

Core Training

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Module 6 Objectives

1. Identify (I) the role of the muscles in producing motion and creating spinal stability
2. Discuss (V) spinal loads during static and dynamic activities including sitting, standing, walking and lifting
3. Indicate (IV) how lifting technique alters the loading pattern on the spine
4. Describe (V) the concept of superstiffness and techniques that increase or decrease spinal stability

Muscles that are important for spinal stability

Abdominal muscles...

1. Enhance torso stiffness to eliminate energy leaks for efficient transfer of hip generated power;
2. Efficiently store and recover elastic energy;
3. Generate moments about the three axes of rotation

Abdominal Fascia surrounds rectus abdominis and carries hoop stresses from one side of torso around to the other

Rectus Abdominis

- Designed for forward flexion
- Train for short-range stiffness rather than force over a range in length

Obliques and Transverse

- Work together to flex, laterally bend and twist torso
- Very important in spine stabilization since their criss-crossing architecture provide a cross-brace for the lumbar spine
- Activate together (by bracing technique) to create “superstiffness”
- Never “hollow” to isolate transverse

Psoas

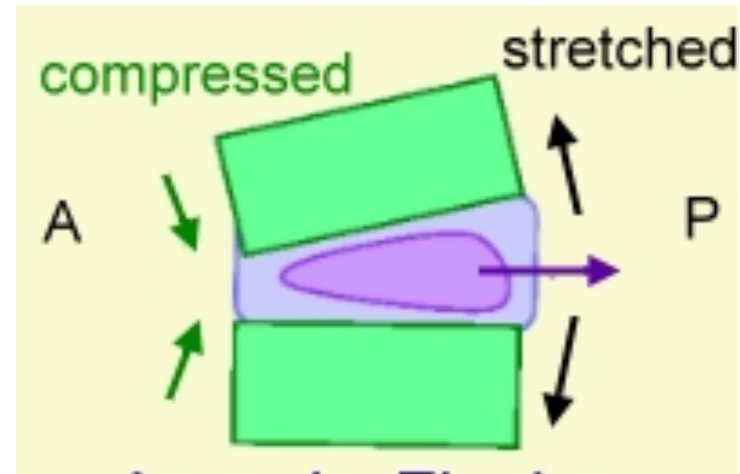
- Primary hip flexor
- Imposes substantial lumbar spine compression (attaches to each lumbar vertebrae)
- Also a spinal stabilizer and when activated it buttresses the spine

Quadratus Lumborum

- Stabilizer
- Guy wire system attaching every lumbar vertebrae to the rib cage and pelvis
- Active in virtually every loading mode

Vertebrae

- Forward flexion
 - Produces a bending moment on the lumbar spine
 - Disc is subjected to increased tensile (stretching) stress on the posterior (dorsal) portion
 - Disc is subjected to increased compressive stress on the anterior (ventral) portion
 - Annulus bulges on compressive side
 - Nucleus is shifted posteriorly
- Reverse for Extension



Body Position

Sitting

- Should be a dynamic task
- No single, ideal sitting posture (all cause static loads on spinal tissues)
- Variable postures minimize the risk of tissue overload
- If the person is flexion intolerant:
 - Slouching and unsupported upright sitting will exacerbate pain
 - Endurance capacity of hip flexors and back extensors are eventually exceeded
 - Lumbar support is essential

Walking

- Excellent therapeutic technique if performed correctly
- Very tolerable spine loads and gentle disc motion
- Arms should swing from shoulders to reduce spine loads (up to 10%)
- Walk faster with a more upright posture while swinging arms from shoulders
- Common faults:
 - Spine flexion
 - Chin poking
 - No arm swing
 - Slow small steps

