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CERVICAL ALIGNMENT



Disclosure

- Innovasis- consulting
- Spinewave- consulting
- Nuvasive- consulting, teaching
- Precision Spine- royalties
- 4-web- consulting



Agenda

- Historical significance of alignment
- Cervical parameters
- Clinical significance in ant/post fusion and disc arthroplasty

Goals of Spinal Surgery

- Decompress
- Fuse and/or stabilize
- *Preserve or restore alignment*

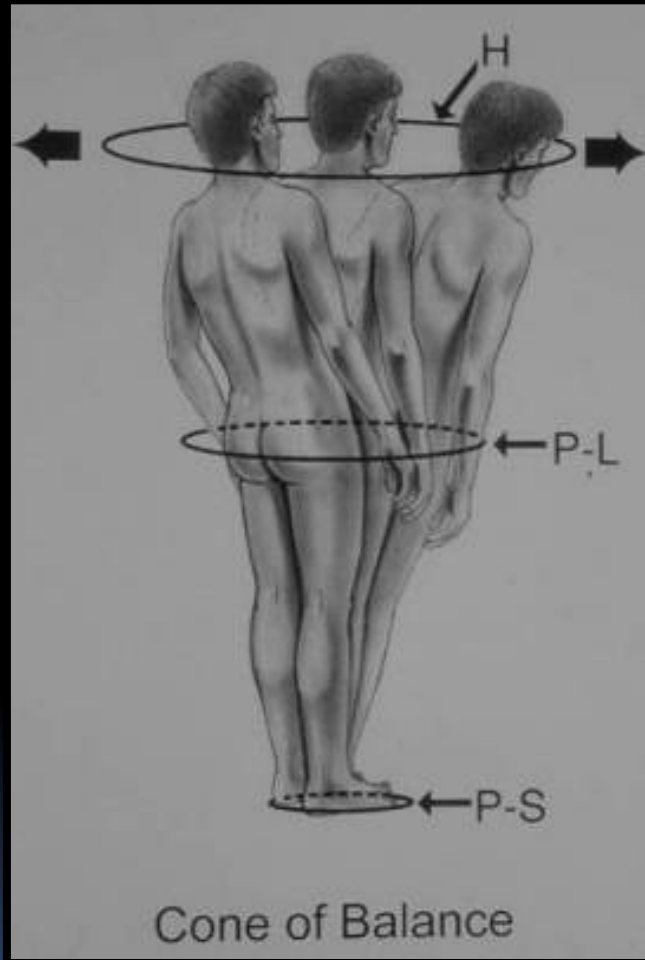


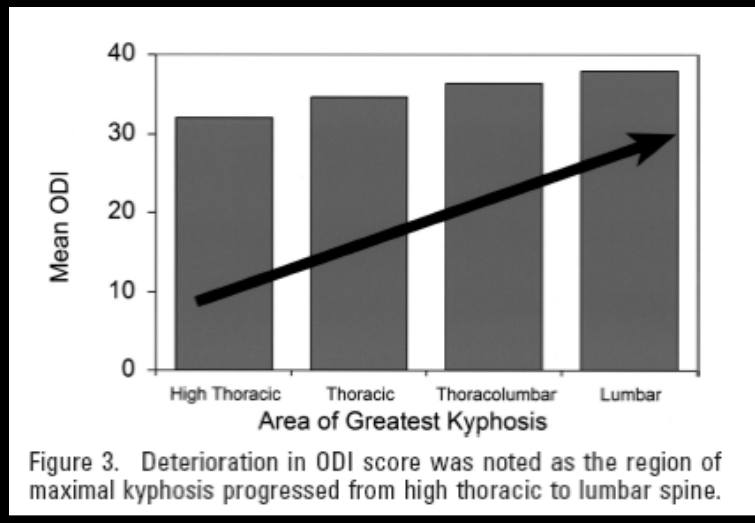
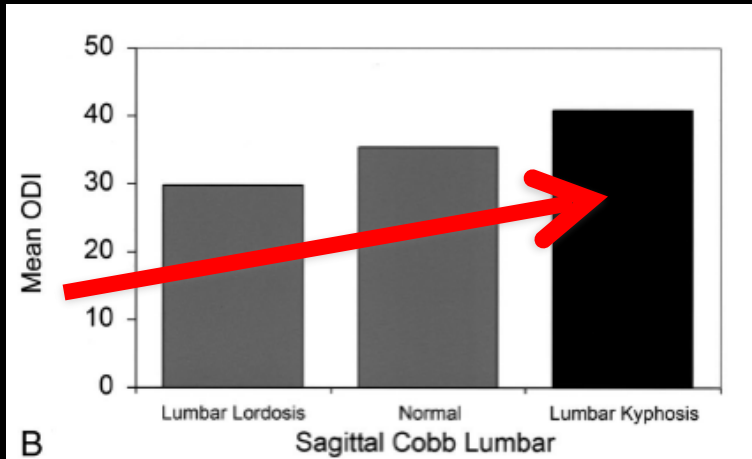
COMPENSATED
ALIGNMENT

