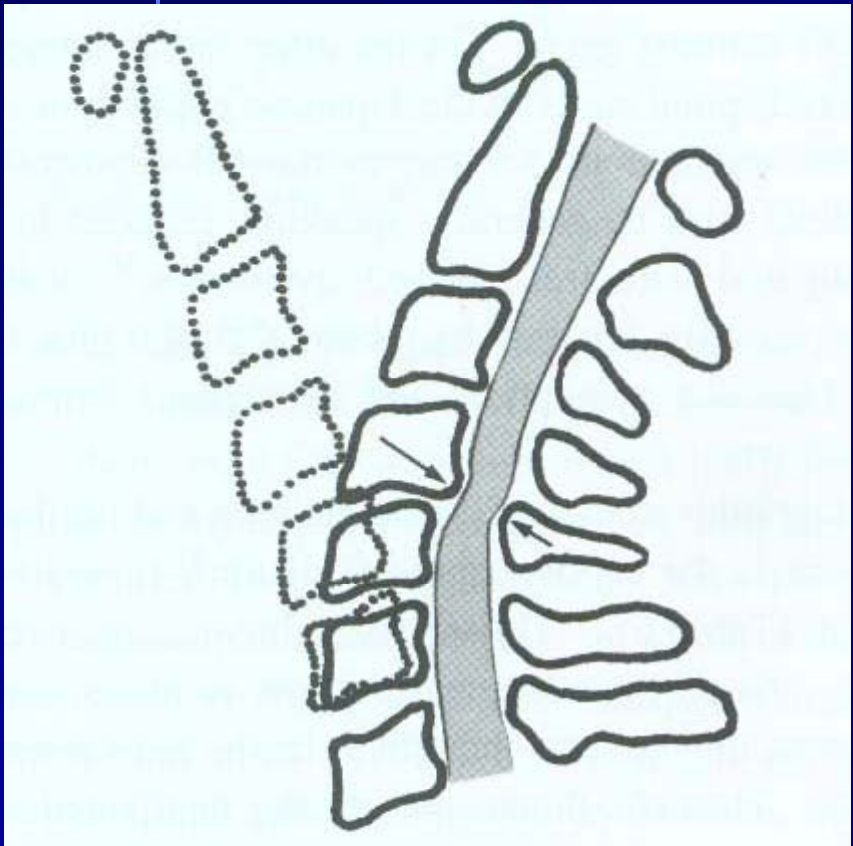
  ≤ 0.85 abnormal.

  - A canal diameter of 17 mm or greater at the mid vertebral body level is considered normal.
- < 10-13 mm are at risk for symptomatic spondylosis.

THE DIAMETER OF CERVICAL SPINAL CANAL

- C1 22.1
- C2 18.8
- C3 16.2
- C4 15.8
- C5 15.7
- C6 15.6
- C7 15.9

Pincer mechanism in extension



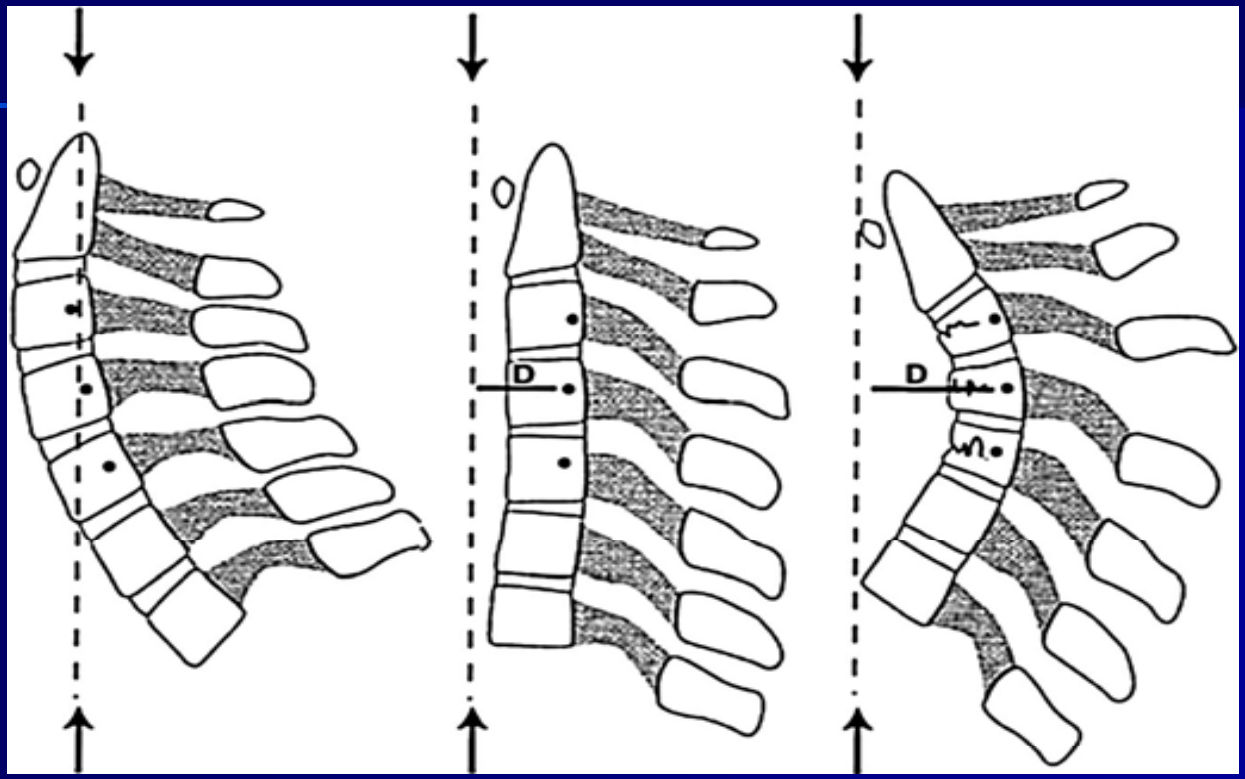
Pinching forces compromise

micro circulation ->

Ischemia in watershed area

Edema and cavitation.

Progression of cervical kyphosis, loss of lordosis



A, the nonpathological state, in which the dorsal vertebral body *height is less than the ventral vertebral body height, results in normal cervical lordosis.*

B, loss of the ventral disc interspace height, which occurs with the natural degenerative process, results in loss of lordosis. This causes elongation of the moment arm applied to the spine (D), leading to ventral vertebral body compression.

C, a further exaggeration of pathological kyphotic posture may then ensue,

CLINICAL PRESENTATION

- Symptoms
  - Neck stiffness (early complaint)
  - Leg weakness, stiffness
  - Gait abnormalities
  - Difficulty with fine motor movements and tasks with hands. “Clumsy myelopathic Hands”
  - Loss of bladder or bowel sphincter control
- Signs
  - Abnormal reflexes
  - Hyperactive DTR, clonus, spasticity, Babinski, Hoffman, inverted radial reflex,Lhermitte’s sign.

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- CLINICAL SYNDROMES:
  - Transverse lesion syndrome : End stage
    CST and STT, dorsal column
  - Motor system syndrome
  - Central cord syndrome
  - Brown-Sequard syndrome
  - Brachialgia and cord syndrome

Crandall P, Batzdorf U et al: Cervical spondylitic myelopathy. J Neurosurg 25:57-66,1966.