Lifting and Spinal Loading

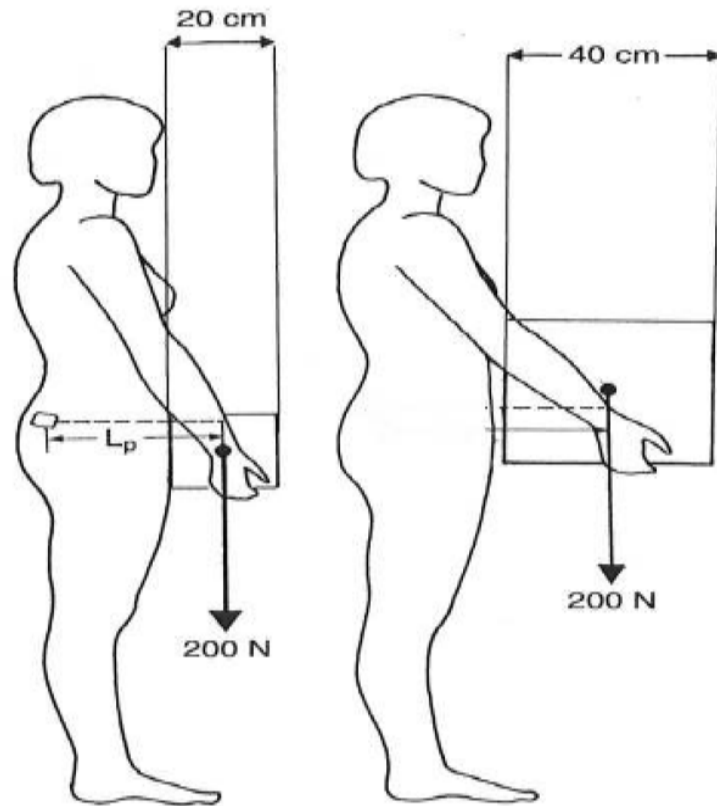
Several factors influence loads on the spine:

- Position of the object relative to the center of motion in the spine
 - Greater distance increases the bending moment and thus increases spinal loads
 - Waist circumference can be a factor
- Size, shape, weight and density of the object
- Degree of flexion or rotation of the spine
 - Spinal flexion increases lever arm of load AND adds the moment arm of body weight due to gravity
 - Spinal flexion also increases muscle activation force thus increasing compressive loads
- Rate of loading

Technique is critical to reduce spinal load during lifting!

- Optimally, the load is positioned between the feet to reduce the level arm of the external load
- Proper use of IAP and bracing technique are important
- The hip hinge must be used instead of spinal flexion

Influence of Size of Object on Lumbar Spine Loads



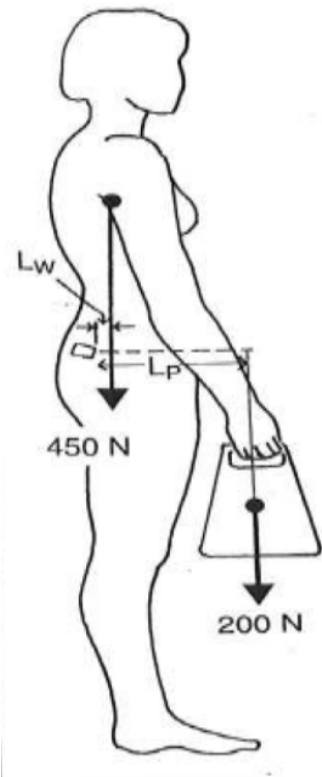
Forward-bending
moment = 60Nm

Forward-bending
moment = 80Nm

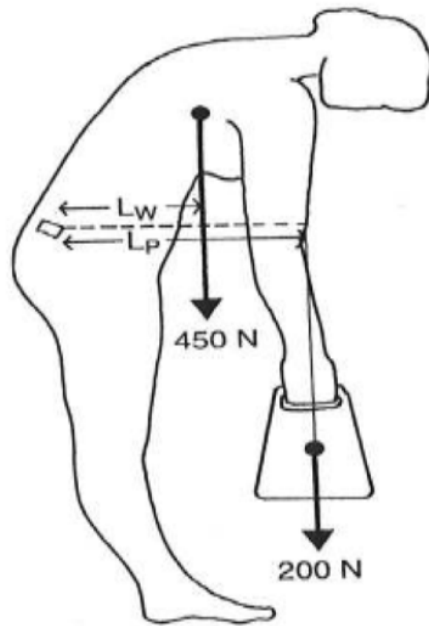
A larger object...

