

## DIAGNOSTIC VIDEOFLUOROSCOPY IMPRESSIONS and BIOMECHANICS REPORT

**Patient Name:** Ima Wreck

**Date of Birth:** 10/20/19

**Date of Accident:** 05/06/2013

**Date of Digitization and Report:** 12/13/2014

**DMX was obtained:** 12/13/2014

**Referring Physician:** Smart Doc, X.X..

**HISTORY:** Motor vehicle collision (MVC), rear-end impact; post-trauma neck pain and headaches, suspected spinal ligament injury.

**STUDY:** DMX views of the cervical spine include: Lateral Nodding, Lateral Flexion & Extension, Oblique Flexion & Extension, A-P Lateral Bending, A-P Rotation, A-P Open Mouth Lateral Bending.

**FINDINGS:** The neutral lateral film demonstrates straightening of the lordotic curve. Mild intervertebral disc space narrowing noted at C5-6; otherwise, remaining disc spaces are well maintained. Minimal anterior spur formation noted at C5; otherwise, remaining vertebral bodies, arches, and processes are of normal size, shape, and dimension. The odontoid process is intact and the ADI is within normal limits. No cervical ribs are identified. There is no evidence of acute fracture or lytic change. The surrounding soft tissues as visualized are unremarkable.

The lateral film demonstrates excess posterior angulation at C2-3 during extension, indicative of spinal ligament laxity. Motion in the A-P Open Mouth lateral bending projection shows excess lateral translation of C1 on C2 bilaterally.

The lateral flexion and extension films demonstrate excess total anteroposterior translation at C2-3 indicative of Alteration of Motion Segment Integrity (AOMSI). Interruption in George's Line noted at C2-3 due to anterolisthesis during flexion, as well as at C3-4 due to retrolisthesis during extension, consistent with intersegmental ligamentous instability.

Motion is unremarkable in the A-P lateral bending, A-P rotation, Right and Left Oblique flexion and extension, and lateral nodding projections. Intervertebral hypermobility described above related to annulus and/or ligamentous injury due to stretching and/or tearing and is consistent with trauma sustained due to a motor vehicle collision. Clinical correlation of abnormal findings advised.

### IMPRESSION:

- 1. Excess posterior angulation during extension at C2-3, consistent with spinal ligament laxity.**
- 2. Angular variation values at C2-3 indicative of AOMSI.**
- 3. George's Line interruptions noted at C2-3 and C3-4 suggest ligamentous instability.**
- 4. Excess lateral translation of C1 on C2 bilaterally, consistent with atlantoaxial ligamentous laxity.**
- 5. Postural changes described above.**
- 6. Degenerative changes described above.**

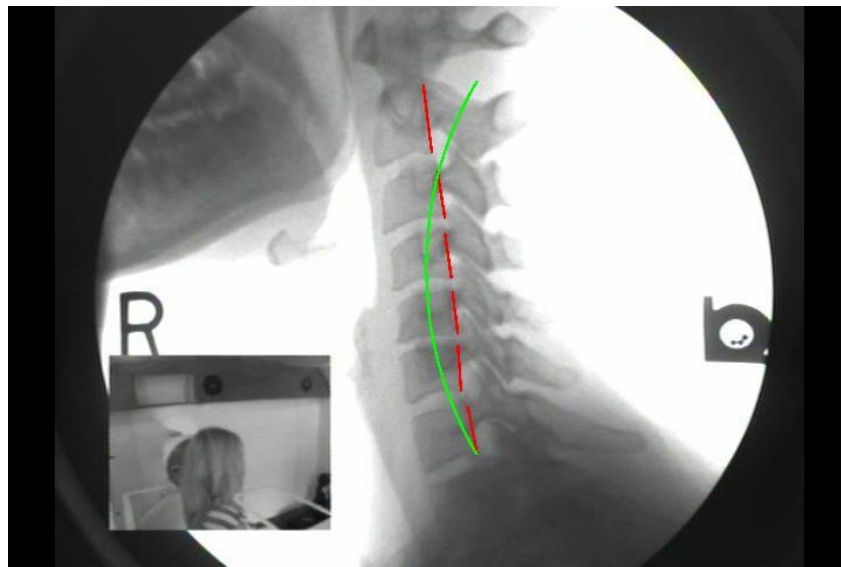
**NOTE:** The computerized analysis of this patient's DMX appears to have been performed correctly and corresponds to my own interpretation of the study.

