Documenting Ligament Laxity and Spinal Impairment Using The AMA Guides

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What is Ligament Laxity?

- Ligament laxity is a loss of functional stability between two adjacent vertebra.
- It is described in the *AMA Guides to the Evaluation of Permanent Impairment*, 3rd, 4th, 5th and 6th Editions
- It is an <u>objective finding</u> based not on opinion but on <u>mathematical modeling</u>.
- When identified it represents a 25-28% whole body impairment.

Is Ligament Laxity a Common Finding in Sudden Impact Injuries?

- In a sample of 588 patients involved in sudden impact injuries 65% demonstrated one level of ratable impairment.
- 26% demonstrated two or more levels of ligament instability.

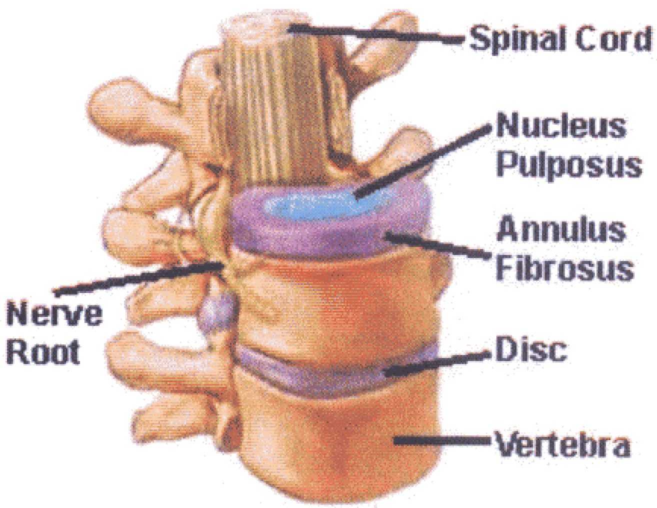
What Does AOMSI Mean to the Patient
(Alteration of Motion Segment Integrity)

- Ligament laxity identifies a patho-kinematic abnormality that alerts a doctor to use precautionary treatment procedures
- In some instances surgical intervention may be required to stabilize the motion segment
- It informs the patient as to the current extent of injury and to potential future consequences
- It provides the treating doctor a biomechanically accurate diagnosis to create a long-term treatment plan to ensure stabilty
- When litigation is involved it objectively identifies injury independently of a positive or negative MRI. It creates the opportunity for fair and equitable settlements based upon insurance carrier algorithms.

Why is Functional Stability Important?

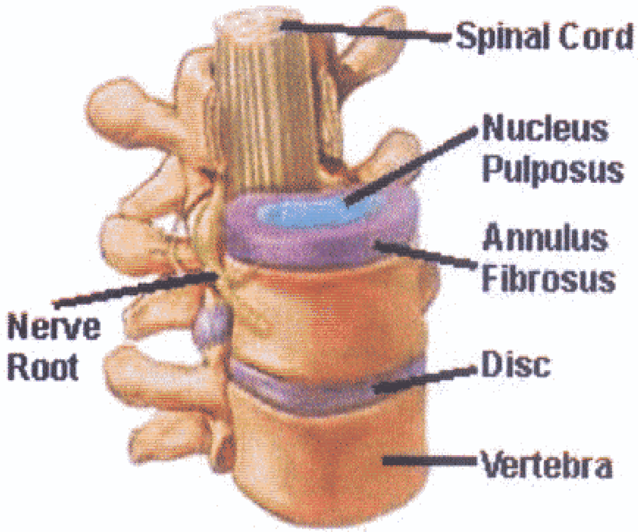
- The spine is a multi-component semi-rigid elastic structure
  - Semi-rigid is an engineering term describing the nature and properties of a single material or the behavior of a system of mixed materials.
- The spinal column is a system of mixed materials consisting of alternating rigid vertebra and interconnected by elastic ligaments.
- In a sequential and alternating combination, the vertebra and ligaments transmit forces and limit motion while sharing and minimizing forces imposed on the system .

