Der Balgrist

UniversitätsSpital Zürich

Anterior Approaches and Surgical Techniques in the Treatment of Degenerative Cervical Myelopathy

Michael G. Fehlings MD PhD FRCSC FACS FRSC FCAHS

Professor of Neurosurgery
Vice Chair Department of Surgery
Halbert Chair in Neural Repair and Regeneration
Co-Director Spine Program
University of Toronto

Fellow Royal Society
Chair AOSpine SCI Knowledge Forum

Rick Hansen Institute
Institut Rick Hansen

AOSPINE

UofT

Neurosurgery

Christopher and Dana Reeve Foundation
Go Forward.

McEwen Centre for Regenerative Medicine

McLaughlin Centre for Molecular Medicine

www.uhn.on.ca/programs/spine

Professor Mazda Farshad

Professor Armin Curt

Disclosures

- No commercial disclosures of relevance
- Grant support: CIHR, DOD, AOSpine, Rick Hansen Institute

Krembil Neuroscience Center, Toronto Western Hospital, University of Toronto

Acknowledgements

Spinal Program

Krembil Neuroscience Center

University Health Network, University of Toronto

- Fehlings Laboratory
- SCI-NET Collaborators (CIHR-NET)

Contact information

www.uhn.on.ca/programs/spine

Michael.fehlings@uhn.on.ca

Canadian Institutes of Health Research

Physician Services Incorporated Foundation

Ontario Neurotrauma Foundation

Cervical Spine Research Society

Christopher Reeve Paralysis Foundation

INTS 2018: INVITATION TO TORONTO

Toronto, Canada, August 11-16, 2018

Joint Meeting with NNS and AANS/CNS

National Neurotrauma Society (NNS)

American Association of Neurological Surgeons / Congress of Neurological Surgeons (AANS/CNS)

AANS/CNS Section On NEUROTRAUMA & CRITICAL CARE

Spine

SPINE Volume 40, Number 0, pp 1-19

LITERATURE REVIEW

Degenerative Cervical Myelopathy

Epidemiology, Genetics, and Pathogenesis

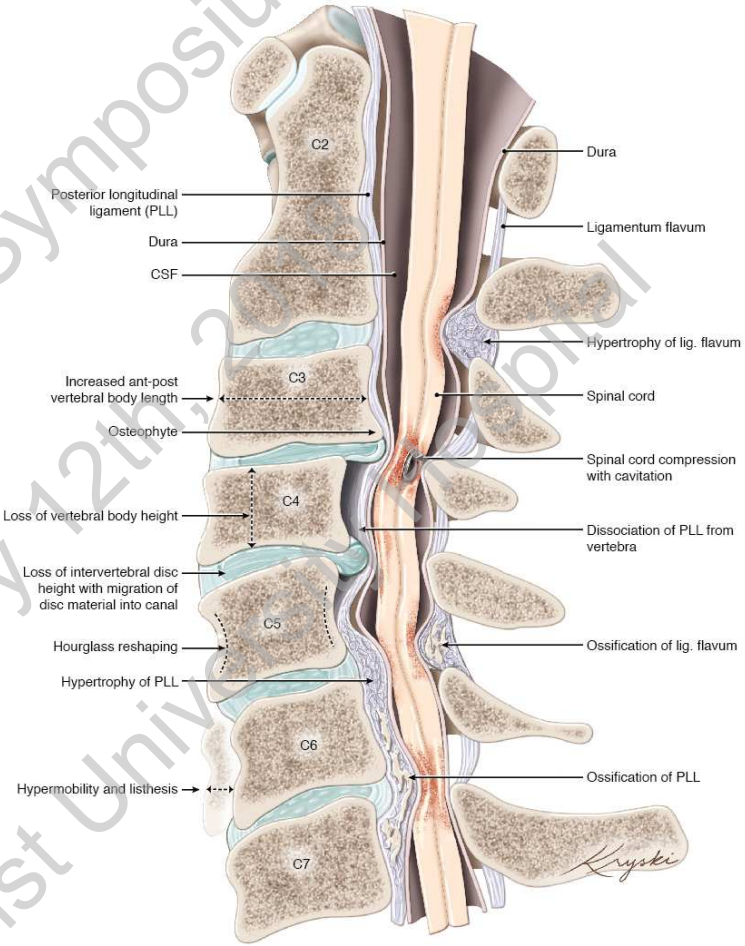
Aria Nouri, MD,*†‡ Lindsay Tetreault, BSc,*†‡ Anoushka Singh, PhD,*† Spyridon K. Karadimas, MD, PhD,*†‡ and Michael G. Fehlings, MD, PhD, FRCSC, FACS*†‡

Pathogenesis:

Degenerative cervical changes result in spinal cord insult through static and dynamic injury mechanisms.

- **Static injury** – compression by intervertebral disk, osteophytes, hypertrophy/ossification of spinal ligaments (OPLL, LF)
- **Dynamic Injury** – Subluxation/degenerative spondylisthesis, minor trauma - particularly in the setting of preexisting DCM/stenosis

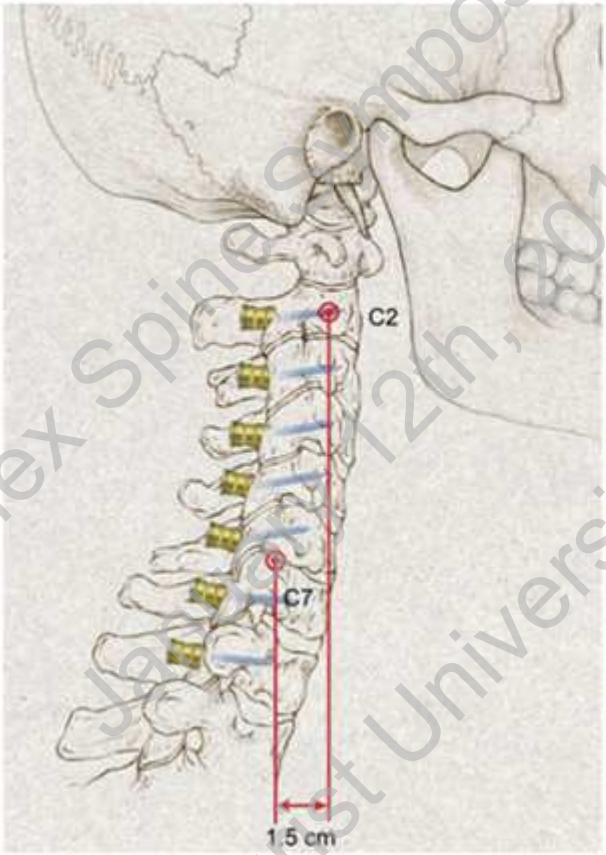
*Spinal deformity (eg kyphosis) can also contribute to the pathogenesis by altering cord tension.

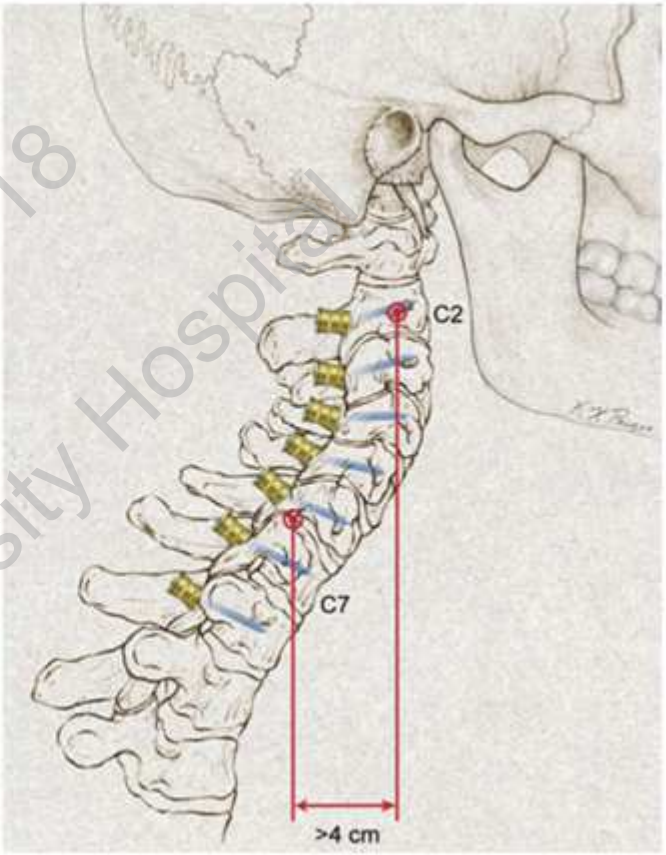


Nouri et al (2015)

