Breathing's Influence On Upper Quarter Dysfunction

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THE SIGNIFICANCE OF BREATHING

Breathing's clinical importance seems to have escaped the attention of many forms of clinical practice.

It is the intent of this presentation to provide a more comprehensive approach to the mechanical function of the thorax and a deeper understanding and appreciation of the importance of breathing patterns as it relates to upper quarter dysfunction.

THE SIGNIFICANCE OF BREATHING

The first breath of life is inhalation. The last breath of life is exhalation

On this day, almost 360,000 individuals breathed their first breath.

On this day, almost 155,000 individuals breathed out for their last time.

250 births each minute

105 deaths each minute

With each inhalation you breathe, 16-20 individuals in the world have inhaled their very first breath.

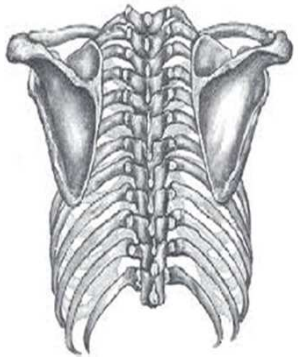
Each time you exhale, 7-9 people somewhere in the world will be exhaling their very last breath.

(Based on respiration rate of 12-15 breathes per minute)

"One by one. One breath in, one breath out. One breath we are born. One day by one day we live. One by one we die. One by one we come and go."

(The World Fact Book, 2013 & www.saltmount.org)

THE SIGNIFICANCE OF BREATHING



http://chicopmr.org/robertegertmd/html/jointpain/shoulder.html

- **The thoracic rib cage is designed to facilitate ventilation and upper extremity function.**
- **The position of the scapula at rest is mainly defined by the shape of the thorax .(Struyf et al., 2011)**
- **Scapular positioning is important to center the humeral head and thus a stable base for shoulder movements during daily activities and sport participation. (Ludewig et al., 2009)**
- **The biomechanics of the rib cage influence overall body mechanics. (Penafortes et al., 2013)**
- **Respiratory imbalance will result in altered total body posture and balance. (Butcher et al., 2004)**
- **Shoulder girdle mechanics are compromised in faulty respiration when chest breathing predominates and can result in shoulder impingement. (Liebenson, 2007)**

BREATHING

Inhalation Process

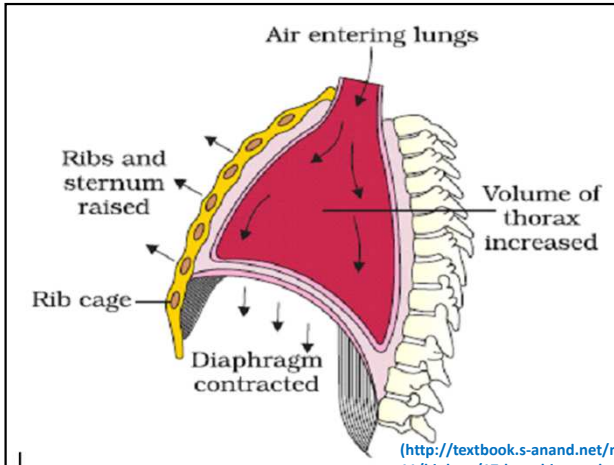
Diaphragm Contracts (lowers)
Muscles Contract Raise Ribs
Chest Cavity Expands
Lung Volume Increases
Air Pressure in Lungs Decreases

RESULT= Air is Drawn Into The Lungs To Equalize Internal Air Pressure With the Air Pressure Outside

Exhalation Process

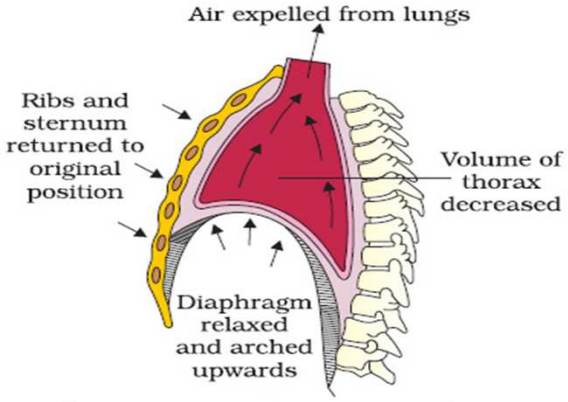
Diaphragm Relaxes (Raises)
Muscles Relax and Ribs Lower
Chest Cavity Contracts
Lung Volume Decreases
Air Pressure in Lungs Increases

RESULT= Air is Expelled From The Lungs To Equalize Internal Pressure with Outside Air