The Anatomy of the Motion Segment



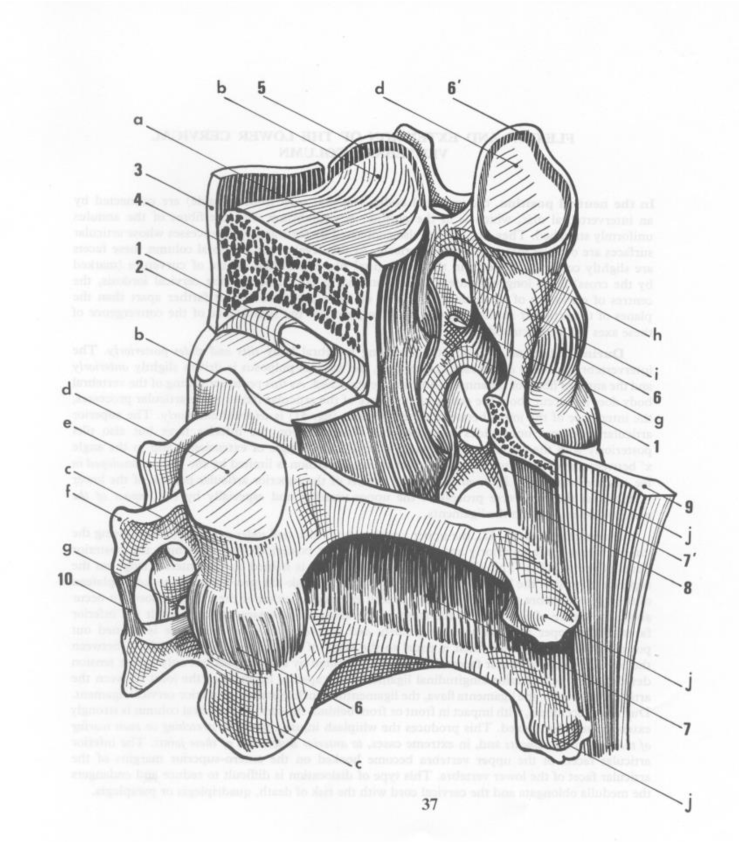
- The term <u>motion segment</u> is used to define the smallest functional unit of the spine.
- The motion segment includes <u>any two adjacent vertebra</u> and the <u>inter-connecting ligaments</u>
- The range and direction of each vertebral motion unit is dictated by the shape of the joint articulation
- The ligaments strength, elasticity and integrity confine joint motion to protect the biomechanical stability of each vertebral unit

Motion Segment Anatomy: Primary Structures



- The vertebra are inter-connected by the strongest ligaments in the body, the strongest are the discs
- The primary role of the disc is to transfer forces and motions through the spine
- The disc attaches to the top and bottom of each vertebra across the whole surface area of the vertebra. The disc never slips
- The disc provides continuity of the vertebra to function as a continuous structure

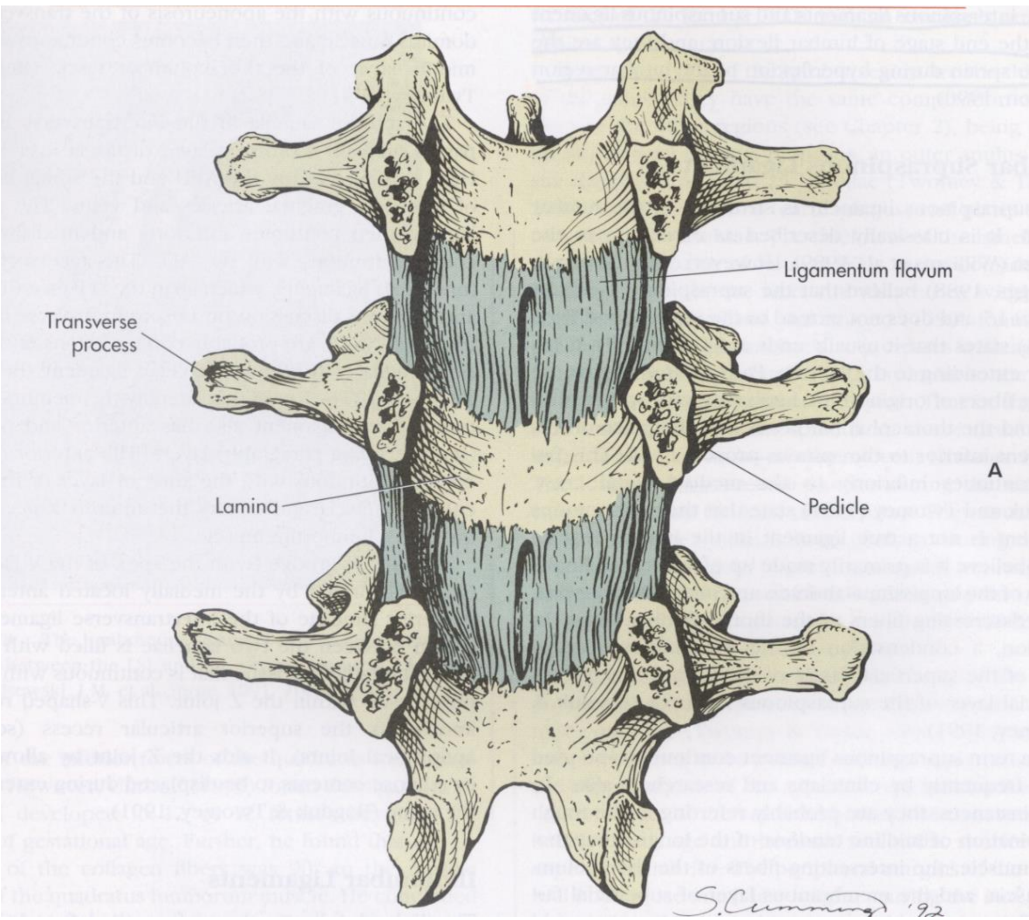
Surrounding Ligaments: Secondary Structures