Cervical spinal alignment - Parameters

C2-7 Cobb angle
(CERVICAL LORDOSIS)





C2-7 Sagittal vertical axis (SVA)
(SAGITTAL PLANE TRANSLATION)

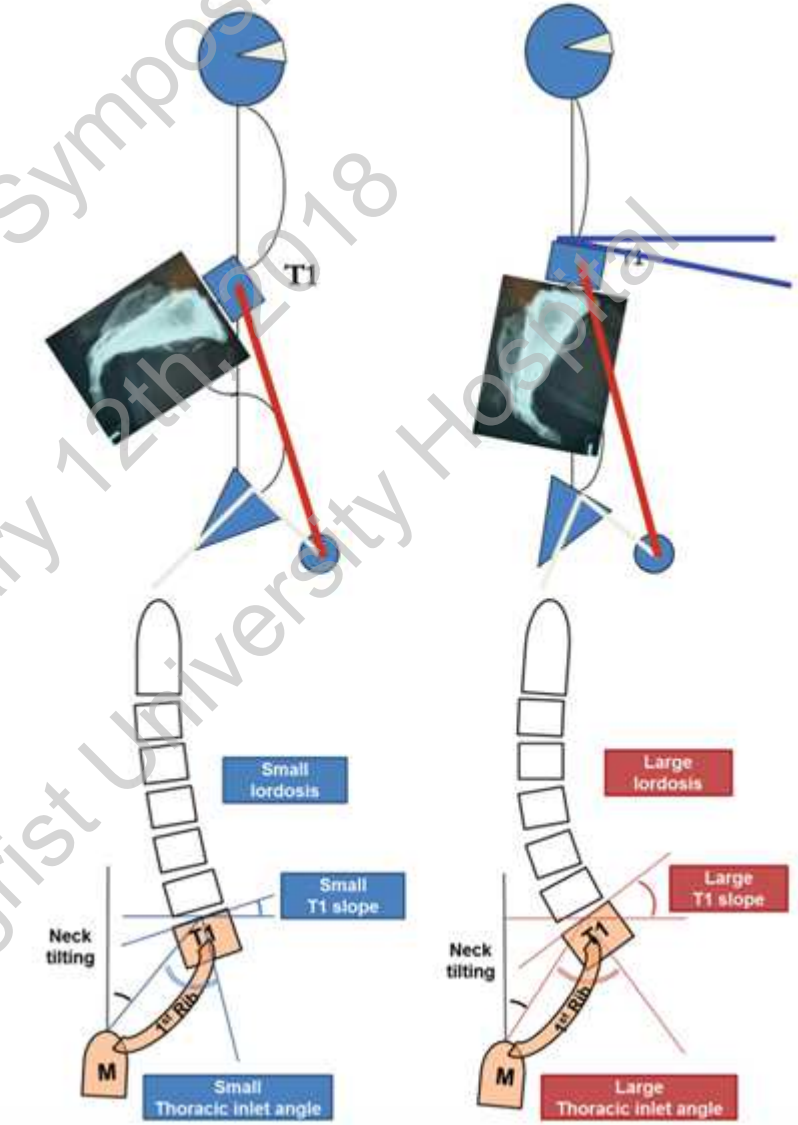
Cervical spinal alignment - Parameters

Chin-brow vertical angle (CBVA)
(HORIZONTAL GAZE)

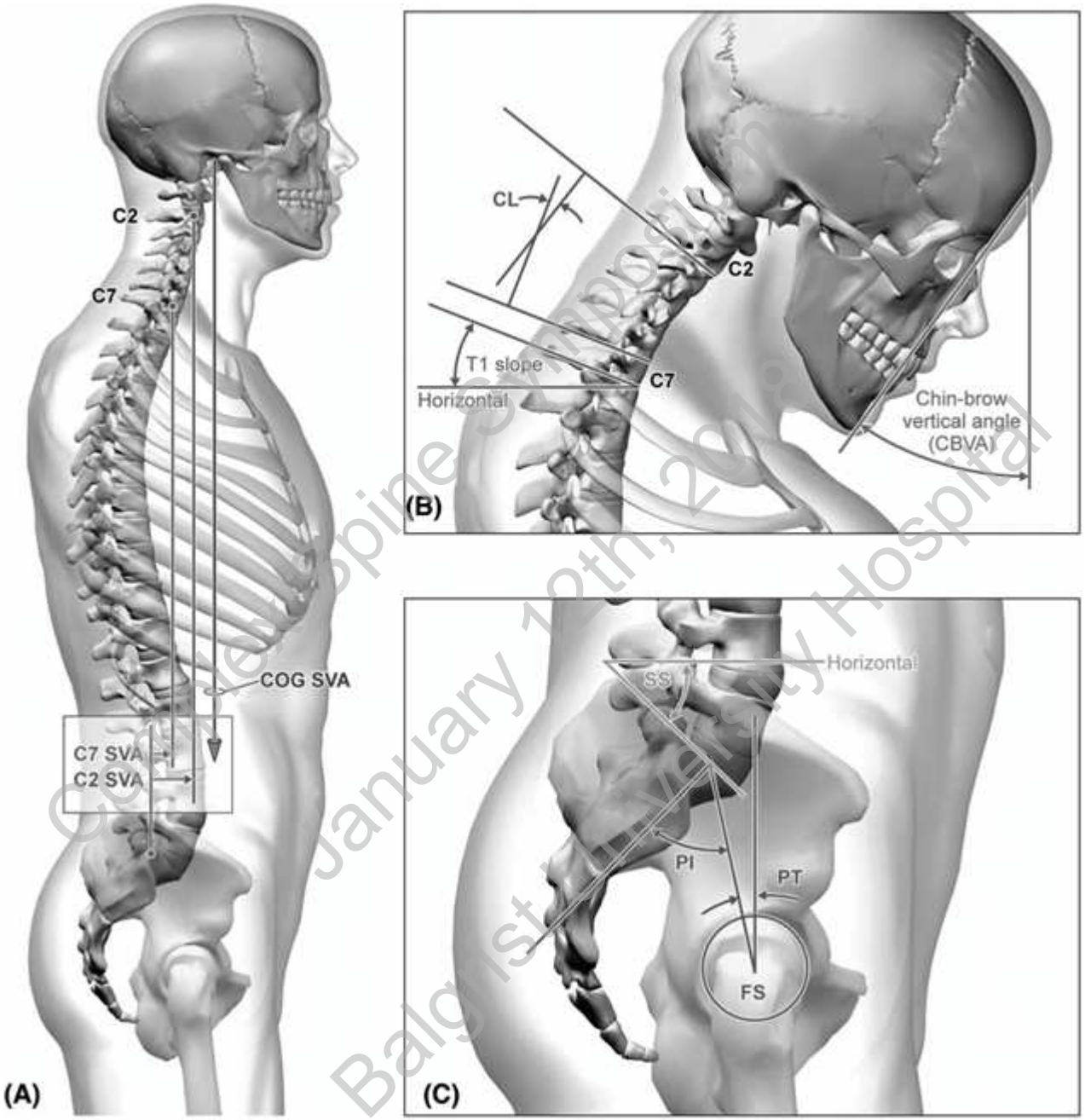
Cervical spinal alignment - Parameters

- Neck tilt
- Thoracic inlet angle (TIA)
- T1 slope
- TIA = T1 slope + neck tilt

- Cervical lordosis depends on T1 slope
- Similar to pelvic incidence and lumbar lordosis



J. K. Scheer *et al.*, Cervical spine alignment, sagittal deformity, and clinical implications: a review. *J Neurosurg Spine* **19**, 141-159 (2013).