INHALATION

(http://textbook.s-anand.net/ncert/class-11/biology/17-breathing-and-exchange-of-gases)



EXHALATION

http://textbook.s-anand.net/ncert/class-11/biology/17-breathing-and-exchange-of-gases

MUSCLES OF RESPIRATION

Type of Respiration	Inspiration	Expiration
Quiet (primary muscles)	Diaphragm External intercostals	Elastic recoil of lung tissue Surface tension Gravity on ribs Internal intercostals
Forced (Accessory muscles)	Sternocleidomastoids Scalenes Pectoralis major Pectoralis minor Serratus anterior Serratus posterior superior Upper iliocostalis	Abdominals External oblique Internal oblique Rectus abdominus Lower iliocostalis Lower longissimus Serratus posterior inferior

BREATHING

• Pressure gradient: is a physical quantity, typically "air" that describes which direction and at what rate the pressure changes the most rapidly around a particular location.

• Changes in volume of air in chest cavity during breathing causes pressure gradients.

↑ Chest Volume → Decrease Pressure → Air Moves In!

↓ Chest Volume → Increase Pressure → Air Moves Out!

Breathing is less about weight/mass/ gravity, and more about pressure.

• You breathe in because your diaphragm contracts and pulls down , causing a lower "pressure gradient" in your lungs.

• Air from outside the body (higher "pressure gradient") rushes into the lungs.

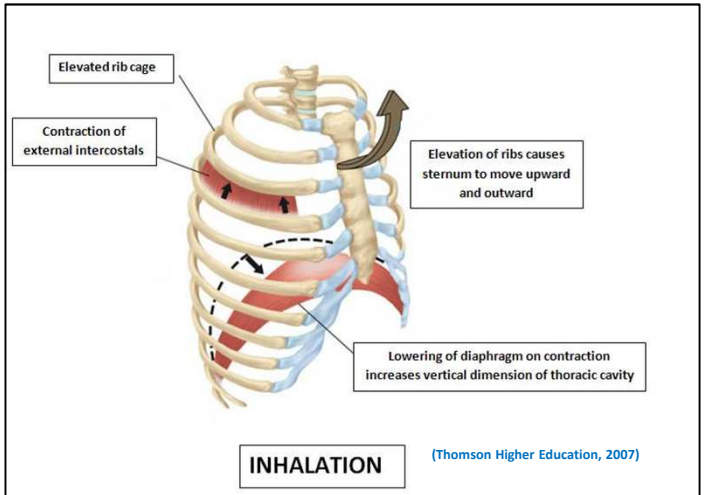
• Things in high pressure will want to balance out things in lower pressure (Boyle's Law).

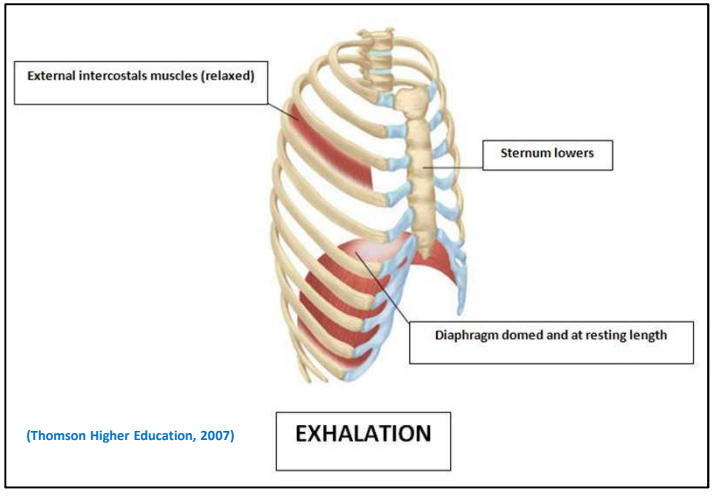
• What this means is that as the pressure increases, the volume will decrease; or as the pressure decreases, the volume will increase. During inhalation the volume of the chest is increased and as a consequence the pressure in the lungs falls and air is drawn in. Conversely when we exhale the volume of the chest is reduced; the pressure in the lungs increases and air is forced out.

BREATHING & PRESSURE GRADIENTS

- Normal respiration = 12-15 breaths per minute
- Which make for about 17,000-22,000 breathing excursions per 24 hours.
- It means that during this time there are around 20,000 rhythmic cycles of pressure (inhalation and exhalation) and volume changes (pressure gradients) in the cranium, thoracic, and abdominal cavities.

What about the athlete who is <u>hyperinflated</u>?