- moves line of resistance further from axis of rotation thus increasing its moment even without a change in weight
- moves hands (and object) higher because they are further away from the body which activates more upper body musculature
- moves Center of mass higher due to larger size and increased carrying height

Influence of Upper Body Position on Lumbar Spine Loads



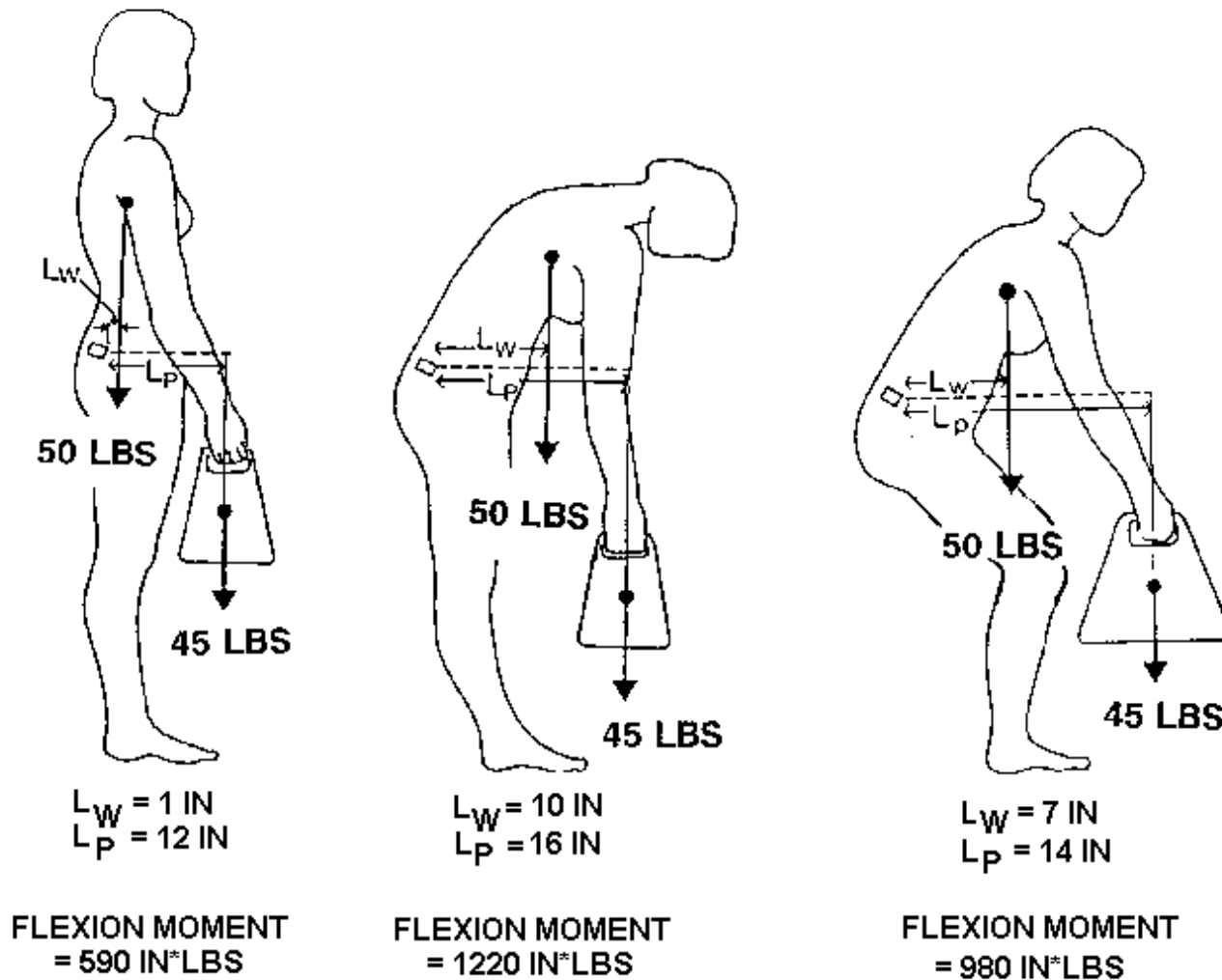
Forward-bending
moment = 69Nm



Forward-bending
moment = 192Nm

- Forward spinal flexion moves line of gravity anterior to axis and moves load further from axis
- This creates two anterior flexor moments (Moment = Force x Distance)
- In order to achieve rotational equilibrium an equal and opposite moment must be produced by the extensor muscles
- At the end range of spinal flexion the extensors shut down (“unusual phenomenon of sudden muscle inhibition”) and the flexor moment is created by the passive force of the ligaments

