THE AGING SPINE

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- Understand pathology and natural history
- Obtain pertinent history
- Perform insightful physical exam
- Obtain timely imaging study

- Include psycho-social evaluation
- Counsel regarding risk/benefit ratio
- Skillfully perform technical procedure
- Develop post-operative individual rehabilitation program

“Choose your specialist and you choose your disease”
Anonymous

- Chiropractor
- Neurosurgeon
- Orthopaedic Surgeon

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Decision Making Process

• Systematic
• Knowledgeable
• Literature-supported

Critical Decision of Initial Evaluation

• Mechanical vs. Non-mechanical
• Neuro Intact vs. Deficit
• Local, Referred, or Radicular Pain
• Psychosocial Status

Cervical Spondylosis

Disc degeneration, mechanical breakdown, symptoms due to instability, later possible osteophytic outgrowths

Disc Herniation

Annular protrusion, extrusion of nuclear material. Symptoms due to tension on dura, root, or cord.

Radiculopathy

• Signs & symptoms due to root compression
• Typically postero-lateral disc herniation or spondylotic foraminal encroachment

Myelopathy

• Signs & symptoms attributable to spinal cord compressive pathology
• Typically slow spondylotic narrowing, osteophytes, on occasion acute disc extrusion
Syndromes of Cervical Disc Degeneration

- Axial/mechanical neck pain
- Radiculopathy
- Myelopathy
- Other syndromes
  - Vertebral basilar insufficiency
  - Dysphagia

“We understand the relationship of structural change, clinical pain, and dysfunction best in the presence of traditional neural compressive lesions of nerve root or spinal cord, but understand it least in the presence pain alone, where the degree of degenerative anatomic change does not correlate well with degree of dysfunction.”

(Lipson, Seminars in Spine Surgery, 1989)
Cervical Spondylitic Myelopathy

- Bilateral numbness and tingling
- Ataxic gait disturbance
- Bowel and bladder dysfunction
- Quadriparesis

Physical Exam - Signs

- Lhermite’s Sign – compression and flexion, electric shock sensation
- DTR’s – Hyperreflexia
- Inverted radial reflex
- Hoffman’s sign
- Generalized weakness
- Ataxic gait
Differential Diagnosis
Myelopathy

1. Tumors or infection or cord or canal
2. Motor neuron disease
3. Disseminated or multiple sclerosis
4. Subacute combined degeneration
5. Syringomyelia

6. Vertebrobasilar ischemia
7. Arnold Chiari malformation
8. Peripheral neuropathies
9. Cerebral or cerebellar disease
10. Guillian-Barre syndrome

Acute Radiculopathy

- Natural History
- Initial Non-operative

Symptoms – Cervical Spondylosis

- Neck pain
- Also often referred
  - Interscapular, shoulder, arm pain, or suboccipital headaches
- Bizarre type – blurring of vision, tinnitus, or dysphasia

Spondylosis

- Altered disc anatomy (central to process)
- Osteophytes around disc, neurocentral joints and facets
- Ligamentous thickening
- Instability and subluxation
- Disc herniation

Cervical Spondylosis without Radicular Pain or Myelopathy

- Pain in neck, shoulder and headaches
- Compression test +
- Most often at C5/6
- EMG’s usually normal in UE, may show paraspinal changes
- Pain is from the degenerative disc and degenerative changes in facet and uncovertebral joints
Non-operative Program

• Primary goal – functional activity
• Appropriate diagnostic studies
• Avoid unnecessary surgery
• Cost-effective

Conservative Treatment

• Rest
• Immobilization (collar or brace)
• Traction
• Physical therapy
• Medication

Neck Pain

Natural History Neck Pain:
A Long-Term Follow-Up of 205 Patients
(Gore et al, Spine 1987)

Purpose: To identify prognostic factors for patients with neck pain
Natural History (Gore et al.)

- All patients had neck pain with no history of surgery, no neurologic deficit, no malignancy, no R.A., no fracture/dislocations
- All initial plain films and follow up films and interview
- 10-25 years followup

Natural History (Gore et al.)

- 79% had decreased pain
- 43% pain-free
- 22% no relief

ACDF for Severe Cervical Degeneration

Natural History (Gore et al.)

- Only initial severe pain was a useful predictor of unsatisfactory outcome
- No other clinical features of value!