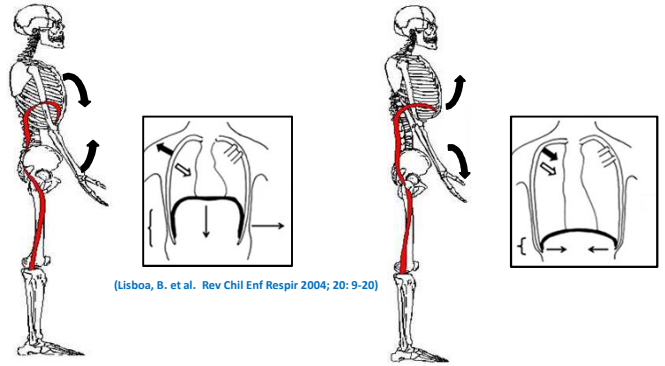


ZONE OF APPOSITION

- **The ZOA is the portion of the Diaphragm that is directly opposed to the inner aspect of the lower rib cage (De Troyer and Estienne, 1988; Reid & Dechman, 1995; Goldman & Mead, 1973).**
- **Abdominals oppose the diaphragm and help pull the ribs down, which helps to maintain an optimal ZOA.**

Rev Chil Enf Respir 2004; 20: 9-20

ZONE OF APPOSITION AND POSTURE



(Lisboa, B. et al. Rev Chil Enf Respir 2004; 20: 9-20)

Figure 1:
Backward tilt of pelvis and depressed lower rib cage.

Figure 2:
Forward tilt of pelvis and elevated lower cage.

DYNAMIC HYPERINFLATION

Hyperinflation is the inability to empty the air out of the lungs.

- **The time required to empty the lungs is far greater than the time available for expiration.**
- **In other words, the individual initiates the next inspiration before reaching normal end-expiratory lung volume.**
- **A residual positive pressure remains in the lung "air trapping".**
- **This pressure causes increased load for inspiratory muscles.**
- **The presence of hyperinflation limits the volume of air inspired or expired during normal respiration to expand, and ventilation can only be increased by faster breathing, contributing to further hyperinflation in a vicious cycle.**

Hyperinflation is a "TIME" problem! Manipulating your breathing pattern to generate enough <u>time</u> to allow emptying on the lung on exhalation.

HYPERINFLATION

HYPERINFLATION

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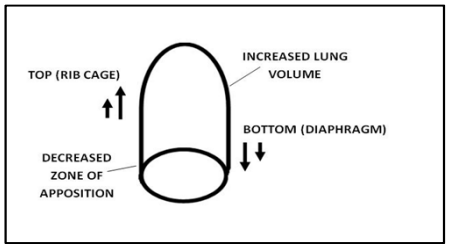
HYPERINFLATION & DIAPHRAGM

- The diaphragm is profoundly affected by hyperinflation.
- Like all skeletal muscle, the diaphragm is governed by the length-tension relationship.
- That is, at a certain length i.e. optimal length, the diaphragm muscle fibers are in an optimal relationship and the tension is maximal for a given movement. If the muscle is working at a shorter length, the tension produced is much less.
- The reduced length of the diaphragm mainly affects the up and down movement that is apposed to the lower rib cage, the so called "Zone of Apposition."
- Because the diaphragm works like a piston, a shorter ZOA implies a shorter range of motion, independent of the effect on maximal tension.

"What goes up must come down!" "What goes in must come out!"



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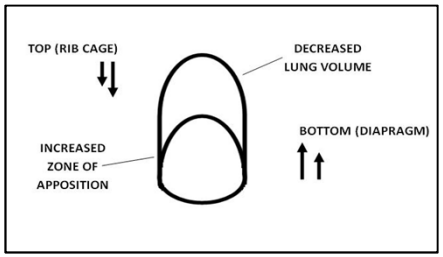
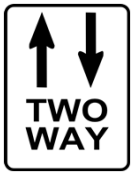
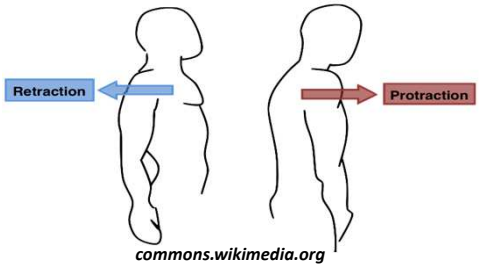




