Spinal Health, Exercise & Heavy Athletics

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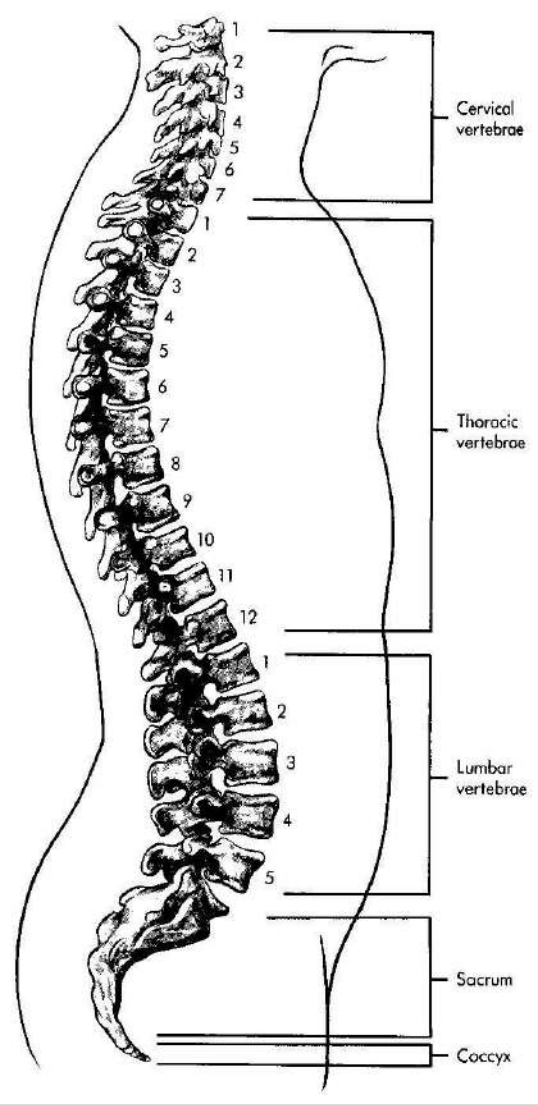
Structure of the Spinal (Vertebral) Column

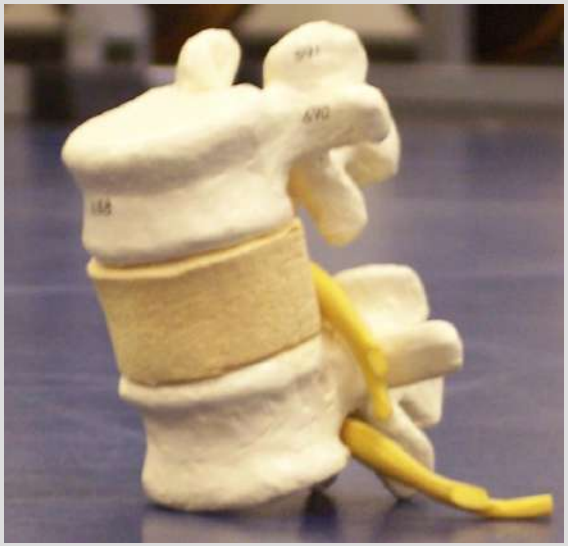


1.Primary (Thoracic & Sacral) versus Secondary (Lumbar & Cervical) Spinal Curvatures

2. Unequal Anterior – Posterior Intervertebral Disk thicknesses to accommodate the different curvatures

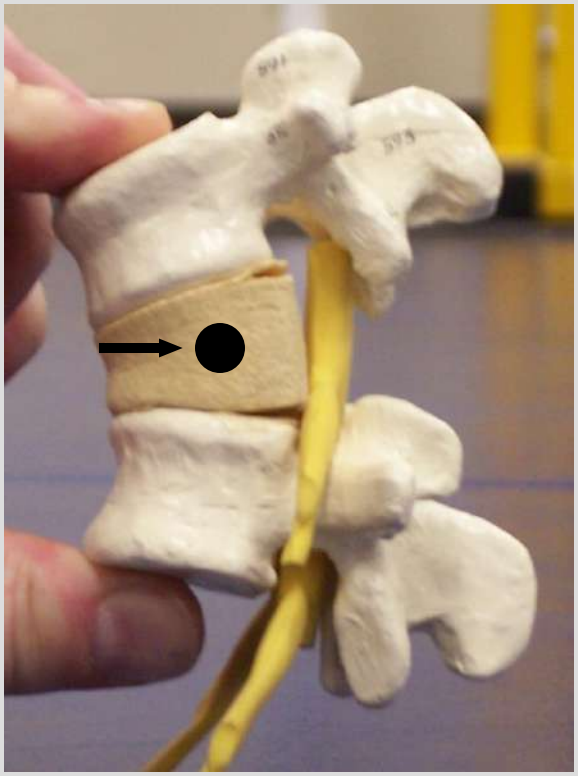
3. Greatest Structural Strength to resist compression and shear load forces when maintained in a “neutral” position (normal curvatures throughout)

4. WHY ?



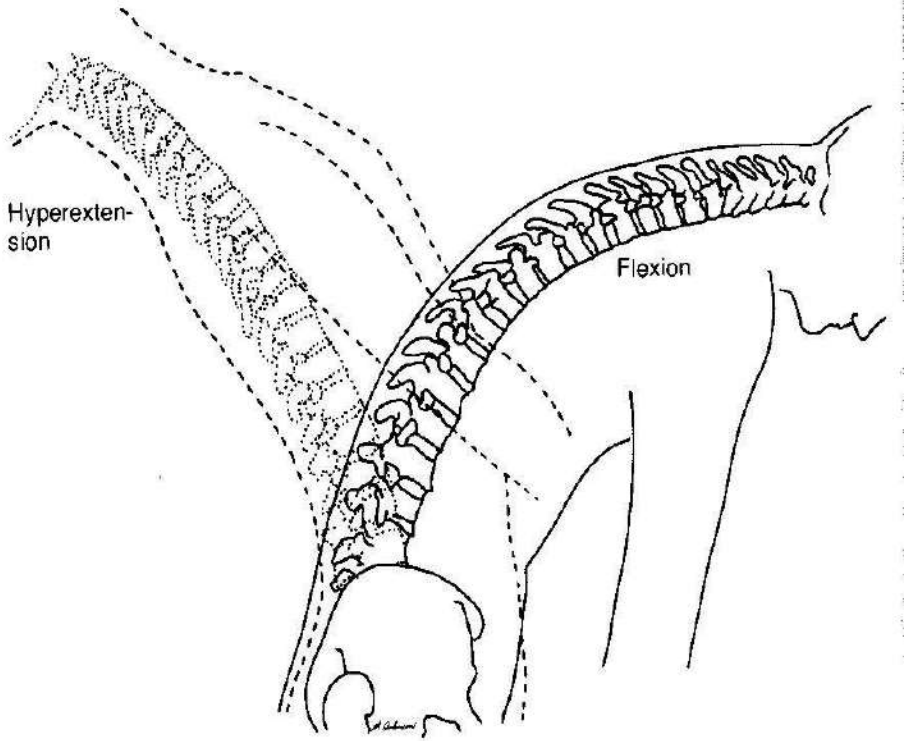
Deformation of the Disks

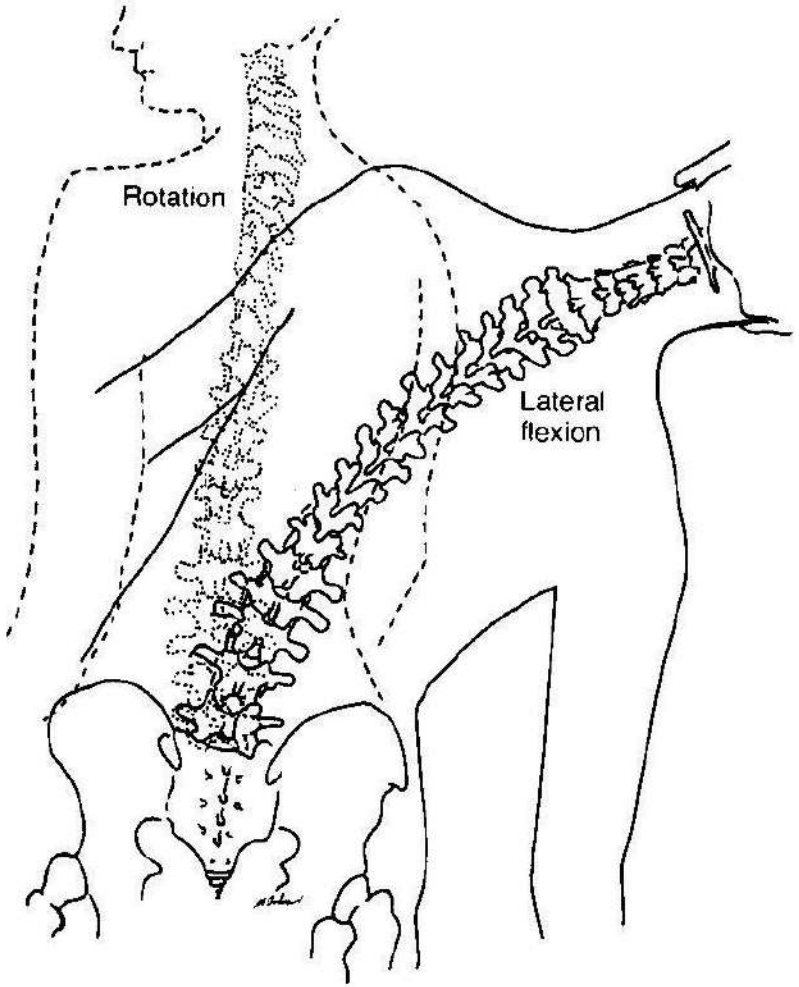
1. Motion Segment – Two Adjacent Vertebrae and the Intervening Disk.
2. All spinal movements result from a summation of motion segment movements.
3. These movements are associated with deformation of the involved disks.
4. Disks are mechanically weaker relative to supporting load forces when their geometric shape is altered – deformation of the disk.



Flexion of Lumbar Motion Segment. Anterior disk is compressed while posterior disk is stretched. The disk nucleus is pushed backward (posterior).

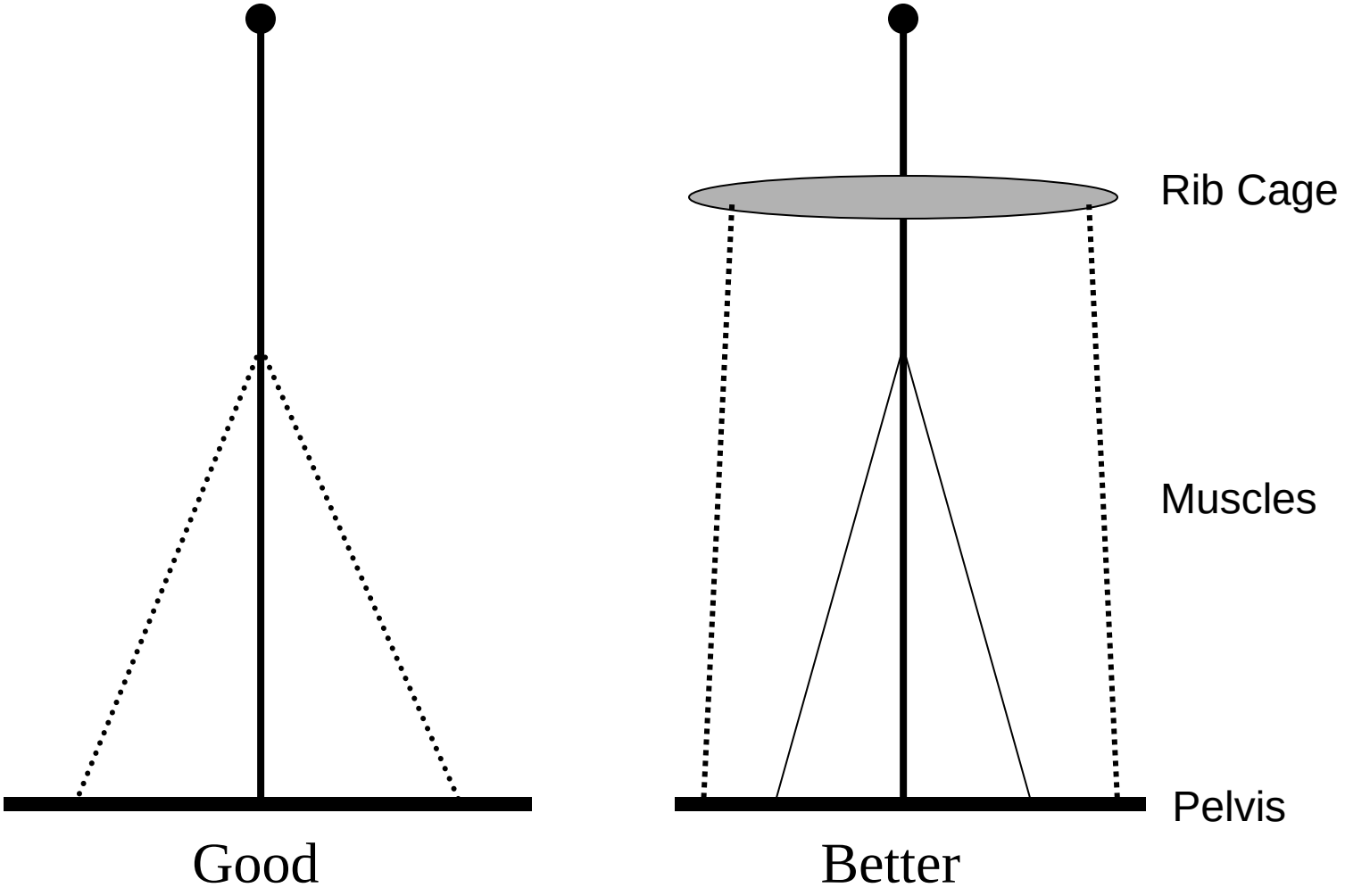
Spinal Movements Alter Normal Curves

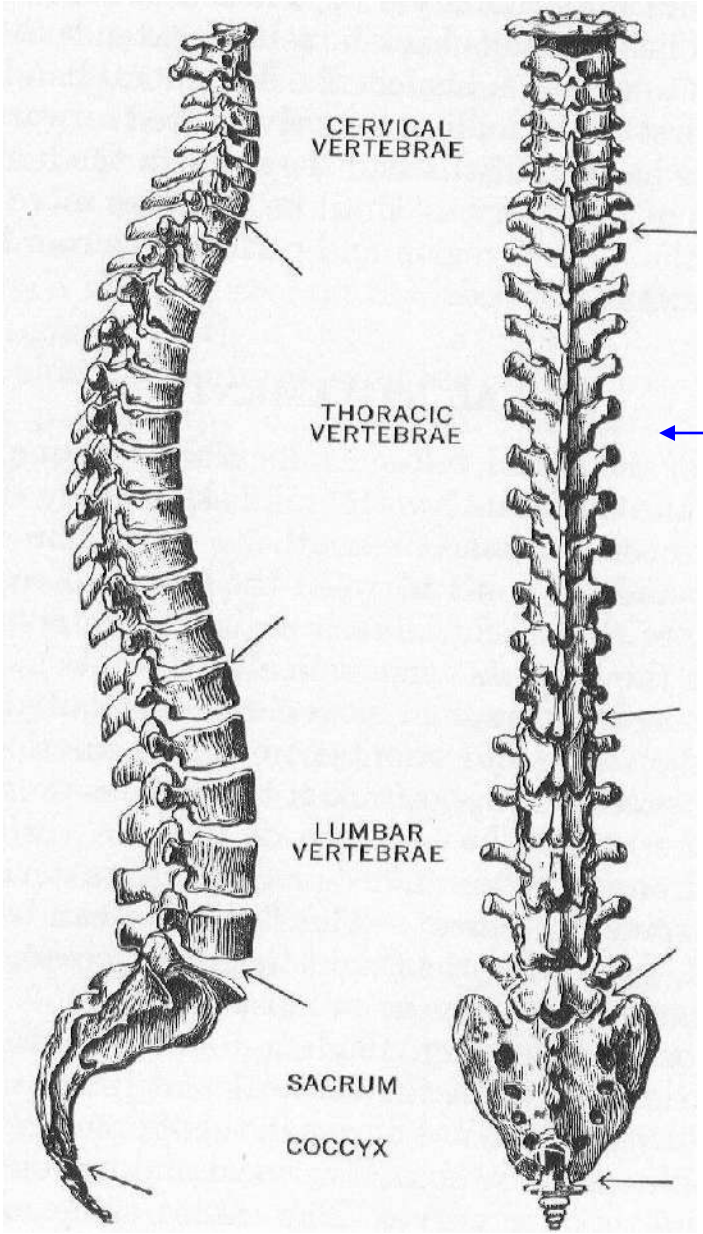




Limit speed and range of motion!