Why is Alignment Important?

- Poor alignment = disability
- Must compensate for anatomic deformation
- Mechanical disadvantage challenges balance mechanisms

Deviation from stable zone = increased muscular/energy use





- **Loss of lumbar lordosis is especially poorly tolerated and has direct effect on disability**

Causes of Sagittal Imbalance



SPINE Volume 35, Number 25, pp 2224-2231
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Adult Spinal Deformity—Postoperative Standing Imbalance

■ Clinical Impact of Spinopelvic Alignment on Pain/Disability

Various etiologies are tied to spinopelvic malalignment; however, degenerative and iatrogenic causes comprise the majority of cases.

Schwab, *Spine*, 2010:1

- **Preservation/restoration** of lumbar lordosis is crucial to the (*clinical outcome: pain/disability*) success of any lumbar fusion.¹
- Sagittal balance is directly correlated to clinical outcome: avoid sagittal decompensation.^{1,2}
- If the clinically relevant radiographic parameters are not achieved the patient runs a **10X** higher risk of reoperation.²

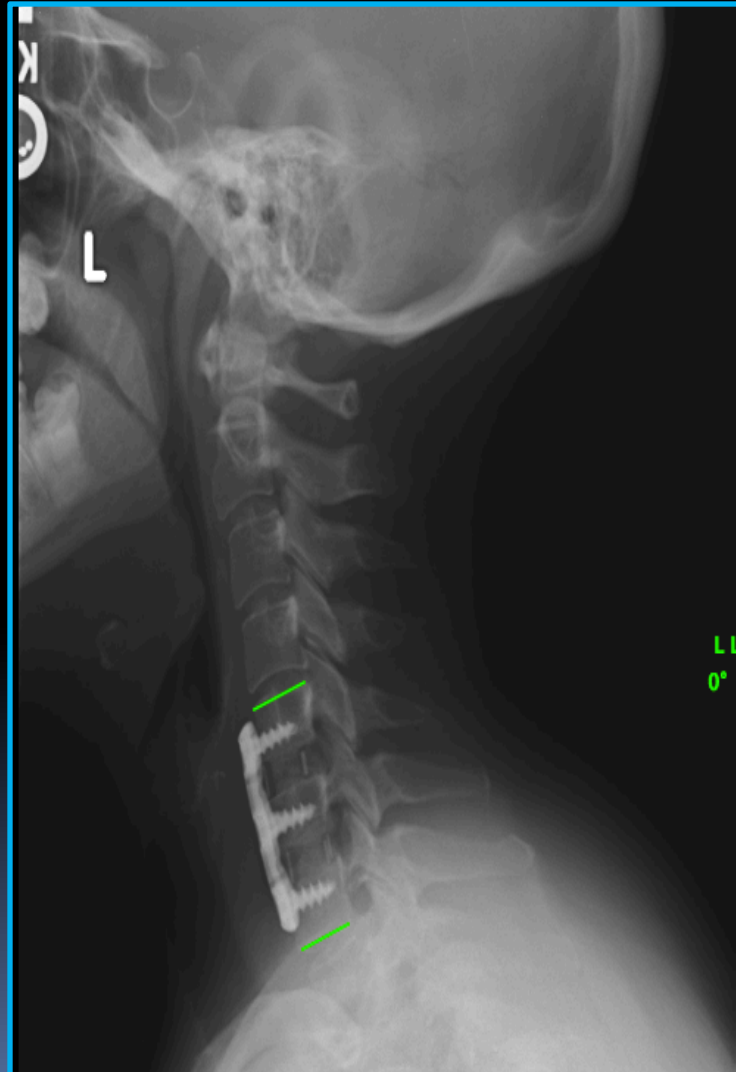


MALALIGNMENT

¹Mehta VA, Amin A, Omeis I, et al. Implications of spinopelvic alignment for the spine surgeon. *Neurosurgery* 2012;70:707-21.

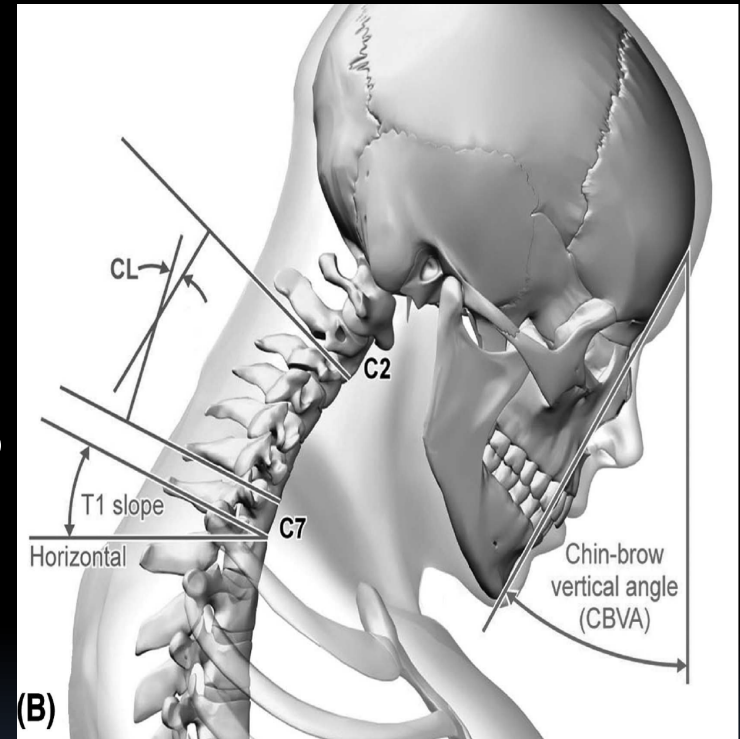
³Rothenthal DA, Mueller DA, Rothenthal E, et al. Pelvic incidence-lumbar lordosis mismatch predisposes to adjacent segment disease after lumbar spinal fusion. *Eur Spine J* 2014;Epub ahead of print.

What do we measure in the cervical spine?