**I C Bones, M.D.**

**Board Certified Diagnostic Radiologist**

## Lateral Cervical, Flexion/Extension

### Neutral Lateral

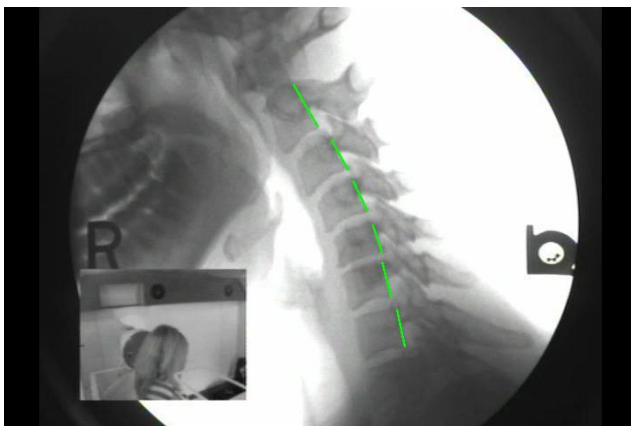


Anterior

Posterior

- This colored line represents the patient's position and the path of the posterior longitudinal ligament.
- This colored curved line represents the Normal Spinal Position and expected path of the posterior longitudinal ligament.

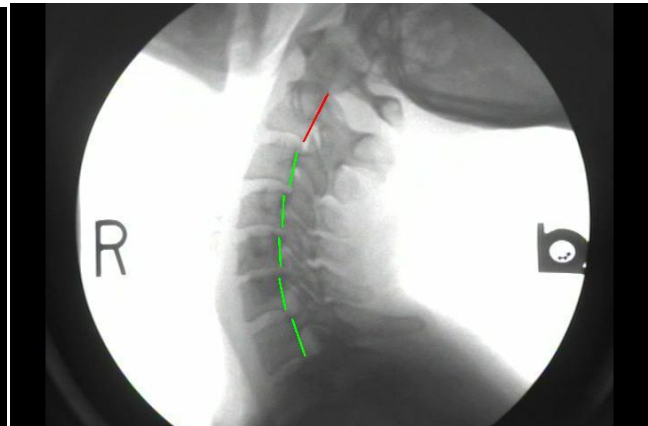
### Flexion



Anterior

Posterior

### Extension



Anterior

Posterior

- This colored line represents the path of the posterior longitudinal ligament and exceeds normal allowable segmental motion indicating ligament laxity.<sup>1-5</sup>
- This colored line is the path of the posterior longitudinal ligament and appears to be stable with no significant ligamentous laxity.

## Intervertebral Angulation

| Segment | Flexion | Extension | Normal Limit <sup>1</sup> | Ratable Limit <sup>2</sup><br>(Angular Variation) |
|---------|---------|-----------|---------------------------|---|
| C2-C3   | 0.9°    | -14.6°    | 7.0°                      | 11.0°   |
| C3-C4   | 3.6°    | -9.6°     | 7.0°                      | 11.0°   |
| C4-C5   | 6.9°    | -6.0°     | 7.0°                      | 11.0°   |
| C5-C6   | 4.1°    | -8.4° *   | 7.0°                      | 11.0°   |
| C6-C7   | 2.3°    | -7.6°     | 7.0°                      | 11.0°   |