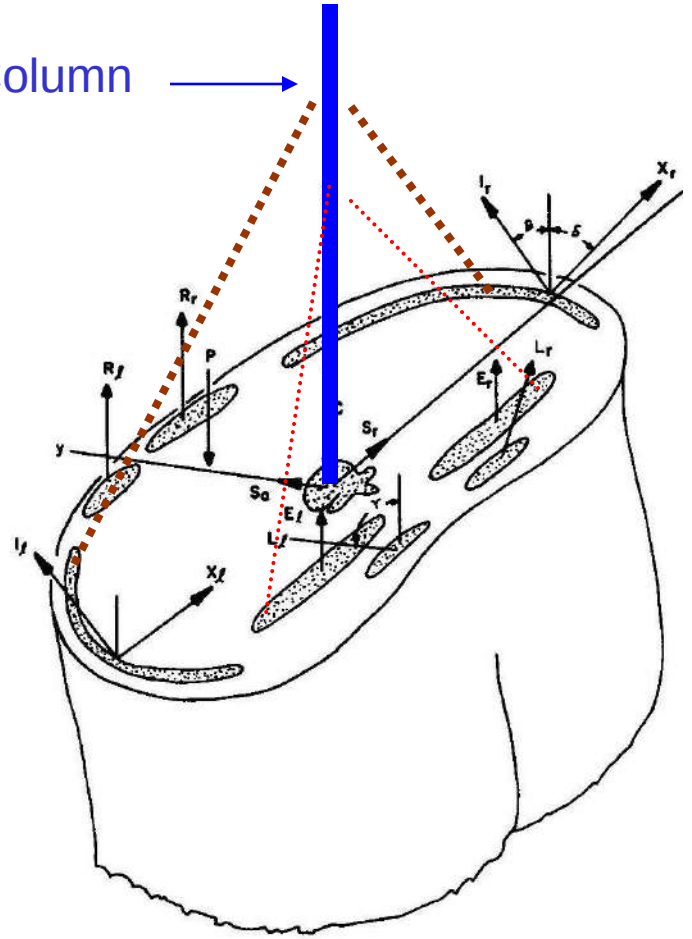
“Guy” Wire Systems to Support a Vertical Structure



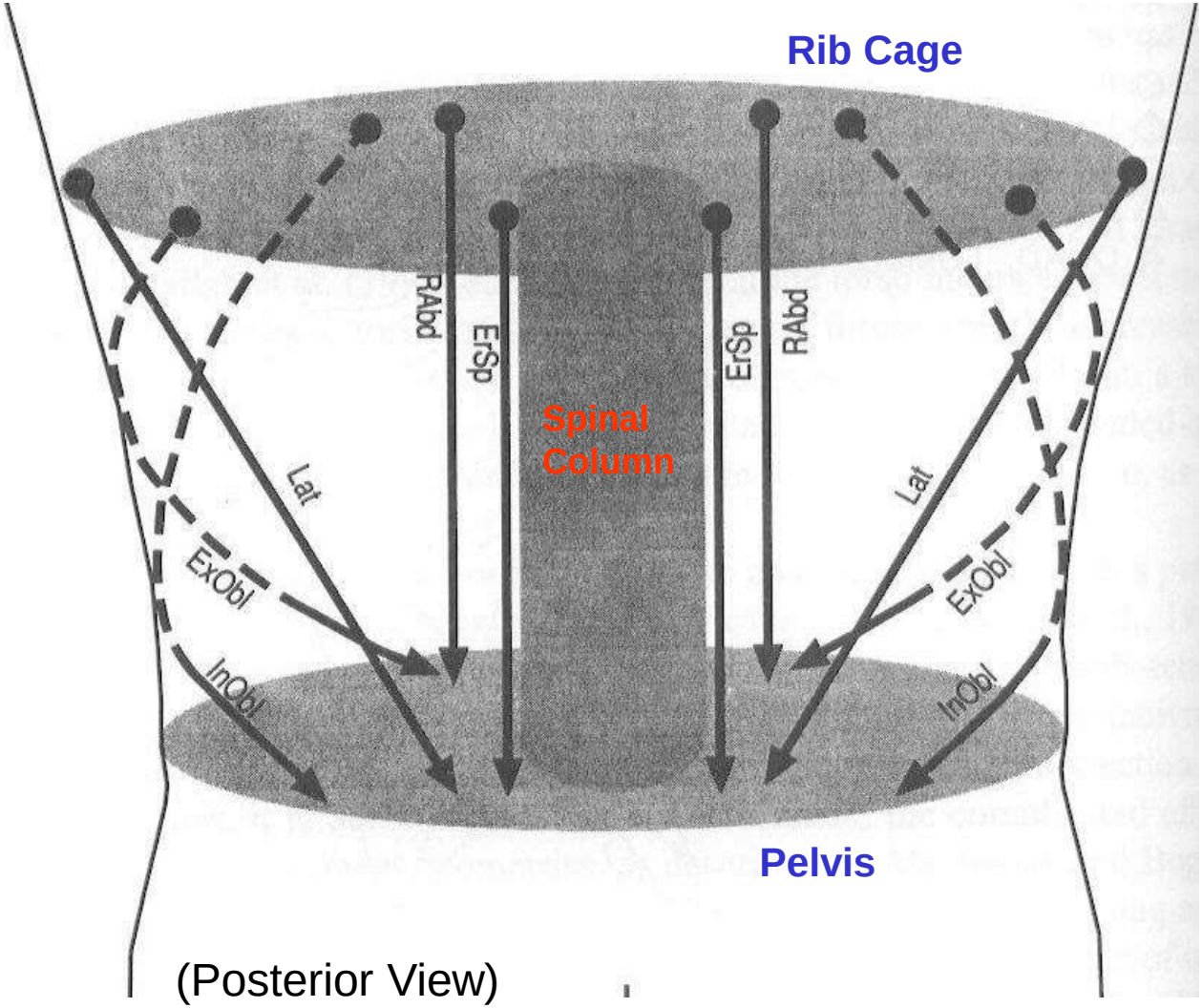


Neutral (normal) vertebral column geometry can be maintained by appropriate utilization of a “guy” wire system of muscle supports

Spinal Column



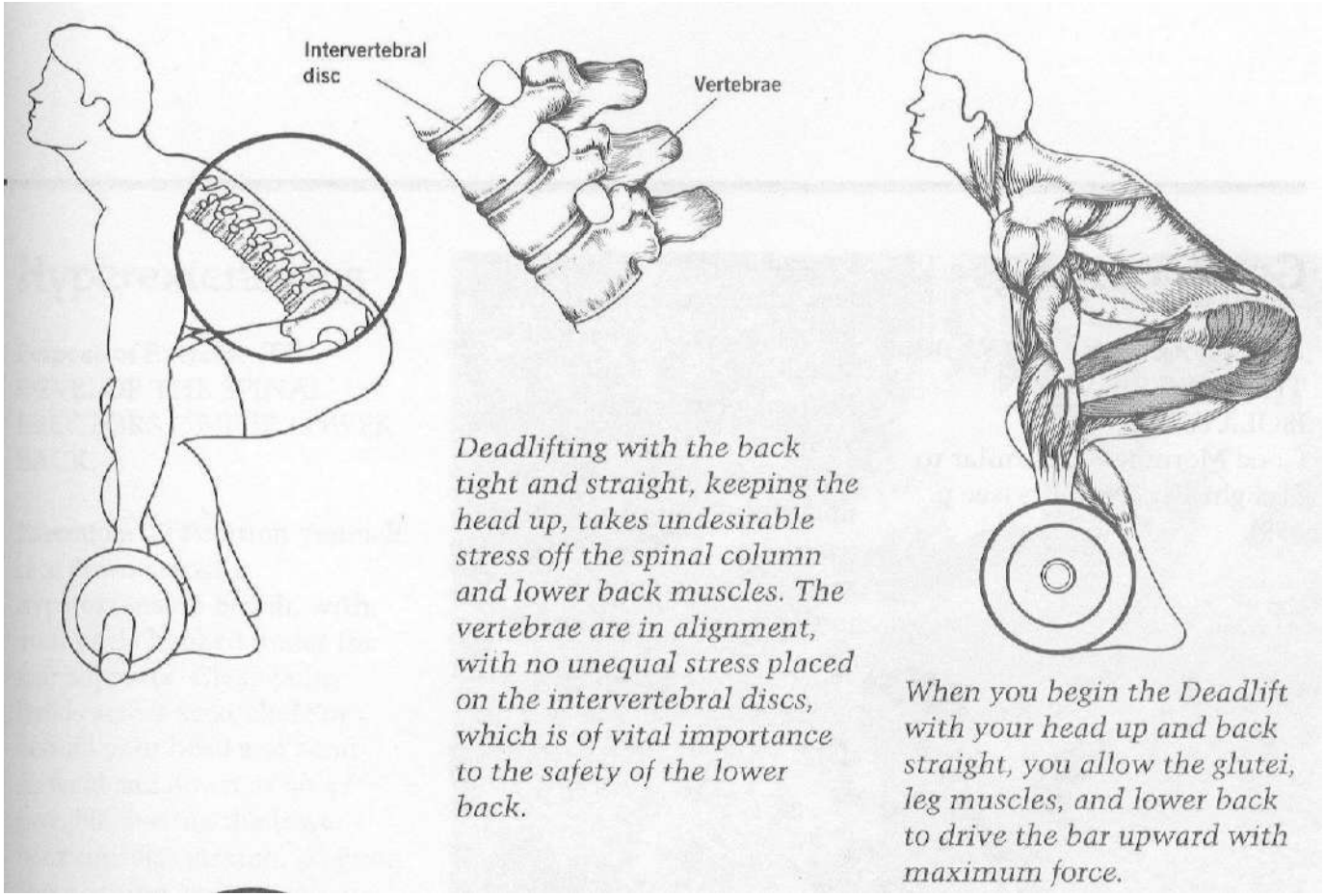
Spinal column stabilization from muscles that attach to the rib cage.



Base of support size is important. Do not "hollow" via emphasis on transverse abdominis activation.

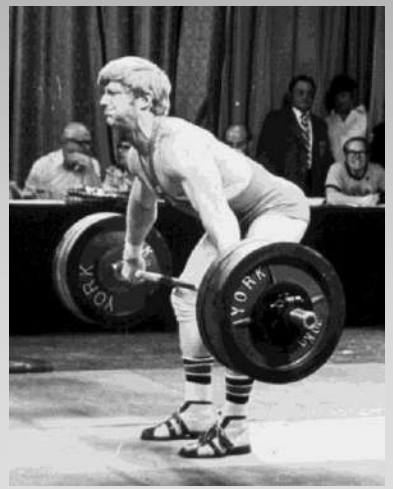
Remember the importance of training motor control patterns (specific movements) not muscles. The abdominal wall muscles work as a group during real life movements. Not in isolation!

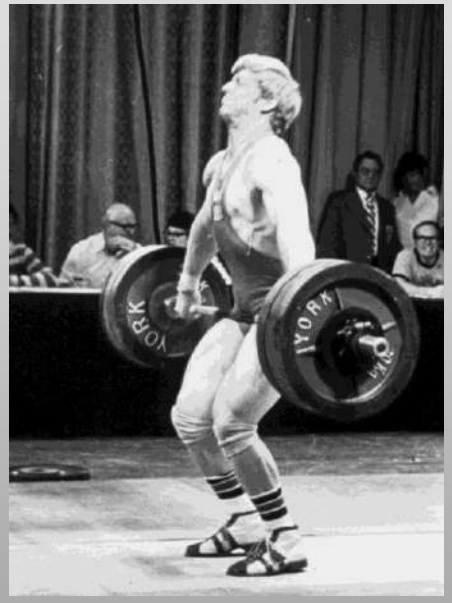
Maintain Normal Spinal Curves

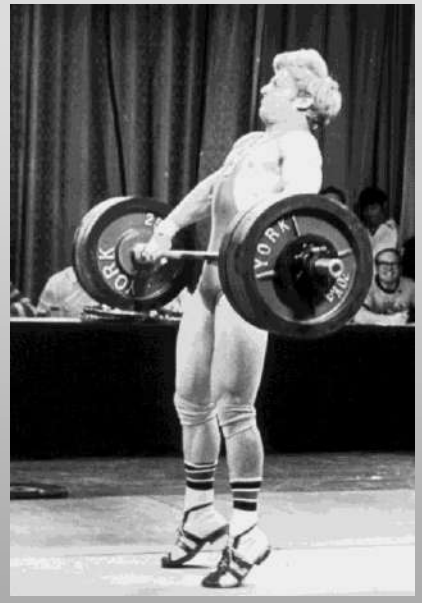


From: Encyclopedia of Modern Bodybuilding
A. Schwarzenegger, page 351.

Weightlifting – Flat Back Lifting

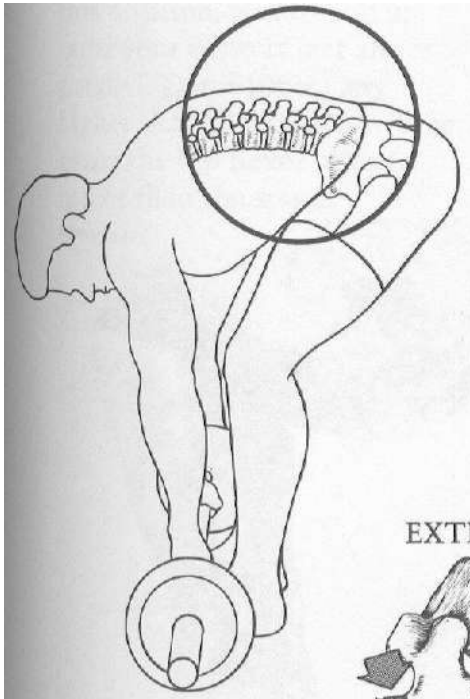




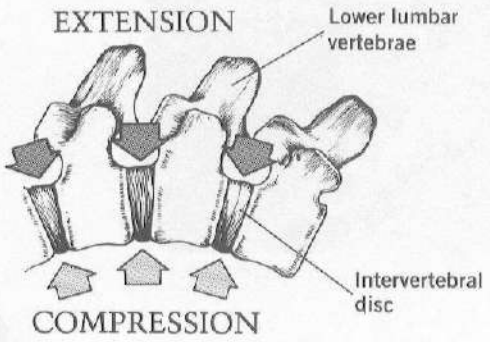


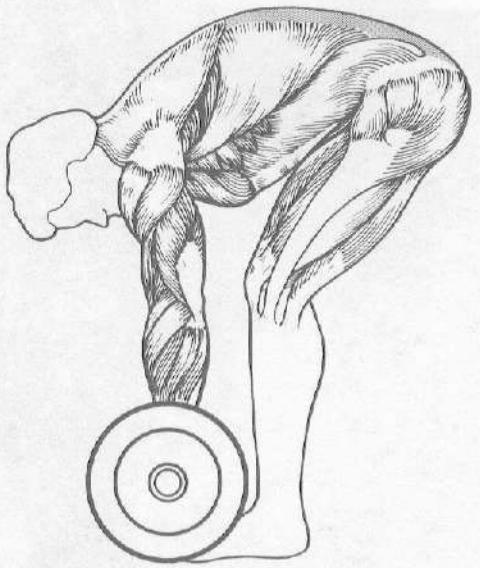
Bruce Klemens Photography

Load Forces & Spinal Flexion



Deadlifting with the back in an arched position with the head down places unequal pressure on the delicate intervertebral discs and lower back muscles. The discs are simultaneously compressed on one side and extended on the other. Keeping the head up and the back straight distributes the stress and reduces the chance of injury.





Starting a Deadlift with your back bent forward means that the lower back is going to have to do most of the initial work to get the bar moving. This is not only dangerous, but it turns the exercise into a lower back movement, which is not what it is supposed to be.

From: Encyclopedia of Modern Bodybuilding
A. Schwarzenegger, page 351.

It is reasonable and desirable to include some resisted dynamic spinal exercises. However, the loads should be light to moderate and the range of motion should be less than maximal, not as extreme as shown below!

The conventional style deadlift in Powerlifting, and related movements included in strongman contests, involve very high spinal forces due to the large loads lifted. Minimize spinal flexion in order to reduce the risk of injury.

