




CERVICAL SESSION:
Should We All Be Using Low-Dose
Total Body Imaging Technology for
Spinal Alignment?

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SELBY SPINE CONFERENCE
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DISCLOSURES

- Nuvasive: Royalties, Consulting, Research Support, Advisory Board,
- K2M: Royalties, Consulting
- Allosource: Scientific Advisory Board
- SDSF: Board of Directors
- GSO: Board of Directors

OBJECTIVES

- 1. Identify the cervical parameters that matter most**
 - When do I need full length films?
- 2. Understand the value of low dose radiation full body Imaging**

MEASUREMENT SPAGHETTI

- Every month there is a measurement for a new/"novel" measurement
- How do we make sense of all these parameters
- Need to rationally think through the pathology and therefore what is needed

Journal of Orthopaedic Surgery, University of Toronto, 15th Annual Meeting of the International Spine Study Group (ISSG)

Sagittal Parameters

1. **Cervical lordosis**
 1. Cobb angles
 2. Jackson's physiologic stress lines
 3. Harrison Tangent Method
2. Cervical sagittal vertical axis (CSVA)
 1. C2-C7 SVA
 2. C2-S1 SVA
 3. COG of head-C7 SVA
3. Chin brow vertical angle (CBVA)
4. Highlight available normal values
5. T1 Slope
6. Cervical spinal cord tension in deformity (myelopathy)

Cervical Lordosis: Cobb Angle (C2-C7)

- Pro's
 - Clinical mainstay
 - Easy to use
 - Reliable readings
- Con's
 - - Does not measure interdiscal lordosis

Impact of Cervical Sagittal Alignment Parameters on Neck Disability

Sravish Iyer, MD,* Venu M. Nemani, MD, PhD,* Joseph Nguyen, MPH,* Jonathan Elysee,* Aomicha Burapachaisri,* Christopher P. Ames, MD,[†] and Han Jo Kim, MD^{1,†}

● **CL and NDI**

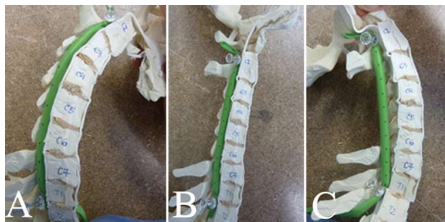
Jackson Physiologic Stress Lines

- Angle between parallel
- lines drawn along
- posterior surfaces of C2
- and C7 vertebral bodies.

Harrison Posterior Tangent Method

- Segmental angles are summed up
- Measures change in lordosis per level
- Time consuming

Cord Tension



J Neurosurg: Spine / Volume 19 / August 2013

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Cervical Sagittal Vertical Axis



- Directly correlated with HRQOL, in which larger C2 SVA relates to poor HRQOL

Tang, et al.

Normal Cervical SVA Values in Asymptomatic Adults

- Much Less variability

Odontoid marker at C7	15.6 ± 11.2 mm
Odontoid marker at sacrum	13.2 ± 29.5 mm

Hardacker JW, Shuford RF, Capicotto PN, et al. Radiographic standing cervical segmental alignment in adult volunteers without neck symptoms. *Spine* 1997;22:1472-80;discussion 80.

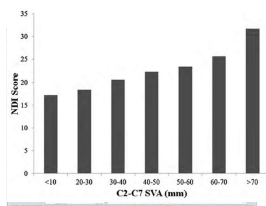
The Impact of Standing Regional Cervical Sagittal Alignment on Outcomes in Posterior Cervical Fusion Surgery

Neurosurgery 71:662-669, 2012

● **Study Design:** Retrospective radiographic and clinical assessment of 113 patients treated with multilevel posterior cervical fusion for cervical stenosis, myelopathy, and kyphosis.