- Each vertebra is surrounded by seven common ligaments
  1. Anterior longitudinal
  2. Posterior longitudinal
  3. Ligamenta flava
  4. Inter-spinous
  5. Supra-spinous

  6-7. Two (2) inter-transverse
- Any and every motion engages multiple ligaments into a resistive state

Ligamentum Flavum



- The ligamentum Flavum illustrates the completeness of an intact ligament system to confine and restrict motion from one vertebra to another

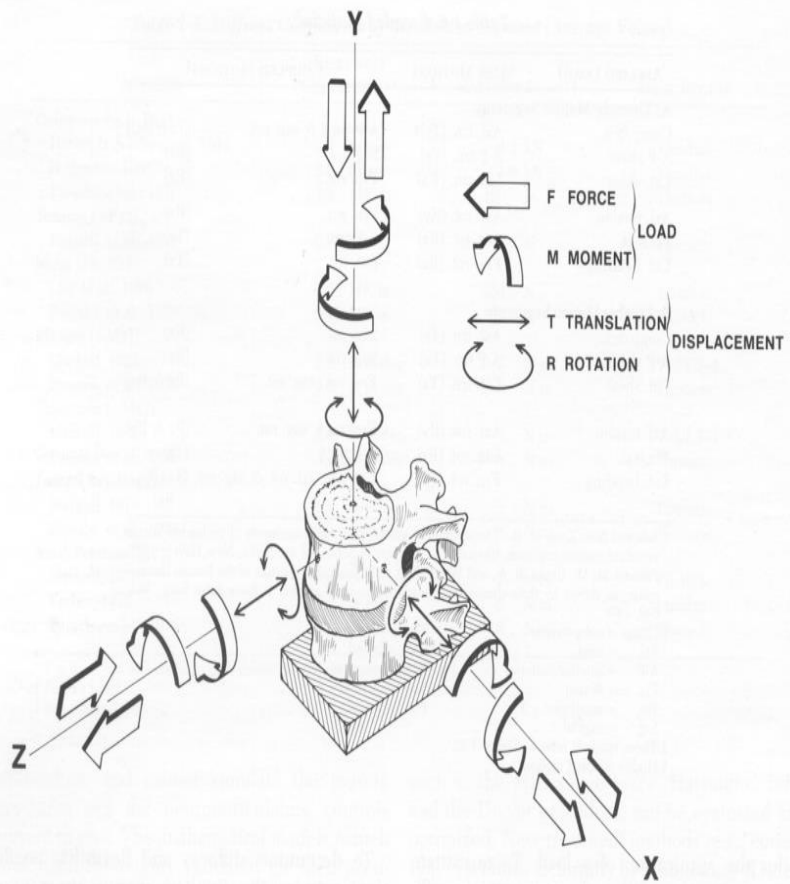
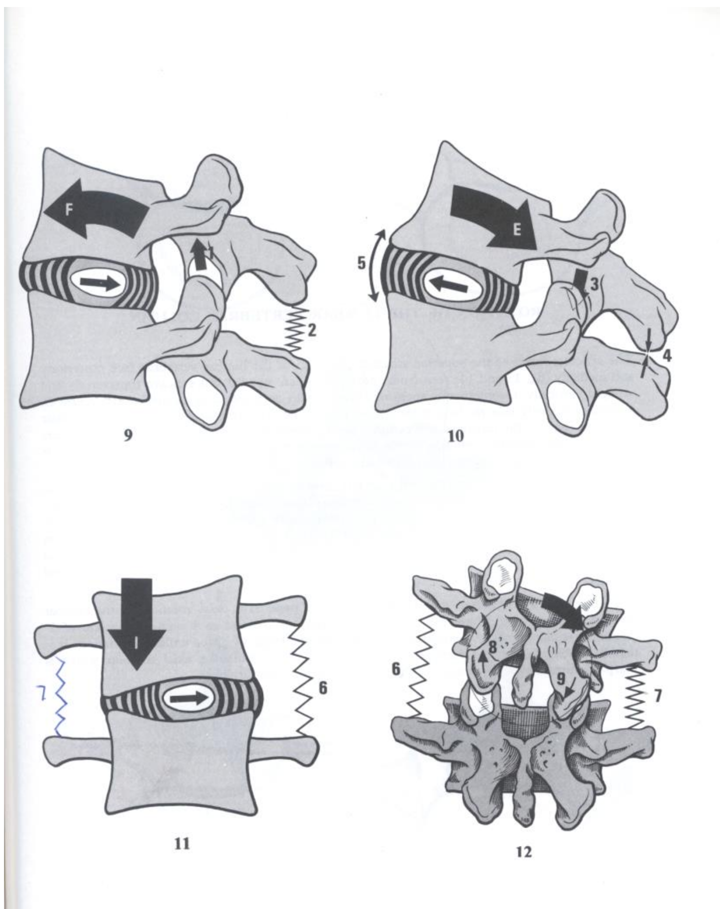