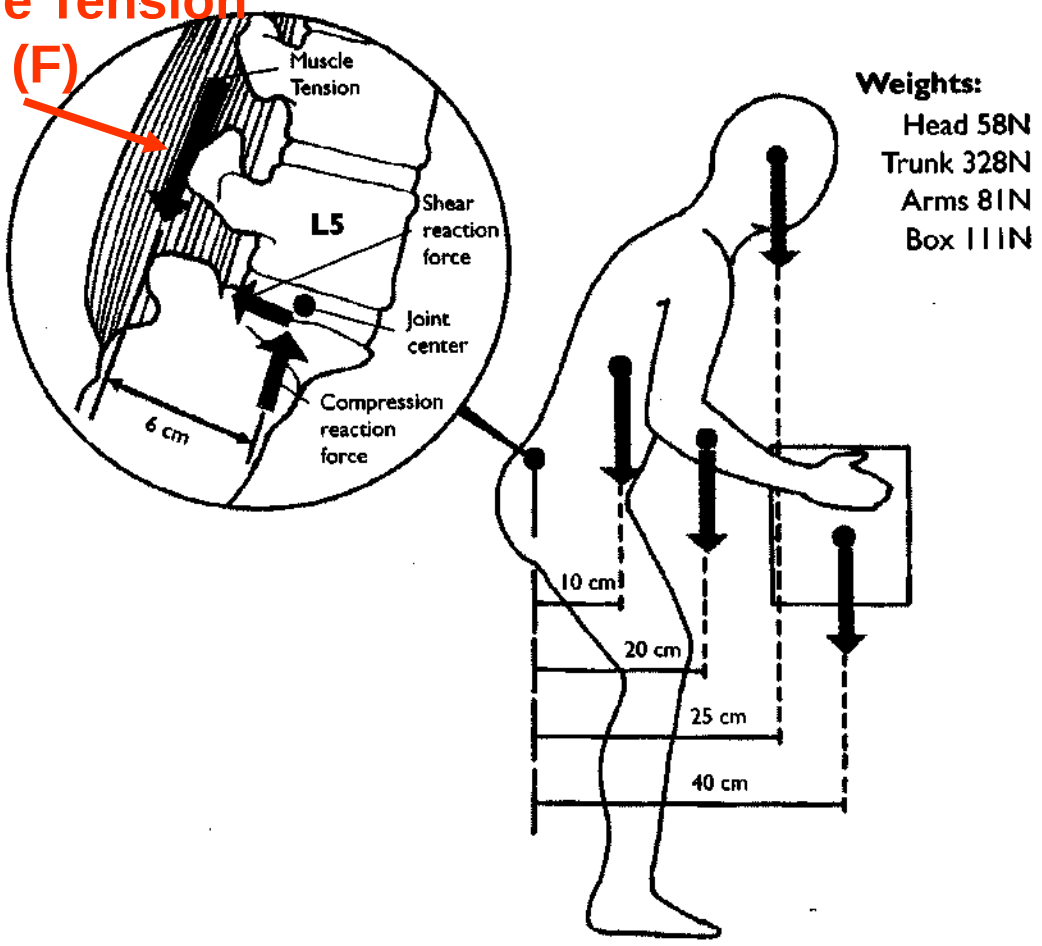
Higher Risk

Lower Risk

FIGURE 9-30

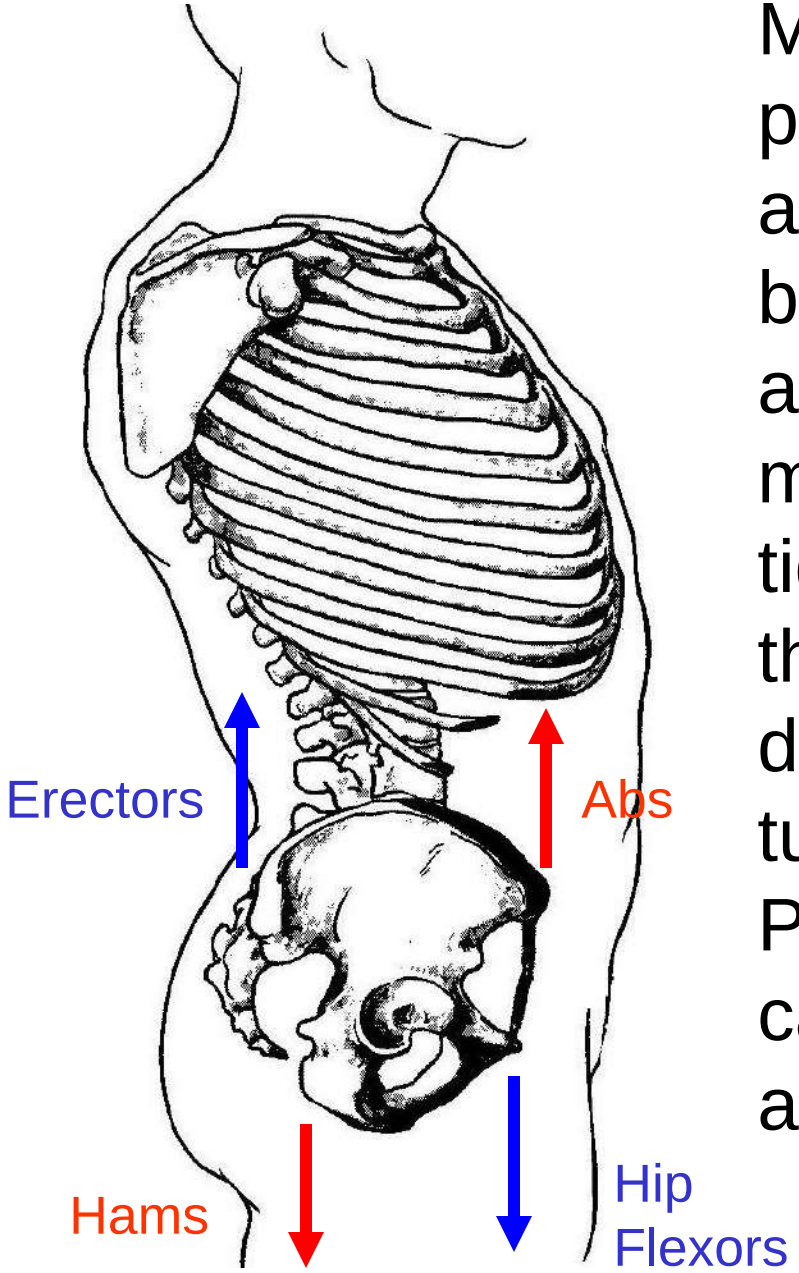
The back muscles, with a moment arm of approximately 6 cm, must counter the torque produced by the weights of body segments plus any external load. This illustrates why it is advisable to lift and carry heavy objects close to the trunk.

Muscle Tension Force (F)



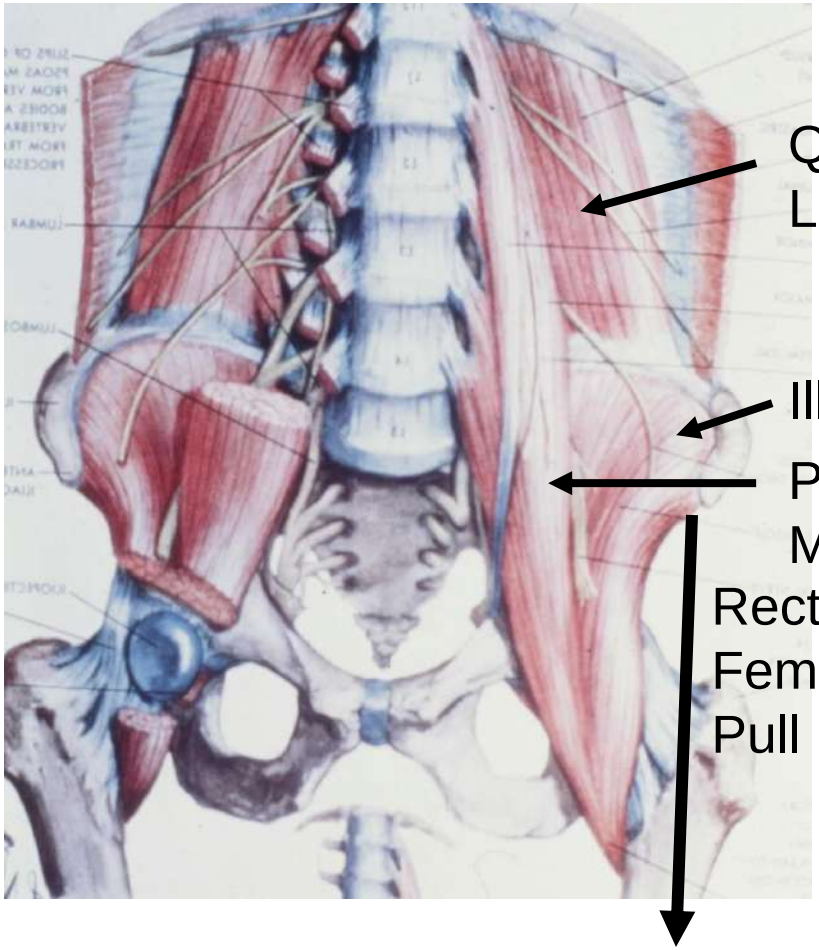
Torque at L5,S1 vertebral joint created by body segments and load:
T = (328 N)(10 cm) + (81 N)(20 cm) + (58 N)(25 cm) + (111 N)(40 cm)
= 10,790 Ncm

T = F x (6cm) = 10,790 Ncm
F= 10,790 Ncm / 6 cm
F= 1798 N
(404 lbs.)

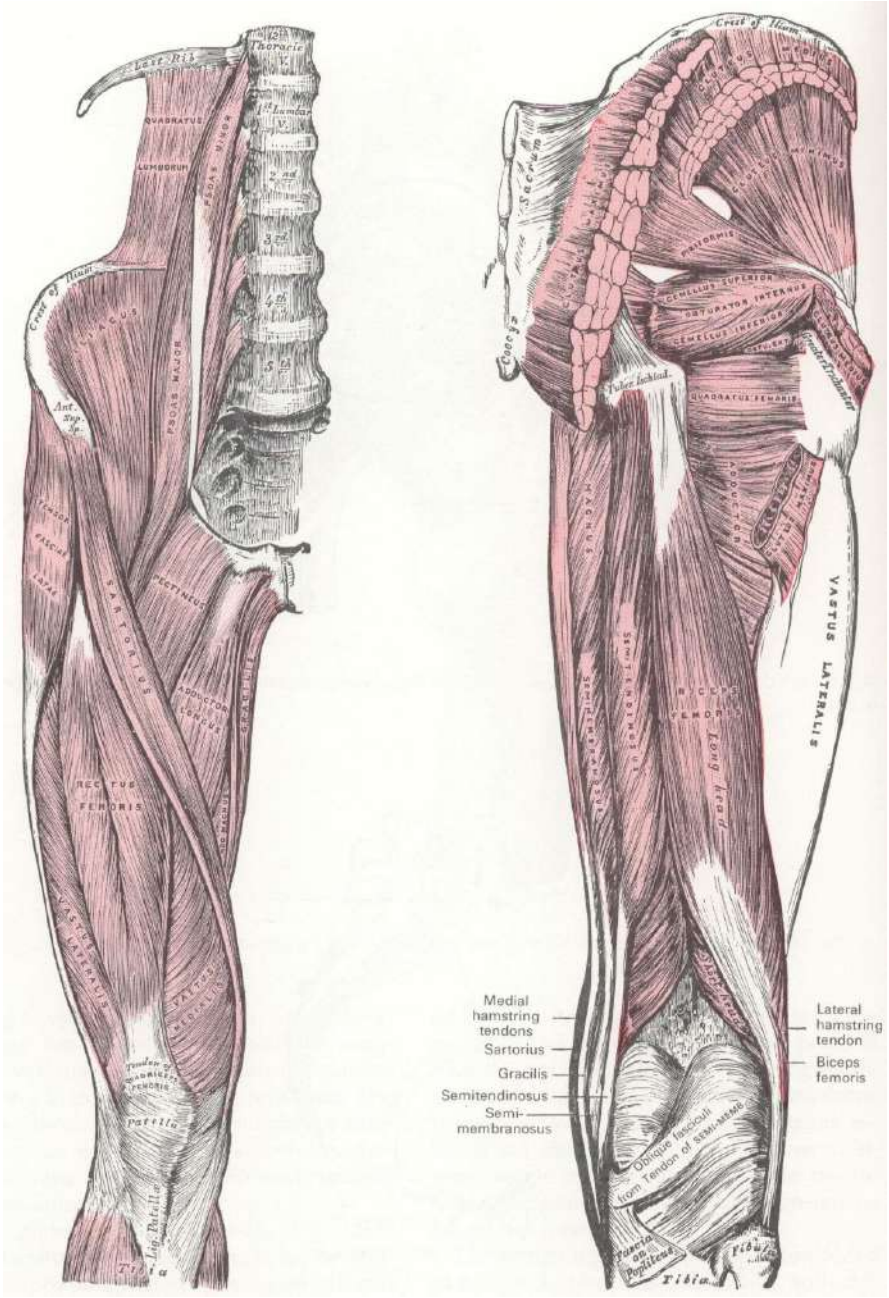


Maintain a level pelvic position in order to maintain a neutral spine. This requires balanced muscle strength and flexibility, as opposed to muscle weakness and tightness. The pelvis can be thought of as a wheel that dominating muscle forces can turn – Anterior or Posterior Pelvic Tilt. Seated postures cause pelvic rotation and altered spinal curves!

Hip Flexor Muscles and the Posterior Abdominal Wall

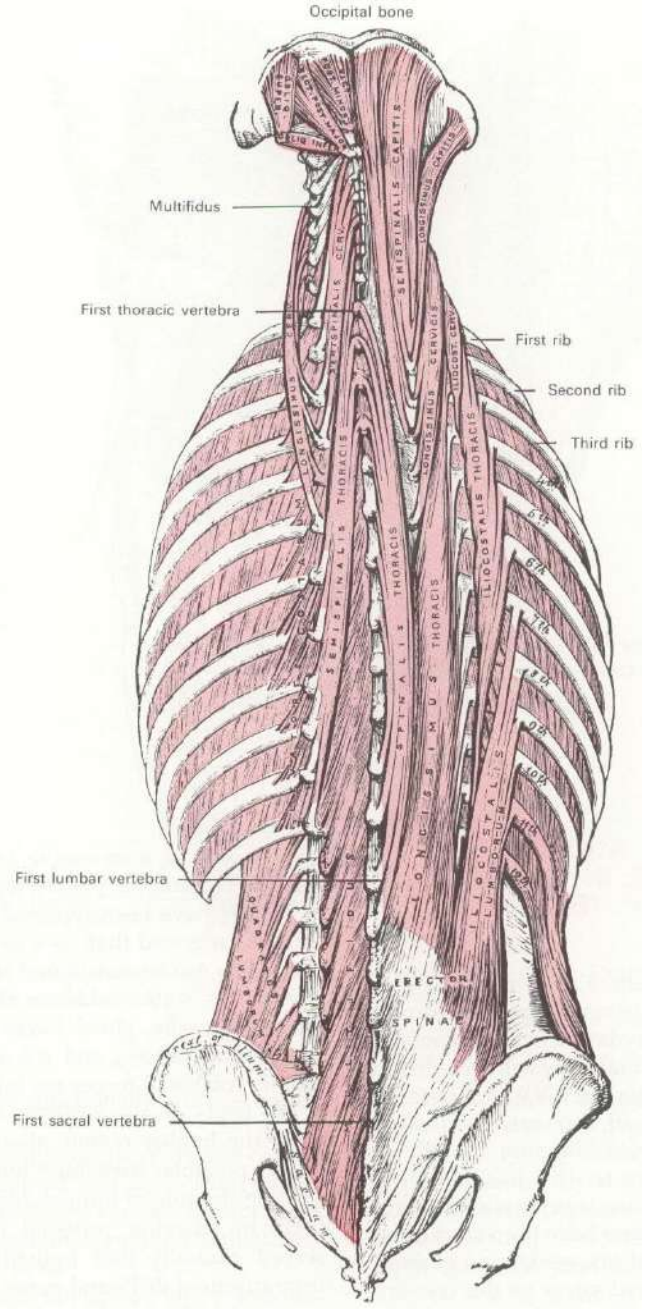


Exercises that require forceful hip flexor activity may increase lumbar curvature via the downward and forward (inferior and anterior) pull direction of the Psoas Major.