C. P. Ames *et al.*, Cervical radiographical alignment: comprehensive assessment techniques and potential importance in cervical myelopathy. *Spine (Phila Pa 1976)* **38**, S149-160 (2013).

C2-7 SVA is correlated with NDI and SF-36 PCS in DCM

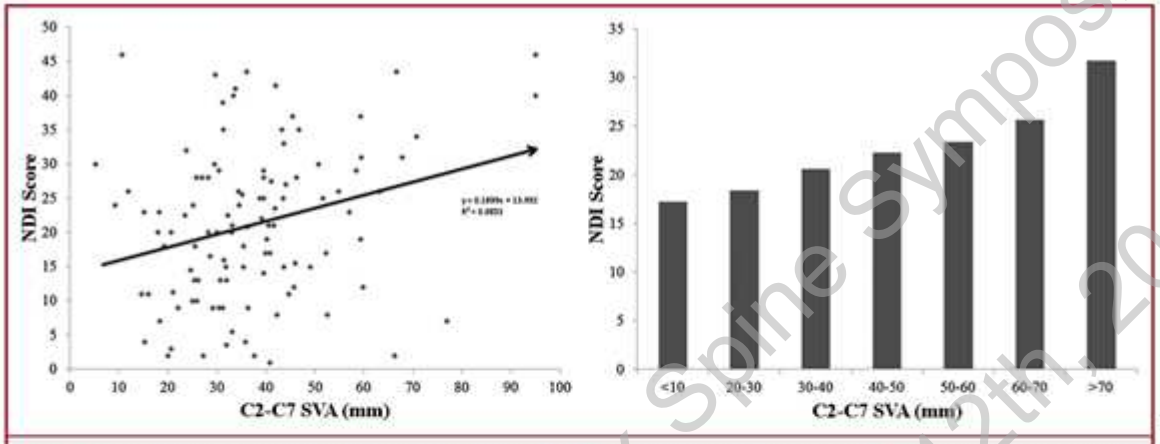


FIGURE 2. *Positive correlation observed between C2-C7 SVA and NDI scores.* **Left,** *regression results superimposed on raw data.* **Right,** *bar graph of mean data. SVA, sagittal vertical axis; NDI, neck disability index.*

RESEARCH—HUMAN—CLINICAL STUDIES

The Impact of Standing Regional Cervical Sagittal Alignment on Outcomes in Posterior Cervical Fusion Surgery

Jessica A. Tang, BS*
Justin K. Scheer, BS†
Justin S. Smith, MD, PhD**
Vedat Deviren, MD§
Shay Bess, MD¶
Robert A. Hart, MD‖
Virginia Lafage, PhD#
Christopher I. Shaffrey, MD**
Frank Schwab, MD#
Christopher P. Ames, MD*
the ISSG

BACKGROUND: Positive spinal regional and global sagittal malalignment has been repeatedly shown to correlate with pain and disability in thoracolumbar fusion.
OBJECTIVE: To evaluate the relationship between regional cervical sagittal alignment and postoperative outcomes for patients receiving multilevel cervical posterior fusion.
METHODS: From 2006 to 2010, 113 patients received multilevel posterior cervical fusion for cervical stenosis, myelopathy, and kyphosis. Radiographic measurements made at intermediate follow-up included the following: (1) C1-C2 lordosis, (2) C2-C7 lordosis, (3) C2-C7 sagittal vertical axis (C2-C7 SVA; distance between C2 plumb line and C7), (4) center of gravity of head SVA (CGH-C7 SVA), and (5) C1-C7 SVA. Health-related quality-of-life measures included neck disability index (NDI), visual analog pain scale, and SF-36 physical component scores. Pearson product-moment correlation coefficients were calculated between pairs of radiographic measures and health-related quality-of-life scores.

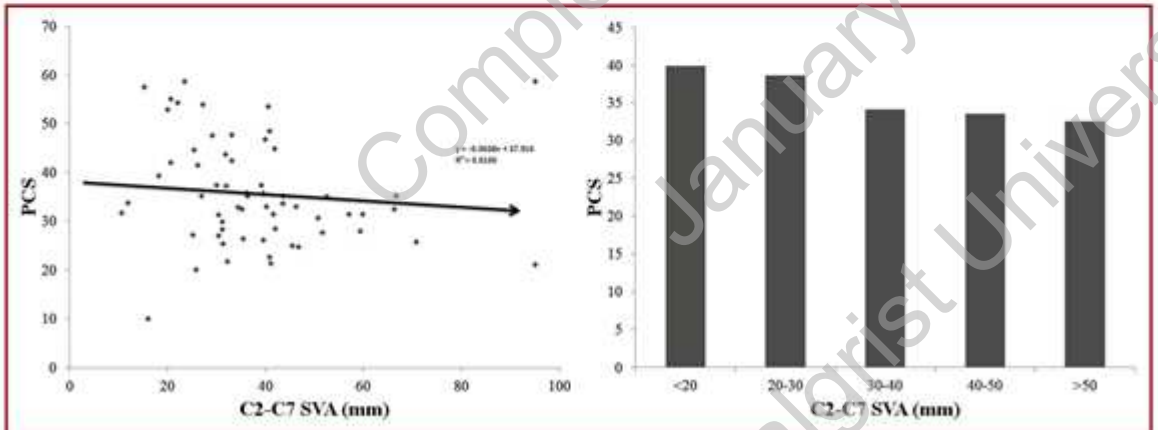
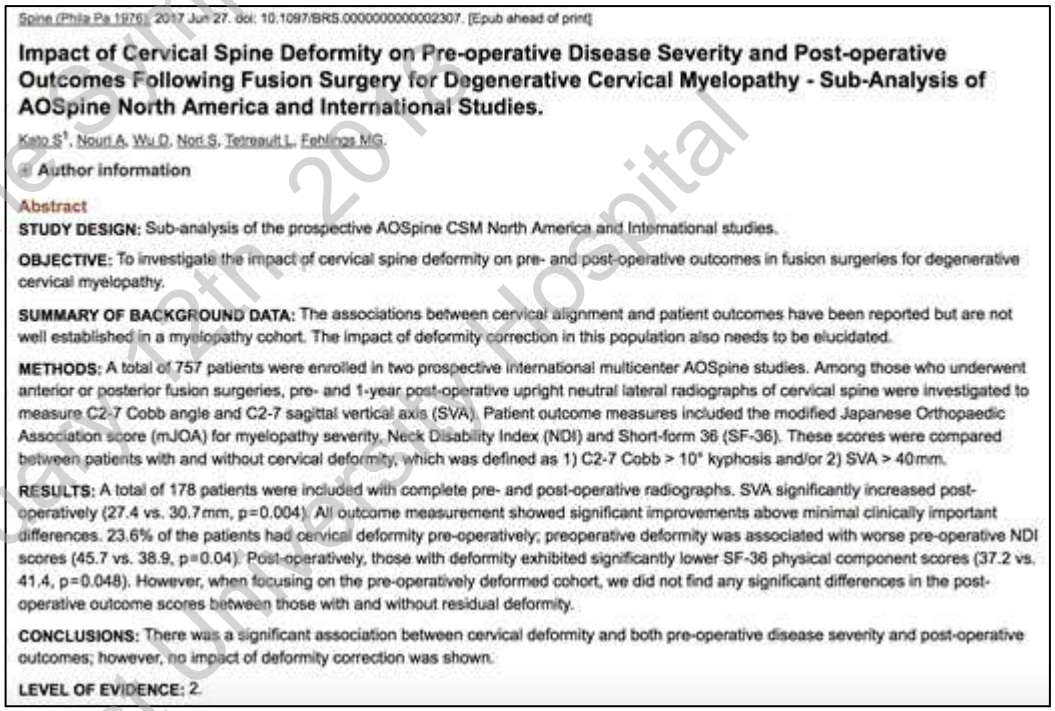


FIGURE 3. *Negative correlation observed between C2-C7 SVA and PCS scores.* **Left,** *regression results superimposed on raw data.* **Right,** *bar graph of mean data. SVA, sagittal vertical axis; PCS, physical component score.*

Cervical deformity is associated with greater disability and poorer QOL in DCM

- N=178
- AOSpine CSM-NA or CSM-I
- C2-7 Cobb and C2-7 SVA
- Pre-operative and 1-year post-operative
- 'Deformity' defined as 1) C2-7 Cobb > 10° kyphosis and/or 2) SVA > 40 mm

- Pre-operative deformity associated with worse NDI scores (45.7 vs. 38.9, P=0.04)
- Post-operatively, deformity associated with worse SF-36 PCS (37.2 vs. 41.4, P=0.048)



Spine (Phila Pa 1976). 2017 Jun 27. doi: 10.1097/BRS.0000000000002307. [Epub ahead of print]

Impact of Cervical Spine Deformity on Pre-operative Disease Severity and Post-operative Outcomes Following Fusion Surgery for Degenerative Cervical Myelopathy - Sub-Analysis of AOSpine North America and International Studies.