Fig. 1-23. A three-dimensional coordinate system has been placed at the center of the upper vertebral body of a motion segment. The coordinate system is fixed in space. To document the complete mechanical behavior of the spine motion segment, six forces along and six moments or torques about the three axes of the coordinate system are applied. These twelve load components are depicted. The application of any one of the load components produces displacement of the upper vertebra with respect to the lower vertebra. The displacement consists of translation and rotation. These two motions can be further divided with respect to the coordinate axes. Thus, the three-dimensional displacement has six components, three translations along and three rotations about the three axes of the coordinate system. These are also shown.

Range of Motions

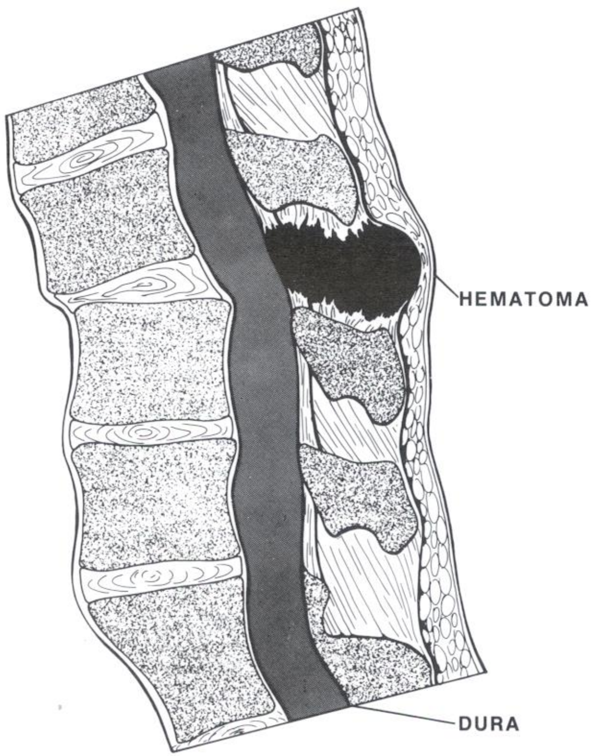
- Range of motions are determined by joint design and constrained by ligaments
- As a range of motion is increased in any direction it engages multiple ligaments that when stretched, become more rigid and resistant. The resistive force is oriented to pull the vertebra back to its original neutral position
- When a vertebra reaches an endpoint range of motion it is fully confined by the strength and elasticity of the ligaments

Structural Design and Elastic Properties Likened to a System of Springs and Levers



