Lumbar Spine Stabilization

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Physical Therapy Rehabilitation

- Matured from passive procedures done to the patient to more active procedures done by the patient.
- Spinal stabilization training became mainstay in physical therapy following Saal and Saal (1989) results.

Stabilization Training

- Often prescribed without consideration of what is to be stabilized
- Without assessment of which muscles or motions need to be strengthened
- Without consideration of patient's daily, occupational or recreational needs

Stabilization Training:

- Webster's New World Dictionary defines stability as the "State of quality of being firm, steady and not easily thrown off balance."
- McGill describes a continuum of stability with the analogy of a Ball in a Bowl.

Ball in Bowl

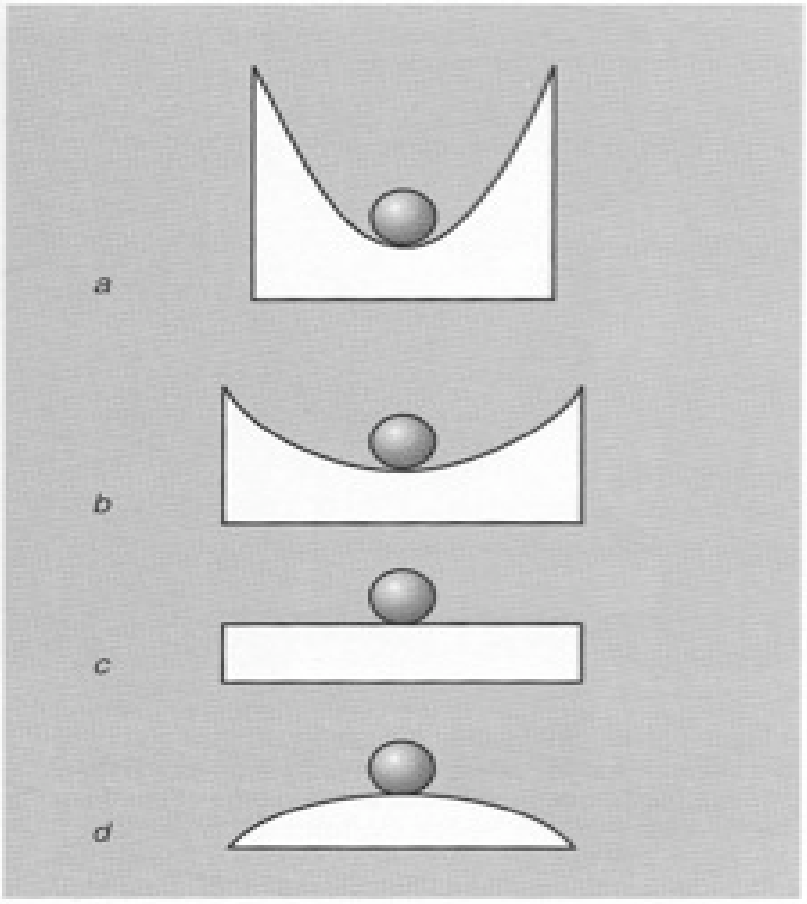


Figure 6.2 The continuum of stability. The deepest bowl *(a)* is most stable, and the hump *(d)* is least stable. The ball in the bowl seeks the energy well or position of minimum potential energy ($m \cdot g \cdot h$). Deepening the bowl or increasing the steepness of the sides increases the ability to survive perturbation. This increases stability.

Slope of the walls =joint stiffness
Width of the bowl = joint laxity.

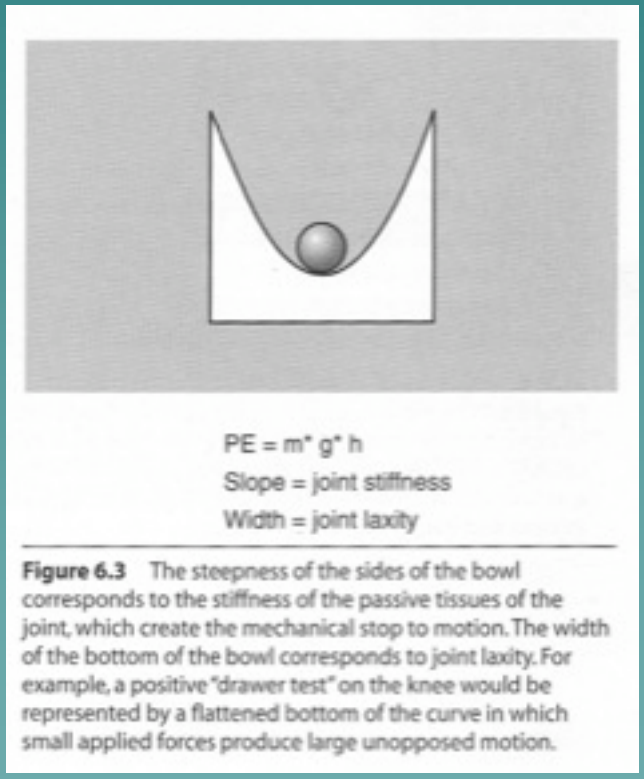


Figure 6.3 The steepness of the sides of the bowl corresponds to the stiffness of the passive tissues of the joint, which create the mechanical stop to motion. The width of the bottom of the bowl corresponds to joint laxity. For example, a positive "drawer test" on the knee would be represented by a flattened bottom of the curve in which small applied forces produce large unopposed motion.