Kato S[1], Nouri A, Wu D, Nori S, Tetreault L, Fehlings MG.

+ Author information

Abstract

STUDY DESIGN: Sub-analysis of the prospective AOSpine CSM North America and International studies.

OBJECTIVE: To investigate the impact of cervical spine deformity on pre- and post-operative outcomes in fusion surgeries for degenerative cervical myelopathy.

SUMMARY OF BACKGROUND DATA: The associations between cervical alignment and patient outcomes have been reported but are not well established in a myelopathy cohort. The impact of deformity correction in this population also needs to be elucidated.

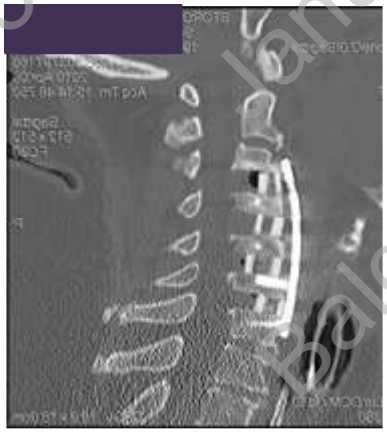
METHODS: A total of 757 patients were enrolled in two prospective international multicenter AOSpine studies. Among those who underwent anterior or posterior fusion surgeries, pre- and 1-year post-operative upright neutral lateral radiographs of cervical spine were investigated to measure C2-7 Cobb angle and C2-7 sagittal vertical axis (SVA). Patient outcome measures included the modified Japanese Orthopaedic Association score (mJOA) for myelopathy severity, Neck Disability Index (NDI) and Short-form 36 (SF-36). These scores were compared between patients with and without cervical deformity, which was defined as 1) C2-7 Cobb > 10° kyphosis and/or 2) SVA > 40 mm.

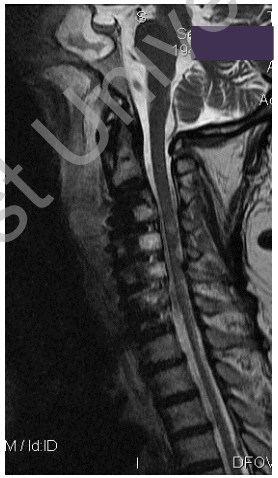
RESULTS: A total of 178 patients were included with complete pre- and post-operative radiographs. SVA significantly increased post-operatively (27.4 vs. 30.7 mm, p=0.004). All outcome measurement showed significant improvements above minimal clinically important differences. 23.6% of the patients had cervical deformity pre-operatively; preoperative deformity was associated with worse pre-operative NDI scores (45.7 vs. 38.9, p=0.04). Post-operatively, those with deformity exhibited significantly lower SF-36 physical component scores (37.2 vs. 41.4, p=0.048). However, when focusing on the pre-operatively deformed cohort, we did not find any significant differences in the post-operative outcome scores between those with and without residual deformity.

CONCLUSIONS: There was a significant association between cervical deformity and both pre-operative disease severity and post-operative outcomes; however, no impact of deformity correction was shown.

LEVEL OF EVIDENCE: 2.

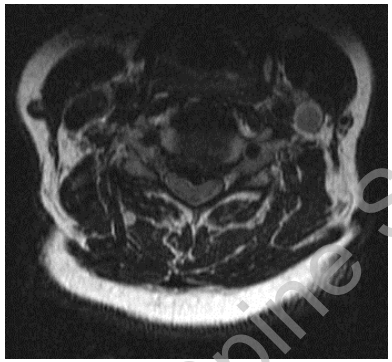
Multilevel ACDF

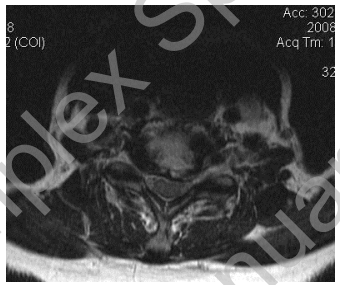




- Kyphotic deformity
- At disc level pathology
- Reducible deformity

Anterior Cervical Corpectomy and Fusion

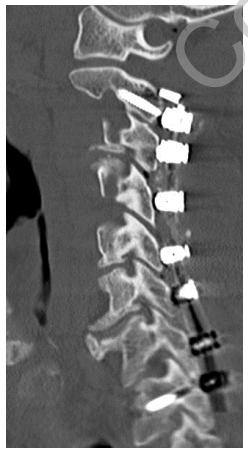




- Ventral pathology which extends behind the vertebral body
- Hybrid constructs offer excellent biomechanical stability and allow multilevel anterior alone constructs

Hybrid Anterior Technique for Complex Subaxial Cervical Pathology

Posterior techniques
Laminectomy and Fusion

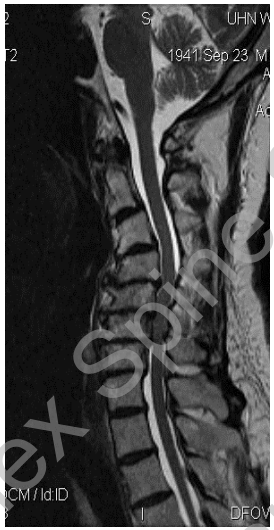


- Multilevel pathology
- Relative preservation of lordosis
- Allows for multilevel foraminotomies

Laminoplasty

- Good option for multilevel stenosis with preserved lordosis
- Not indicated if significant kyphosis/ instability

Combined Anterior/Posterior



- Fixed kyphosis
- Combined anterior/posterior compression
- Need for multilevel corpectomy
- Posterior tension band fixation

Case Report of a 58 yo male Pt.

History of numerous cervical traumas

Social history: drug addiction to heroin, alcoholism, opioid use and heavy smoker 1pack/d

Complaints:
Severe axial neck pain
Left sided weakness in his body since 2 yrs.
Ongoing weakness on his left side and fine motor dysfunction of both hands (L>R).
Right hand dominant, manage of buttons with severe difficulty.
Severe numbness affecting left and right hand hand, balance difficulties when walking.