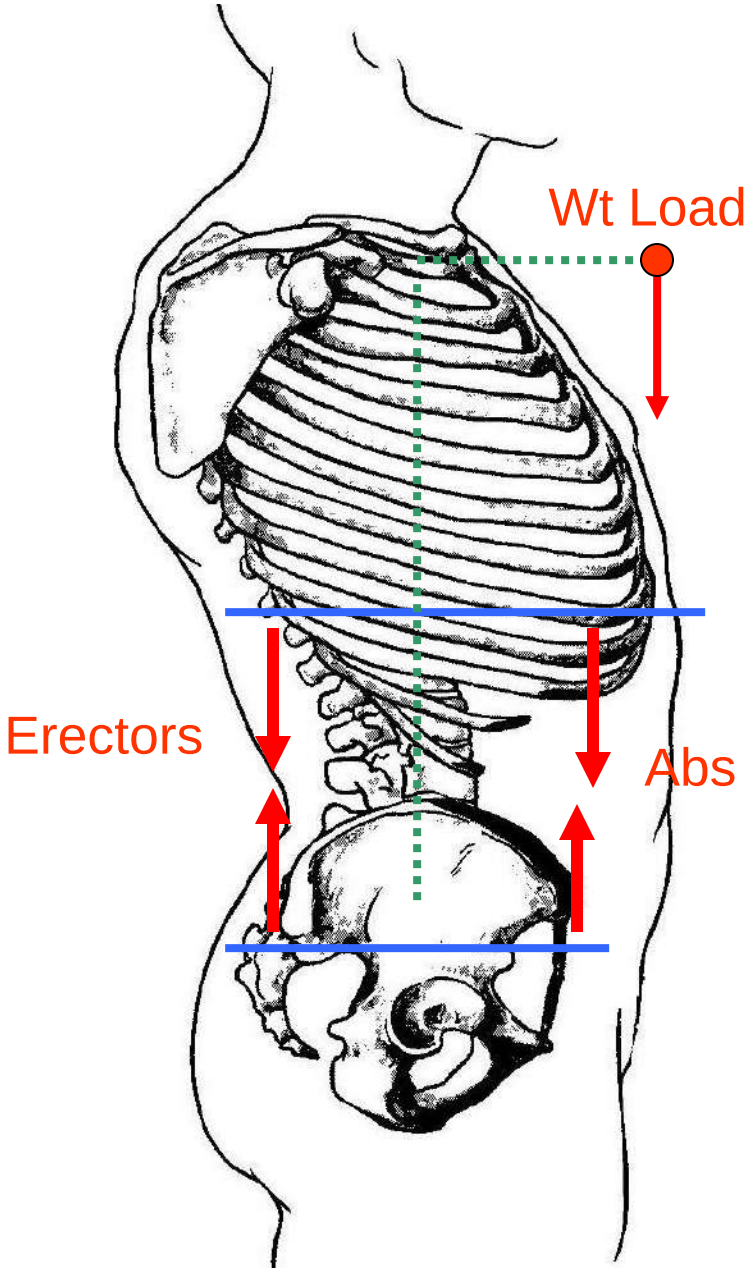
The Complex Interconnections Between the Lower Extremity, Pelvis, and Spinal Column.

Many muscles that control hip and knee movements attach to the pelvis. Likewise, many torso muscles, such as the abdominals and quadratus lumborum attach to the pelvis. However, the Psoas Major directly connects the lumbar spine to the lower extremity (femur or thigh bone). Thus, lower extremity muscle activity effects pelvic position and can indirectly influence spinal curvatures since the spinal column rests on the pelvis.



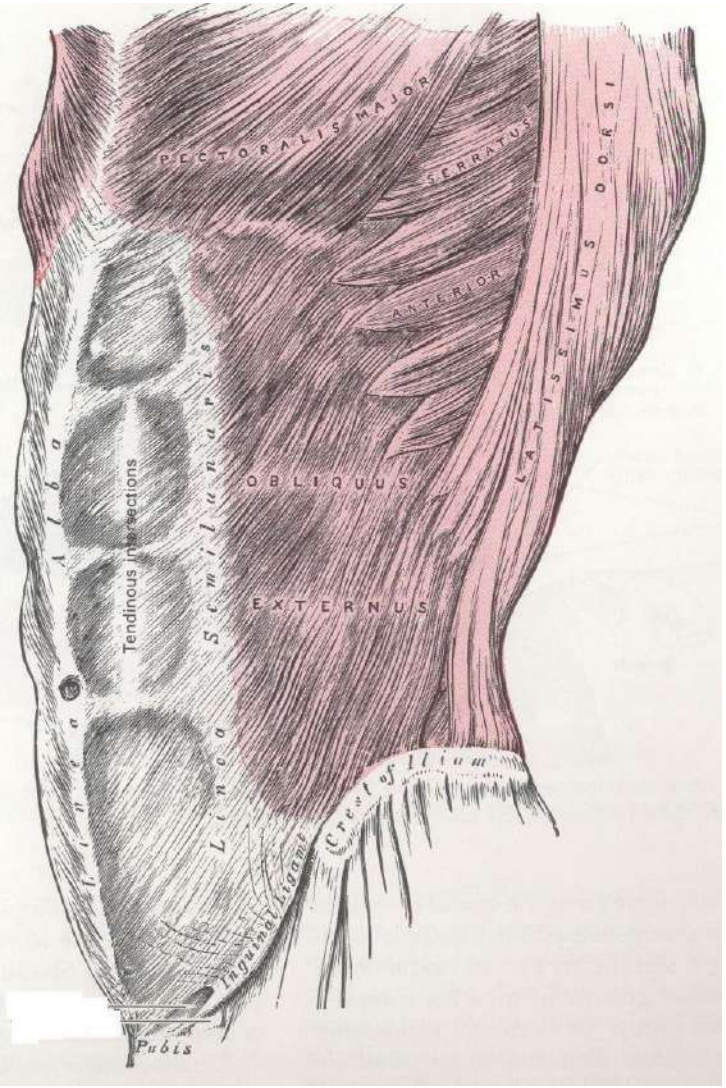
Posterior Torso Musculature

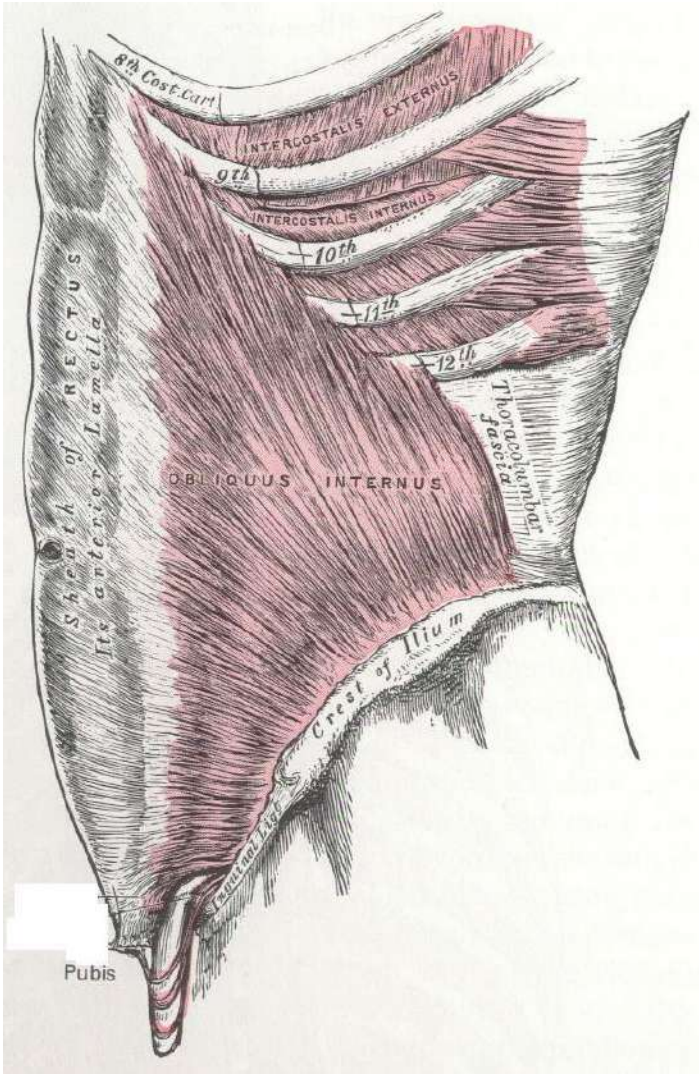
The numerous branches of the spinal erector group of muscles are positioned close to the spinal column itself and thus have poor leverage to keep the spine and torso in the desired position when lifting an object. This often results in the need for large erector muscle tension levels, which in turn results in large spinal compression load forces.



Tension in the Abs, Erectors, or both (co-activation) compresses the spinal column (compression load). If a weight in the hands tends to flex the spine rather than or in addition to Ab tension, then a large counter balancing erector muscle tension causes large spinal compression loading!

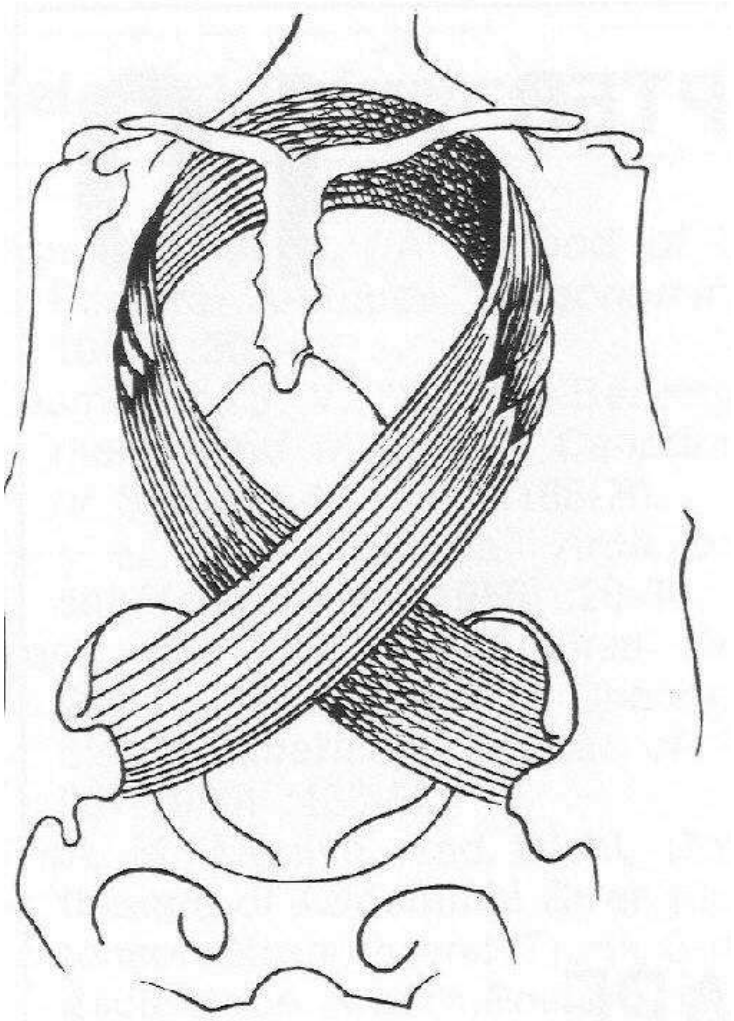
Anterior Torso Musculature

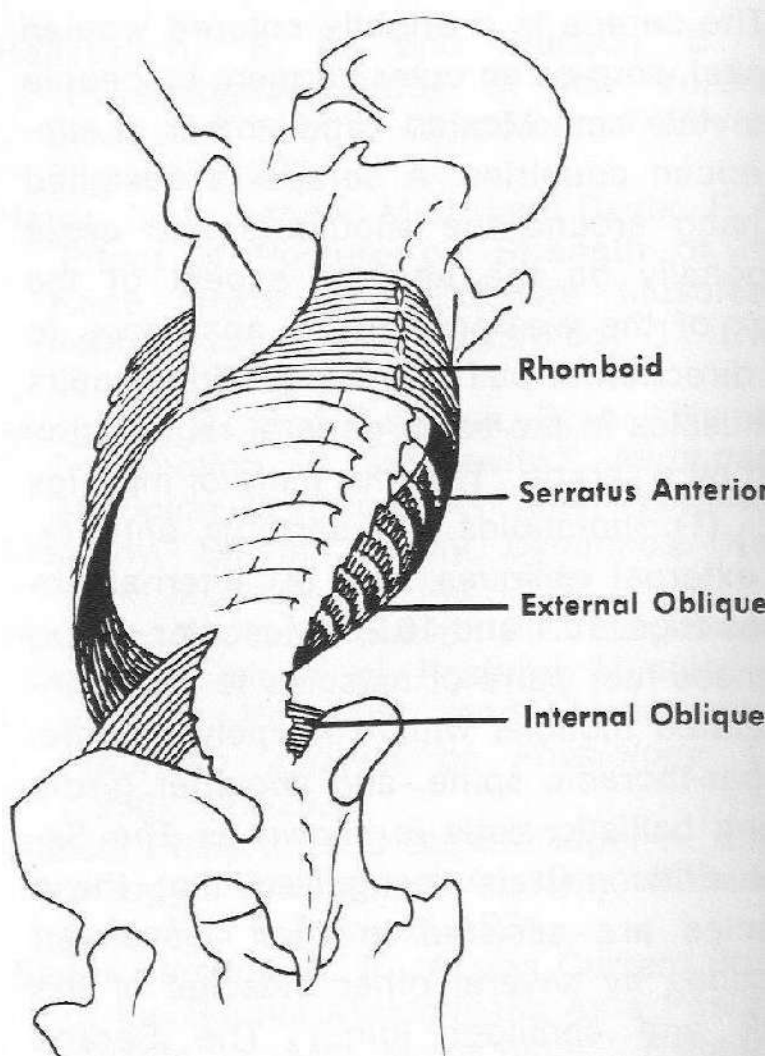




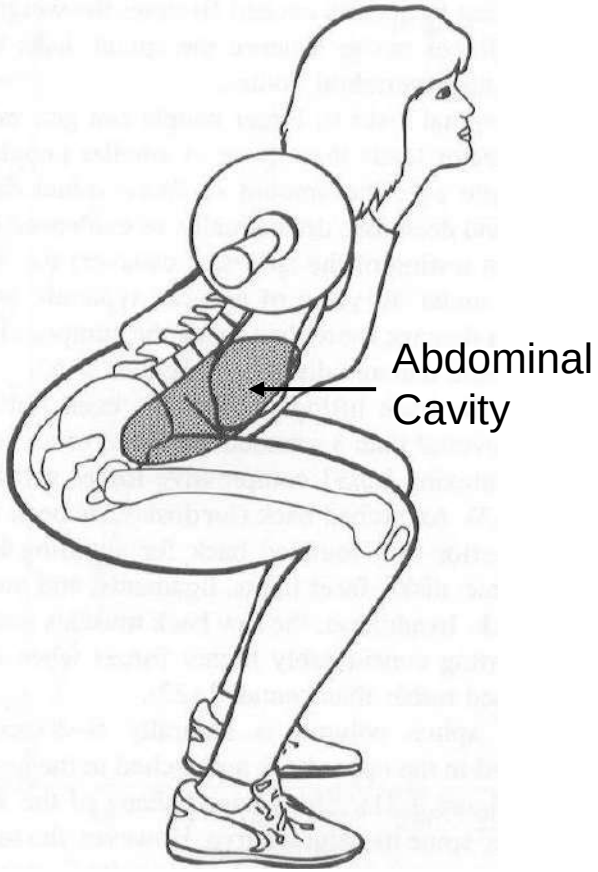
Note the connection of shoulder joint muscles (pec & lat) with abdominal wall musculature and connective tissue.

“Serape” Muscles – Important for Torso Rotational Movements (Throwing!)





Anterior Abdominal Wall (AB) Development

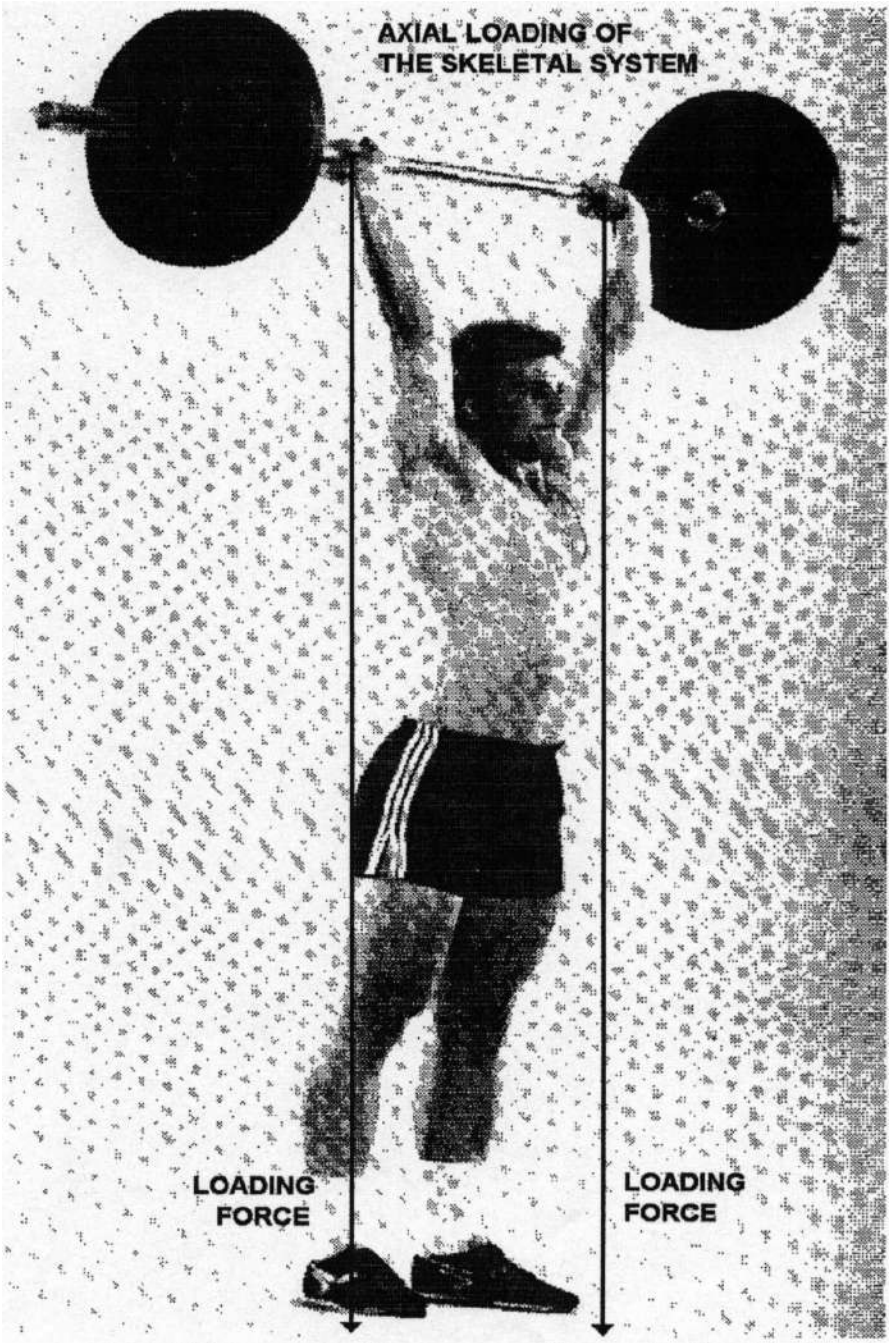


The abdominal muscles control spinal flexion and intra-abdominal pressure (IAP). They do not control hip flexion, although they can help stabilize the pelvis when hip flexors are active. In general, minimize hip flexor activity when trying to develop the abdominal muscles. IAP can help support the spinal column, but the use of a belt to help support the spine and increase IAP is not generally recommended. Why? Altered neural recruitment patterns & increased blood pressure.