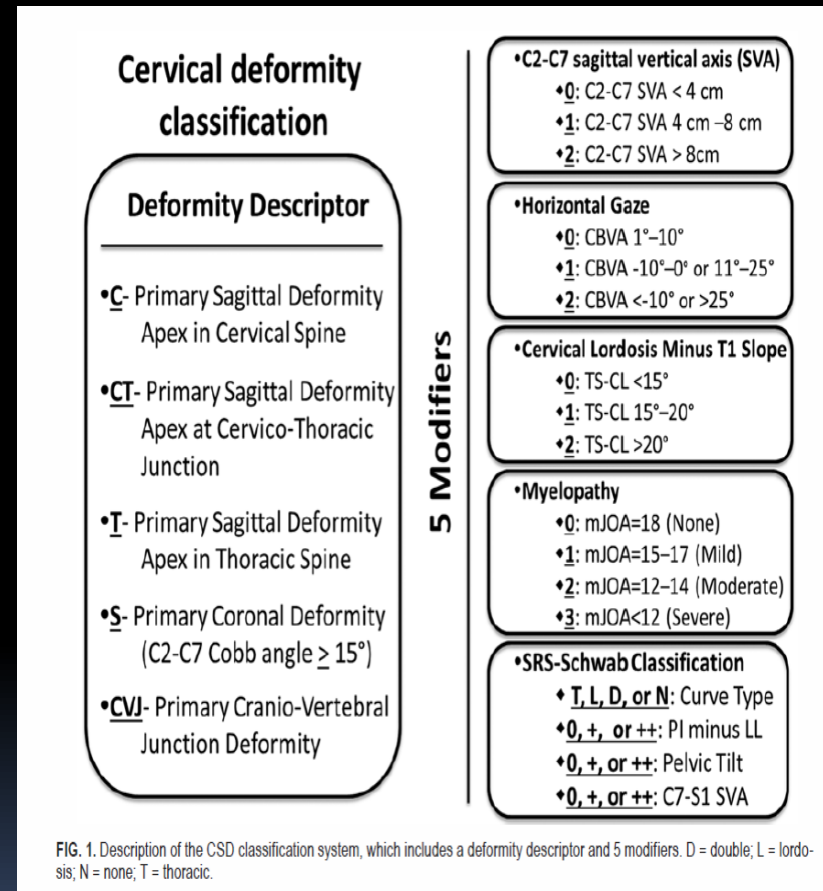
Ames, Spine 2013:!

- Chin Brow Vertical Angle (CBVA), C2-C7 SVA, and regional Cervical Lordosis (CL) should be considered
- Patients with poor alignment can develop painful compensatory mechanisms including hyperlordosis of subaxial segments



Ames J Neurosurg Spine 2015:¹

- Assess cervical spine deformity within the framework of global spinopelvic alignment



¹ Ames CP, Smith JS, Eastlack R, Blaskiewicz DJ et al. Reliability assessment of a novel cervical spine deformity classification system. *J Neurosurg Spine* 2015; 23(6):673-83.



Cervical parameters

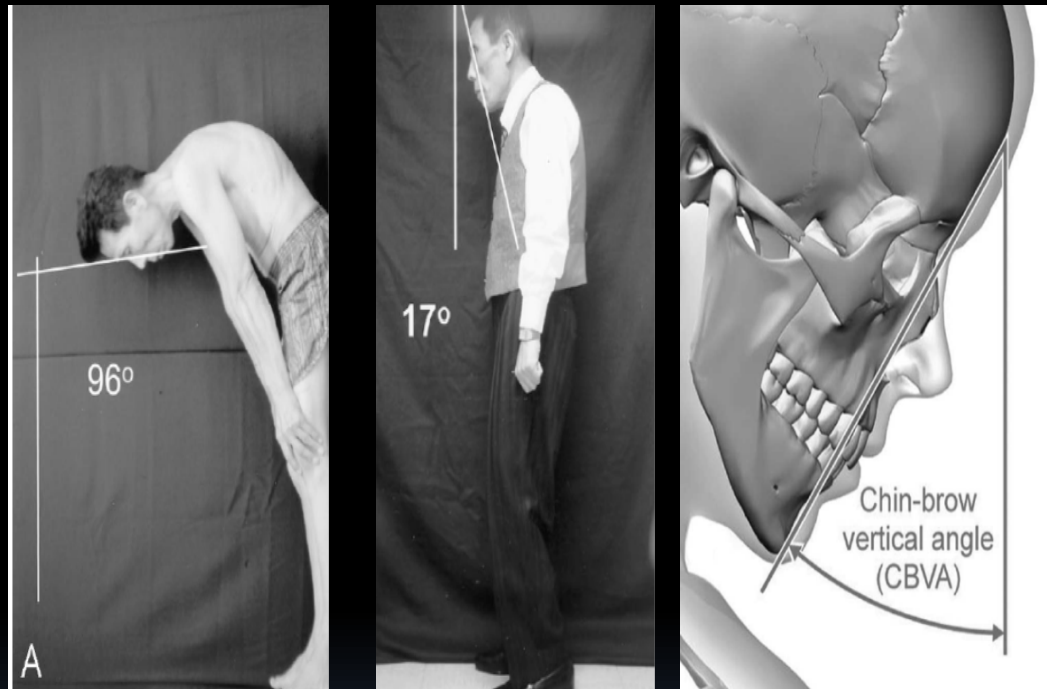
- Chin Brow Vertical Angle
- T1 slope
- Cervical Sagittal Vertical Axis
- Cervical Lordosis