Japanese Orthopaedic Association Criteria for the Evaluation of Operative Results in Patients with Cervical Myelopathy*

I. Upper extremity function
Impossible to eat with either chopsticks or spoon (0 points)
Possible to eat with spoon, but not with chopsticks (1 point)
Possible to eat with chopsticks but inadequate (2 points)
Possible to eat with chopsticks but awkward (3 points)
Normal (4 points)
II. Lower extremity function
Impossible to walk (0 points)
Need cane or aid on flat ground (1 point)
Need cane or aid only on stairs (2 points)
Possible to walk without cane or aid, but slow (3 points)
Normal (4 points)
III. Sensory
Upper extremity
Apparent sensory loss (0 points)
Minimal sensory loss (1 point)
Normal (2 points)
Lower extremity
Apparent sensory loss (0 points)
Minimal sensory loss (1 point)
Normal (2 points)
Trunk
Apparent sensory loss (0 points)
Minimal sensory loss (1 point)
Normal (2 points)
IV. Bladder function
Complete retention (0 points)
Severe disturbance (1 point)
Inadequate evacuation of bladder
Straining
Dribbling of urine
Mild disturbance (2 points)
Urinary frequency
Urinary hesitancy
Normal (3 points)

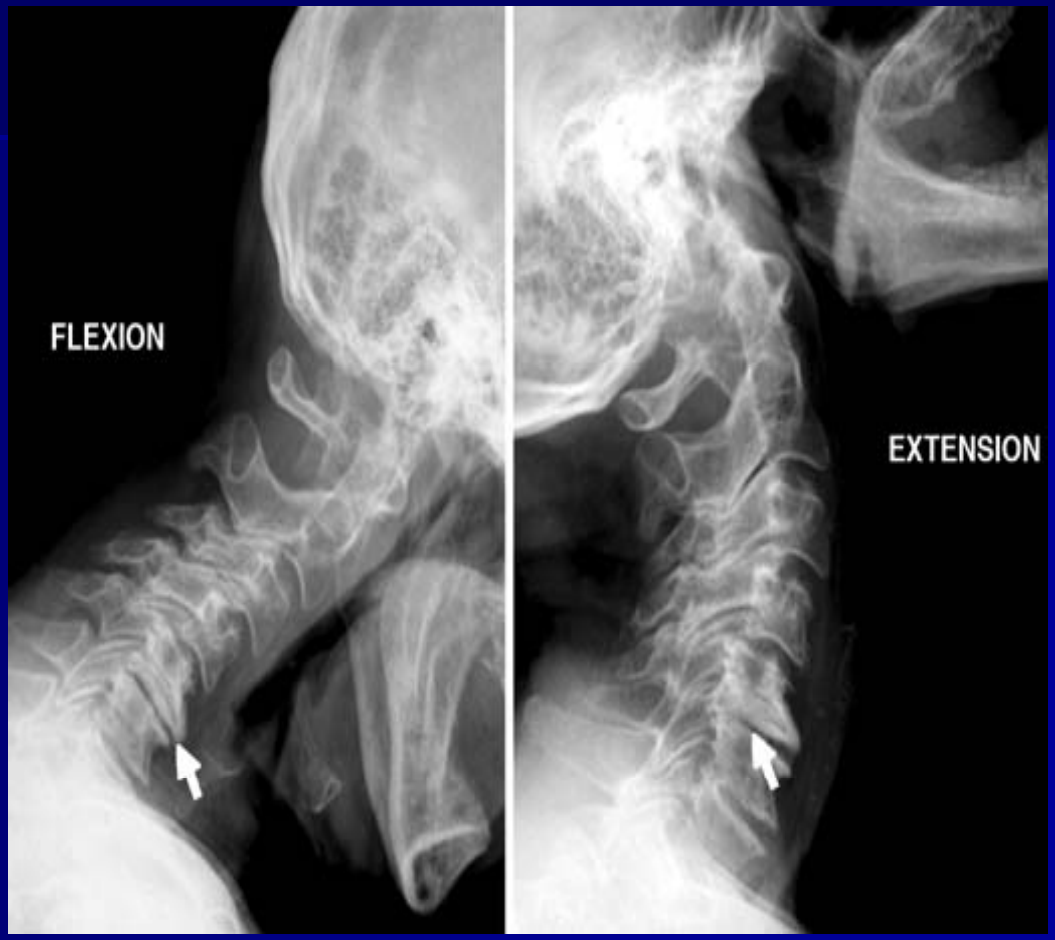
*Total normal score = 17 points.

Nurick Grades for the Severity of Myelopathy	
Grade	Findings
0	Signs or symptoms of root involvement but without evidence of spinal cord disease
1	Signs of spinal cord disease but no difficulty in walking
2	Slight difficulty in walking that does not prevent fulltime employment
3	Difficulty in walking that prevents full-time employment or the ability to do all housework
4	Able to walk only with someone else's help or with the aid of a frame
5	Chair bound or bedridden

DIAGNOSTIC RADIOLOGY

X-RAYS

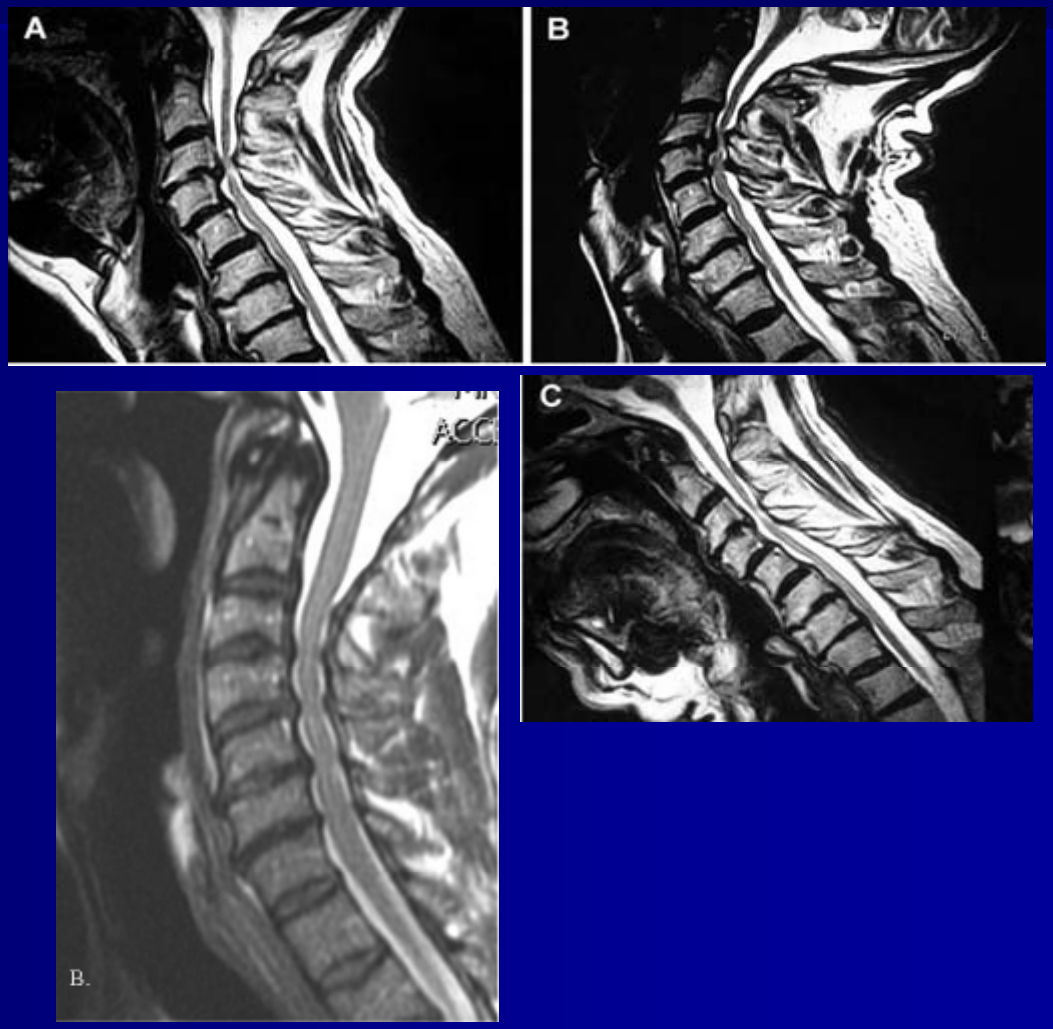
- Disc space narrowing / osteophytes, loss of lordosis, uncovertebral hypertrophy, canal diameter, Neural foramina
- Dynamic X ray : instability