SAGITTAL SHOULDER FUNCTION



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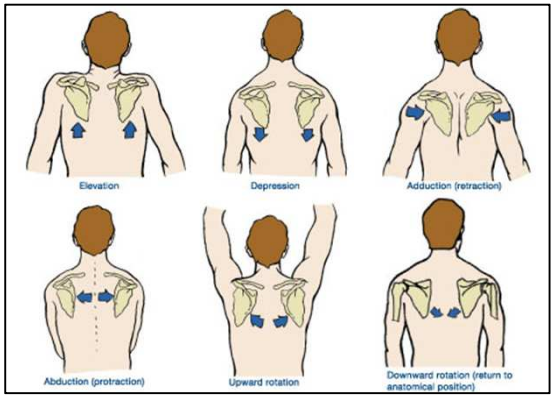
Thoracic Extension/Ribs ER "INHALATION"	Thoracic Flexion/Ribs IR "EXHALATION"
Scapular Elevation	Scapular Depression
Scapula Posterior Tilts	Scapula Anterior Tilts
Humeral Flexion	Humeral Extension
Gleno-Humeral IR	Gleno-Humeral ER
Humeral-Glenoid ER	Humeral-Glenoid IR

MOTIONS OF THE SCAPULA



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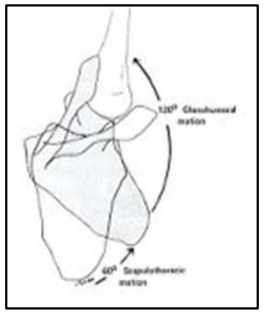
SCAPULO-HUMERAL RHYTHM THORACIC-SCAPULAR RHYTHM



- The scapula contributes upwards of 60° of arm elevation. The scapula must move 1° for every 2° that your arm lifts overhead. Or a 2:1 ratio!

<u>30° OF SHOULDER ELEVATION</u>

1° of HG elevation 30°: 0° of ST upward rotation

<u>30° - 90° OF SHOULDER ELEVATION</u>

2° of HG elevation 60°: 1° of ST upward rotation 30°

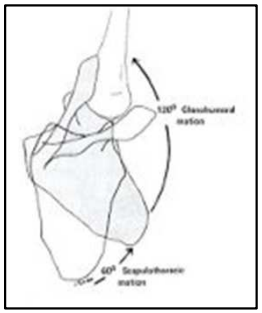
<u>90° TO FULL SHOULDER ELEVATION</u>

1° of HG elevation 30°: 1° of ST upward rotation 30°

HG:ST 120:60

- When you move your arm in an upward direction, the scapula should upwardly rotate, abduct, and slightly posteriorly tilt on the thorax.

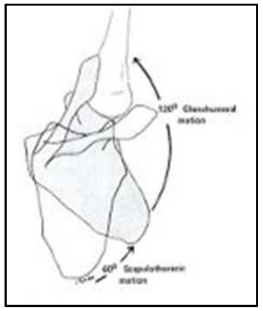
SCAPULO-HUMERAL RHYTHM THORACIC-SCAPULAR RHYTHM



(Norkin & Levangie, 1992)

What happens with an athlete who is <u>hyperinflated</u>?

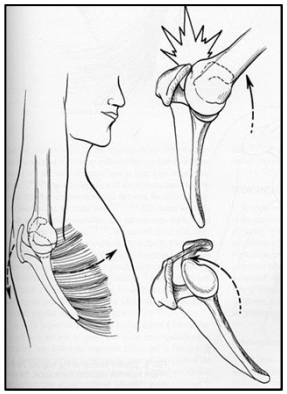
THORACIC-HUMERAL MOVEMENT
HUMERAL-THORACIC MOVEMENT



(Norkin & Levangie, 1992)

- What is it?
- Can you move your thorax independent of your humerus?
- Humeral-Thoracic movement = Humeral movement with no thoracic movement. (push-up)
- Thoracic-Humeral movement = Thoracic movement with no humeral movement. (i.e. back extension/inhalation)
- Scapula allows Thoracic-Humeral /Humeral Thoracic motion or the combination of the two to occur.

SHOULDER IMPINGEMENT



http://bosshin.com/st_winging

- Shoulder elevation in asymptomatic individuals, the scapula rotates upwardly, rotates externally and posteriorly tilts.
- Patients with impingement the scapula demonstrates decreased upward rotation and decreased posterior tilt.
- Compared with scapular protraction, scapular retraction has been shown to both increase subacromial space width and enhance supraspinatus force production during humeral elevation. Moreover, scapular IR and scapular anterior tilt, both of which decrease subacromial space width and increase impingement risk (Escamilla, 2009).
- In patients with subacromial impingement, decreased SA activity and increased anterior tipping and internal rotation were found(Ludewig & Cook, 2000).