Lifting Technique Influences Loads on Lumbar Spine



Squat strategy moves line of gravity and load closer to axis thus reducing their moments.

Spinal Loads During Exercise

McGill 2007

Flexion

<u>Exercise</u>	<u>Compression</u>
Straight Leg Situp	3506
Bent Leg Situp	3350
Straight Leg Raise	2525
Bent Leg Raise	1767
Hanging Straight Leg	2805
Hanging Bent Leg	3313

Extension

<u>Exercise</u>	<u>Compression</u>
Roman chair extension	4000
Superman	6000

Thoughts on twisting:

- High tissue loads may develop when twisting AND torque is generated – this increases risk
- Twisting torque *while* twisting away from neutral appears to be problematic
- Consider the typical torso twisting machines found in many gyms

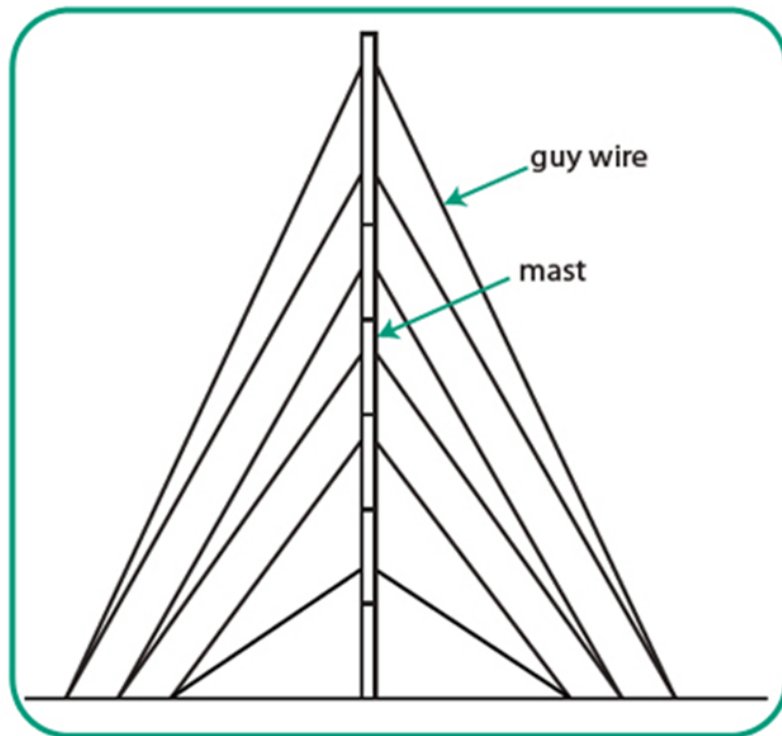
Intra-Abdominal Pressure (IAP)

- IAP contributes to both unloading and stabilization of the lumbar spine
- Co-contraction of diaphragm, abdominal and pelvic floor muscles creates a “pressurized balloon” (or rigid cylinder) attempting to separate the diaphragm and pelvic floor
- This creates an extensor moment that can reduce extensor load up to 40%
- Transverse abdominis is a critical player as it creates compression through horizontal orientation without creating a flexor moment
 - It cannot be isolated
 - It contracts with the abdominal bracing unit (obliques, rectus)
- A proper breathing pattern is critical to maintaining IAP and stability
 - Lungs must be filled to the top of tidal volume
 - Letting air out during lifting would reduce IAP and compromise stability
 - Many athletes simply do not breathe or they “sip” air instead
 - Spinal stability may be compromised if the person is breathing hard or is out of breath (such as following a sprint or aerobic task) and a lifting task is required