DIAGNOSTIC RADIOLOGY

MRI: standard diagnostic test

Cord / SAS / Disc / Intrinsic tumors / Signal changes /Nerve roots/ Ligament /Soft tissue .



MRI SIGNAL CHANGES

- 280 Pts (1996 - 2005)
- Follow up of 108 Pts , 71 Pts MRI data available
- T2 WI → Edema, Myelomalacia, Gliosis, Inflammation
- T1 WI → cystic necrosis
- 3 level grading system

  Grade I HSI on T2 (1 disc level) no change on T1

  Grade II HSI on T2 (>1 disc level) no change on T1

  Grade III Hypo intensity on T1

Mitsuru Yagi et al: Long-Term surgical outcome and risk factors in patients with cervical myelopathy and a change in signal intensity of intramedullary spinal cord on magnetic resonance imaging; J Neursurg Spine 12/59-65/2010

Summary of intramedullary signal intensity change on MR images in 50 patients

		JOA Score (mean ± SD)		
Grade	No. of pts	Preop	1 yr Postop	At Final FU
I	10	9.2 ± 1.6	14.1 ± 1.9	13.9 ± 1.4
II	19	10.4 ± 1.1	14.4 ± 1.9	12.8 ± 1.4
III	21	8.1 ± 1.3	11.9 ± 1.1	11.0 ± 1.3

Mitsuru Yagi et al: Long-Term surgical outcome and risk factors in patients with cervical myelopathy and a change in signal intensity of intramedullary spinal cord on magnetic resonance imaging; J Neursurg Spine 12/59-65/2010

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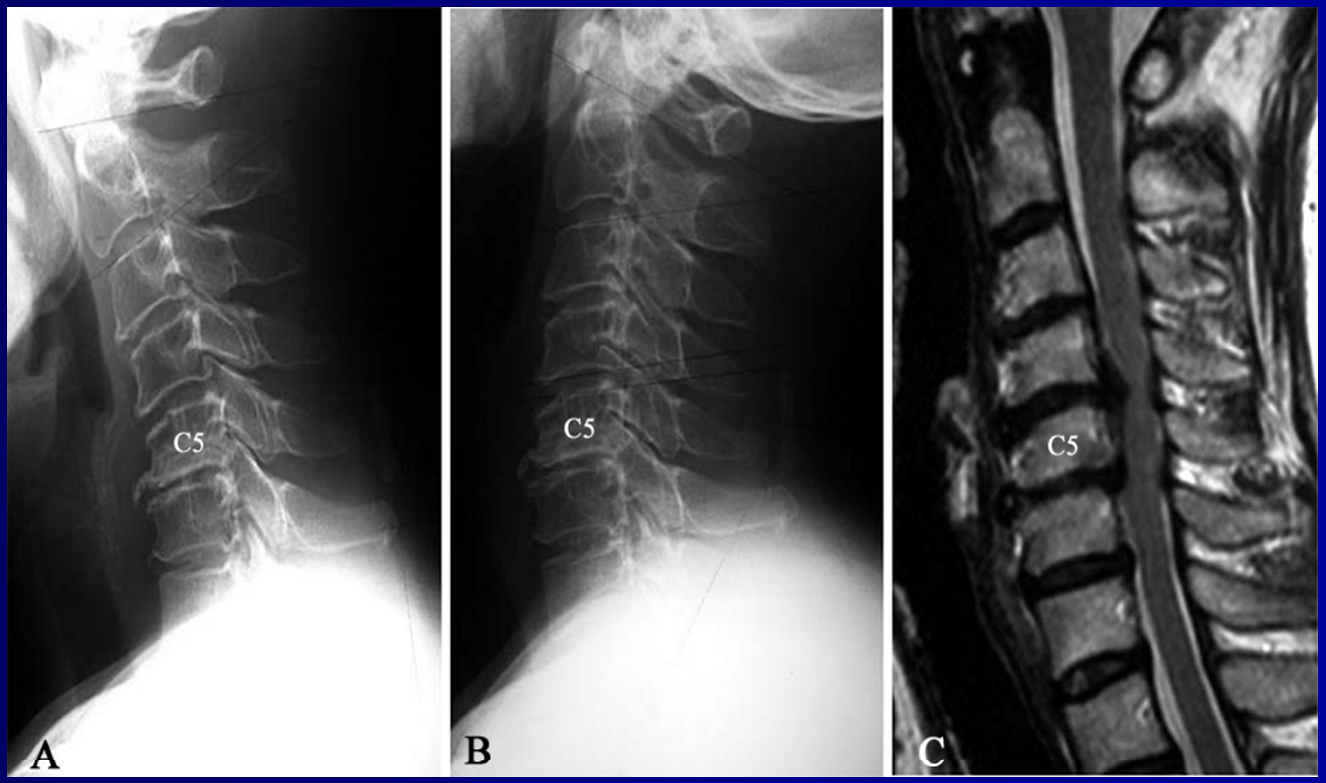
- NCCT : Size and shape of canal / osteophytic ridges / Kyphosis /OPLL
- CT myelography: Invasive / Used for who can not undergo MRI

- Useful to define bony anatomy and neural foramina / Excellent definition of herniated disc and Spondylotic ridges.

Eli M. Baron, M.D et al; CSM: A Brief review of its pathophysiology, clinical course , and diagnosis . Neurosurg /Vol 60/1/jan 2007 suppl

OPLL



TREATMENT

- NON – OPERATIVE
- OPERATIVE

Nonoperative Treatment of CSM

- Intermittent cervical immobilization in a soft collar.
- Anti-inflammatory medications.
- Bed rest.
- Active discouragement of high-risk activities.
- Avoidance of physical overloading.
  - Exposure to cold.
  - Movement on slippery surfaces.
  - Manipulation therapies.
  - Vigorous or prolonged flexion of the head.