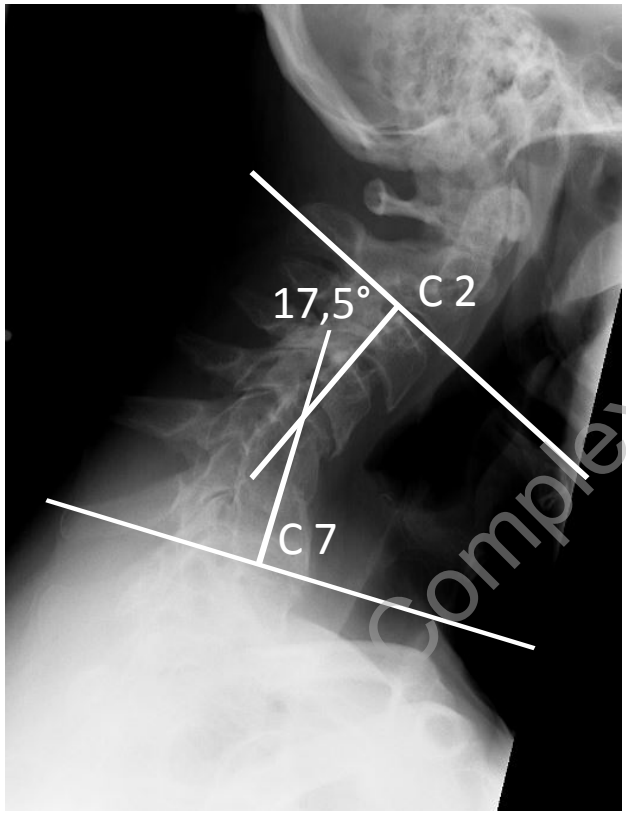
MJOA Score 10/18
(3/5 upper extremity motor function, 4/7 lower extremity motor function, 1/3 upper Extremity sensory function, 2/3 bladder function)

Severe category of cervical myelopathy!

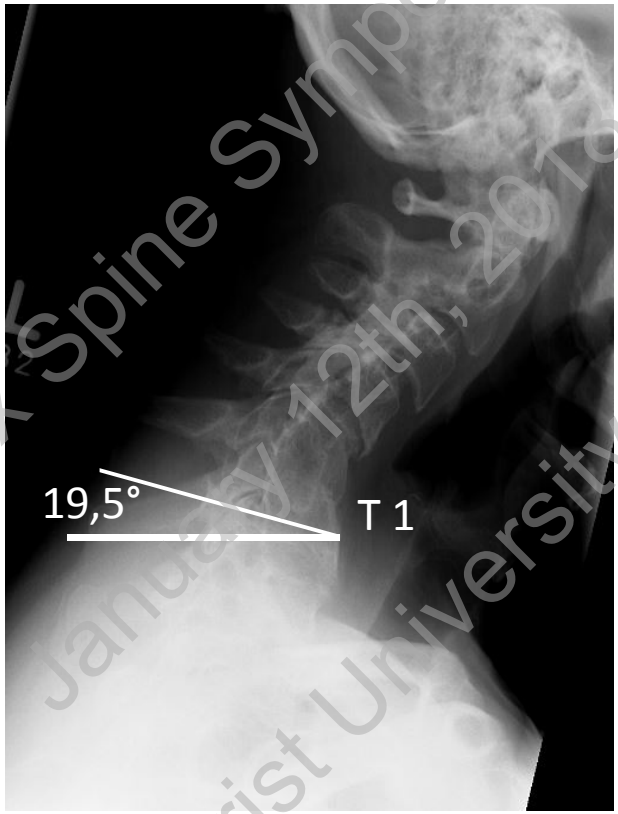
Pre-operative functional X-ray

Limited range of motion in flexion and neck extension

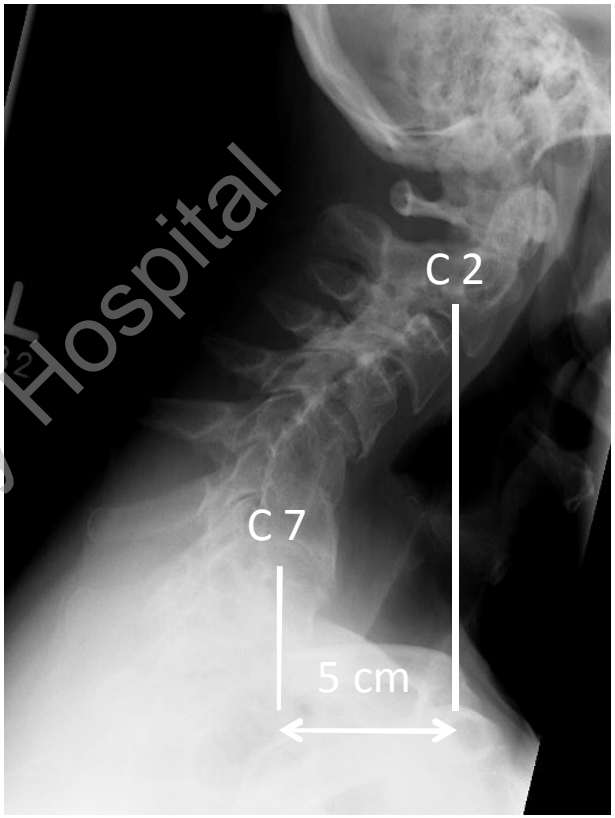
Cervical spinal alignment and parameters



C2-7 cobb angle 17,5°

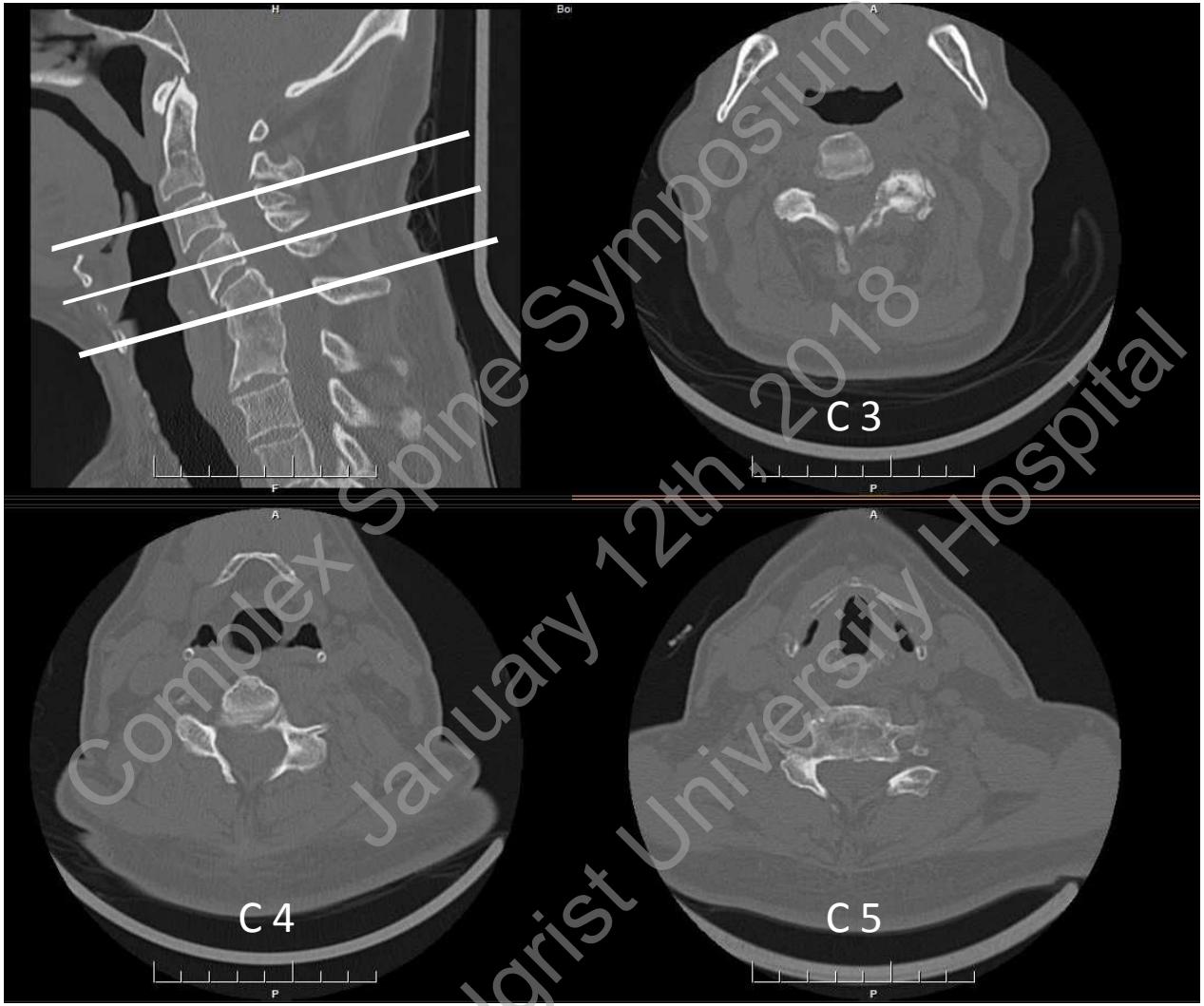


T1 slope 19,5°



C2-C7 SVA 5 cm

Pre-operative serial axial CT-scans of cervical spine



Signs of old C6 compression fx with consolidation in focal kyphosis position. Widening of interspinous processes and facets.