Chin Brow Vertical Angle



Suk Spine 2003:¹

- Normal not defined but clinical outcomes are good if -10-+10 degrees



CBVA: measured between a line from the brow to the chin to the vertical while patient stands with hips and knees extended

¹ Suk KS, Kim KT, Lee SH. Significance of chin-brow vertical angle in correction of kyphotic deformity of ankylosing spondylitis patients. *Spine* 2003;28(17):2001-5.

T1 Slope: Is There Deformity Regionally or Globally?



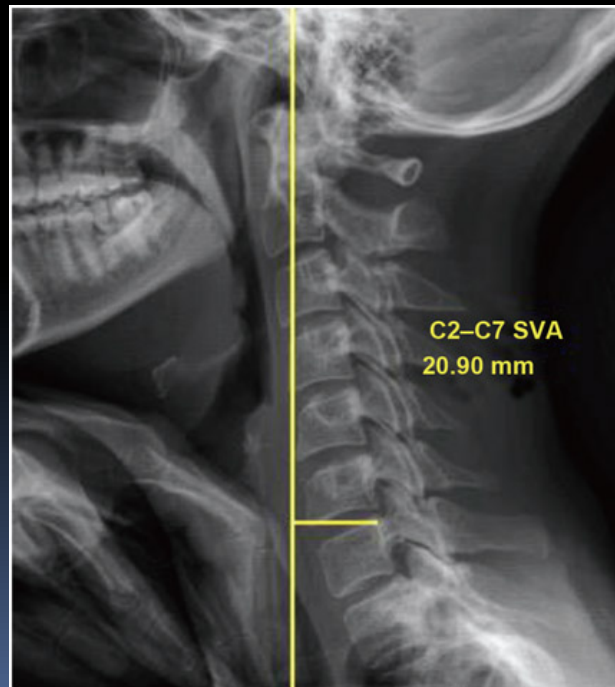
Knott Spine J 2010:¹

- Patients whose T1 tilt falls outside the range 13 to 25° should be sent for full spine radiographs
- T1 tilt
 - Angle between horizontal line and superior endplate of T1



Cervical Sagittal Vertical Axis

- Distance between plumb line dropped from centroid of C2 and posterior superior corner of C7