Strengthening muscles associated with spinal health without generating excessive load forces

Beginner Intermediate & Advanced Torso Training Exercises

1. Side & Supine Bridges, The “Bird Dog”
2. Crunches / Sit-Ups
3. Leg Lifts
4. “Stiff Leg” (i.e., Romanian) Deadlifts (RDL)
5. “Good Morning”
6. Hyperextensions (Back Extension)
7. Glute – Hamstring Raises
8. Dumbbell Rows, Step-Ups, Overhead Squat
9. Torso rotation exercises
10. Consumer Grade Abdominal Exercises Devices



“Structural” lifts load the spine and require the torso muscles to be active and strengthened over time. These include squats, and pulling movements; such as deadlifts, power cleans, and all overhead lifts. They are fundamental exercises for improving torso strength.

Side Bridges

Beginner

Intermediate

Advanced

Supine Bridge

Beginner

Advanced

“Bird Dog”

Good integration of shoulder, torso, and hip musculature.
A beginner can use only the horizontal leg position with both hands on the floor. Hold for 5-10 seconds, then switch sides. A more advanced version employs slow hand and foot motion patterns (circles, squares, etc.)

Crunches

Start

Finish

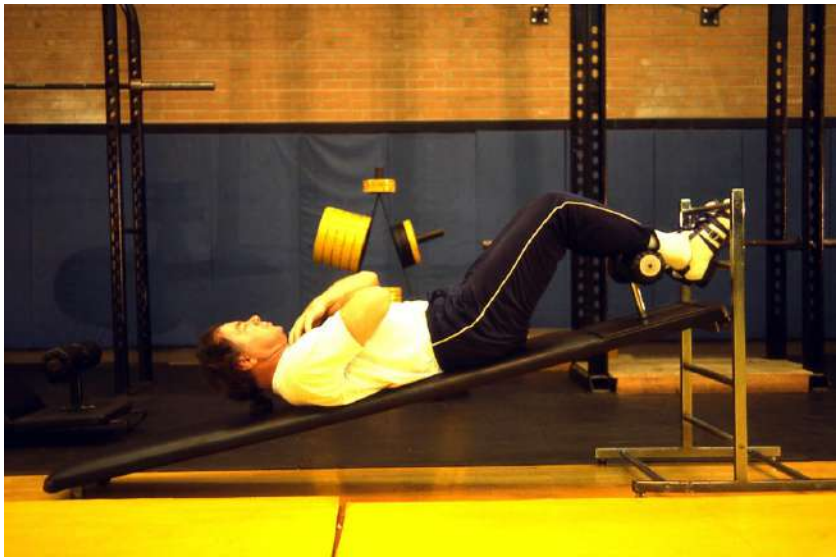
1. Feel that the lumbar curve is maintained
2. Activate the rectus abdominis to lift shoulders
3. Limit the range of motion to submaximal
4. Do not hyper-flex the cervical spine

Double Crunch!

Start

Combined shoulder lift and posterior pelvic rotation. Must be performed slowly, both contraction and relaxation.

Finish



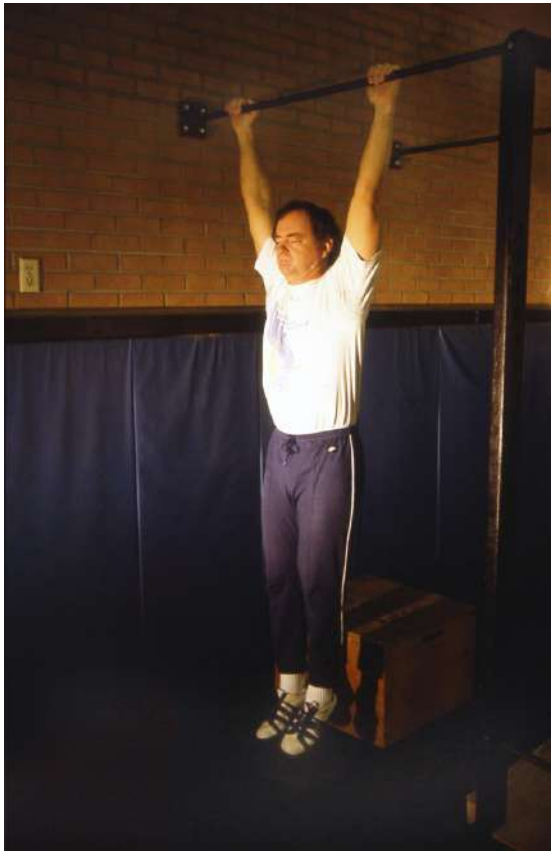
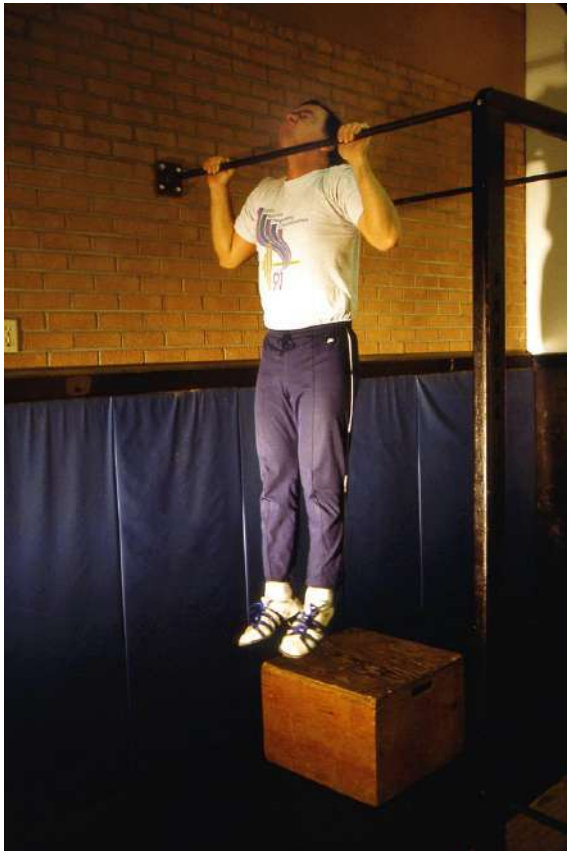
The full “sit-up” involves considerable hip flexion and high hip flexor muscle tension, especially on an inclined board. Do you need this? The spine is also flexed maximally. About 20,000 flexion cycles under moderate compression load can cause damage in cadaver specimens. 100 sit-ups per day, five days per week, 50 weeks per year = 25,000 cycles; but there are rest / recovery intervals in this sit-up example.

Leg Lifts

Start

Finish (60° hip ROM)

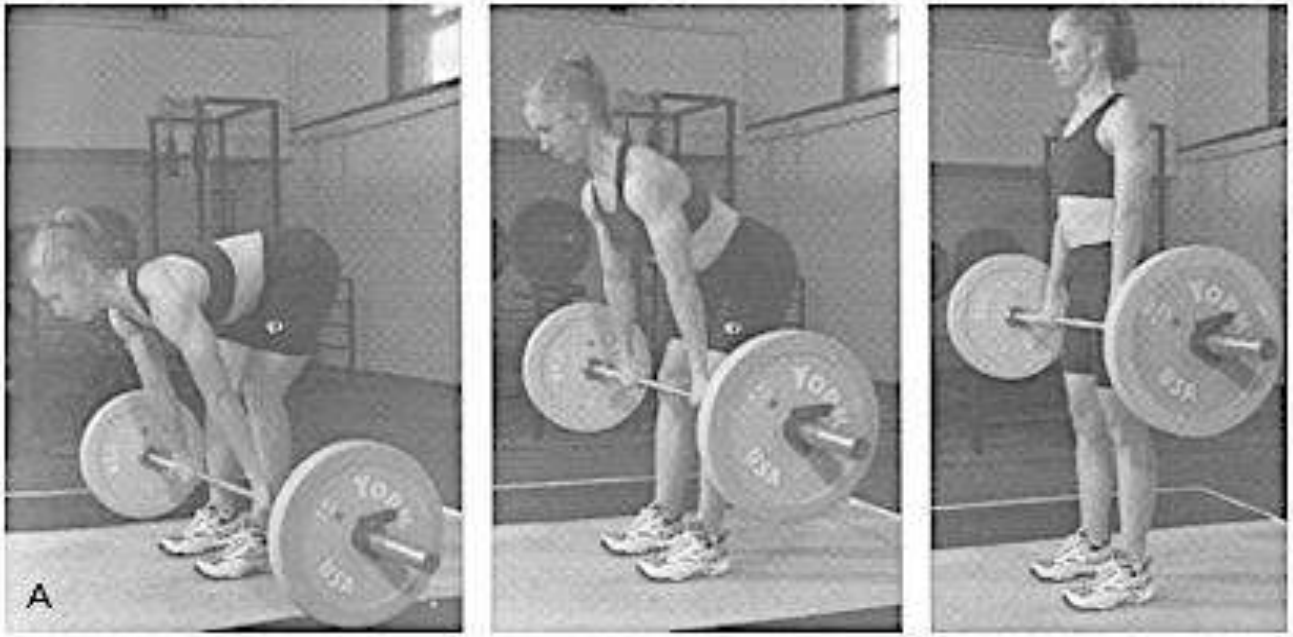
Beginner to intermediate (flat to inclined surface) “leg lift” with posterior pelvic rotation and low to moderate gravitational resistance.

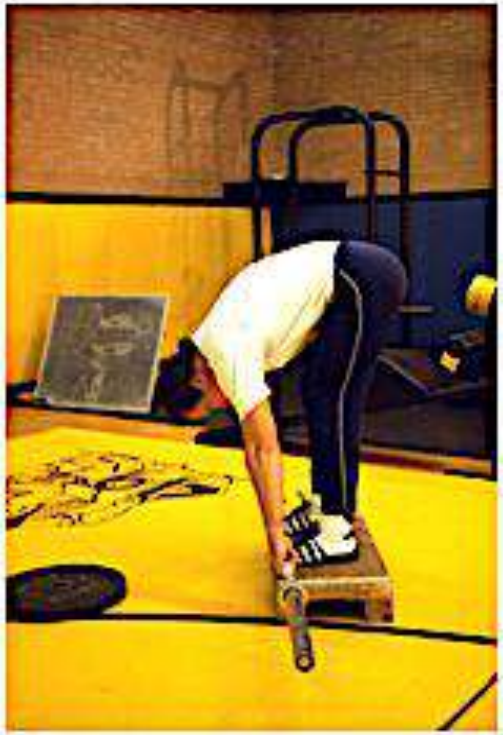

Advanced “leg lift” exercise – 120° hip ROM with maximal gravitational resistance.

A B C

The stiff-leg deadlift—variations
Bent knees, straight back (A) Straight knees, straight back (B) Straight knees, rounded back (C)

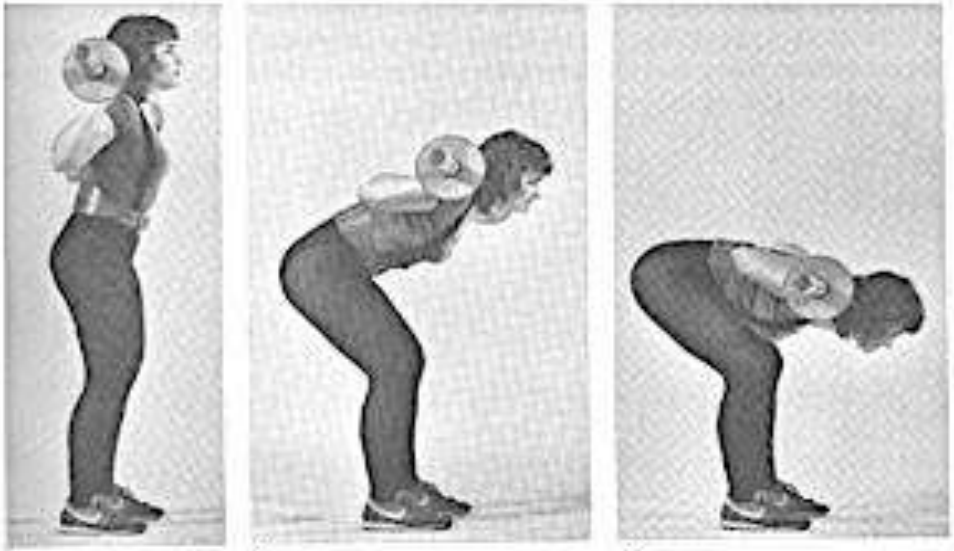


A



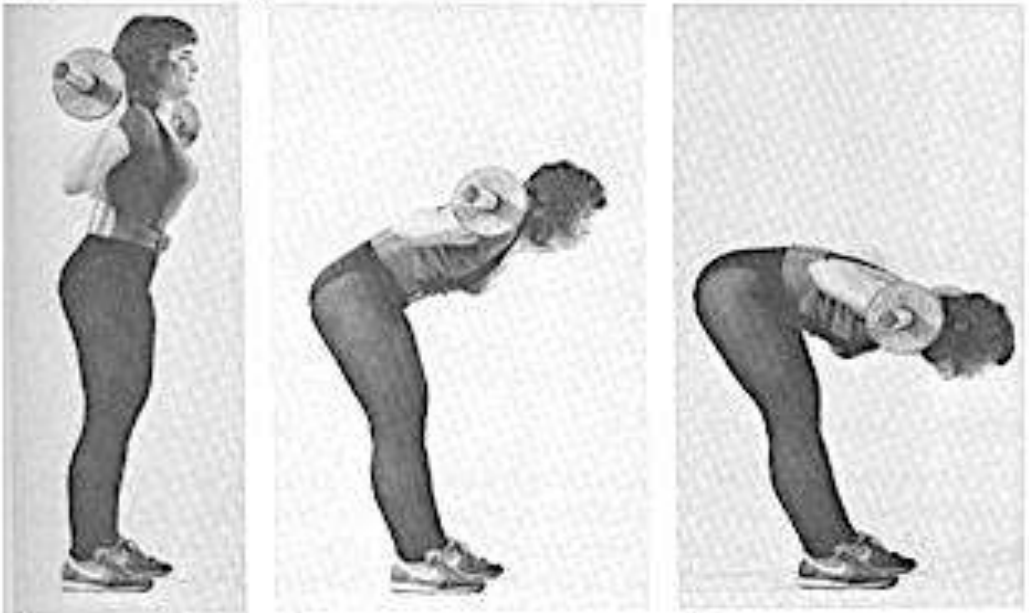
Stiff Leg Deadlift Variations (RDL)

"Good Morning" exercise variations



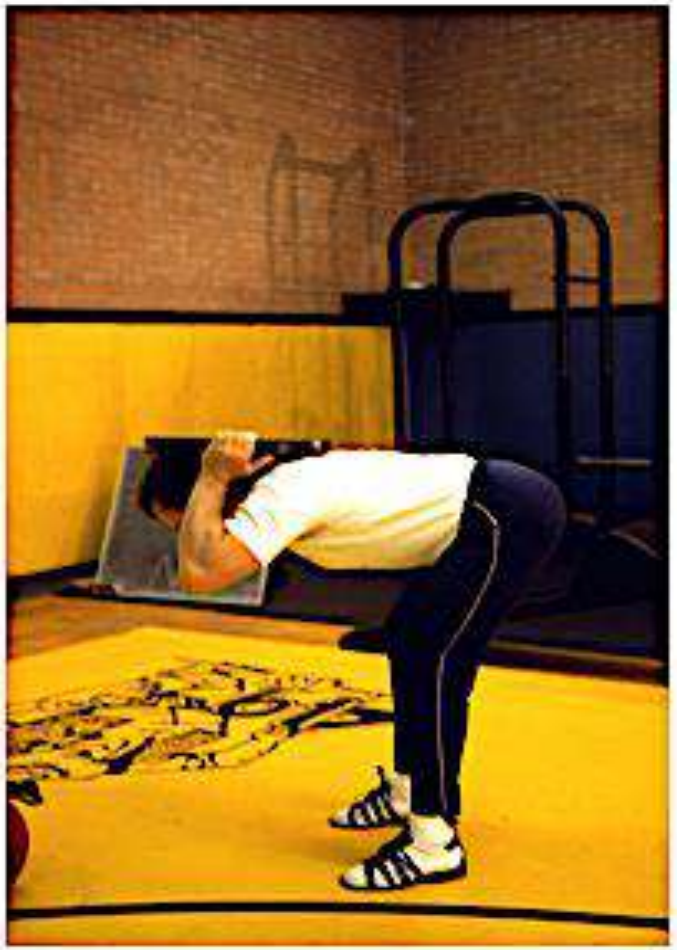
A B C

"Good morning"—knees bent
The bent-knee position should remain constant through the full range of motion. The movement down and up is done slowly.