Medical Therapy of Cervical Spondylosis

- Steroids - doubtful value

Physical Therapy

– Supervised isometric exercises do produce clinically significant improvement in pain.

– Cervical Traction therapy widely used, but studies are poor quality and flawed.

• Intermittent traction, 10-20 lbs, 15 minutes, 3 times per day

– Swezey, et al 1999: Retrospective study found that cervical traction provided symptomatic relief in 81% of patients.

Choosing the Operative Procedure

- Sagittal alignment
- Extent of disease
- Location of abnormality
- Previous operations

Indications for Operative Treatment of Cervical Myelopathy

- Progressive clinical myelopathy with evidence of spinal stenosis.
- Progression of a neurological deficit.
- The failure of neurological findings to improve with non-operative treatment (> 12 wks).

CLINICORADIOLOGICAL FACTORS INDICATING OPERATIVE TREATMENT

- Myelopathic hands/ Unsteady gait / Weakness / Spasticity / Bowel, bladder involvement.
- Midsagittal diameter < 13mm
- Vertebral olisthesis > 3.5 mm
- Pincer diameter (dynamic stenosis) < 12 mm
- MRI – signal changes (T2WI high signal intensity).

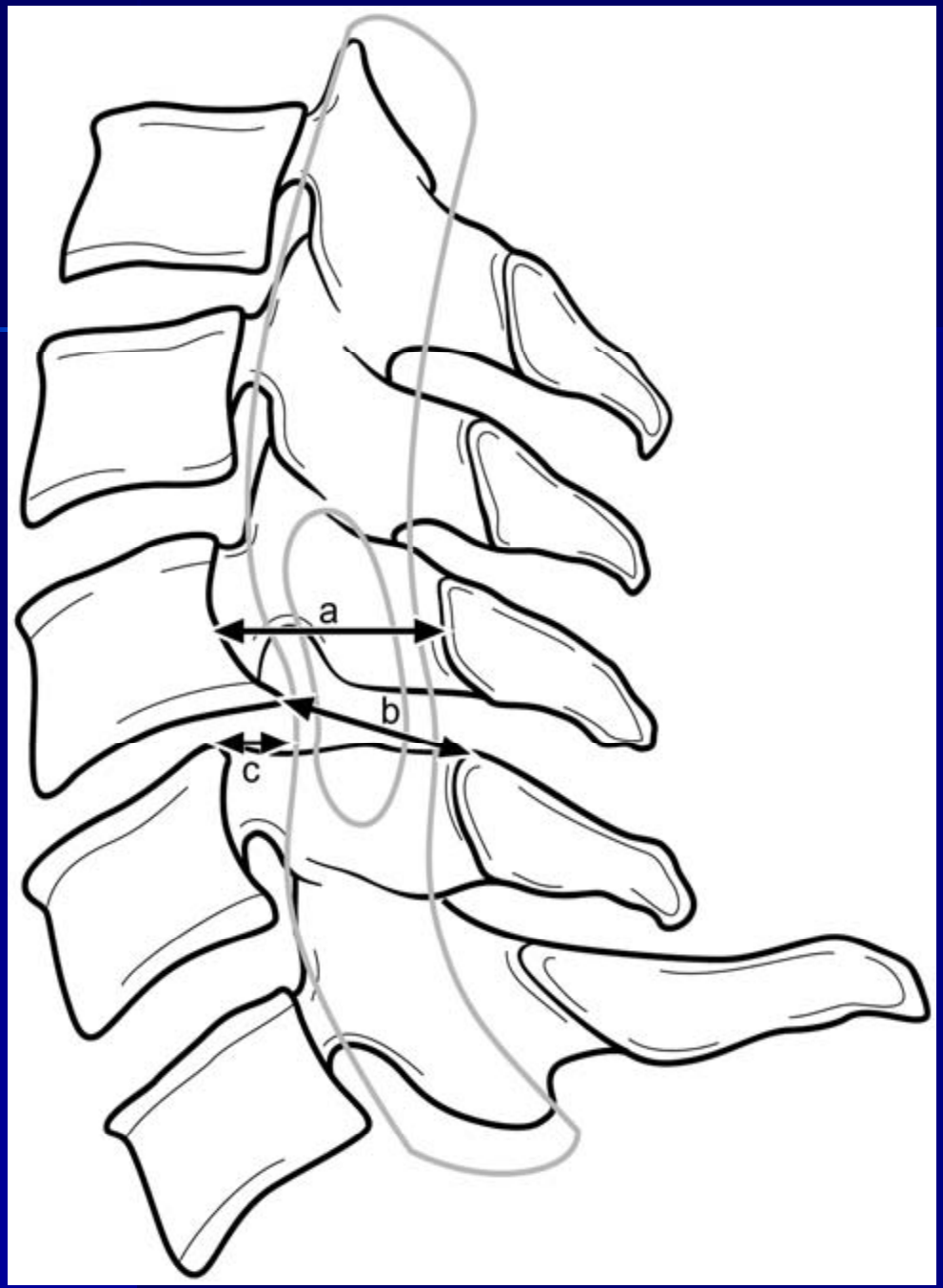


Illustration depicting the radiographic criteria used in the assessment of cervical stenosis and myelopathy.

a, The midsagittal diameter of the **spinal canal is measured as the distance from the middle of the dorsal surface of the vertebral body to the nearest point on the spinolaminar line. Patients in whom the osseous canal measures <13 mm are considered to be developmentally stenotic.**

b, A distance of <12 mm from **the posteroinferior corner of a vertebral body to the anterosuperior edge of the lamina of the immediately caudal vertebra with the neck in extension is suggestive of dynamic stenosis.**

c, Olisthesis of >3.5 mm **is a measure of excessive translation between the vertebral bodies.**

THE GOALS OF OPERATIVE TREATMENT

PRIMARY GOAL:

- To prevent deterioration
- Reverse the myelopathy
  - ❑ Decompressing the spinal cord
  - ❑ Stabilizing the spine
  - ❑ Secondarily improving cord perfusion

SECONDARY GOAL:

- Achieve successful fusion
- Prevent late deformity

Surgical Treatment of Cervical Spondylosis

Overview :

- ACDF
- ACCF
- Posterior cervical foraminotomy
- Cervical laminectomy and fusion
- Cervical laminoplasty
- Newer techniques : Multiple oblique corpectomy
  Endoscopic techniques

Operative Options for and Issues Related to Anterior Surgical Approaches to CSM

- ACDF

- Removal of disc/ posterior osteophytes
- End plates are completely removed
- Distraction of disc space results in indirect decompression of foramen
- Insertion of appropriate sized bone graft (2mm)