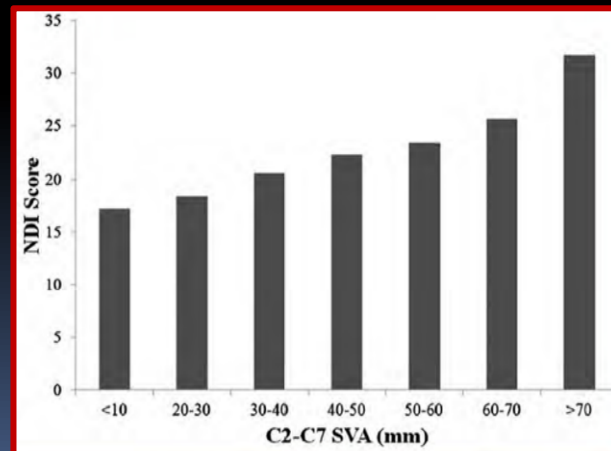
Cervical SVA

Tang Neurosurgery 2012:

- Looked at relationship to patient-reported HRQOL scores following multilevel posterior cervical fusion
- Standing radiographs needed to get true alignment assessment
- Disability increased with sagittal malalignment following surgery
- **Cervical SVA >40mm was correlated to worse outcomes assessed by NDI**

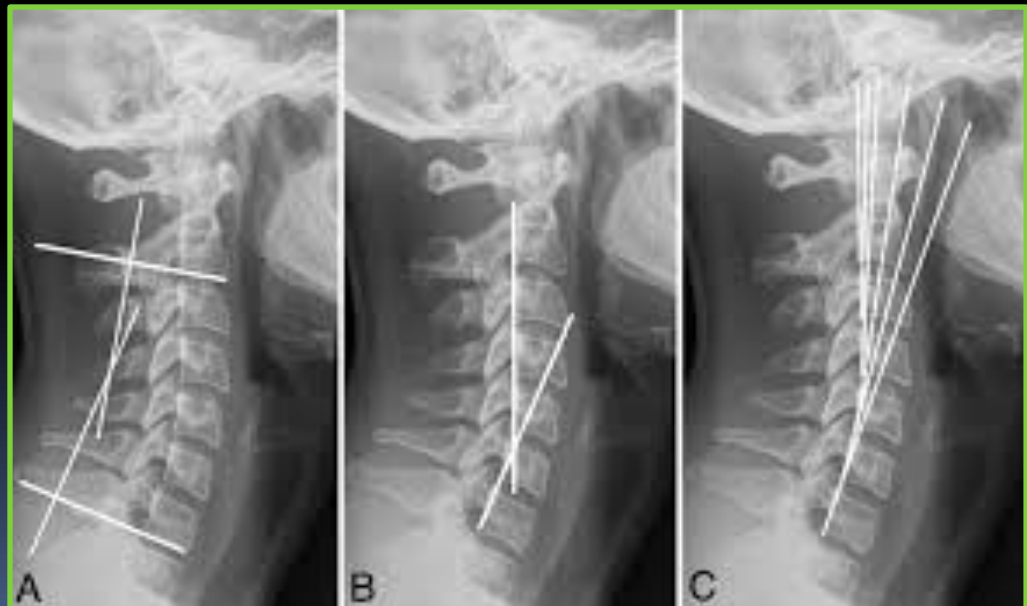


FIGURE 4. Comparison of effects of positive sagittal alignment on NDI and PCS scores. **Left,** patient with C2-C7 SVA of 20.9 mm exhibiting PCS score of 55.1 and NDI score of 3 (no disability). **Right,** patient with C2-C7 SVA of 59.2 mm exhibiting PCS score of 28 and NDI score of 37 (severe disability). SVA, sagittal vertical axis; NDI, neck disability index; PCS, physical component score.