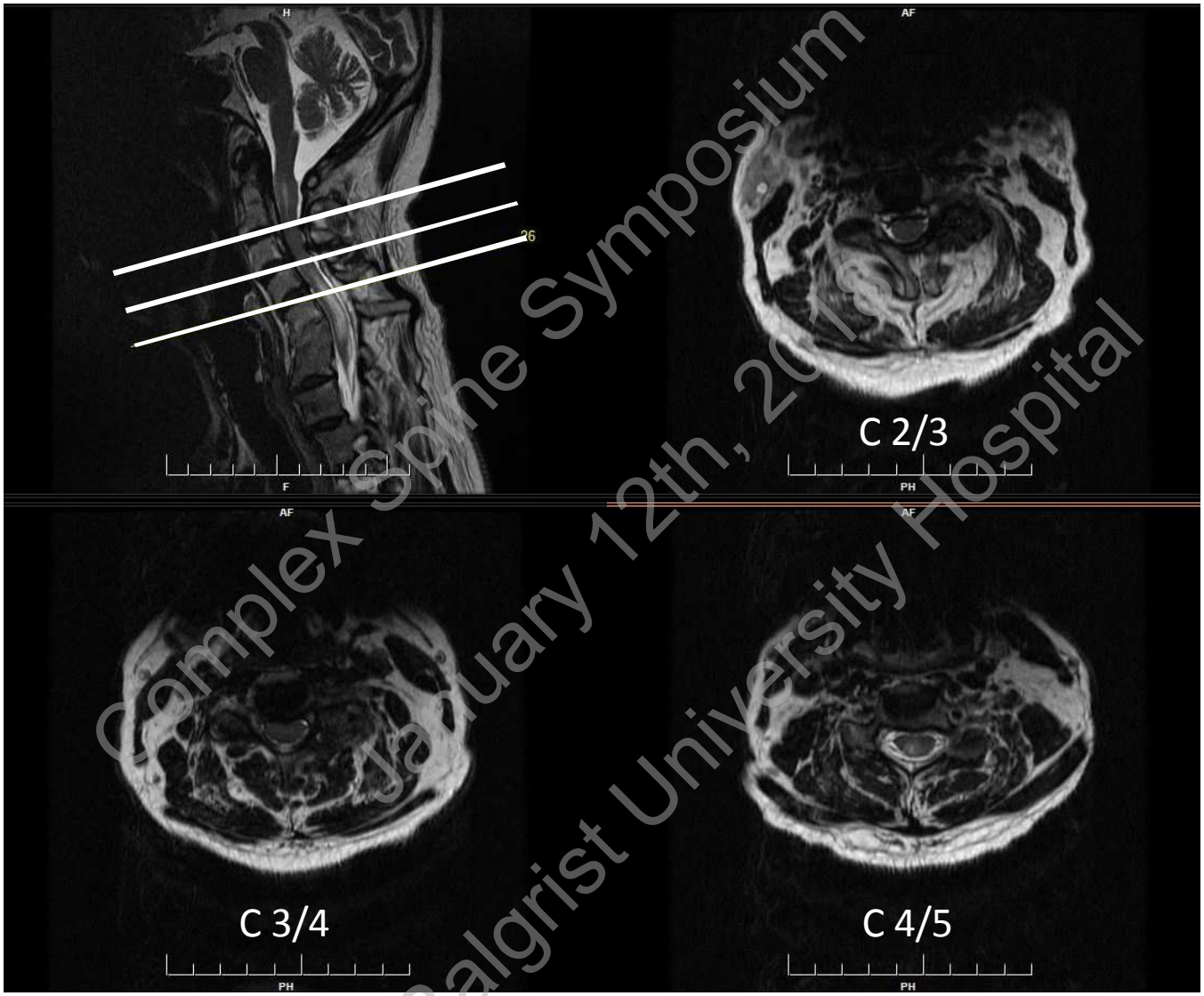
Pre-operative sagital T2 MRI-scan of cervical spine

*Signs of old C6 compression fx with consolidation in fixed focal kyphosis.

**Severe T2 signal change of spinal cord at level of C5-7 with edema formation and cavitation.

***Splaying of the interspinous processes at C5-7.

Pre-operative serial axial MRI-scans of cervical spine



Spondylotic changes at C2-C5 with bulging disks, buckling of the ligamentum flavum at C3-5

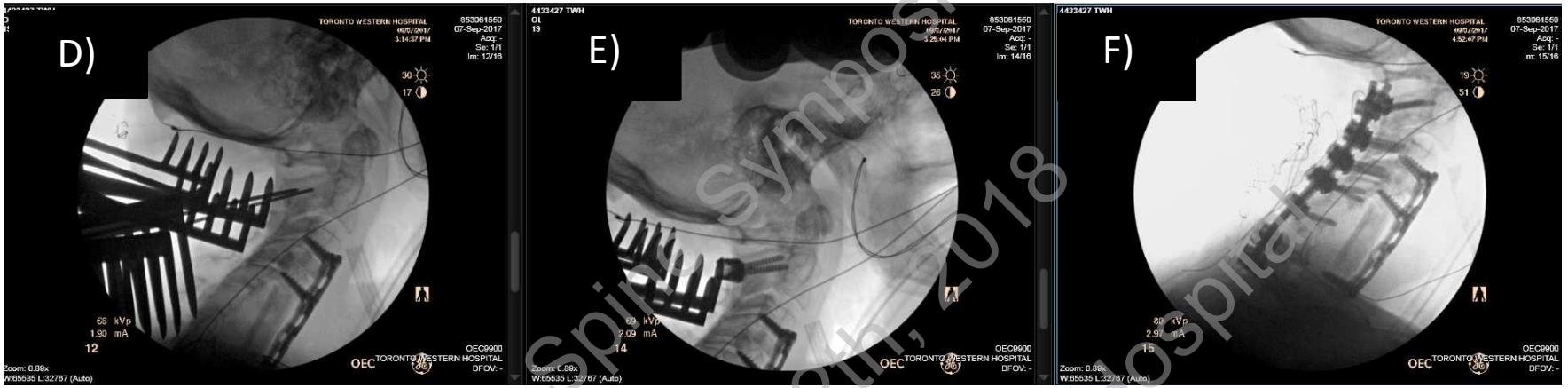
Anterior surgery stages

A) Multilevel anterior cervical decompression and reconstruction with C3 to C7 diskectomies, C5 and C6 corpectomy and anterior osteotomies with release of of fused uncovertebral joints at C5-6 and C6-7 over an extended transverse mid-cervical incision.

B) Partial reduction of subaxial kyphotic deformity with fibular strut bone bank graft at C4-7 with local autogenous bone graft supplementing fibular allograft C3-4.

C) Anterior cervical titanium plate fixation.