A B C

"Good morning"—legs straight
The movement down and up is slow.



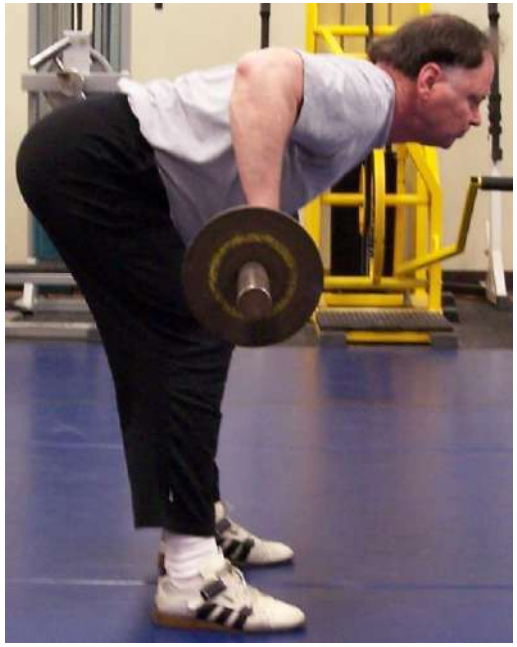
Bent Knee – Flat Back
Weight Plate or No Load

Barbell Good Morning: Bent Knee – Flat Back

Toe Touch

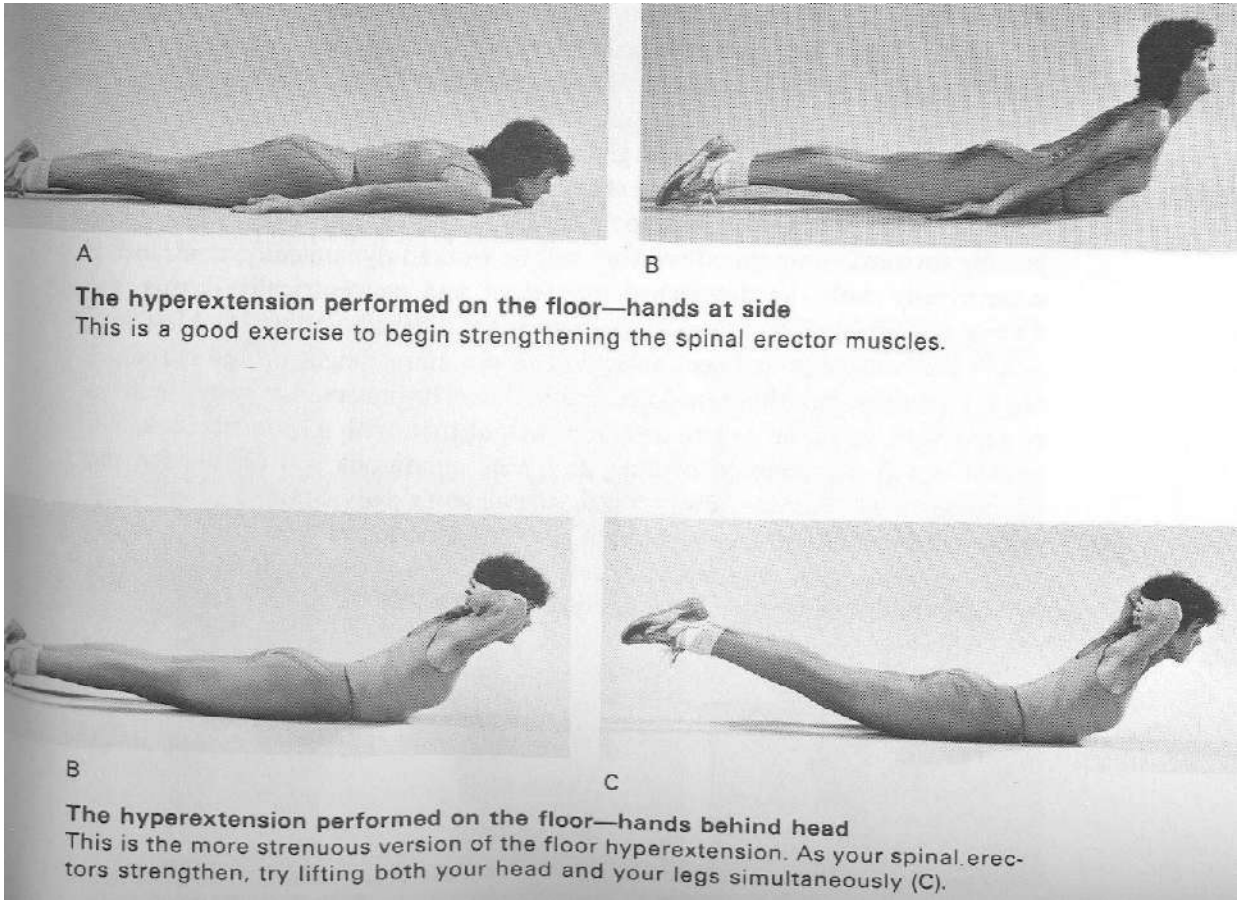
Anterior Pelvic Rotation
+ Spinal Flexion

Anterior Pelvic Rotation
with (almost) Flat Back



Application of the Flat Back
Posture to Properly Execute
the Bent Over Barbell Row

Beginner to advanced versions of the floor hyperextension



A B

The hyperextension performed on the floor—hands at side
This is a good exercise to begin strengthening the spinal erector muscles.

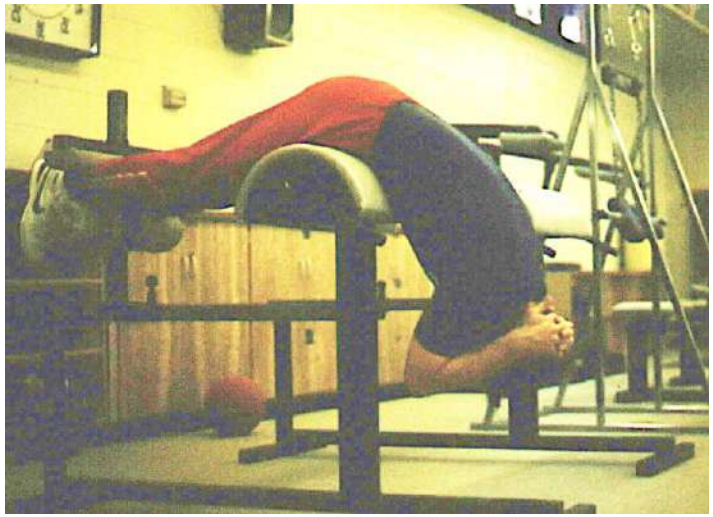
B C

The hyperextension performed on the floor—hands behind head
This is the more strenuous version of the floor hyperextension. As your spinal erectors strengthen, try lifting both your head and your legs simultaneously (C).

No Equipment Needed!

Limit the Range of Motion to Reduce Mechanical Stress on the Spine!

Identify This Exercise



Start:

1. Spine flexed
2. Pelvis ~ neutral
3. Knees almost straight

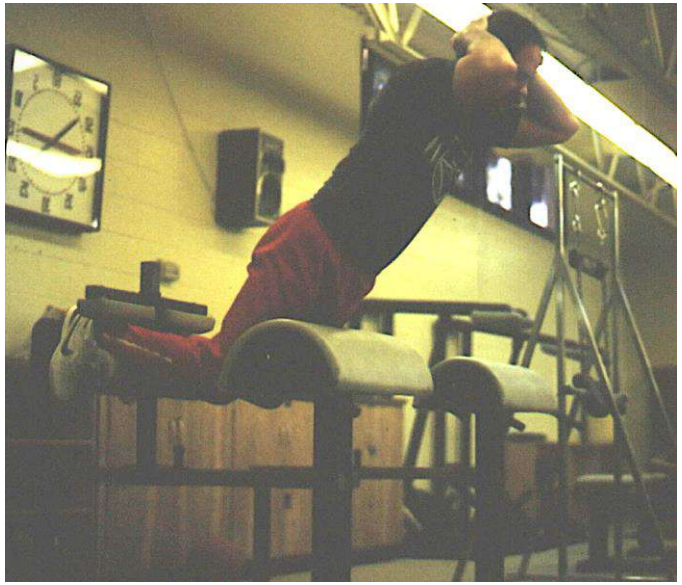
Finish:

1. Spine hyperextended
2. Pelvis ~ neutral
3. Knees almost straight

What muscles control these movements?

= Hyperextension
(Back Extension)

Identify This Exercise



Start:

1. Spine flat
2. Pelvis anteriorly rotated
3. Knees almost straight

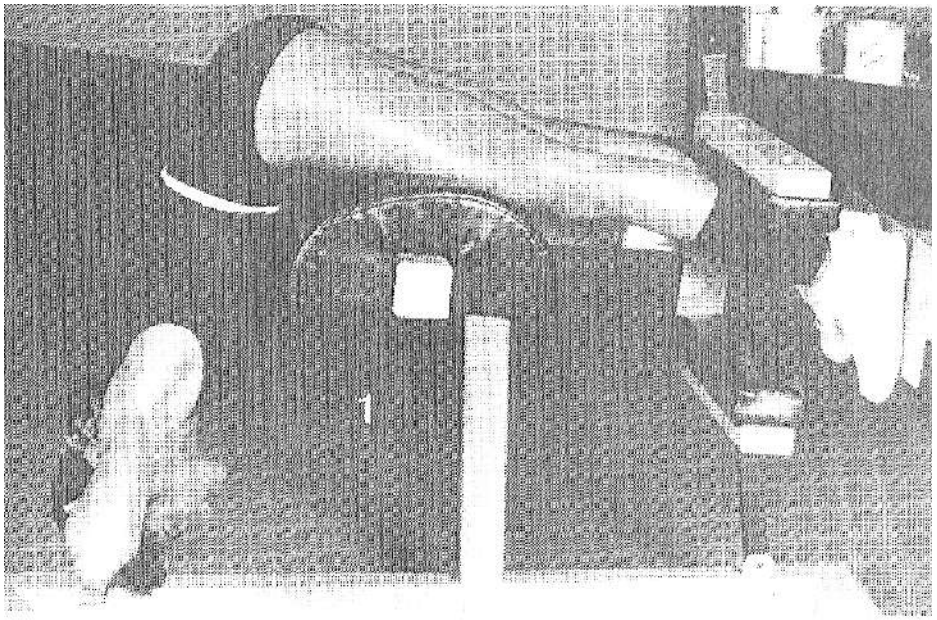
Finish:

1. Spine flat
2. Pelvis neutral
3. Knees flexed

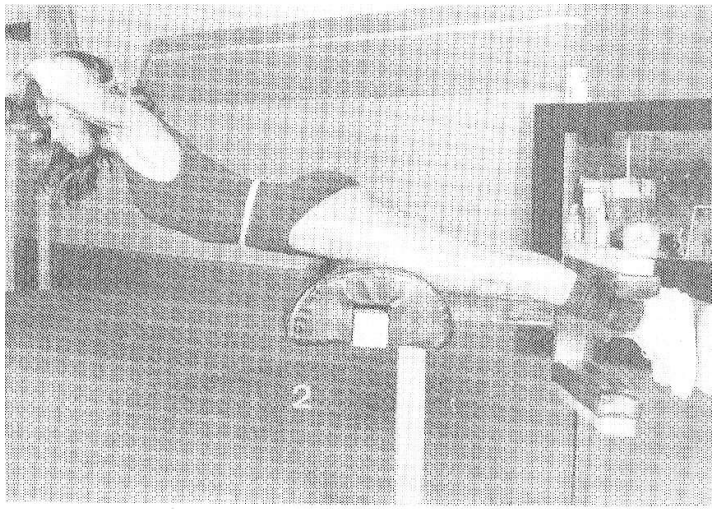
What muscles control these movements?

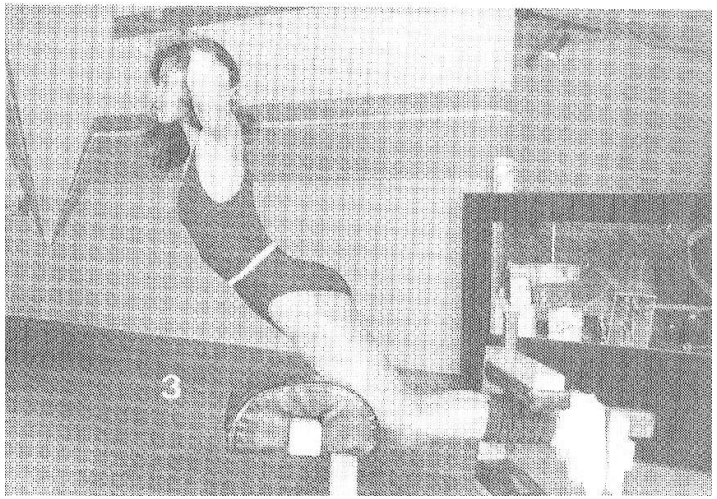
= Glute / Ham Raise

Technique Considerations
Hyperextension versus Glute - Ham Raise



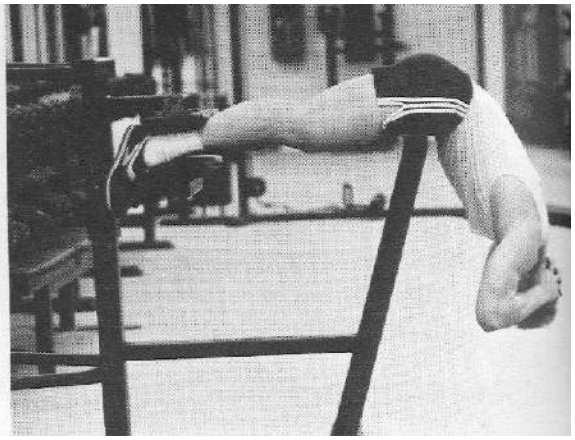
1. Correct Glute – Ham Raise
   (finish could be more vertical)





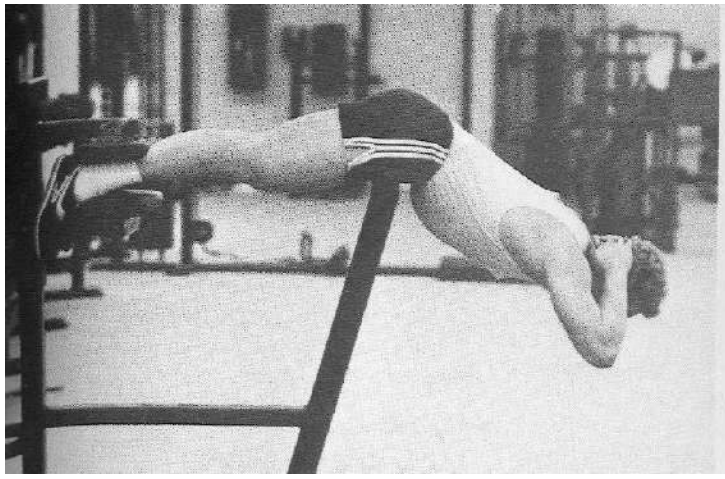
Technique Considerations
Hyperextension versus Glute - Ham Raise