Dominant Neck Pain – Non-operative

- Neck and/or radicular pain
- 45% satisfactory long-term results non-operatively
- 55% persistent significant symptoms. Of these, 23% could not return to their occupations

ACDF for Severe Cervical Degeneration
"It does not appear that cervical disc degeneration is a brief, self-limiting disorder, but rather a chronic disease, productive of significant pain and incapacity over an extended period of time."

Rothman, The Spine, 1992

The Neurological Manifestations of Cervical Spondylosis
- Brain WR, Northfield D, Wilkinson M. Brain 1952; 75: 197-225

Cervical Spondylotic Myelopathy

Cervical Myelopathy: A Complication of Cervical Spondylosis
- Clarke E, Robinson PK Brain 1956; 79: 483-510
Natural History

- 75% Episodic worsening
- 20% Steady, slow progressing
- 5% Rapid development

Natural History and Prognosis of Cervical Spondylosis

Lees F, Turner JWA
BMJ 1963; 2: 1607-10

- Myelopathy rarely developed in those with spondylosis if not present at time of initial consult.
- Stepwise progression

The Natural History and the Results of Surgical Treatment of the Spinal Cord Disorder Associated with Cervical Spondylosis

Nurick S
Brain 1972; 95: 101-8

- Disability established early
- Classified by gait

Myelopathy Due to Cervical Spondylosis Treated by Collar Immobilization

Roberts AH
Neurology 1966; 16: 951-9

- 24 patients – 6.5 years
- 113, 113, 113
- Motor symptoms tended to be more progressive

Pathophysiology/CSM

- Cord compression with distortion
- Ischemia – anterior spinal flow
- Atoplasmic flow diminution
- Demyelization of the white matter in both ascending and descending traits

Central Cord Syndrome

- Classic pre-existing stenosis
- Extension force
- Contusion / hematoma central area of cord
- Pyraminal fibers more central after they cross medulla
Syndrome of Acute Central Cervical Spinal Cord Injury; with Special Reference to the Mechanisms Involved in Hyperextension Injuries of Cervical Spine

- Schneider RC, Cherry G, Pantek H
J Neurosurg 1954; 11: 546-77

Size of Canal Correlates With Neurologic Deficit

Large – No Cord Injury
Medium – Incomplete
Small – Complete

Cervical Sagittal Spinal Canal Size in Spine Injuries
- Eismont F, Clifford S, et al
Spine 1984; 9: 663-6

“Developmental narrowing of the cervical canal in a stable spine does not appear to predispose an individual to permanent catastrophic neurologic injury and therefore should not preclude any athlete from participating in contact sports”

- Torg JS, Naranja RJ Jr, et al
JBJS-A 1996; 78: 1308-14

Asymptomatic MRI

- Abnormality 19% of total
- 28% ≥ 40 years old

40 y.o. - 5% HNP
3% “bulge”
20% stenosis foraminal
- Disc degenerated at 1 or more level - 60%

- Boden SD, McCowin PR, Davis DO, et al
JBJS-A 1990; 72: 1178-84

Asymptomatic MRI

- 497 patients
- Degeneration increases with age
- “…demonstrable compression of the spinal cord was observed in 7.6% of subjects, mostly over 50 years of age.”

MRI of cervical intervertebral discs in asymptomatic subjects
JBJS – B 1998; 80: 19-24

Asymptomatic MRI

- 100 patients
- Disc Protrusion
  - 20% of 45 – 54 year olds
  - 57% of ≥ 64 year olds
- Cord Impingement
  - 16% < 64
  - 26% ≥ 64
- Cord Compression
  - 7 of 100

Asymptomatic Degenerative Disk Disease and Spondylosis of the Cervical Spine: MR Imaging.
- Teresi L, Lufkin R, et al
Radiology 1987: 83-8
Significance of CSF Area Measurements in Cervical Spondylitic Myelopathy
Golash A, Birchall D, Laitt RD, Jackson A
• 20 CSM, 20 spondylosis, 10 normal
• Cross sectional area – CSA, cord, canal and CSF
• Subjective compression on sagittal images was an insensitive indicator of myelopathy
• All 3 CSA decreases in Group A
• CSF-CSA – independent prognosticator of the presence of clinical myelopathy (< 0.02)
• Decrease CSF < 0.7 cm² – 90% clinical myelopathy

Factors Predicting Motor Recovery and Functional Outcome After Traumatic Central Cord Syndrome: A Long-term Follow-up
Dvorak MF, Fisher CG, et al
Spine 2005; 30: 2303-11
• AMS 59 at injury, 92 at follow-up
• Continence 81%
• Independent ambulation 86%
“Although the majority improve to AMS 90-100, many have significant disability…”