Cervical Lordosis

- Measured from C2-C7
- Can be affected by thoracic deformity
- 20-40 degrees

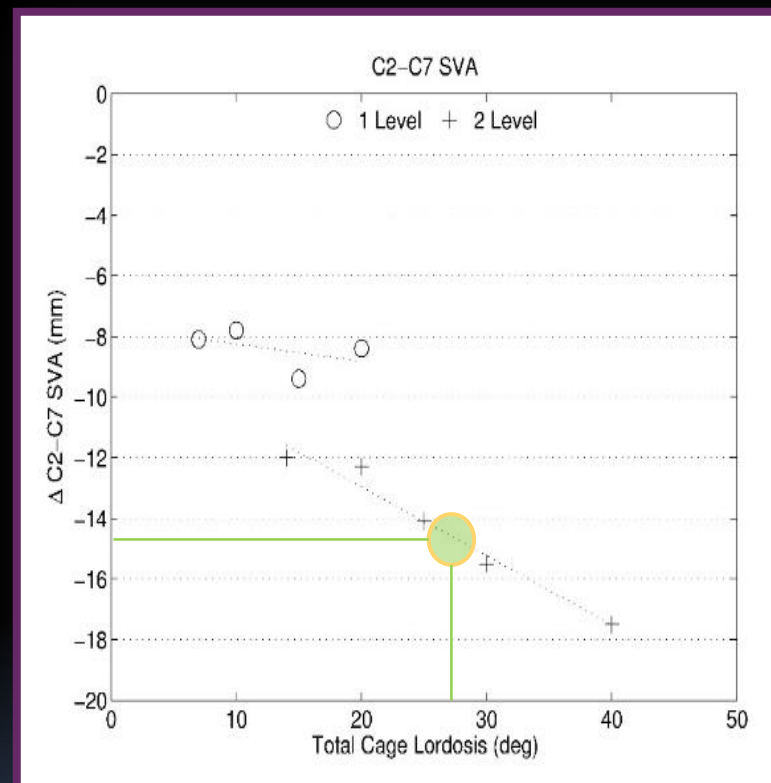


Cervical Lordosis



Blaskiewicz ISASS 2015:¹

- An increase in implant lordosis corresponds with a compensatory reduction in CSVA
- In order to reduce a 55mm CSVA to a ~40mm CSVA you would need ~25-30 degrees of implant lordosis between the two operative levels



¹ Blaskiewicz DJ, Han PP, Harris JE. Adjacent Level Lordosis Changes In The Cervical Spine Adjacent To Deformity Correction With Supraphysiologic Lordotic Implants: In Vitro Evaluation. 15th annual International Society for the Advancement of Spine Surgery (ISASS) 2015; April 15-17, 2015, San Diego, CA.



Outcomes

- Evidence against posterior alone in kyphotic cervical spine in myelopathy patients
 - 13 deg or more of kyphosis associated with worse outcome neurologically
 - Suda et al. Spine (Phila Pa 1976), 28 (2003), pp. 1258-1262
 - More recently, 8.5 deg of kyphosis

- Some have shown decreased upper extremity improvement in myelopathy if there is anterior compression of cord
- Taniyama et al. developed modified K-Line
- Distance of less than 4mm



Park Spine J 2014:¹

- The alignment of the cervical spine can affect ASD
- Those patients who did not have adequate lordosis had higher rate of adjacent segment disease



¹ Park MS, Kelly MP, Lee DH. Sagittal alignment as a predictor of clinical adjacent segment pathology requiring surgery after anterior cervical arthrodesis. *Spine J* 2014;14(17):1228-1234

- Adjacent level ossification shown to be higher in patients with kyphotic or neutral alignment





Alignment in disc arthroplasty

- Many authors have tried to assess preoperative alignment and ROM as a predictor of CDA success and decreases ASD
- A preop high T1 slope was associated with significant increase in operative ASD with Bryan disc (medtronic)
 - [Yang et al. Ther Clin Risk Manag. 2017; 13: 1119–1125](#)



How do we use all of this?

- Always get standing cervical xrays
 - Even sitting xrays can give false assessment of alignment
- Consider full length 36 in films especially if high T1 slope with normal lordosis
- CSVA correction most strongly correlated to clinical outcome
- May affect surgical plan if studies continue to support its relevance as it has in thoracolumbar spine



- Further study needed specifically looking at clinical outcome and ASD with cervical disc arthroplasty



THANK YOU