## Intervertebral Translation

| Segment | Flexion | Extension | Total A-P Translation <sup>2</sup> | Normal Limit <sup>1</sup> | Ratable Limit <sup>2</sup> |
|---------|---------|-----------|------------------------------------|---------------------------|----------------------------|
| C2-     | 2.4 mm  | -1.7 mm   | 4.1 mm *                           | 1.0 mm                    | 3.5 mm                     |
| C3-     | 0.3 mm  | -2.5 mm   | 2.9 mm                             | 1.0 mm                    | 3.5 mm                     |
| C4-     | 0.1 mm  | -1.8 mm   | 2.0 mm                             | 1.0 mm                    | 3.5 mm                     |
| C5-     | -1.0 mm | -1.6 mm   | 0.6 mm                             | 1.0 mm                    | 3.5 mm                     |
| C6-     | 1.1 mm  | 1.1 mm    | 0.0 mm                             | 1.0 mm                    | 3.5 mm                     |

\*Outside Ratable Limits

**Impressions and Assessment**

During extension, excess intervertebral angulation causes widening of the anterior intervertebral disc/joint space is noted at the C2-C3 level. This finding indicates possible damage to the anterior longitudinal ligament and/or intervertebral disc at that level.<sup>2-3</sup>

There is probable damage to the anterior and posterior longitudinal ligaments and/or intervertebral disc as indicated by the increased total anteroposterior translation of the **C2-C3\*** level.<sup>2</sup>

Segmental flexion instability is noted at the following segments: None

Segmental extension instability is noted at the following segments: C2-C3

Segmental translational instability for flexion is noted at the following segments: None

Segmental translational instability for extension is noted at the following segments: None

Segmental instability for excess total anteroposterior translation: **C2-C3\***

**\*According to the above biomechanical assessment, there are findings of Alteration of Motion Segment Integrity (AOMSI). Consequently, this patient may be ratable for a permanent injury upon reaching maximal medical improvement.**

<sup>1</sup> Lin RM, Tsai KH, Chu LP, Chang PQ. Characteristics of sagittal vertebral alignment in flexion determined by dynamic radiographs of the cervical spine. SPINE 2001, February; 26(3): (256-261).

<sup>2</sup> Guide to the Evaluation of Permanent Impairment, 5th Edition, American Medical Association, 2001

<sup>3</sup> Griffiths HJ, Olson PN, Everson LI et al. Hyperextension strain or "whiplash" injuries to the cervical spine. Skeletal Radiol. 1995;24:263-6.

<sup>4</sup> White, A.A., Johnson, R.M., Panjabi, M.M., and Southwick, W.O.: Biomechanical analysis of clinical stability in the cervical spine. Clin Ortho, 109:85, 1975.

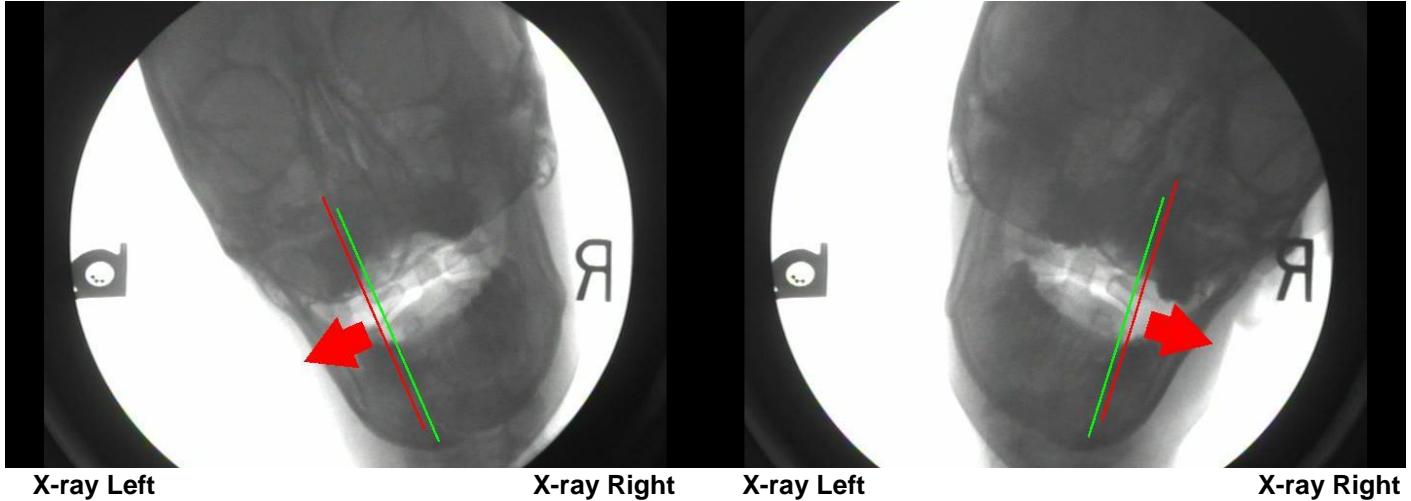
<sup>5</sup> White AW, Panjabi MM., Clinical Biomechanics of the Spine. 2<sup>nd</sup> ed. Philadelphia, Pa: JB Lippincott; 1990