- Advantages

- Relative preservation of stability
- Low prevalence of graft extrusion

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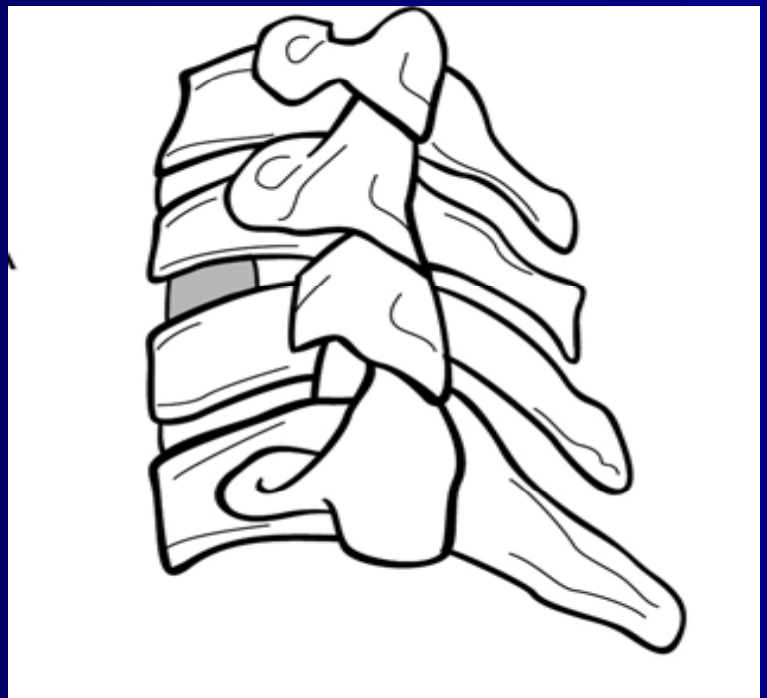
- Disadvantages
  - Less exposure
  - Risk of incomplete decompression
  - Accelerated disease at adjacent level
  - Not recommended for congenital Canal stenosis



COMPLICATIONS OF ACDF

- Donor site morbidity
- Graft extrusion
- Collapse
- Non union
- Pseudarthrosis

  If plating is used
- Screw breakage
- Screw migration
- Soft- tissue injury

CERVICAL CORPECTOMY

- Complete removal of vertebral body, adjacent disc
- Removal of large osteophytes
- Removal of PLL
- Central decompression of 15mm at C3, 19mm at C6 provides safety margin of 5mm to the medial border of foramen transversarium.
- Intraop indicators of adequate decompression
  - 15-19 mm wide trough
  - Visual confirmation of spinal cord decompression

Fusion Techniques

- Cloward technique - Uses cylindrical bone dowel from iliac crest
  - Circular hole of 10 x14mm hole drilled
  - Bone graft sits on soft cancellous bone above and below

Disadvantages:

- Fusion is less stable
- No distraction
- Risk of collapse.

Melvin D. Law et al: Evaluation and Management of CSM; J Bone Joint Surg / 76:1420-1433/1994

contd

- Smith Robinson Technique: most commonly used
  - Uses horseshoe – shaped graft (height 6-10mm)
  - Ends plate prepared
  - 2mm posterior shelf created in the superior aspect of inferior VB to prevent migration
- Advantages:
  - Provides distraction → Opens the foramina
  - Provides most stable construct
  - Reduces invagination of ligamentum flavum
- Disadvantages:
  - Difficult to decompress root directly
  - Limited visibility
  - Difficult to remove osteophytes

Melvin D.Law et al : Evaluation and Management of CSM; J Bone Joint Surg / 76:1420-1433/1994

ROLE OF ANTERIOR PLATING

- Appropriate plate length is selected
- Distance of 5mm between the ends of plate and adjacent disc to be maintained
- Screw should be placed in a dense bone tissue
- Use locking mechanism to resist screw pullout
  - Advantages:
  - Improves the rate of fusion
  - Reduces length of postop immobilization
  - Does not add substantially to duration of surgery
  - Less postop kyphosis
  - Decreases the prevalence of graft related complications

contd…

- Disadvantages:
  - Screw breakage
  - Migration
  - Soft tissue injury
  - Dysphagia
  - Plate fatigue

Raj D. Rao et al : Operative treatment of CSM : J Bone Joint Surg /88 /1619-1640 /2006

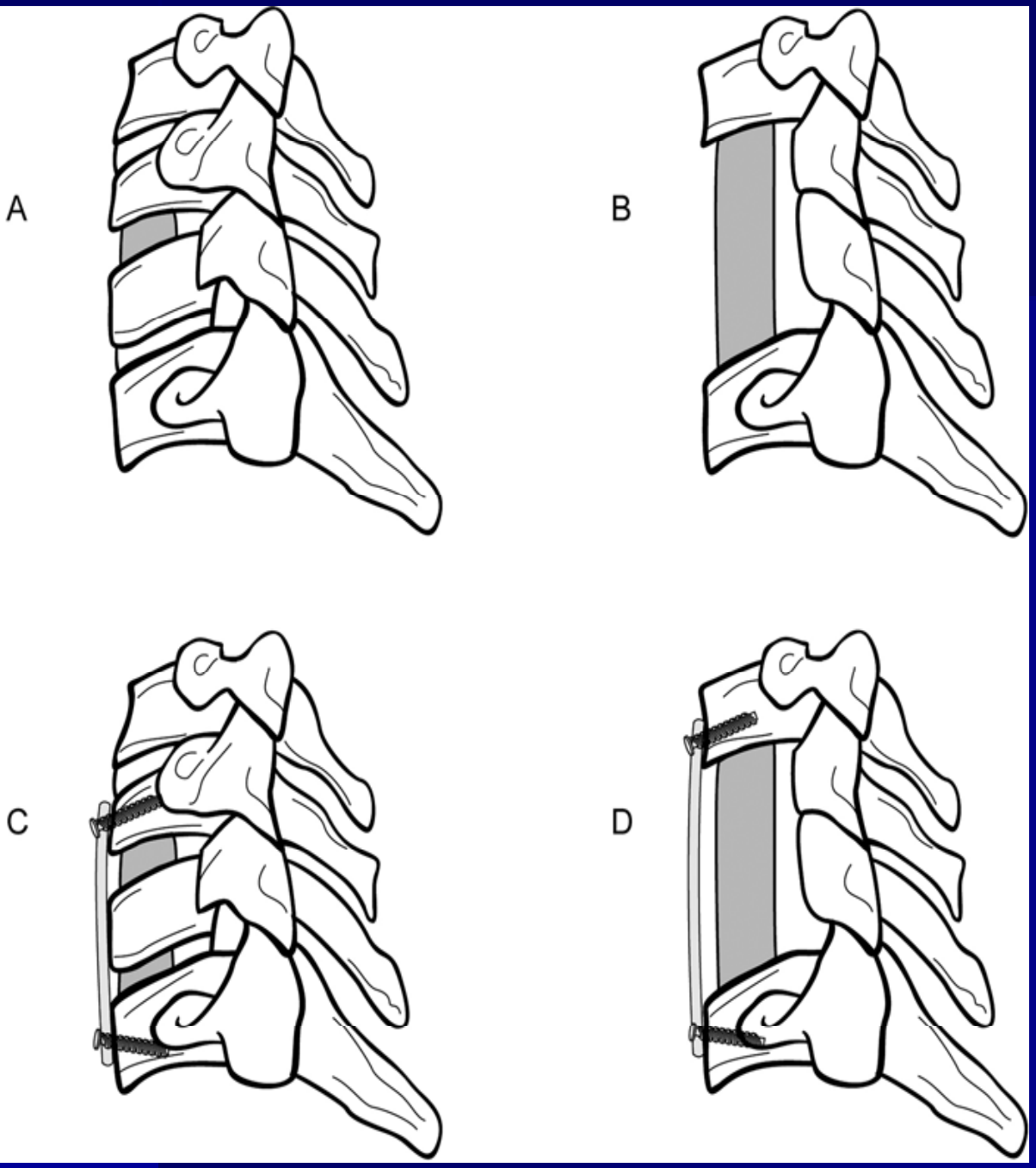


Illustration depicting common anterior procedures used in cervical myelopathy.
A, Anterior cervical **discectomy and insertion of a bone spacer for fusion.**
B, Anterior cervical corpectomy and insertion **of a bone strut graft.**
C, Anterior cervical discectomy followed by insertion of a bone spacer for fusion **and anterior plating.** ***D, Anterior cervical corpectomy, strut graft insertion, and anterior plating.***

Figs. 3-F and 3-G Radiographs made after the patient was managed with corpectomy of the C5 and C6 vertebral bodies, strut-grafting with use of a titanium mesh cage packed with local autogenous bone, and the application of an anterior cervical plate from C4 to C7.