● **Results:**

- C2-C7 SVA correlated with SF-36 PCS (r=-0.43, p<0.001)
- CGH-C7 SVA correlated with SF-36 PCS (r=-0.36, p=0.005)
- C2-C7 SVA correlated with NDI (r=0.20, p=0.036)
- C2-C7 SVA correlated with C1-C2 lordosis (r=0.33, p=0.001)



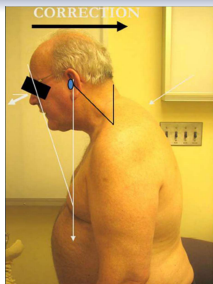
● **Threshold value C2-C7 SVA of -40 mm, beyond which correlations were most significant**

Tang JA, Scheer JK, Smith JS, et al. The impact of standing regional cervical sagittal alignment on outcomes in posterior cervical fusion surgery. *Neurosurgery* 2012;71:662-9;discussion 9.

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Chin-Brow Vertical Angle

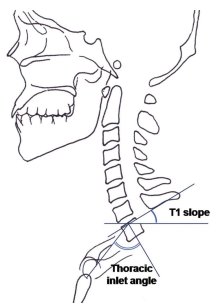


● Has been shown to be associated with positive postoperative outcomes, such as improved gaze, ambulation, and activities of daily living.

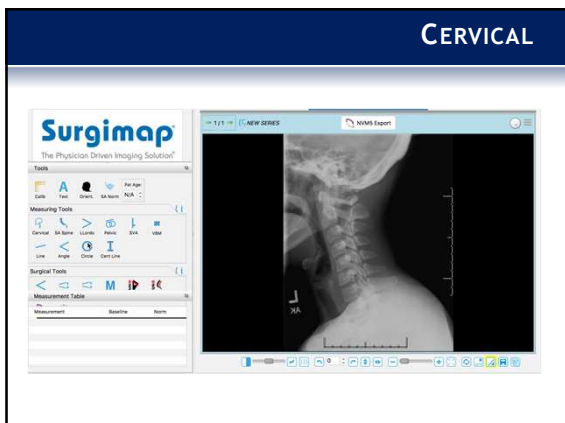
Sagittal Parameters

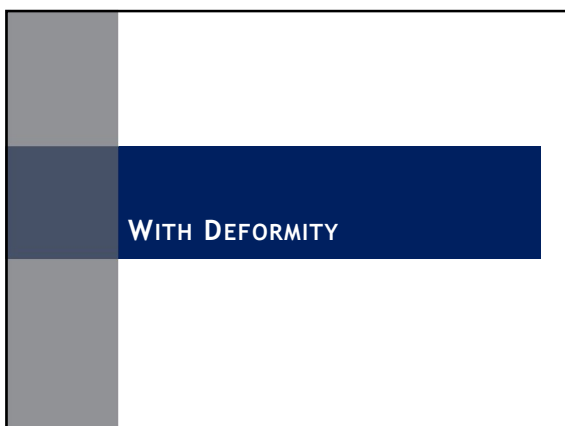
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T1 Slope



● Angle between horizontal line and superior endplate of T1





COMMENTARY

Subaraman Ramchandran, MBSCh^{*}
 Justin S. Smith, MD, PhD^{*}
 Tamir Allon, MD^{*}
 Eric Klineberg, MD^{*}
 Christopher Shaffrey, MD^{*}

Assessment of Impact of Long-Cassette Standing X-Rays on Surgical Planning for Cervical Pathology: An International Survey of Spine Surgeons

- Have a low threshold to get 36" x-rays
- Surgical plan changed dramatically with addition of long cassette x-rays
- If there is t-kyphosis present get them
- If the T1 Slope is > 30 degrees get them
 - Klineberg et al.

Smith et al., Neurosurgery, 2016

FIGURE 3. Change in the mean response rates on addition of full-length standing radiographs. Increased slope indicates greater increase in the mean response rate. Slopes are plotted for cervical cases 10 (red line), cases 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100. Color scheme available online only.