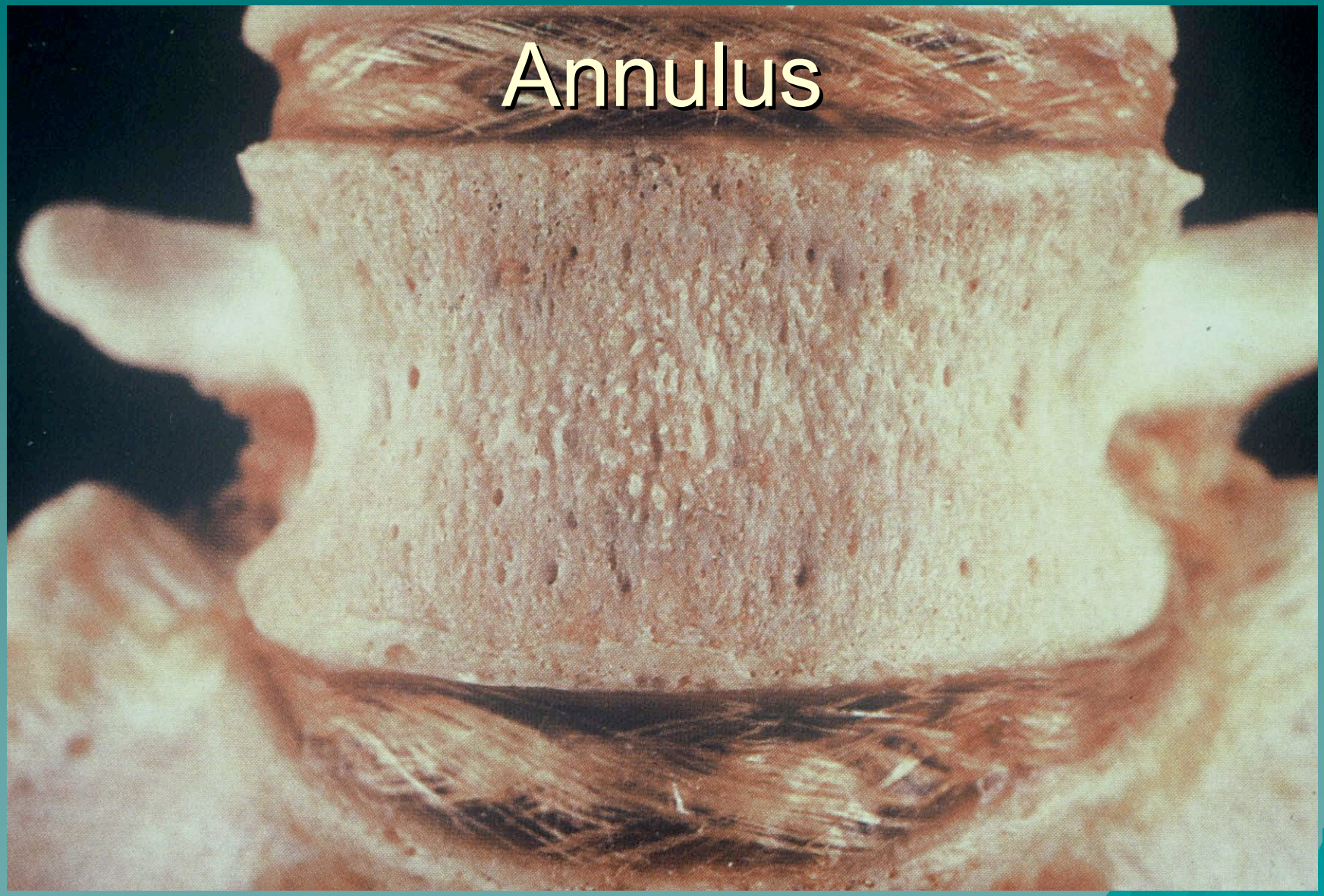
Stability of lumbar motion segment achieved by:

- Intricate Balance of
  - Osteoligamentous structures
  - Musculotendinous structures
  - Motor control system

Injuries damage this intricate balance

- This moves the intervertebral segment along the continuum of instability
- Applied force exceeds the stiffness of the motion segment.