- The spinal joint is formed by the articulation of two vertebra at the facet joints. The facet acts as a central pivot.
- During flexion the vertebral bodies approximate while the posterior elements (spinous processes) separate. The facet joints slides on one another as the vertebra pivots
- All motions of the vertebra are confined by the inter-connecting ligaments

Injury and Loss of Motion Segment Integrity: Flexion Injury



- During a sudden impact injury (when stopped) the vertebra suddenly accelerates or decelerates in 10 msec.
- This suddenness overcomes the elastic strength of the ligament. The ligament at first yields (i.e.) stretches to such an extent that it can not return to its original shape
  - This is due to internal disruption of the ligament tissue (tertiary strain/sprain a.k.a. tearing)
- This is followed by complete structural or functional failure of the ligament

Ligament Injury Compromises the Integrity of the Motion Segment

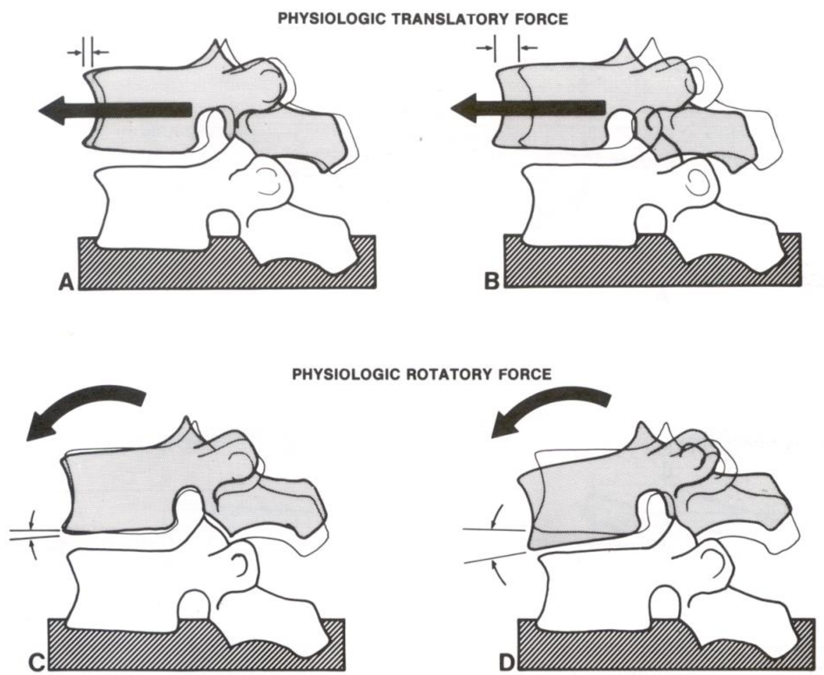
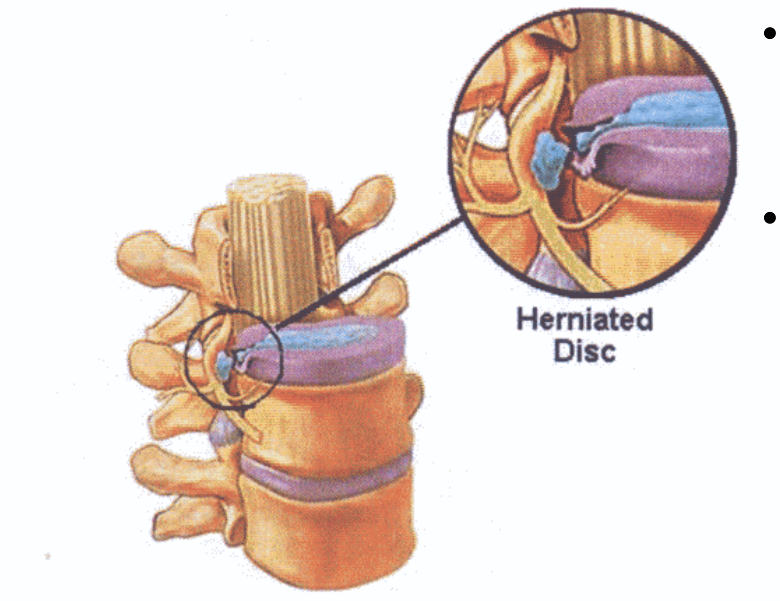
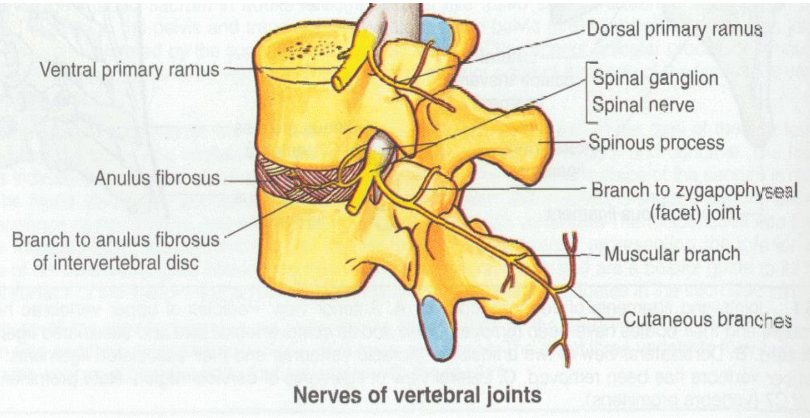