Duration of myelopathy prior to surgery and the transverse area of the spinal cord at the maximum compression level were the most significant prognostic parameters for surgical outcome.
Cervical Radiculopathy and Myelopathy: When and What can Surgery Contribute to Treatment?
- Yonenobu, K
Eur Spine J 2000; 9: 1-7

Relative Asymptomatic Cord Compression CSM – Central Cord Syndrome
• Numerator Central Cord Syndrome
Denominator Asymptomatic Stenosis
• Is Canal size predictive?
  – Counsel patients
• Natural History of Myelopathy, clinical evaluation is key
• Rule – Treat people not pictures
  – Although exceptions

Tetraparesis Following Dental Extraction: Case Report and Discussion of Preventive Measures for Cervical Spinal Hyperextension Injury
Whiteson JH, Panaro N, et al
J Spinal Cord Med 1997; 20: 422-3
• Asymptomatic prior
• Suggest radiographic screening prior to a procedure requiring hyperextension
Spinal Cord Injury Without Radiographic Abnormality: Results of the National Emergency X-Radiography Utilization Study in blunt Cervical Trauma

Hendey GW, Wolfson AB, Mower WR, et al
J Trauma 2002; 53: 1-4

- Prospective, 21 Centers
- 34,069 entered, 818 (2.4%) SCI
- SCIWORA 2 (0.08%)
- Children 3,000, 30 SCI, 0 SCIWORA
- "Central Cord" 10 cases
- MRI – Central HNP, stenosis, cord edema or contusion

In the Presence of Myelopathy

The longer you have spinal cord compression, the more severe are the signs and symptoms of your myelopathy (numbness and tingling into extremities, weakness, clumsiness of hands, staggering or urinary urgency) the less likely am I to make you better with surgical decompression.

Conclusion

- Treat people not pictures
- Careful history and exam
- Educate the patient

ROLE OF NON-SURGICAL MANAGEMENT IN CERVICAL SPONDYLOTIC MYELOPATHY
NONOPERATIVE MANAGEMENT OF CERVICAL MYELOPATHY: A SYSTEMATIC REVIEW
Rhee, John M. MD; Shamji, Mohammed F. MD, PhD, FRCS(C); Erwin, W. Mark DC, PhD; Bransford, Richard J. MD; Yoon, S. Tim MD, PhD; Smith, Justin S. MD, PhD; Kim, Han Jo MD; Ely, Claire G. BS; Detriot, Joseph R. MPH, PhD; Patel, Alpesh A. MD; FACS; Katz-Ryan, Subhinder BS(PT), MS, PhD

- Moderate strength of evidence
- Strong recommendation
1. Asymptomatic Stenosis
   - 8% myelopathy at 1 year,
   - 35% at median 44 months
2. High signal T2 intra-medullary
3. Absence can predict early myelopathy
4. Presence can predict late myelopathy
5. There are no utilities in predictions
6. OPLL – no recommendation

ROLE OF NON-SURGICAL MANAGEMENT IN CERVICAL SPONDYLOTIC MYELOPATHY
SYMPTOMATIC PROGRESSION OF CERVICAL MYELOPATHY AND THE ROLE OF NONSURGICAL MANAGEMENT: A CONSENSUS STATEMENT
Fehlings, Michael G. MD, PhD, FRCS(C); Wilson, Jefferson R. MD; Yoon, S. Tim MD, PhD; Rhee, John M. MD; Shamji, Mohammed F. MD, PhD; Lawrence, Brandon D. MD

- 20-62% deteriorate at 3-6 years' follow-up
- No predictor
- A symptomatic stenosis myelopathy
  - 8% at 1 year
  - 23% at 4 years

ROLE OF NON-SURGICAL MANAGEMENT IN CERVICAL SPONDYLOTIC MYELOPATHY
FREQUENCY, TIMING, AND PREDICTORS OF NEUROLOGICAL DYSFUNCTION IN THE NONMYELOPATHIC PATIENT WITH CERVICAL SPINAL CORD COMPRESSION, CANAL STENOSIS, AND/OR OSSIFICATION OF THE POSTERIOR LONGITUDINAL LIGAMENT
Wilson, Jefferson R. MD*; Barry, Sean MD†; Fischer, Dena J. DDS, MSD, MS‡; Skelly, Andrea C. PhD, MPH‡; Arnold, Paul M. MD§; Riew, K. Daniel MD¶; Shaffrey, Christopher I. MDǁ; Traynelis, Vincent C. MD**; Fehlings, Michael G. MD, PhD, FRCS(C)*