Posterior surgery stages



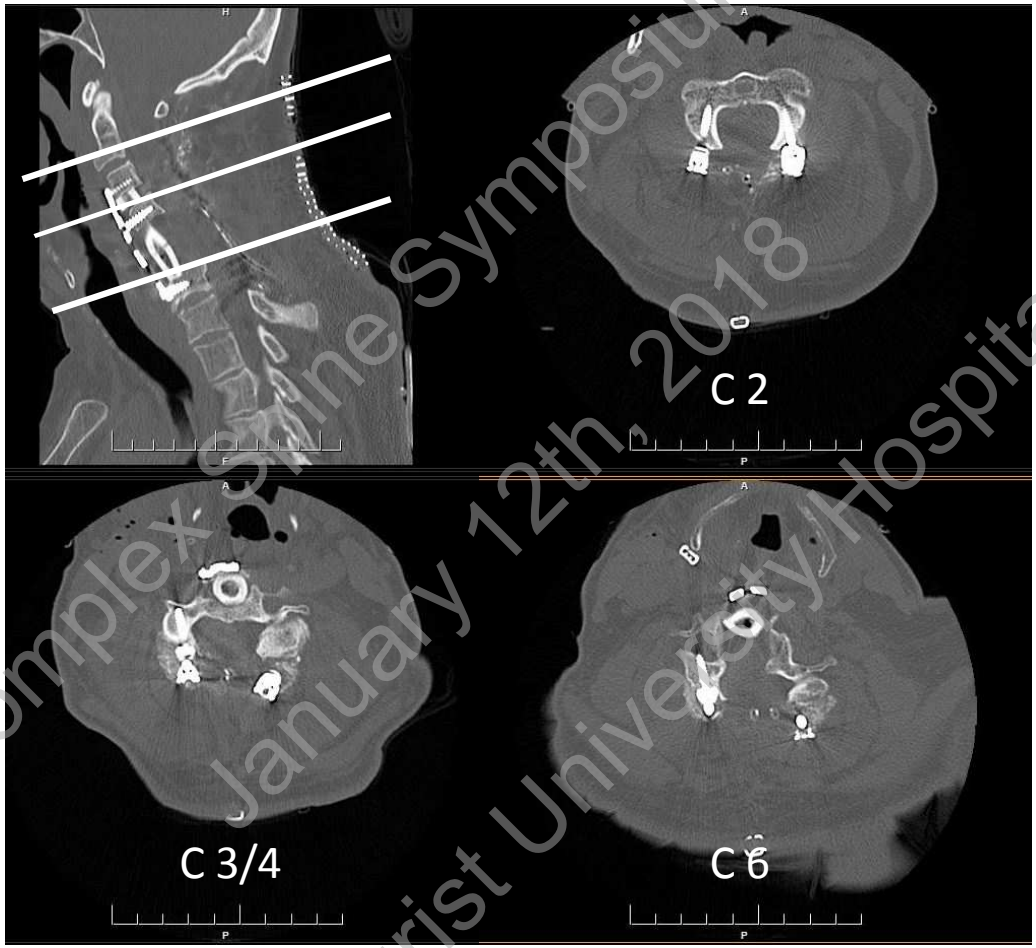
D) Multilevel posterior cervical decompression and reconstruction with C2 to C7 laminectomies, T1 laminotomies and bilateral foraminotomies.

E) Instrumented reconstruction with C2 pedicle screws, C3-C7 lateral mass fixation, T1 pedicle screw fixation under computer assisted navigation.

F) Bone grafting with local autogenous bone graft supplemented with demineralized bone matrix allograft and morselized fibular allograft.

Post-operative serial sagittal CT-scans of cervical spine 2 days after surgery

Post-operative serial axial CT-scans of cervical spine 2 days after surgery



2 month postop follow up Status:

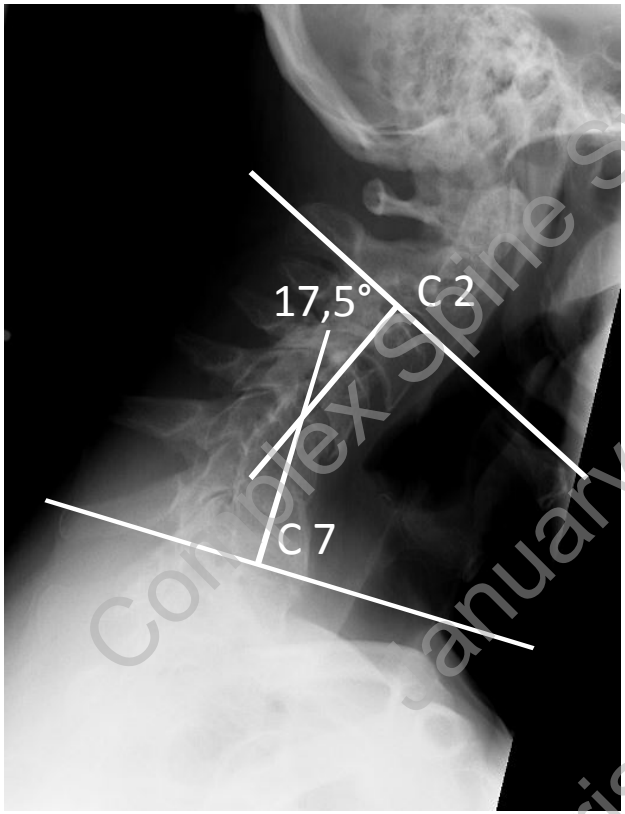
- Overall improvement of neurological symptoms with less neck pain and reduced L arm spasms.
- Numbness of upper arm extremities better than preop.
- No use of assistive device while walking.
- Improvement of fine motor skills.

Physical examination:

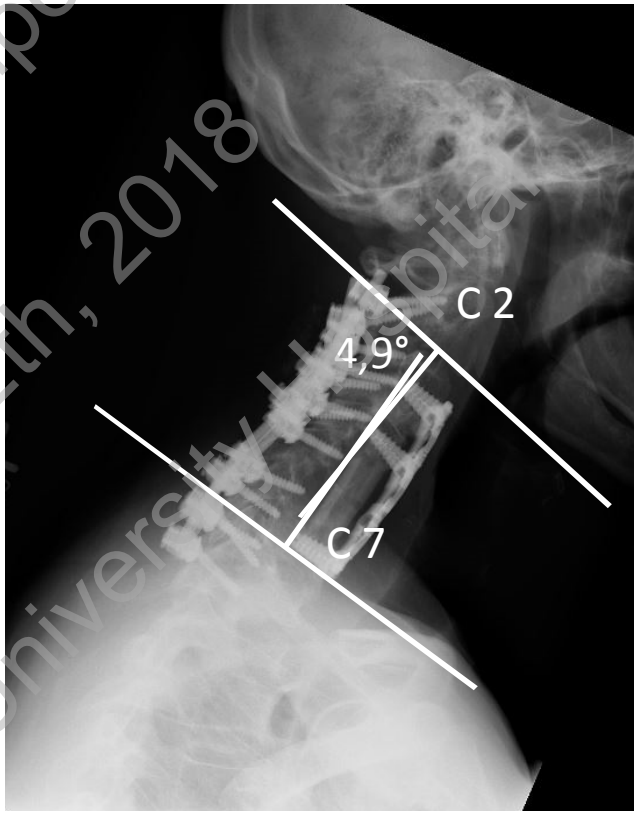
Motor: Upper extremity 5/5 motor power, intrinsics 4+/5
Motor power lower extremities 4+5

MJOA Score improved to 15/18 (previous 10/18)
(4/5 upper extremity motor function, 6/7 lower extremity motor function, 2/3 upper extremity sensory function, 3/3 bladder function)

Change of cervical spinal alignment cobb angle



Preop X-ray: 17,5°



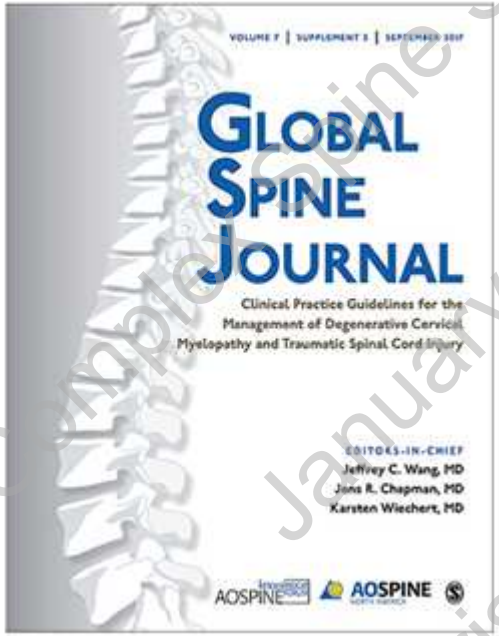
Postop X-ray: 4,9°

Guidelines for the Management of Degenerative Cervical Myelopathy

Michael G. Fehlings MD PhD

Sponsored by the Cervical Spine Research Society and
AOSpine North America

Surgery
UNIVERSITY OF TORONTO



- AOSpine North America
- AOSpine International
- Cervical Spine Research Society
- American Association/Congress of Neurologic Surgeons

Open Access

Global Spine Journal

Volume 7, Issue 3_suppl,

September 2017

http://journals.sagepub.com/toc/gsja/7/3_suppl

Overview of Methods

1. Several systematic reviews were conducted by external methodologists to synthesize evidence from studies with the highest quality
2. A multidisciplinary guideline development group used this knowledge, in combination with their clinical expertise to develop recommendations for how to best manage patients with mild, moderate and severe disease.