## A-P Open Mouth Lateral Bending

Left Lateral Flexion

Right Lateral

Flexion



- The red line represents the position of the atlas lateral mass in the side bending position.
- The green line represents the position of the Axis superior articular process.

*Shifting of the red line from green greater than 1.7mm is indicative of subluxation. <sup>6</sup>*  
*Clinical correlation is advised with shifting greater than 1.7mm. <sup>6</sup>*  
*Shifting of greater than 3.0mm laterally indicates laxity of the Alar and/or Accessory ligaments. <sup>7-10</sup>*

### Lateral Translation Values, C1 on C2 During Lateral Cervical Flexion

|                                    | Patient's Values<br>Significance | Clinical                             |
|------------------------------------|----------------------------------|--------------------------------------|
| C1-C2 Lateral Translation -- Left  | <b>3.4 mm</b>                    | C1-C2 Ligamentous Laxity/Instability |
| C1-C2 Lateral Translation -- Right | <b>3.2 mm</b>                    | C1-C2 Ligamentous Laxity/Instability |

### Impressions and Assessment

The patient has a C1-C2 Left Translation of **3.4 mm** and a C1-C2 Right Translation of **3.2 mm**. This displacement overhang of C1 on C2 indicates laxity of the Alar and/or Accessory ligaments.

<sup>6</sup>Krakenes J, Kaale BR, Moen G, Nordli H, Gilhus NE, Rovik J. MRI assessment of the alar ligaments in the late state of whiplash injury-structural abnormalities and observer agreement. *Neuroradiology* 2002 Jul;44(7): 617-24.  
<sup>7</sup>Hohl M, Baker HR: The atlanto-axial joint. *J Bone Joint Surg [Am]* 46:1739, 1964.  
<sup>8</sup>Porterfield JA, DeRosa C. *Mechanical Neck Pain: Perspectives in Functional Anatomy*. Philadelphia, Pa: WB Saunders Co; 1995  
<sup>9</sup>Louis R: *Stability and instability of the cervical spine. Cervical Spine I*. Chicago, Springer-Verlag, 1987  
<sup>10</sup>Panjabi MM, Summers DJ, Pelker RR, et al: Three dimensional load displacement curves due to forces on the cervical spine. *J Orthop* 4:152-161, 1986  
 The patient's Dynamic Motion X-rays were obtained by Arizona Digital Motion X-Ray, Inc.  
 Films were digitized and computer-analyzed by Precision Spinal Diagnostics, PLLC.  
 X-Ray digitization for spinal biomechanics has been shown to be valid when compared to standard hand drawn methods.  
 The X-Ray mensuration method used in analyzing this patient have been studied for reliability and validity.