MULTIPLE OBLIQUE CORPECTOMY

- Prospective study 268 pts.
- 527 levels - decompressed C2-C3 – 15, C3–C4 - 69, C4-C5 – 138, C6-C7 – 99, C7-T1-4
- MOC done 1 level – 108, 2 level- 87, 3 level-57, 4 level- 18, 5 level -4
- OT time -129 min (92-183 min).
- Blood loss – 68ml

Group (m JOA range)	Preop No. of Patients (%)	Postop No. of Patients (%)
I (0–4)	0	9 (3.4)
II (5–9)	178 (66.4)	20 (7.5)
III (10–13)	90 (33.6)	98 (36.6)
IV (14–17)	0	141 (52.6)

Salvatore Chibbaro et al : Multilevel oblique corpectomy without fusion in managing CSM : Long-term outcome and stability evaluation in 268 pts. J. Neursurg: Spine/vol10 may2009

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- Indication: Acquired multi level CSM (anterior)
- Contraindication: kyphosis, posterior compression
- Advantages: Multi level surgery ,complete decompression anteriorly , no need for instrumentation / fusion, avoiding the scar of previous anterior surgery
- Disadvantages: Bilateral foramen decompression can not be achieved.
- Complications: Horners, XI N injury, VA injury

Salvatore Chibbaro et al : Multilevel oblique corpectomy without fusion in managing CSM : Long-term outcome and stability evaluation in 268 pts. J. Neursurg: Spine/vol10 may2009

Evidentiary summary of studies examining laminoplasty or laminectomy with arthrodesis as compared to anterior surgery for CSM*

Authors & year	Description of study	Comments
➢ Lee et al 2007	348 patients who underwent ACDF (n = 121) or ACCF (n = 173) over 4-yr period. FU over 2 yrs in 310 patients. Patients were prospectively interviewed at 1, 2, 6, 12, & 24 mos regarding the presence & subjective severity of dysphagia using the dysphagia grading system defined by Bazaz et al.† Proportion analysis (chi-square or Fisher exact test), prevalence ratios, & 95% CIs were used to compare the prevalence of dysphagia w/ age, sex, type of surgery (e.g., discectomy vs corpectomy, primary vs revision), use of instrumentation, number & location of surgical levels.	Overall prevalence for dysphagia at 1, 2, 6, 12, & 24 months was 54.0, 33.6, 18.6, 15.2, & 13.6%, respectively. The prevalence of dysphagia was found to be significantly higher in women, after revision surgery, & with > 2-level surgery. N o statistical difference in dysphagia rates was seen between ACDF & ACCF. This study was graded Class III due to unbalanced allocation of study groups since the ACCF group had a greater proportion of surgeries >3 levels ($p < 0.01$) & the use of fixation was surgeon dependent.
➢ Nirala et al 2004	201 patients who underwent multilevel anterior cervical decompression & fusion w/o fixation using autograft. ACDF (n = 69) or ACCF (n = 132) over a 10-yr period. Radiological outcomes in followed using dynamic radiographs. Patients wore a hard cervical collar for 3 mos. Outcomes using Odom's criteria.	ACDF had 69.6% fusion rate vs ACCF 93.9% ($p = 0.0001$). Within subgroups, 2-level ACDF had 86.7% fusion vs 1-level ACCF (96.3%). 3-level ACDF had 57.6% vs 2-level ACCF (92.4%). 4-level ACDF had 50% fusion vs 3-level ACCF (91.7%). O dom's criteria (good/excellent) similar in both groups. More graft dislodgements in ACCF (3.8%) vs ACDF (1.4%). Class III due to biased allocation (more Pott's disease in ACCF) & unblinded radiographic assessment

Authors & year	Description of study	Comments
➢ Swank et al 1997	Allograft tricortical iliac crest reconstruction & anterior cervical plating were studied in 64 patients (38 ACDF & 26 ACCF). The average FU was 39 mos. Hard cervical collar for 4–6 wks. Outcome assessed w/ plain radiographs. Clinical outcomes were subjective.	Non-union: ACDF 42% vs ACCF 31%. 2-level ACDF 36% vs 1-level ACCF 10%. 3 level ACDF 54% vs 2 level ACCF 44%. C lass III due to biased allocation of groups (constrained plates had a higher fusion rate than dynamic; more of dynamic plates in ACDF group; retrospective nature also leads to bias; no blinding of radiographic assessors). Clinical outcomes subjective.
➢ Wang et al 2001	Anterior decompression/fusion over 2 levels w/ iliac crest & plate fixation in 52 patients (20 ACCF & 32 ACDF). Average FU was 3.6 yrs. Hard cervical collar for 6–8 wks. Outcome w/ dynamic radiographs & Odom's criteria.	Fusion rates were not statistically significant ($p = 0.385$). The clinical results of the surgeries were similar between the groups based on Odom's criteria. The addition of cervical plates to either 2-level ACDF or single-level ACCF yielded similar fusion & complication rates. 1 nonunion in ACCF group. No difference in graft collapse (1 mm in both groups) or kyphosis (1° in both groups) Odom's outcomes similar. Class III due to biased allocation & unblinded outcome assessors

Posterior Surgery in CSM

- Laminectomy

  - Useful alternative for multiple level D/C
  - Elderly pts
  - All levels of stenosis should be included
  - Inclusion of C2 and T1 --- ↑ instability
  - Adequacy of D/C to be confirmed

INDICATIONS FOR LAMINECTOMY

- Single or multilevel disease
- Congenital stenosis
- To access intradural pathology
- Operative factors – decreasing risk
- Combined supplementary procedure in anterior and posterior approach
- Need to perform posterior instrumentation.