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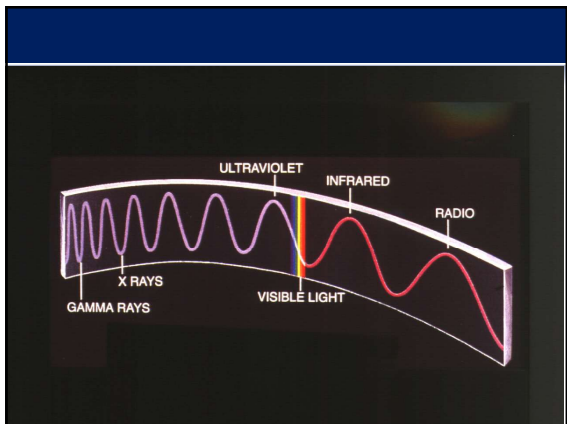


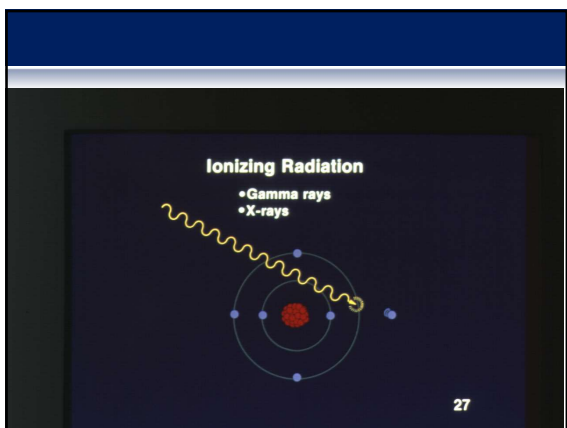
FIGURE 2. Examples of control and test case imaging. Shown are coronal imaging of a sample control case (A), standing long-cassette radiograph of the same control case showing normal global alignment (B), coronal imaging of a sample test case (C), and standing long-cassette radiograph of the same test case showing significant upper thoracic kyphosis (D).