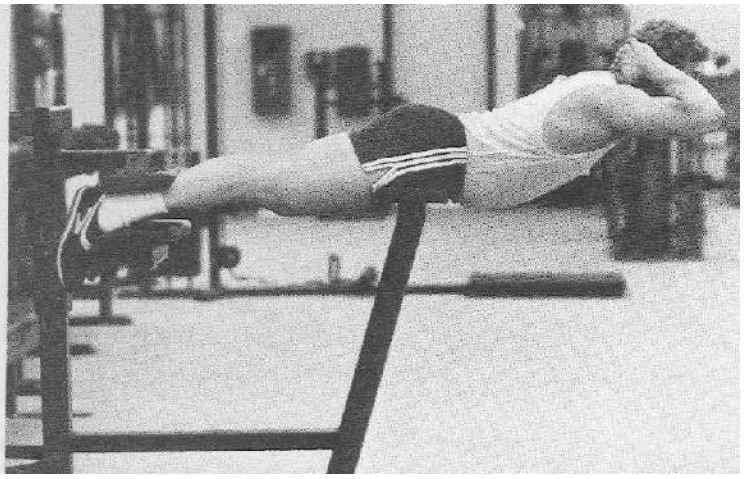
Hyperextensions

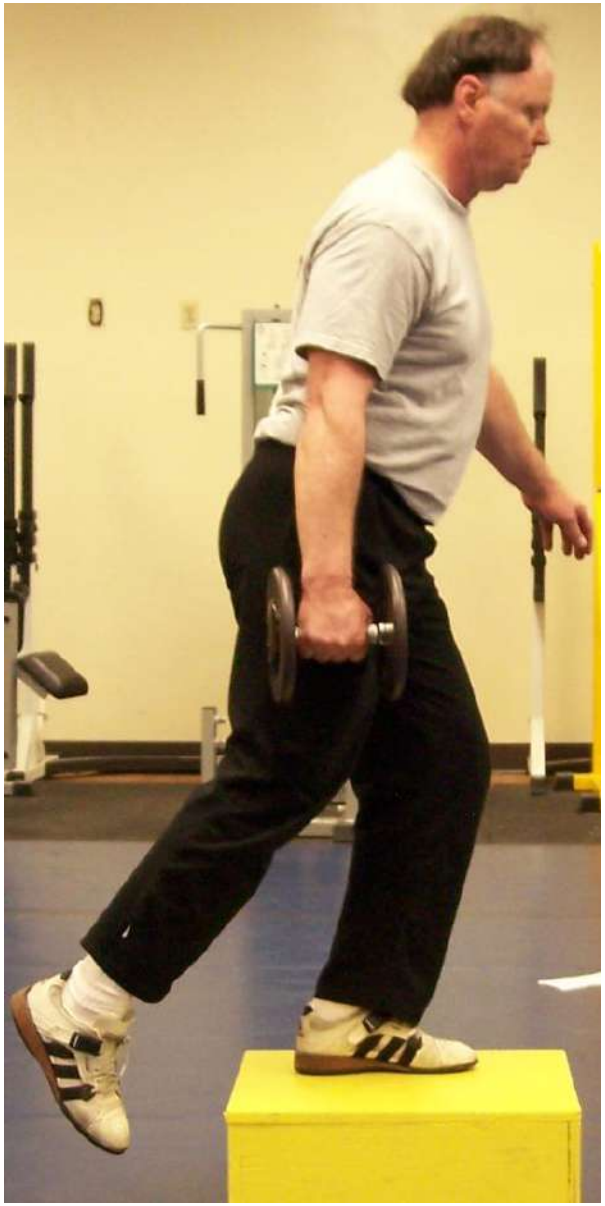


The hyperextension on a typical special-purpose bench
Note the position of the head and spine in (C)—only slightly more than parallel with the floor. Movements up and down should be slow.

2. Correct Hyperextension (Back Extension) Technique







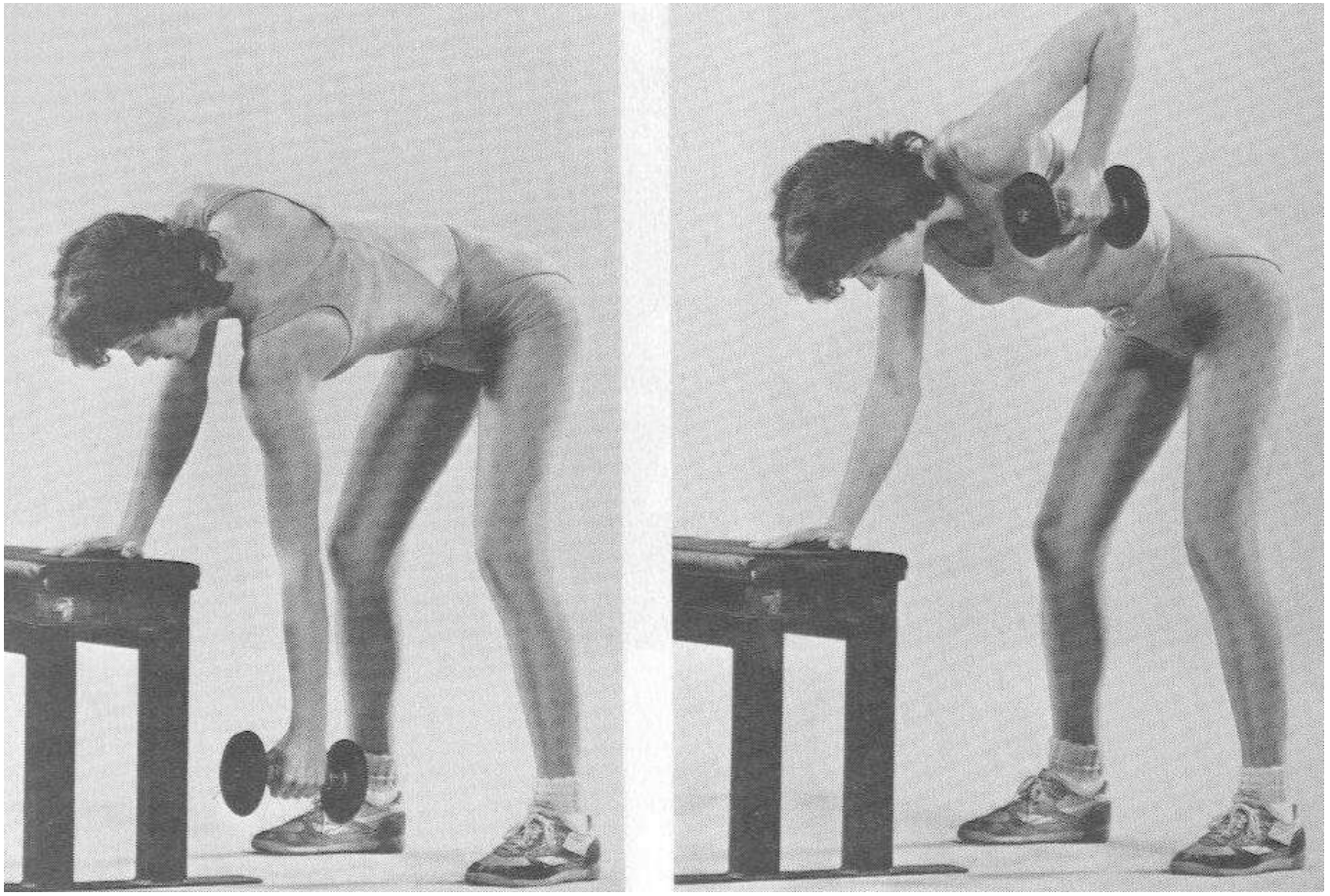
Example of Asymmetrical Loading and Single Leg Step-Up (partial single leg squat) to enhance Torso and Pelvic Stability.

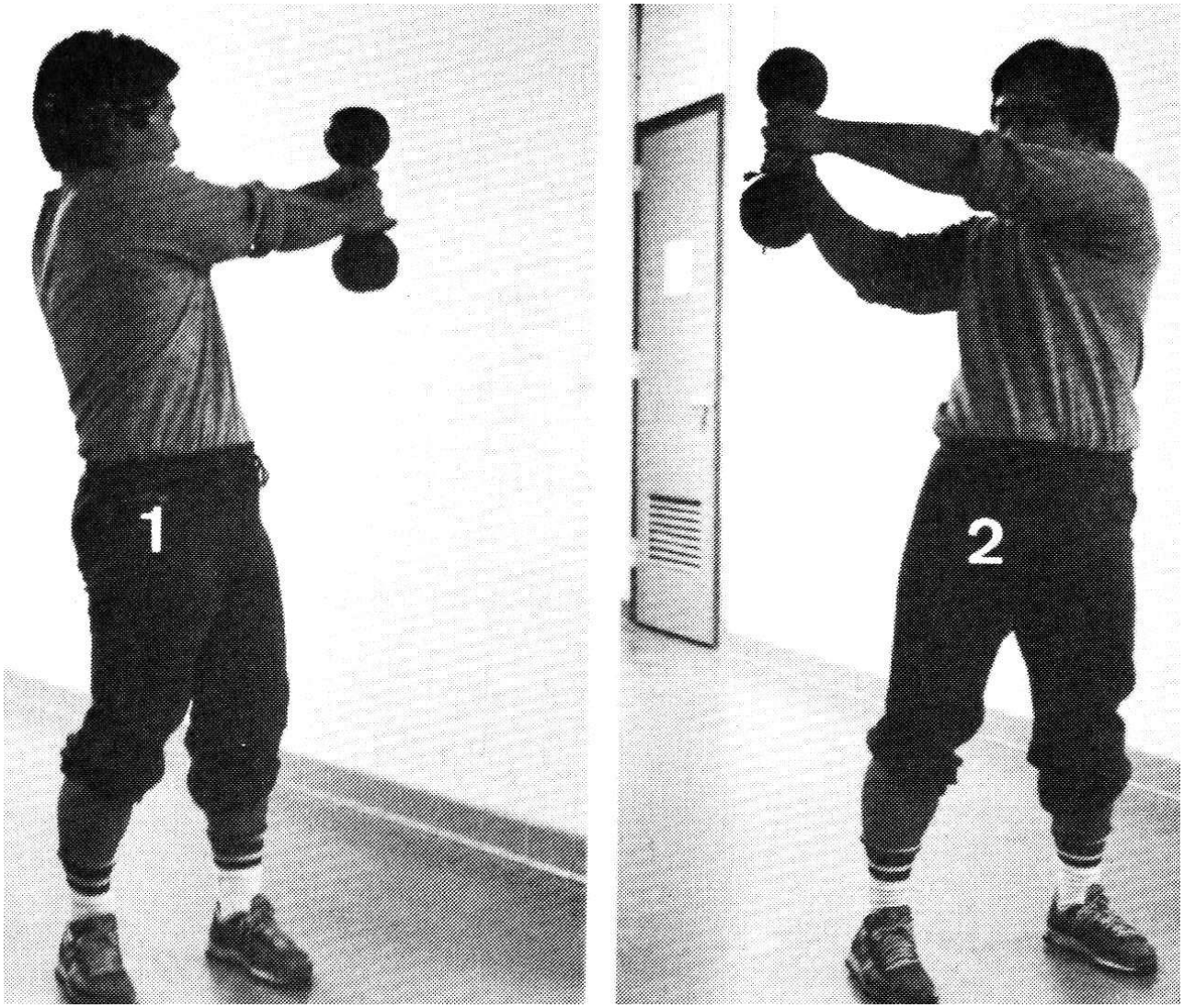
Options:
Up R, down R
Up R, down L

“Overhead Squat”

Good test exercise for balance, multi-joint flexibility, and integration of shoulder, torso, and hip musculature. Beginners should use a broom stick or empty bar. Note that a wide grip is used.

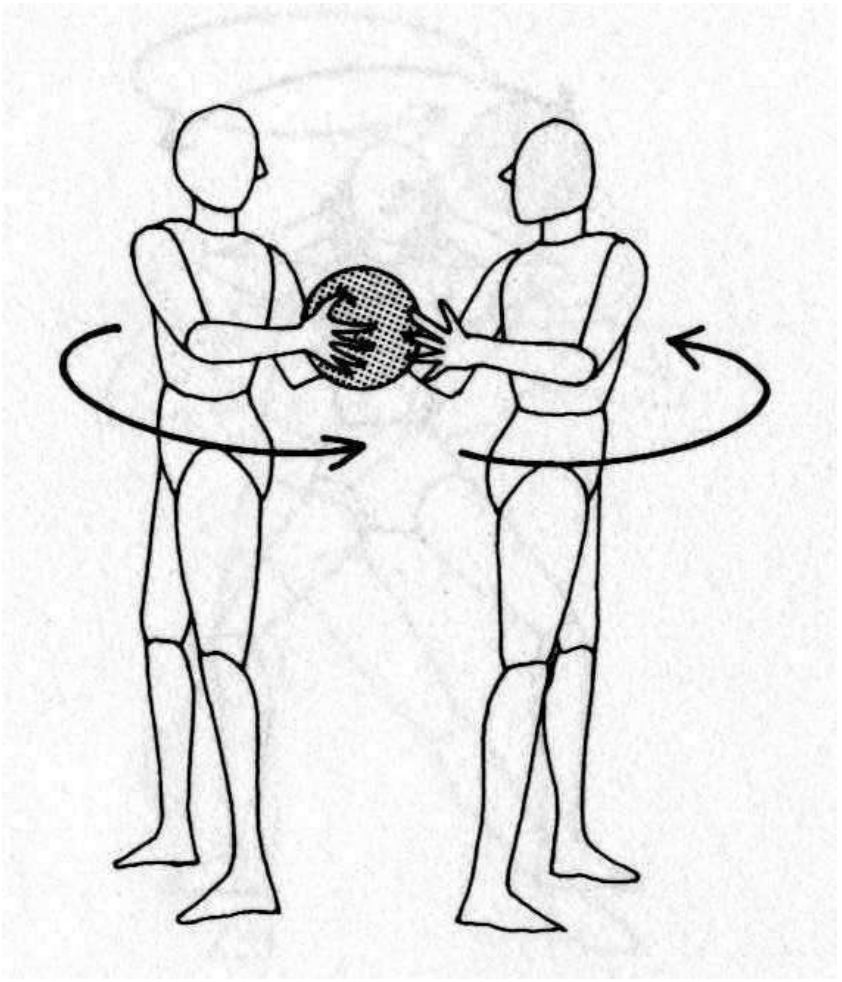
The dumbbell row is a reasonable exercise that can be used to train the torso musculature for resisted torsional movements (rotation RT or LF or the spine) with neutral spine curvatures. Seated torso rotation machines can result in very high load forces being applied to the spine.

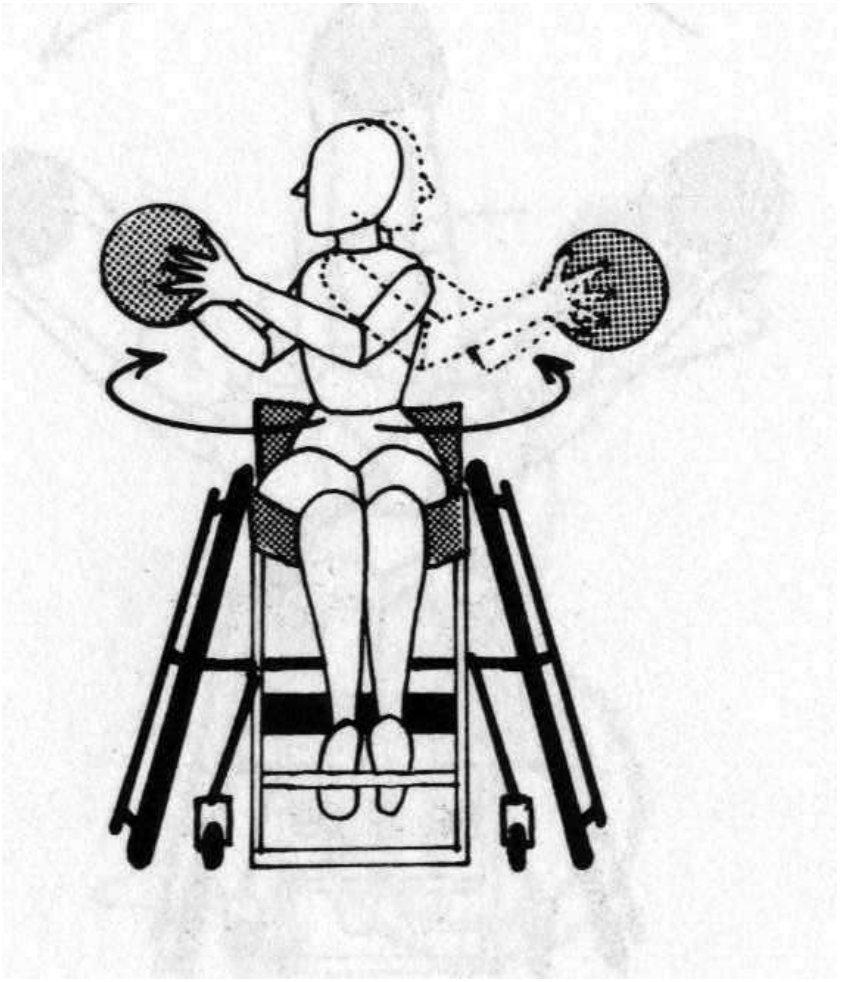


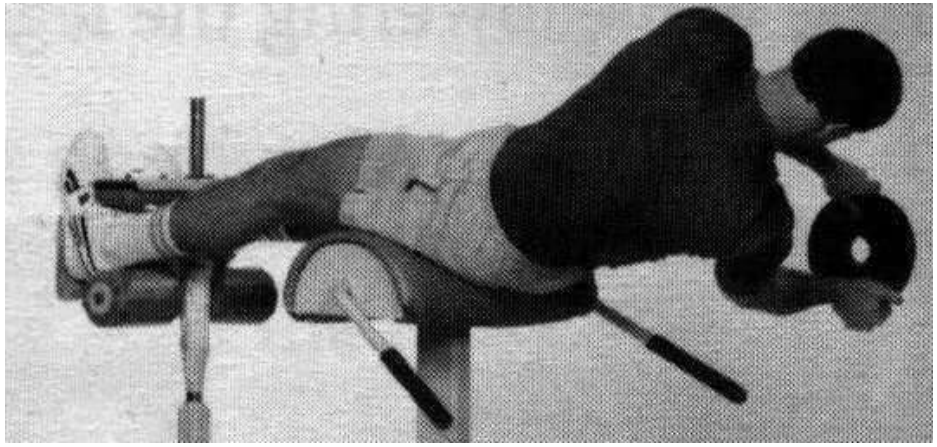


Deceleration under muscle control is very important!