Trunk Muscle Co-contraction

- “Superstiffness” is a technique that engages numerous muscle groups simultaneously to stabilize the spine
- The varying orientations of the muscle groups provide a three-dimensional stability to hold the spine in neutral
- Synergistic effect: When entire ab wall is activated the three layers bind together to create a stiffness that is greater than the sum of its parts
- Factors:
 - Spine must be in neutral
 - Abdominal bracing: activation of all three layers of the abdominal wall plus lumbar extensors
 - “Guy wire” effect of muscles: wide base of support; need stabilizing compression and resistance of shear in direction of force

Guy Wire Concept



- Spine is a flexible pole (like a fishing rod)
- Will buckle easily under a compressive load (about 20 lbs)
- Guy wires attached at different levels and anchored to the ground in a circular pattern
- Each guy wire is pulled to the same tension (this is critical)
- The rod can now sustain very high loads
- If you reduce tension in just one wire the rod will buckle at a reduced load
 - Balance of muscle forces is key
 - An overpowering rectus abdominis creates a flexor moment
- The muscles are the guy wires for the spine
 - Superstiffness can be achieved with co-contraction of low levels of %MVC
 - No single muscle group is the primary stabilizer (it changes with task)

Stabilization

Abdominal Bracing

- Co-contraction of all abdominal muscles
- Maintains wide base for abdominal muscles (guy wires)
- Increases spinal stability
- Locks pelvis to ribcage to resist torsional forces
- Shallow breathing should be maintained (can simultaneously increase IAP)
- Check for co-contraction by palpation of rectus and obliques
- Stability:
 - Anterior (sagittal)
 - Poster (sagittal)
 - Side (frontal)
 - Twisting (transverse)

Abdominal Hollowing

- “Sucking in” of transverse abdominis
- Obliques fall silent
- Narrows base for abdominal muscles
- Decreases spinal stability
- Creates energy leaks
- Increases injury risk

III-Advised Rehabilitation Recommendations McGill, 2007

1. Strengthen torso muscles to protect the back
2. Bend the knees when performing sit-ups
3. Sit-ups will increase back health
4. Bend the knees, not the back, when lifting
5. “Tight” hamstrings and unequal leg length lead to back troubles
6. A single exercise or back stability program is adequate for all cases

Low Back Pain/Injury Rehabilitation Exercise Recommendations from McGill

- Exercise daily.
- Exercise must not exacerbate pain.
- Add walking (fast, not slow) to the routine.
- Avoid spine bending after rising from bed.
- More reps of less demanding exercises will enhance endurance and strength.
- No set of exercises is ideal for all individuals.
- Be patient and stick with the program.

Principles for Low Back Training

- Distinguish hip flexion from lumbar flexion
 - Potty Squat is a helpful technique
- Use abdominal bracing instead of hollowing
 - Co-contraction of all core muscles
 - >25% Maximal Voluntary Contraction is all that is needed
- Learn to activate the gluteals
 - Medius and maximus
- Stabilize (3 dimensions)
- Train stiffness rather than flexibility
- Train endurance rather than strength

McGill's Principles for Low Back Training

- Stage 1: Groove motion/motor patterns and corrective exercise
- Stage 2: Build whole body and spine stability
- Stage 3: Endurance
- Stage 4: Develop ultimate strength
- Stage 5: Ultimate performance with speed, power and agility

McGill - Core Moves to Avoid

- Full sit-ups (straight leg or bent knee)
 - High psoas activation and compressive loads
- Leg raises
 - High psoas activation and spine compression
- Superman
- Resisted spinal extension from full flexion
- Leg press too low can cause pelvic rotation
- Stretching the lower back in the morning
 - Wait 1-2 hours

Recommended Core Exercises from McGill

- Flossing
- Modified Curl-Up
- Side Bridge
- Bird Dog
- Overhead Cable Pull
- Squat with Overhead Resistance
- Back extension on gym ball or table
- 1 Arm Row
- Cable Pull-Down