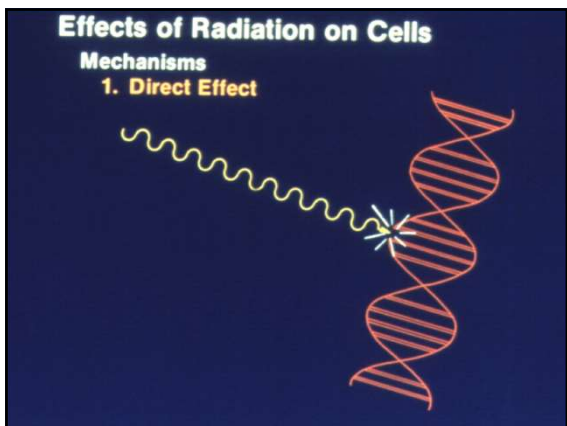
DEGENERATIVE DEFORMITY

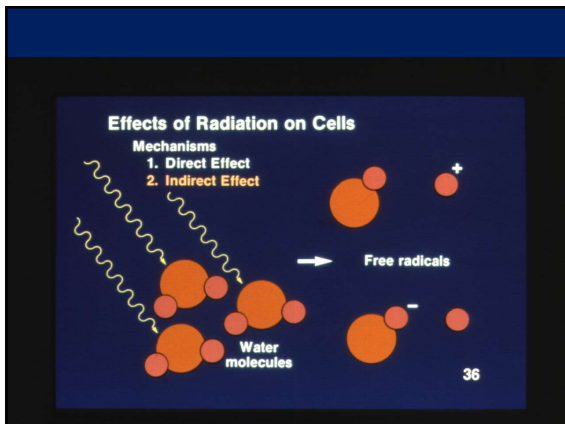


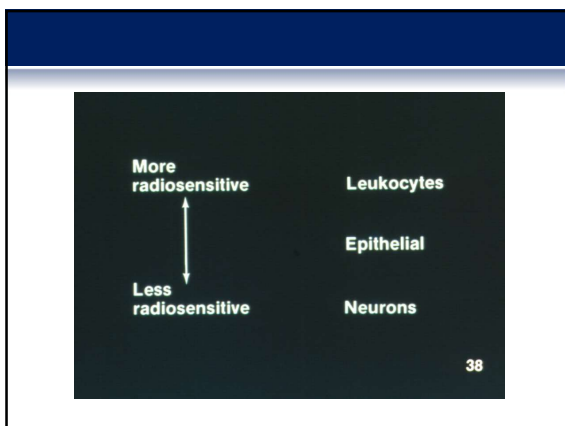
OBJECTIVE 2: THE VALUE OF LOW DOSE FULL BODY IMAGING

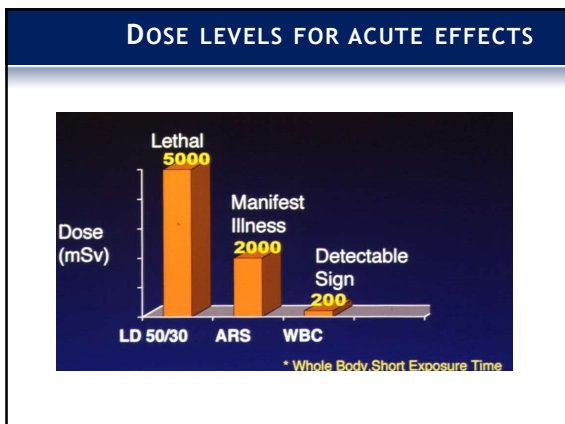












BACKGROUND RADIATION PER YEAR

Radon	2.0	3.0 Natural
Internal	.4	
Terrestrial	.3	
Cosmic	.3	
Dx Medical	.4	.6 Man-Made
Nuc. Medical	.1	
Cons. Prod.	.1	
3.6 Total		



DOSES BY EXAM

EXAM	BONE MARROW DOSE (mRad)	Gonadal Dose (mRad)	
		Male	Female
Skull	10	<1	<1
C-Spine	20	<1	<1
Chest	2	<1	<1
Abdomen	30	100	200
L-Spine	60	175	400
Pelvis	20	300	150
Extremity	2	<1	<1

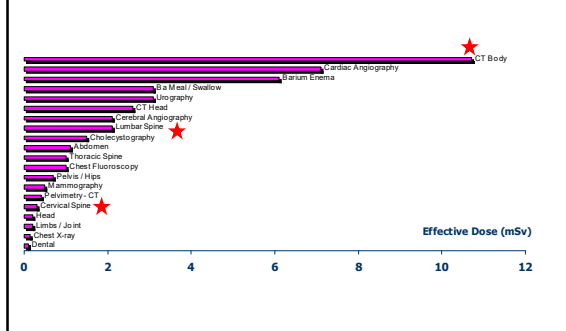
Summary of the National Council on Radiation Protection & Measurements

OCCUPATION EXPOSURE			
1. Effective Dose Limits.	a. Annual	50mSv	5 rem
	b. Cumulative	10mSv x age	1 rem x age
2. Equivalent Dose Annual Limits for Tissues and Organs	a. Lens of the eye	150mSv	15 rem
	b. Localized area of the skin, hands and feet.	500mSv	50 rem

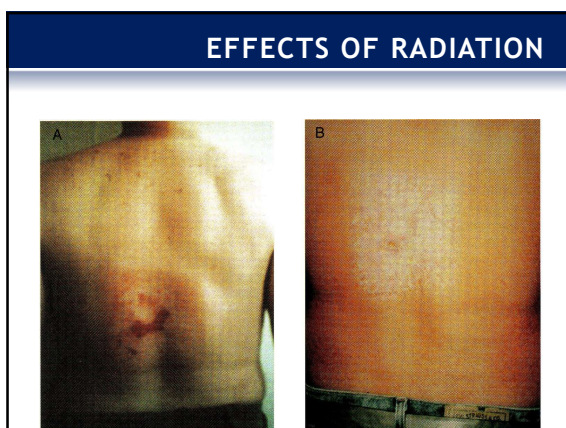
Summary of the National Council on Radiation Protection & Measurements