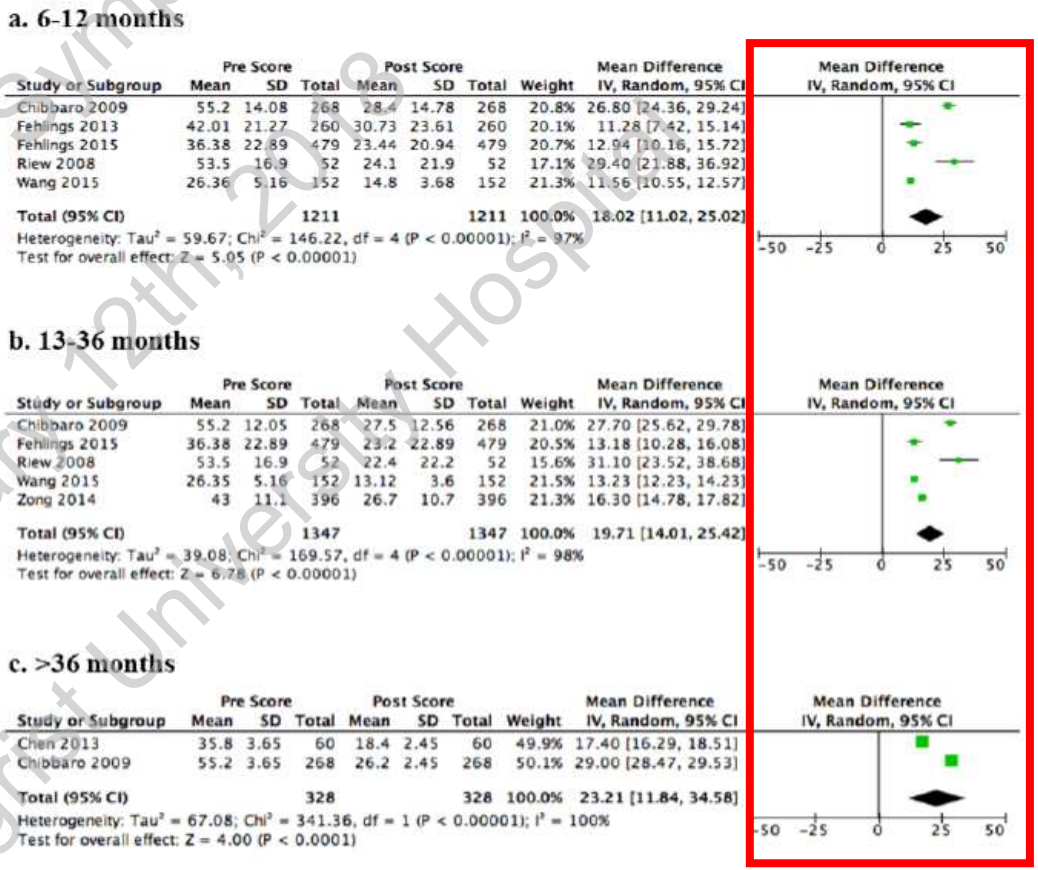
Systematic Review Results: Effectiveness of Surgical Intervention

Aims

- To evaluate neurological outcomes following surgical intervention
- To determine whether outcomes depend on disease severity or duration of symptoms
- To quantify risk of surgical complications

Results: Low to Moderate Evidence

- Surgical intervention results in improvements in Nurick and mJOA scores
- An "optimal" surgical outcome is dependent on preoperative duration of symptoms and myelopathy severity
- Pooled incidences of complications are low (overall rate = 14.1%)



From Evidence to Guidelines: Toronto 2015

Our Multidisciplinary Guideline Development Group

- Neurosurgeons
- Orthopedic Surgeons
- Rehabilitation Specialists
- **Primary Care Physicians**
- Neurologists
- Rheumatologists
- Methodologists

Key Questions and Points of Consideration

Asymptomatic

- Should operative treatment be used to treat nonmyelopathic patients with evidence of cord compression without signs or symptoms of radiculopathy?
- Should operative intervention used to treat nonmyelopathic patients with evidence of cord compression and clinically/electrophysiologically diagnosed radiculopathy?

Mild

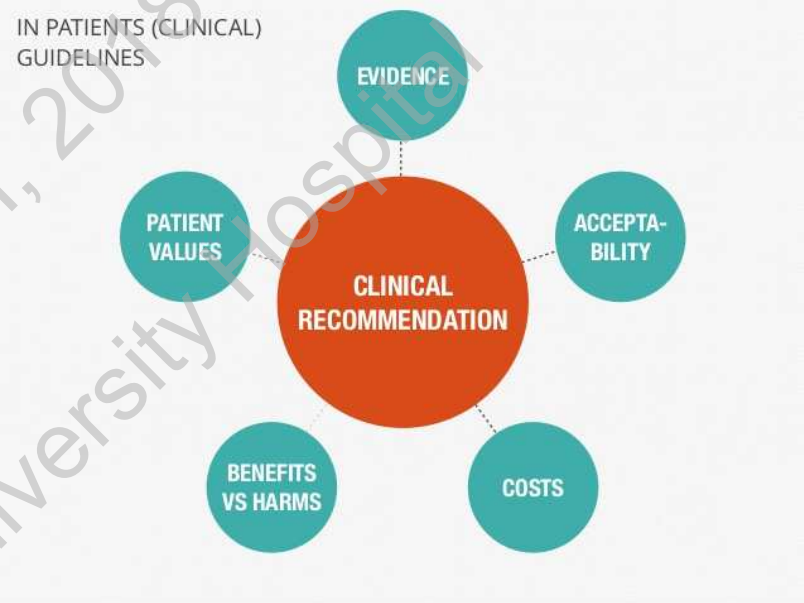
- Should nonoperative treatment be used to treat patients with mild DCM?
- Should operative treatment be used to treat patients with mild DCM?

Moderate

- Should surgery be used to treat patients with moderate DCM?

Severe

- Should surgery be used to treat patients with severe DCM?



GRADE

Our Recommendations

Mild

We ***suggest*** offering either surgical intervention or non-surgical treatment consisting of a supervised trial of structured rehabilitation for patients with mild DCM. If non-surgical treatment is initially pursued and there is subsequent neurologic deterioration, we ***recommend*** operative intervention. If non-surgical treatment is initially pursued and the patient fails to improve, we ***suggest*** offering operative intervention.

Moderate

We ***recommend*** surgical intervention for patients with moderate DCM.

Severe

We ***recommend*** surgical intervention for patients with severe DCM

Take Home Messages

- Cervical deformity has an important impact on baseline neurological status and outcomes of treatment
- C2-C7 sagittal alignment; T1 slope; cervical C2-C7 SVA are the key parameters to assess
- Flexible deformities can be handled either anteriorly or posteriorly
- Anterior options excellent for at disc pathologies
  - Anterior osteotomies can be achieved by resection of uncovertebral joints bilaterally
  - Hybrid options excellent for complex anterior cervical reconstruction
- Fixed deformities require combined anterior/posterior surgery
- Surgical treatment for moderate and severe DCM is the preferred option; judgment and consideration of options for mild DCM