CONTRAINDICATIONS FOR LAMINECTOMY

- Neutral or kyphotic spine
- Children and young adults
- Loss of anterior column support from tumor, trauma, infection
- <u>Complications:</u>
  - Neurological worsening
  - Kyphotic deformity
  - Injuries
  - Blood loss

Youmans neurological surg 5th edition

LAMINECTOMY

- For multilevel → identify C2 spinous process
- Use the drill inner cortical bone thinned out
- Use 1mm Kerrison
- Transect lamina / lig flavum
- Remove one level above and one below
- Width should be to the lateral aspect of Dura
- Facet to be preserved
- Confirm the adequacy

INSTRUMENTATION FOLLOWING LAMINECTOMY

- Provides immediate stability
- Obviates dynamic factors contributing to cord compression

Options:

- Interfacet wiring
- Facet wiring
- Lateral mass plates

CERVICAL LAMINECTOMY-OUTCOME

- 50 patients over a 4 year period
- All presented with symptomatic cervical myelopathy
  - 33 male, 17 female
  - Clinical assessment Nurick grading
- All patients underwent multisegment cervical laminectomy with lateral mass fixation
- Patients followed up at 6 weeks, 3 months, 6 months, and one year

Lali H.S.Sekhon et al : Posterior cervical decompression and fusion for circumferential spondylotic cervical stenosis : Review of 50 consecutive cases; J Clinical Neursurg/ 23-*36 / 2006*

Table 1
Patient demographics n=50,(mean ± s.d)

Male	**33**
Female	17
Average age (years)	63±12.4
Diabetes	12%
Smoker	14%
Clinical myelopathy	95%
Cord signal change on sagittal T2W MRI scan	75%
Preoperative Nurick grade	1.93±2.5
Preoperative Oswestry Neck Disability Score	25.7±3.6
Preoperative circumferential cord compression	100%
Preoperative C2/C7 angle	13.4· ± 14.3·

Lali H.S.Sekhon et al: Posterior cervical decompression and fusion for circumferential spodylotic cervical stenosis : Review of 50 consecutive cases; J Clinical Neursurg/ 23-36 / 2006

Table 2:
Results summary (mean±s.d)

Total levels instrumented	**138**
Average levels instrumented	2.88±1.00
Total number of screws placed	376
Postoperative Nurick grade	1.21± 1.2
Postoperative circumferential cord compression	0%
Postoperative Oswestry Neck Disability Score	1.66 ± 7.1
Worsening of preoperative deformity with screw pullout	4%
Reoperation?	2%
Adjacent segments requiring surgery	2%
Range of follow-up (months)	12-50
Average follow-up (months)	30.1 ± 9.03
Postoperative C2/C7 angle	13.4º ± 14.3º

Lali H.S.Sekhon : Posterior cervical decompression and fusion for circumferential spodylotic cervical stenosis : Review of 50 consecutive cases; J Clinical Neursurg/ 23-*36 / 2006*

LAMINOPLASTY

- Hirabayashi (1983)
- Several modifications
- Increases the effective diameter (C3-C7)
- Retains the covering of posterior laminar bone
- Minimizes instability
- Limits Dural constriction by epidural scar
- Obviates the need for fusion

TYPES OF LAMINOPLASTY

- Single door laminoplasty
- Single door laminoplasty with use of bone graft
- Single door laminoplasty with use of miniplates and screws
- Double door laminoplasty

Raj D. Rao et al : Operative treatment of CSM : J Bone Joint Surg /88 /1619-1640 /2006

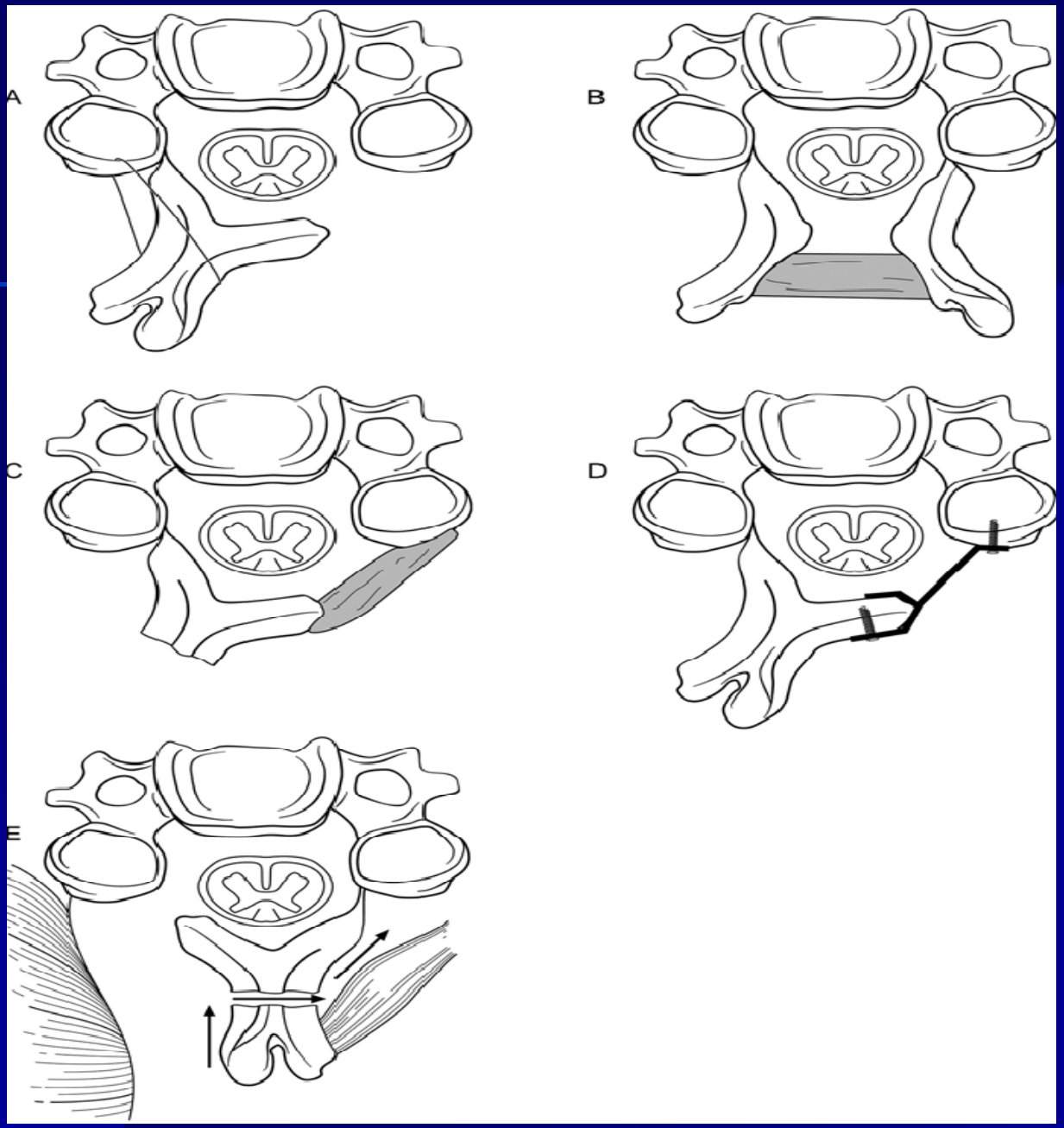
INDICATIONS FOR LAMINOPLASTY

- OPLL over multiple levels
- Congenital canal stenosis
- Multilevel cervical spondylosis
- Posterior compression from ligamentous hypertrophy
- As part of a staged anterior and posterior canal expanding procedure

D. Agarwal et al: Efficacy and results of expansive laminoplasty in patients with severe cervical myelopathy due to cervical canal stenosis ; Neurology india/ march 2004/vol52