PUBLIC EXPOSURE (Annual)			
1. Effective dose limits, continuous or frequent exposure.		1 mSv (0.1 rem)	
2. Effective dose limits, infrequent exposure		5 mSv (0.5 rem)	
3. Equivalent Dose Annual Limits for Tissues and Organs	a. Lens of the eye	15mSv (1.5 rem)	
	b. Localized area of the skin, hands and feet.	50mSv (5.0 rem)	
4. Negligible individual dose (annual)		0.5 mSv (0.05 rem)	

Typical Doses during Radiographic Examinations



EFFECTS OF RADIATION		
Early and Delayed Manifestations of Radiation Injury ⁴		
Tissue/Cell Type	Early	Delayed
Radiosensitive epithelial and parenchymal cells	Necrosis, primarily of stem cells	Ischemic atrophy; ulceration; impaired stem cell reserves; atypia, dysplasia and neoplasia
Vessels	Dilatation; necrosis of endothelial cells; increased vascular permeability	Sclerosis of small arteries and arterioles; capillary telangiectasia; hypertrophy of endothelial cells
Stroma	Edema	Fibrosis; collagen deposition; abnormal fibroblasts



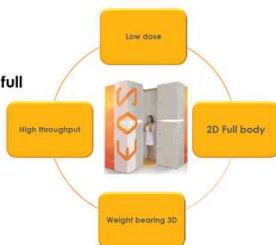
- PRINCIPLES OF SAFETY**
- Reduce **TIME** of exposure
 - Increase **DISTANCE** from the source
 - Make use of available **SHIELDING**

WHAT IS LOW DOSE FULL BODY XRAY?

EOS is a **new modality** for orthopedic imaging

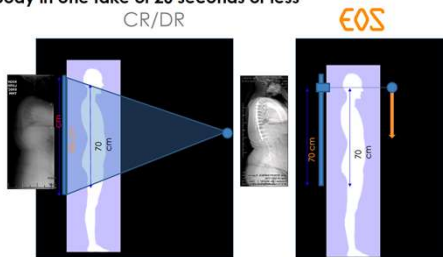
EOS offers to Radiologists and Orthopedists, for the first time, a **full view of the patient's** skeleton :

- in life size,
- weight bearing
- with a significant dose reduction



HOW DOES IT WORK?

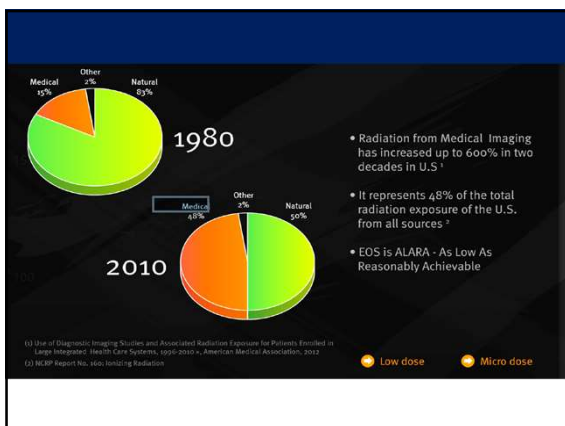
- Scanning suppresses projection zoom errors
- Full body in one take of 20 seconds or less