Annulus



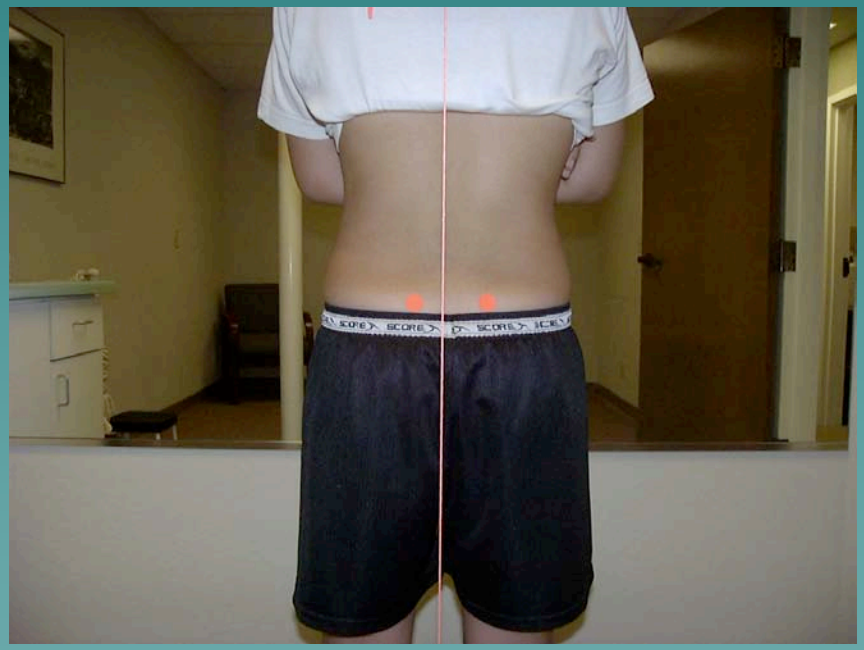
Injuries and result

- Flexion and rotation result in annular tears
- Excessive compression damage endplate and result in insufficient hydrostatic pressure.
- Postural stress can weaken muscle strength
- Pain can change motor control system of the Transverse Abdominus

Sufficient Leg Length Difference

- Moves the spine from its vertical position and low potential energy
- To a position of higher potential energy

Leg Length Difference



Instability:

- May not be measured with increased range of motion.
- Rather a change in the ratio of rotation to translation of the motion segment.
- May occur in any of the three degrees of freedom or three planes of translation

Non-operative treatment of lumbar instabilities includes:

- Stabilization exercises to increase the stiffness of the motion segment
- It is believed this will restore motion characteristics of the vertebral segment
- Improve the motor control of the muscles

Amount of stabilizing force

- McGill reported most people with an undeviated spine can generate sufficient coactivation of the paraspinal and abdominal wall muscles.
- However maintaining this stability for daily and occupational activities requires muscle endurance.
- It also requires equal tension of the muscular “guide wires”.

Endurance Testing of the spine muscles.

- McGill (2002) Tested by holding position isometrically for time (seconds)

  -Side Plank right and left

  -Sustained Sit-up position at 60-degrees

  -Biering-Sorensen Position

Side Plank

Sustained Sit-up at 60-degrees

Biering-Sorensen Position

Mean Endurance Time (sec) and ratios normalized to extensors endurance test scores of healthy 21 year-olds (men :n =92; women :n=137)

	Men	Women	All
Task	Mean	Mean	Mean
Extension	161	185	173
Flexion	136	134	134
Right SB	95	75	83
Left SB	99	78	86
Flexion/ Exten.	0.84	0.72	0.77
RSB/ LSB	0.96	0.96	0.96
RSB/ Exten.	0.58	0.40	0.48
LSB/ Exten.	0.61	0.42	0.50

Mean Endurance Time (sec) and ratios normalized to extensor endurance test scores of normal workers and those who had back disorders but where asymptomatic at the time. Mean age: 34 y.o. (Never had back troubles: n=24; Lost work due to LBD: n=26).

	No History	History of LBD
Task	Mean	Mean
Extension	103	90
Flexion*	**66**	**84**
Right SB	54	58
Left SB	54	65
Flexion/ Exten.*	**0.71**	**1.15**
RSB/ LSB*	**1.05**	**0.93**
RSB/ Exten.*	**0.57**	**0.97**
LSB/ Exten.*	**0.58**	**1.03**

Conclusion

- Stability of the spine achieved primarily from the muscle function and motor control
- Muscles endurance more important that maximal strength
- Balance between the muscles play the most important role in stabilizing the spine

Future of spine stabilization

- Muscle endurance of the transverse plane and non-cardinal planes
- Though isometrically tested, spinal muscles work eccentrically
- Match muscle endurance to patient's daily, occupational and recreational needs.
- Gait analysis and instabilities