Fig. 5-55. (*A*) A stable spine motion segment which translates very little when subjected to an anteriorly directed force. (*B*) An unstable motion segment, which characteristically translates more under the same load. (*C, D*) Here the motion segments are being subjected to a physiologic bending moment. A greater angulation occurs in an unstable spine (*D*) as compared to a stable spine (*C*).

- Depending on the direction of the force/s and the ligament/s damaged, the motion segment is no longer restrained within its normal ranges of motion
- Hypermobility in rotation and translation are the first consequences followed by abnormal wear or degeneration with aberrant neurological sequella either localized or radiating

Consequences of Ligament Laxity



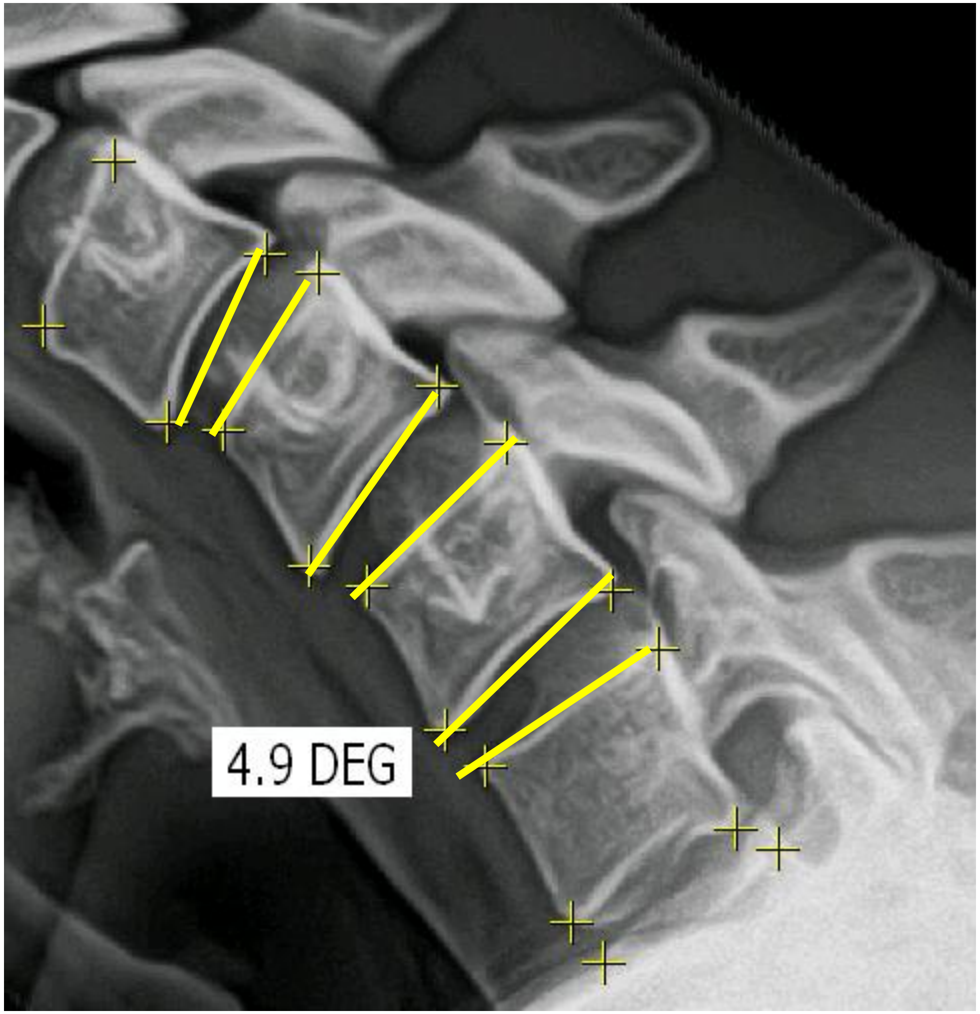


- Irritation to the nerve from disc herniation is easy to understand. Direct pressure or irritation to the nerve root.
- Ligament laxity is more subtle and complicated because it includes aberrant joint motion and aberrant joint loading. Both of which over time will produce irritation to the innervating nervous tissue to all adjacent tissues (joint capsules, mechanoreceptors, etc…)
- As normal joint alignment and loading is compromised functional stenosis occurs along with structural degeneration.
- A viscous cycle of destabilization, and overload continues driven by gravity and normal activities.

Measuring Method used to Determine Ligament Instability and Alteration of Motion Segment Integrity (AOMSI)

- The *AMA Guides to the Evaluation of Permanent Impairment*, 3rd, 4th ,5th and 6th editions have described the measurement method to determine ligament instability (CPT 728.4) as far back as the 1980’s.