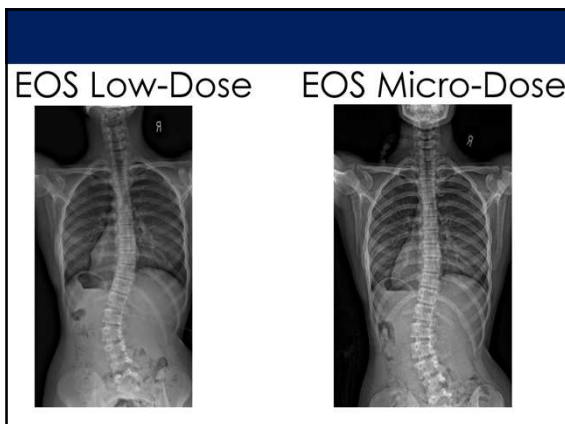


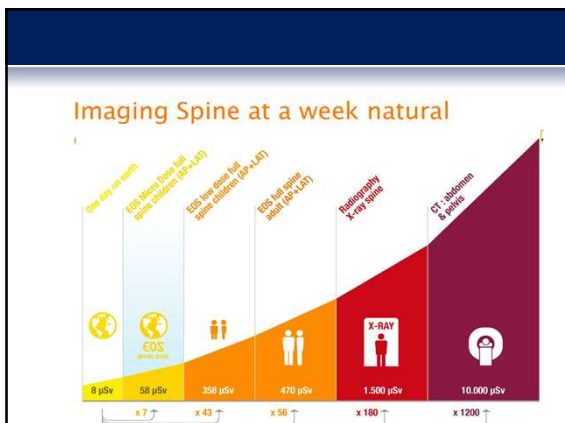
PRACTICALLY WHAT DOES IT MEAN?

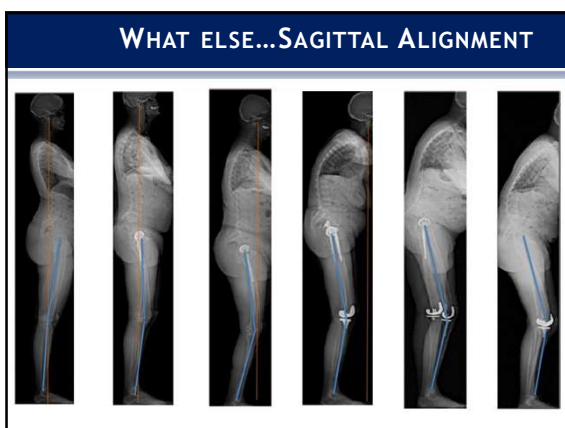


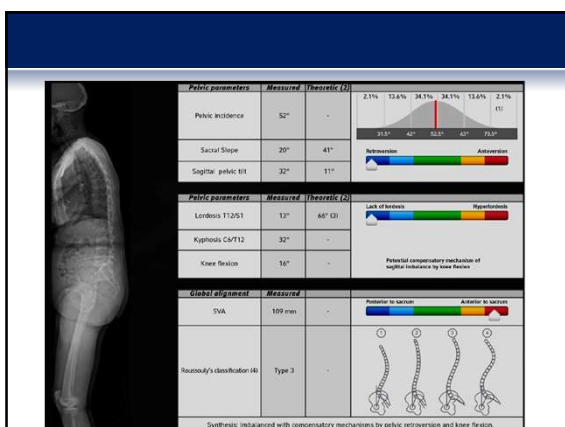








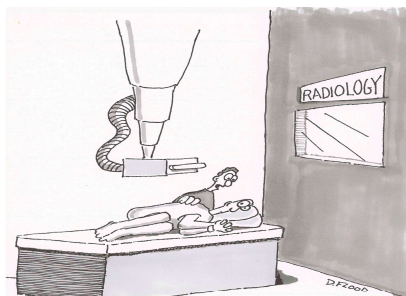




CONCLUSIONS

1. T1 slope >30 degrees get full length film
2. Exagerated kyphosis get full length film
3. When in doubt get full length film...level 5 data
4. IF you need a full length film...use the low does option

THANK YOU!



Take a deep breath and relax while I get the hell out of here.