CONTRAINDICATIONS FOR LAMINOPLASTY

- Isolated radiculopathy
- Loss of anterior column support resulting from tumor, trauma, or infection
- Focal anterior compression
- Absolute kyphosis



Illustrations depicting common techniques used for cervical laminoplasty.
A, Single-door laminoplasty. **Sutures are placed through the spinous process to the articular capsule on the hinge side to hold the lamina elevated.**
B, Double-door laminoplasty. The spinous process is osteotomized **in the midline, and the two halves are pried open on laterally based hinges. Structural bone graft or a spacer fills the defect between the split spinous processes and prevents closure of the laminoplasty doors.**
C, Single-door laminoplasty with use of bone graft or spacer to **prop the door open.**
D, Single-door laminoplasty with use of a laminoplasty plate.
E, Unilateral **muscle-stripping approach to maintain the integrity of soft tissues on the contralateral side. The laminae on one side are exposed with preservation of the nuchal, supraspinous and interspinous ligaments. The spinous processes are osteotomized at their bases and are reflected to the intact side, allowing exposure of the posterior laminar bone. The arrows indicate the plane of the osteotomy and exposure.**

Radiograph made after the patient underwent a laminoplasty with use of mini-plates.

LAMINOPLASTY OUTCOME (AIIMS)

- 24 Pts over 4 yrs
- Stiffness gait, disturbance 100%
- Neck pain 45%
- Bladder disturbance 45%
- Operating time 187min (90 - 360 min)
- Blood loss 716 ml (100-1400 ml)
- Complications : CSF leak (1), redo surgery (1)

D. Agarwal et al: Efficacy and results of expansive laminoplasty in patients with severe cervical myelopathy due to cervical canal stenosis ; Neurology india/ march 2004/vol52

IMPROVEMENT IN NURICK'S GRADE

Nurick's grade	Preoperative (no. of pts)	Postoperative (no. of pts)
GRADE 1	0	1
GRADE 2	0	2
GRADE 3	4	14
GRADE 4	15	6
GRADE 5	5	1

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ADVANTAGES OF CERVICAL LAMINOPLASTY COMPARED WITH LAMINECTOMY

- Reconstruction and preservation of dorsal stabilizing structures
- Reduces the risk of postlaminectomy kyphosis
- Limits range of motion of cervical spine
- Reduces formation of postlaminectomy membrane
- Low risk of adjacent- level disease.

Evidentiary summary of studies examining laminoplasty or laminectomy with arthrodesis as compared to anterior surgery for CSM*

Authors & yr	Desription	Results	Conclusions
Wada et al 2001	Subtotal corpectomy compared to ODL in different yrs for CSM. Corpectomy (Group A, n = 23, 2.5 levels, 15-yr FU, average age 53 yrs). Laminoplasty (n = 24, 12-yr FU, average age 56 yrs). JOA used to follow along w/ evaluation of ROM & axial pain.	JOA scores similar in Group A (7.9 to 13.4) & Group B (7.4 to 12.2). Incidence of moderate /severe axial pain greater in laminoplasty (40 vs 15%, $p < 0.05$). ROM only 29% in Group B vs Group A (49%). Higher rates of C-5 palsy & kyphosis w/ laminoplasty.	Both approaches clinically effective; however, increased pain & decreased ROM w/ laminoplasty along w/ an increase in C-5 palsy; corpectomy carries risk of pseudoarthrosis.
Yonenobu et al 1992	100 patients w/ CSM of which 83 had 2-yr FU; 41 patients underwent ACF (1976-83) while 42 underwent laminoplasty ("French window").	JOA improved in both groups (44% in laminoplasty & 55% in ACF, not significant). In subset w/ canal < 12 mm, outcomes were 55% in laminoplasty & 59% in ACF. Complication rate was graft related & 29% in ACF. Laminoplasty had 7% C-5 radiculopathy.	Groups compared over different time periods (Class III). Results show similar clinical improvement but higher complication rates in ACF.

Edwards et al 2002	**38 patients CSM studied retrospective w/ matched cohorts Group A (13 corpectomy, <1996) & Group B (25 laminoplasty of which 13 chosen, >1996). ODL in 3 patients & T-saw in 10. FU >40 mos.**	**Nurick improved 1.9 to 1.0 in Group A & 2.3 to 0.8 in Group B (not significant). Pain improved to 0.5 in Group A & 1.0 in Group B (not significant); ROM reduced from 37 to 16° in Group A & 39° to 24° in Group B (not significant) w/ pseudoarthrosis; Group A had higher complication (9/1).**	**Unclear matching technique & different periods. Both corpectomy & laminoplasty reliable. Laminoplasty appears to have fewer complications.**
Sakaura et al 2005	43 pts w/ cervical disc displacement & myelopathy. Group A (ACF, n = 15/21, age 44 yrs, 1984-7). Group B (Laminoplasty, n = 18/22, age 51, 1987-94). Average FU was 15 yrs in Group A/10 yrs Group B.	Recovery rate of JOA was 71% in Group A & 70% in Group B. ROM maintained 65% in Group A & 64% in Group B. Similar late deterioration.	Anterior approach associated w/ higher reoperation rate due to pseudarthrosis but outcomes similar.
Hasegawa et al 2002	90 patients w/ CSM. Age > 70 yrs (n = 40, 27 mos FU) & < 60 (n = 50, 36-mo FU). Anterior fusion (n = 35), laminoplasty (n = 29), & laminectomy (n = 26). Comparison between technique & age group (6 groups).	No significant differences in final JOA score between groups. No significant difference in preop JOA scores between groups. Complication rate greater in older patients (15%) vs 8% in younger patients.	Multiple subgroups in series. However, age does not appear to be negative risk factor except for complication. Also, technique does not appear to change control of myelopathy.

Consequences and Complications Following Operative Treatment

- Post operative neck pain and C5 radiculopathy
  - Incidence 25 – 60% (Hosono et al)
  - Laminoplasty (60% of 203) Vs Laminectomy (27% of 115) Vs anterior decompression (19% of 209) *Yonenobu et al. (1992)*
  - Soft tissue injury
  - Facet arthrosis
  - Preop stiffness
  - Old age
  - Prolonged postop immobilization

Wada E et al . Subtotal corpectomy versus laminectomy for multilevel CSM : a long term follow –up study over 10 yrs. Spine./ 26/1443-8/2001

Consequences and Complications Following Operative Treatment

- Postop stiffness :
  - Interlaminar or facet fusion on hinge side

- Postop stability:
  - Incidence of instability 21% for laminectomy
  - Relatively rare for laminoplasty

- Adjacent segment degeneration
  - C5 – C6 and C6 – C7 most vulnerable
  - 3% each yr (Hilibrand et al)

NEUROLOGICAL COMPLICATIONS

- Radiculopathy
- Permanent myelopathy
- Recurrent laryngeal nerve palsy
- Horners syndrome
- Dysphagia
- Esophageal injuries
- Vertebral artery injuries
- Injuries to trachea

Overview

- *Surgery indicated for most pts with clinically evident CSM*
- *Risk benefit ratio to be assessed in pts with early disease*
- *Main objective of Sx is to decompress adequately and to maintain stability*
- *Type of Sx depends upon location ,extent of pathology and also the alignment , dimensions of spinal cord.*
- *Improvement being higher in young pts, early disease.*


THANK YOU