- The method involves measuring the rotation and translation of the vertebra from a cervical or lumbar radiograph (x-ray) in the flexion and extension positions.
- When the range of motion of adjacent motion segments differs by 11 degrees or greater it is classified as AOMSI . This is a direct consequence of a loss of ligament integrity.
- When translation of any motion segment exceeds 3.5 millimeters in the cervical region it is classified as AOMSI.
- When translation of any motion segment exceeds 4.5 millimeters in the lumbar regions it is classified as AOMSI.

Procedure for Measuring AOMSI



- The four corners of each vertebra are identified to calculate the disc angle for each motion segment
- The range of motion of each motion segment is calculated by taking the difference of the flexion and extension disc angles

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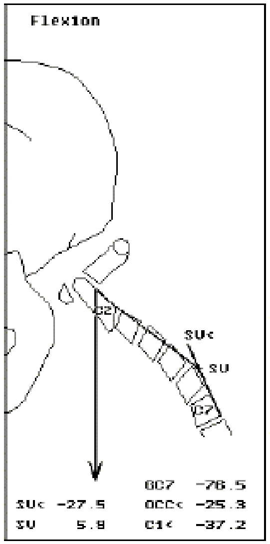
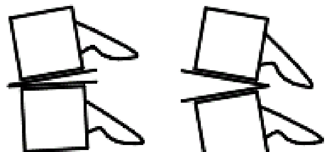
Determining Impairment: Angular Analysis

ANGULAR ANALYSIS

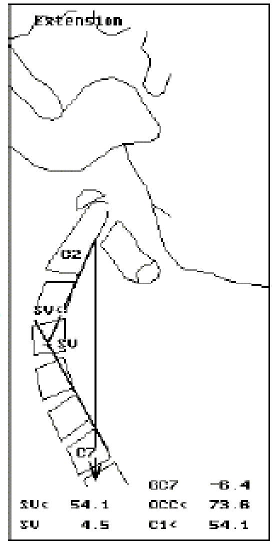




Flexion Angle Extension Angle

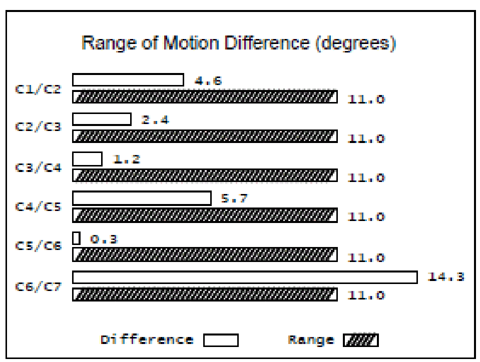
Flexion view is the referenced START position.

1. Flexion and extension angles are calculated for each motion segment level. (1)
2. The difference of flexion and extension angles is calculated to determine segmental range of motion.
3. The difference of range of motion between adjacent motion segment levels is calculated.
4. Paradoxical values (ROM < 0) are identified with a single asterisk in the data table.
5. Intersegmental levels equal to or greater than 11 degrees are identified with a double asterisk.



