

# Segmental Instability

**Segmental instability** refers to the loss of the normal pattern of **motion** between two adjacent **vertebrae**, leading to abnormal movement under physiological loads. It typically involves:

- **Excessive translation** or **angulation** of one **vertebra** relative to another
- **Failure of stabilizing structures**, including **intervertebral discs**, **ligaments**, **facet joints**, and **musculature**
- **Symptoms** may include mechanical **back pain**, neurological compression, or **spinal deformity**

It is often evaluated using **dynamic flexion-extension radiographs**, and is a key concept in conditions like:

- Degenerative spondylolisthesis
- Isthmic spondylolysis
- Post-laminectomy instability

## Diagnosis

The diagnosis of **segmental instability** involves a combination of clinical assessment and imaging studies.

### □ Clinical Features

- Mechanical back or neck pain exacerbated by movement or prolonged posture
- Possible radiculopathy or neurogenic claudication
- Sensation of “giving way” or spinal locking/unlocking
- Instability catch or painful arc on motion

### □ Imaging Criteria

#### 1. Dynamic Radiographs (Flexion-Extension X-rays)

- **Lumbar spine:**
  - > 4 mm of translation
  - > 10–15° of angular motion (L1–L5), > 20° at L5–S1
- **Cervical spine:**
  - > 3.5 mm of translation
  - > 11° of angular motion between adjacent vertebrae

## Angular Motion Criteria for Segmental Instability

To assess **segmental instability** radiographically, dynamic **flexion-extension X-rays** are performed. One important metric is **angular motion** between vertebral segments.

## □ Angular Instability Thresholds (Lumbar Spine)

- **L1-L5:** > 10-15° of angular motion between flexion and extension
- **L5-S1:** > 20° of angular motion

## Example Illustration

Assume flexion and extension lateral radiographs show the following angles:

Segment	Flexion Angle	Extension Angle	Angular Motion	Interpretation
L4-L5	5°	25°	20°	□ Instability (exceeds 15°)
L5-S1	10°	33°	23°	□ Instability (exceeds 20°)
L3-L4	12°	20°	8°	□ Normal (below threshold)

## □ How to Measure

- Draw lines along the endplates of adjacent vertebral bodies (e.g., L4 inferior endplate and L5 superior endplate)
- Measure the angle formed in flexion and extension
- Subtract to get the **range of angular motion**

## □ Note

The threshold values may vary slightly by source, but generally:

- > 15° at L4-L5 or above is considered unstable
- > 20° at L5-S1 accounts for the normally greater mobility at this junction

## 2. MRI

- Disc degeneration or high-intensity zone (HIZ)
- Facet joint effusion (correlates with instability)
- Ligamentous disruption (e.g., interspinous ligament)

## 3. CT Scan

- Pars defects (in spondylolysis)
- Osteophytes or vacuum phenomena (suggest segmental hypermobility)

## 4. Functional Tests

- Standing vs supine MRI
- Upright dynamic MRI (where available)

## □ Diagnostic Criteria

Instability is diagnosed when there is:

- Abnormal segmental motion beyond physiological limits
- Correlation with clinical symptoms
- Structural or dynamic evidence of failure of spinal stabilizers

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