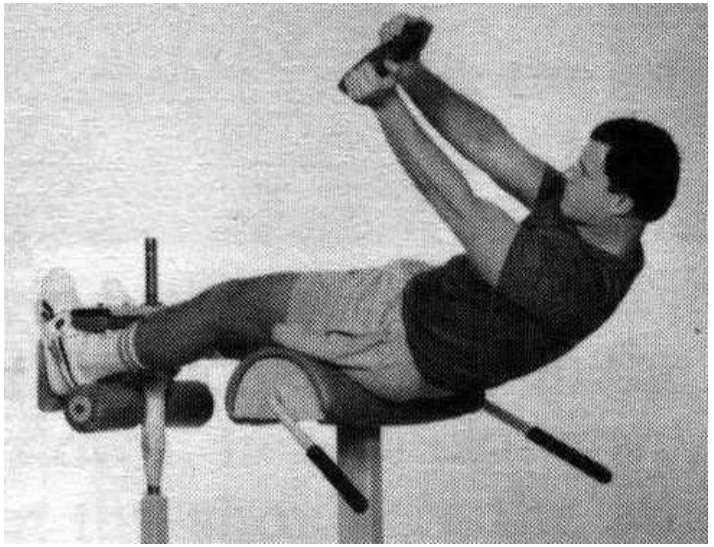
Concentric muscle activation initiates the movement but eccentric muscle activation stops it!



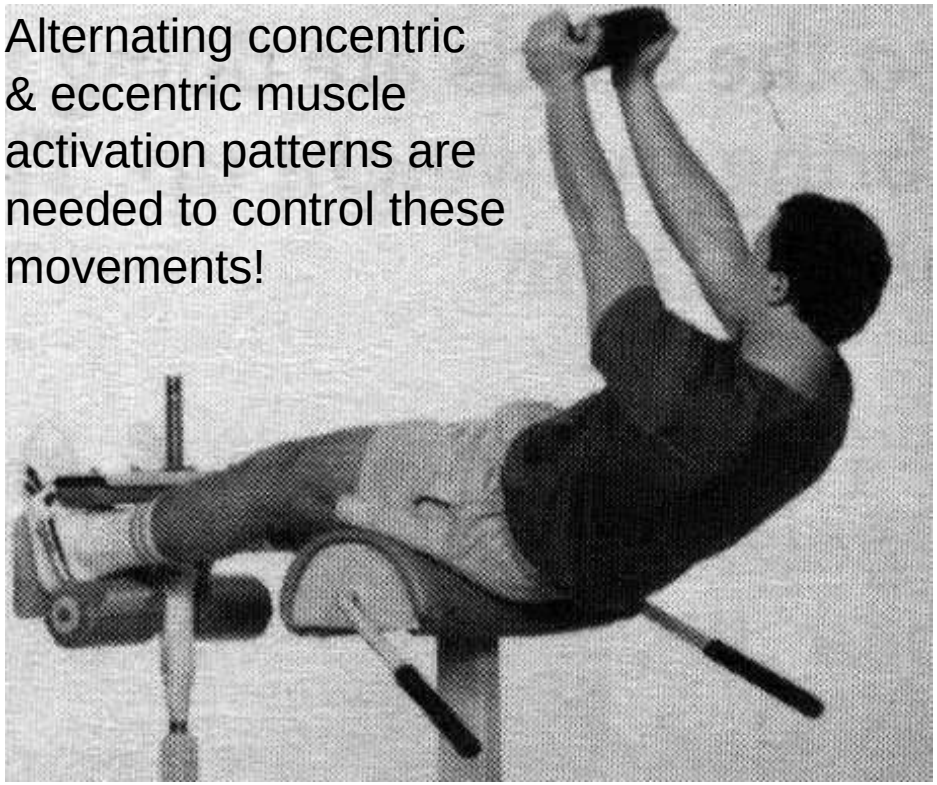


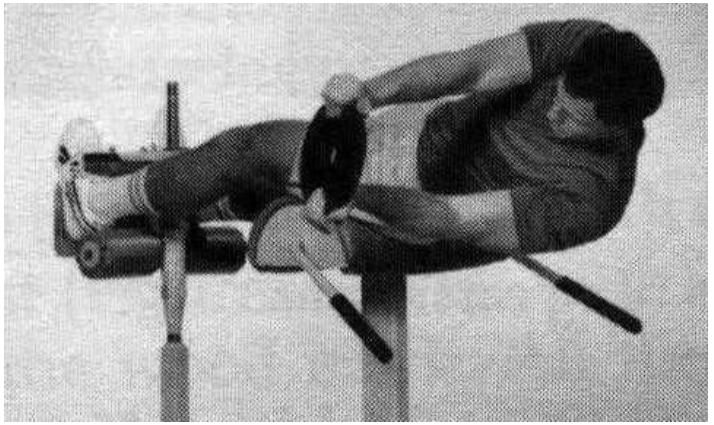


High torso muscle tension levels to maintain the upper body position with an external weight creates high spinal compression loads – then the spine is deformed via rotational movements!



Alternating concentric & eccentric muscle activation patterns are needed to control these movements!



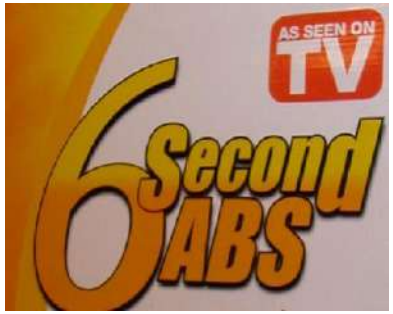


Consumer Grade Abdominal Exercise Devices

Ab “Rollers”

Rolo - Flex

"Smart – Abs"



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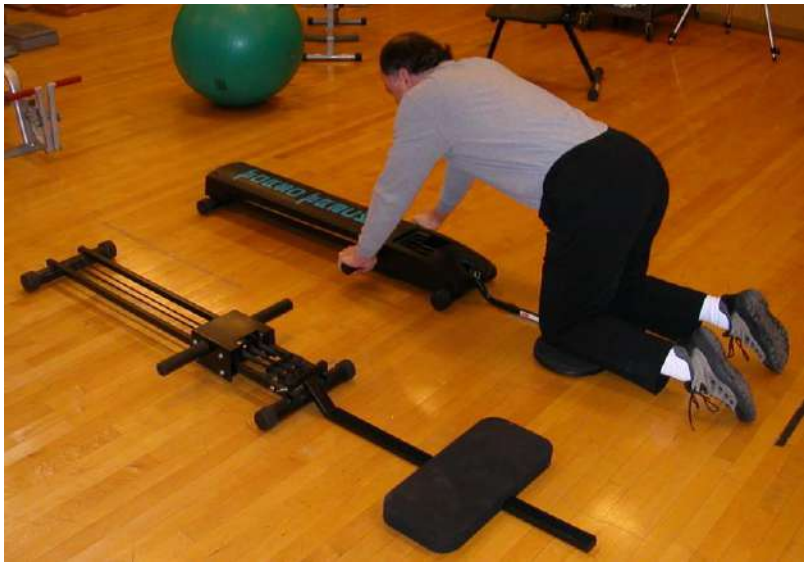
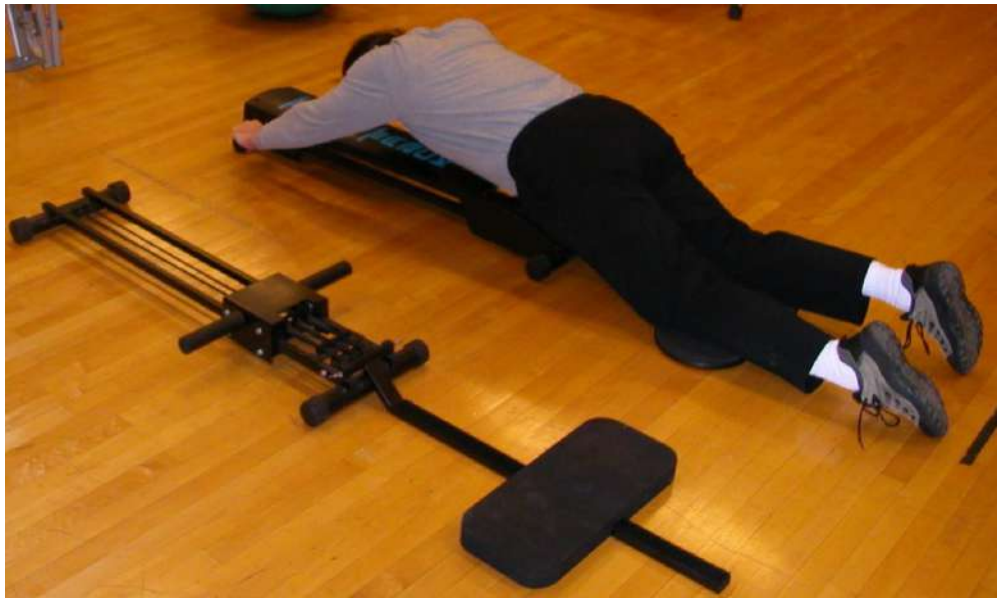
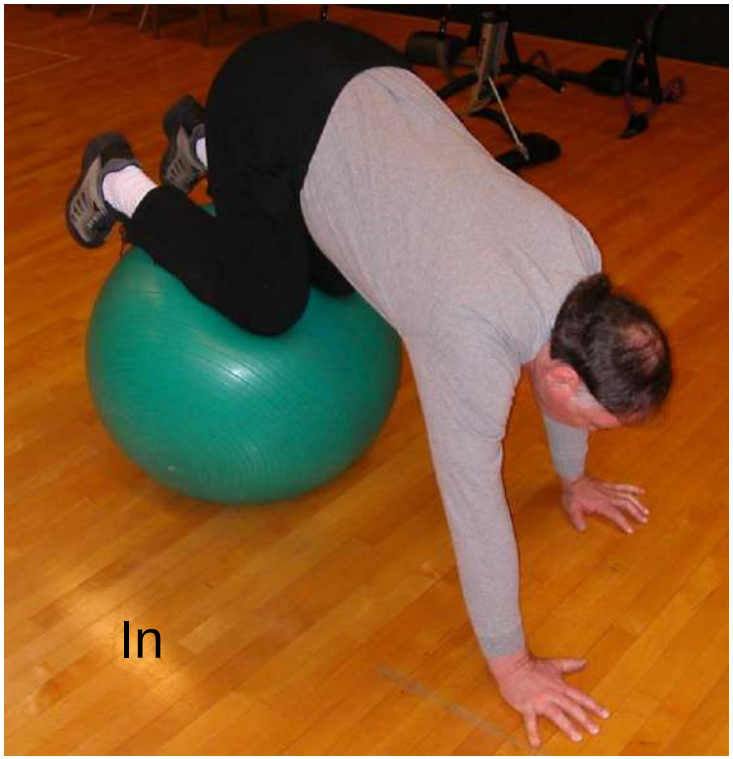




"Torso Track" (proto-type and production model). Adjustable assist tension via elastic bands.

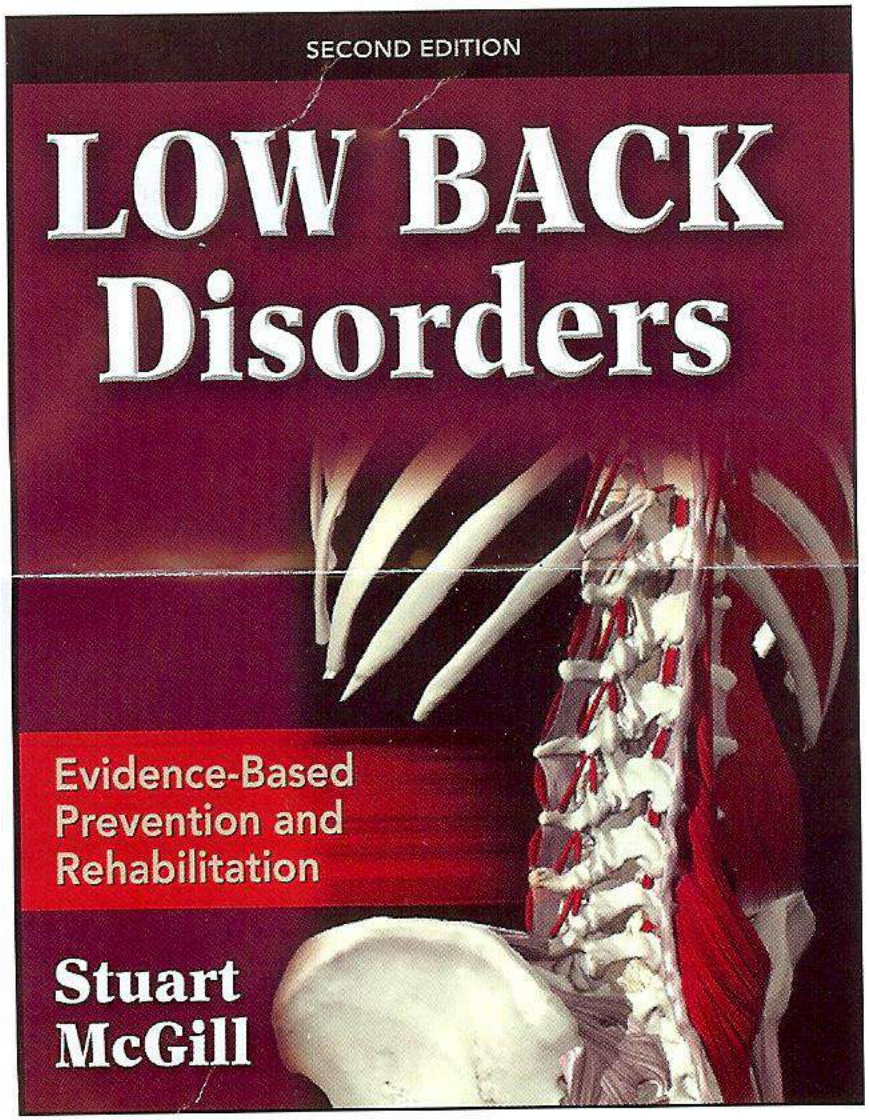
“AB – Mouse” “AB dolly pro” Home Made

This method of applying “bending stress” to a horizontal torso keeps the hand support under the shoulder joints (less shoulder stress), and the unstable lower extremity support can increase muscle recruitment. You can perform push-ups in the “out” position for a more advanced exercise.



General Recommendations for Torso Exercise / Lifting

- Anticipate movement actions that will mechanically stress the spine
- Prepare via torso bracing (this increases IAP)
- Maintain a neutral spine, or limit / minimize spinal ROM
- Reposition yourself via foot movement to face the object to be lifted (never lift with a rotated spine)
- Maintain elevated IAP during a lift / exercise movement and move slowly



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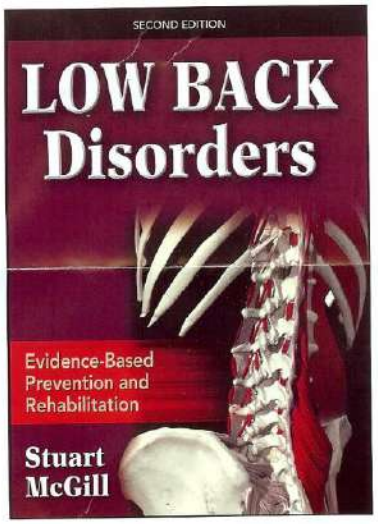

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Audiences: *A reference for physical and occupational therapists, sport and orthopedic physicians, rehabilitation specialists, athletic trainers, and fitness specialists. Also useful for students as a primary or secondary resource on low back disorders.*

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- Special sections highlight how the anatomical, biomechanical, and research results can be applied to clinical situations.
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About the Author

Stuart McGill, PhD, is a professor at the University of Waterloo at Waterloo, Ontario, Canada, and a world-renowned lecturer and expert in spine function, injury prevention, and rehabilitation. He has written more than 200 scientific publications on the topics of lumbar function, low back injury mechanisms, investigation of tissue loading during rehabilitation programs, and the formulation of work-related injury avoidance strategies.

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The END !

Thank You For Your Attention

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