	Flex Ang	Extn Ang	ROM	Inter Segm	ROM Diff	Max Range
C1	15.6	29.6	14.0			
C2	-9.5	9.1	18.6	C1/C2	4.6	11
C3	-5.4	15.6	21.0	C2/C3	2.4	11
C4	-5.1	14.7	19.8	C3/C4	1.2	11
C5	-2.0	12.1	14.1	C4/C5	5.7	11
C6	-17.9	-4.1	13.8	C5/C6	0.3	11
C7	0.0	-0.5	-0.5 *	C6/C7	14.3 **	11

* Abnormal paradoxical motion
** Impairment threshold exceeded



- The spinal geometry and disc angle range of motion are calculated and displayed in tabular and graphical formats. The results are compared to the threshold values as defined by the *GUIDES*.

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Measuring the Difference of Range of Motion

1. The range of motion is determined for each motion segment
2. The difference of each adjacent segment range of motion is calculated.
3. In this example the difference of C5 to C6 is 15.8^{o}. The impairment threshold of 11^{o} is exceeded and the patient qualifies for a 25% whole body impairment

	ROM F / E	DIFF	IMPAIR ≥ 11^{o}
C1	5.7		
C2	9.5	3.8	
C3	12.6	3.1	
C4	13.1	0.5	
C5	17.7	4.6	
C6	1.9	15.8	**
C7	-5.5	7.4	

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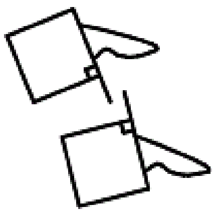
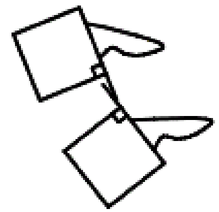
Determining Impairment: Translation Analysis

TRANSLATION ANALYSIS



Flexion

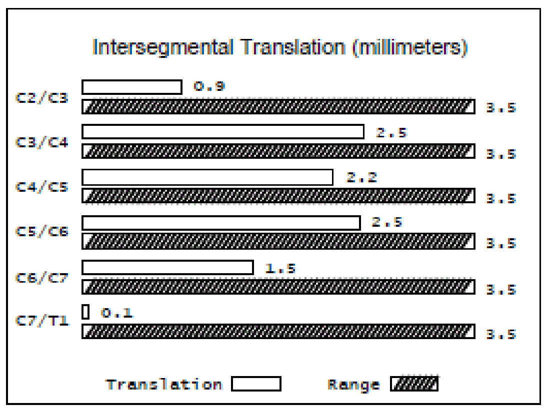
1. Lower vertebra in extension is the referenced START position.
2. Positive number indicates anterior translation.
3. Negative numbers indicate posterior translation. (2)
4. Paradoxical values (posterior translation) are identified with a single asterisk in the data table.
5. Intersegmental levels with differences equal to or greater than 3.5 mm are identified with a double asterisk.



Extension

Inter Segment	Translation	Max Range
C2/C3	0.9	3.5
C3/C4	2.5	3.5
C4/C5	2.2	3.5
C5/C6	2.5	3.5
C6/C7	1.5	3.5
C7/T1	0.1	3.5

* Abnormal paradoxical translation
** Impairment threshold exceeded



<< Negative = Posterior Positive = Anterior >>

The translation (front to back movement) of each vertebra is calculated and displayed. In the cervical region, translation equal to or greater than 3.5 mm qualifies for a 25% whole body impairment .

In the lumbar region translation equal to or greater than 4.5 mm qualifies for a 25% whole body impairment.

When is testing for AOMSI Appropriate

- <u>ANY</u> patient involved in a sudden impact injury should be tested for AOMSI
- This includes but not limited to
  - Automotive accidents of any kind at any impact velocity
  - Sports injuries where concussion is suspect
  - Forceful falls
  - Forceful acceleration or deceleration incidences where neck or low back pain are involved
- Clinical Criteria: Loss of range of motion and pain as sequella to trauma

Where and How do I get AOMSI Testing

- The patient's doctor can order the necessary x-ray studies
- The doctor can contact Spine Metrics, Inc. to complete the testing
- Spine Metrics can be contacted at
- 636-329-8774 or www.spinemetrics.us
- email smsubmitfiles@gmail.com
- Ask for Dr. Raymond Wiegand