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Relative Asymptomatic Cord Compression CSM – Central Cord Syndrome

- Numerator: Central Cord Syndrome
- Denominator: Asymptomatic Stenosis

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NUMERATOR

R.W. – December 2004

- Mexico – surf – extension
- C5 ‘complete’ on transfer, 36 hours
- Some chest sensory sparing(?)
- Discussed decompression
- Done same day
- MI, PE
R.W. – July 2005

- Significant return
- Works manual wheelchair
- Both legs move, right 4/5, left 3/5
- Right UE 4+-5, left 4-
- Spasticity

S.A. – August 2005

- 45 year old male – 80% neck pain, 20% arm pain
  - Consult regarding stenosis
  - Six months of pain, now better
  - No symptoms myelopathy
  - Normal neurologic exam
  - "Oh, by the way…I had an episode in 1999!"
A.H. – July 2004

- Previous lumbar stenosis
- Now paresthesias, mild pain
- Increase ataxia
- PMH – colostomy
- PE: Positive UMN, positive ataxia
- Symptomatic CSM
- Symptomatic stenosis
- Laminoplasty
Radiculopathy and myelopathy at segments adjacent to the site of a previous anterior cervical arthrodesis.

Hilibrand AS, Carlson GD, Palumbo MA, Jones PK, Bohlman HH.
- 374 patients – 409 ACDFs
- 10 years – 25.6% symptomatic
- Increased risk – ACDF at C5-6, and pre-existing Spondylosis
- Multi-level significantly lower

Risk Factor Analysis for Adjacent Segment Pathology in 1,358 Anterior, Posterior, Fusion, and Non-Fusion Cervical Spine Operations.

- Fusion – 1038 A, 29 P, 28 A/P
- Decompression 214 (145 laminoplasty, 69 LF, 49 arthroplasty)
- 2nd surgery – 2.3% per year
- Risks:
  - Smoking
  - Female
  - Procedure
- Posterior A/P fusion 7.5 X vs decompression only
- ACDF, Arthroplasty not significantly different

Jae Chul Lee, MD, PhD – Seoul, Republic of Korea
Sang-Hung Lee, MD, PhD – Seoul, Republic of Korea
Sang Do Kim, MD, St. Louis, MO
K. Daniel Riew, MD – St. Louis, MO

Paper #25 from the Cervical Spine Research Society’s 41st Annual Meeting, Los Angeles, California, December 5-7, 2013
R.B.  
- ACDF C4-6 2001  
- 2010 – recurrent pain

Clinical and Radiographic Analysis of an Artificial Cervical Disc: Seven-Year Clinical and Radiographic Outcomes from a Prospective Randomized Controlled Clinical Trial

- 276 disc arthroplasty, 265 ACDF  
- 395 (212+163) at 7 years  
- 2nd surgery index level  
  - (11/276) 4% device  
  - (29/264) 11% ACDF  
- Adjacent level  
  - 5.1% vs. 11.9% (p = .008)

Paper #5 from the Cervical Spine Research Society’s 41st Annual Meeting, Los Angeles, California, December 5-7, 2013

Vincent C. Traynelis, MD – Chicago, IL  
Praveen Mummaneni, MD – San Francisco, CA  
J. Kenneth Burkus, MD – Columbus, GA  
Regis Haid, MD – Atlanta, GA

Disc Arthroplasty

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Why is the Patient Seeking Care?

- Pain
- Myelopathy
- Deformity
- Infection
- Tumor
- Fracture
- Pseudoarthrosis?
TOTAL CERVICAL-SPINE FUSION FOR NECK PARALYSIS
Jacquelin Perry, Vernon L. Nickel
J Bone Joint Surg Am. 1959 Jan 01;41(1):60-60

ML Beekeeper
- Fixed Deformity
- Neuromuscular
- PT Pre-op helped stretch
THIRTY-SIX YEARS EXPERIENCE OF CERVICAL EXTENSION OSTEOTOMY IN ANKYLOSING SPONDYLITIS: TECHNIQUES AND OUTCOMES.
Simmons ED, DiStefano RJ, Zheng Y, Simmons EH.

- 131 cases
- Ed Senior 56°-4°
- Ed Junior 49°-12°
- Sitting position
- Local anesthesia
- Halo
- Wide lateral resection
SH

- Cruise Ship Fall
- C7 weak, unilateral
- MRI only
JJ

RA
Posterior alone