SCAPULAR-THORACIC
THORACIC-SCAPULAR
MOVEMENTS

- Scapular thoracic (ST) motion refers to the scapula moving on the thorax.
- Traditional scapular thoracic (ST) stabilization programs place a great deal of attention to retracting and depressing the scapula on the thorax.
- Thoracic scapular (TS) motion refers to the thorax moving on the scapula occurring in CKC activities. Thorax moving towards or away from the scapula.
- Thorax position is directly related to the orientation of the spine and thus the position of the pelvis.

BREATHING PHASES
SCAPULAR POSITION

"Inhalation /extension" is equivalent to Thoracic Scapular(TS) Retraction (Thorax moves back on scapula).

"Exhalation/ flexion" is equivalent to Thoracic Scapular (TS) Protraction (Thorax moves away from scapula).

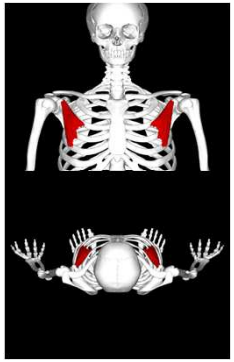
Thoracic Scapular (TS) retraction "extension/inhalation" is equivalent to Scapular Thoracic (ST) protraction.

Thoracic Scapular (TS) protraction "flexion/exhalation" is equivalent to scapular thoracic (ST) retraction.

Right thoracic rotation is equivalent to right (TS) retraction and left (ST) scapular thoracic protraction.

Left thoracic rotation is equivalent to left (TS) retraction and right (ST) scapular thoracic protraction.

PECTORALIS MINOR



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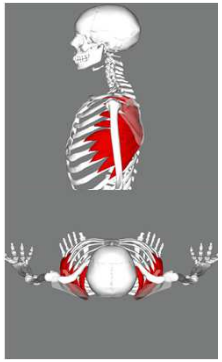
- **DOWNWARDLY ROTATES, ANTERIORLY TILTS, ABDUCTS, AND INTERNALLY ROTATES SCAPULA ON THORAX.**
- **Pectoralis minor inhibits SA which contributes to upward rotation of the scapula this can lead to impingement and sometimes winging of the scapula.**
- **Individuals with a forward head and rounded shoulder posture displayed increased IR as well as anterior tilting throughout shoulder flexion and decreased SA activity (Thigpen, et al., 2010).**

SERRATUS ANTERIOR



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- **UPWARDLY ROTATES, POSTERIORLY TILTS, ADDUCTS AND EXTERNALLY ROTATES SCAPULA ON THORAX.**
- **The scapular muscles are important during humeral elevation because they cause these motions, especially the SA, which contributes to scapular upward rotation, posterior tilt and ER. The SA also helps stabilize the medial border and inferior angle of the scapula, preventing scapular IR (winging) and anterior tilt.**
- **Decreased SA activity reduced scapular upward rotation, increased anterior tilt of and scapular winging (Struyf, et al., 2012; Cools, et al., 2005; Ludewig & Cook, 2000; Borstad & Cook, 2005).**

But…what is research not looking at?
Thorax and ribcage position

Inhalation with Extension (Ribs Up)

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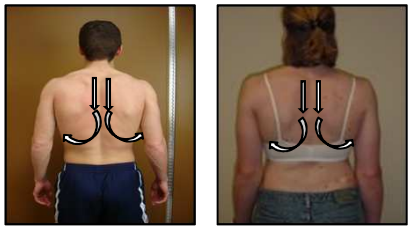
MYOKINEMATIC OVERVIEW HYPERINFLATION AND SCAPULAR POSITION

- **Rib cage is elevated "(TS) Retraction/ Inhalation/ Extension"**
  Protracted Scapula
  - **Thoracic Scapular (TS) Retraction = Scapular Thoracic (ST) protraction**
  - **Inefficient diaphragmatic breathing results in compensations of the upper chest, shoulder fixators, and neck muscles to elevate the rib cage to assist inhalation to occur.**
- **The shoulder is inadvertently affected**
  - **Both scapulae move into an anterior-tilted, downwardly rotated and protracted position. This is often a position linked with humeral-glenoid impingement.**
  - **As the scapula and the acromion move forward and downwards, the head of the humerus has less room to move under the acromion as the humerus moves upward during shoulder flexion or abduction.**
  - **Pectoralis minor, sternocleidomastoid (SCM), scalene, trapezius, erector spinae are often hypertonic and over-developed from the increased vertical movement of the ribcage and elevation of the shoulders during inspiration. This position demands these muscles to work harder to achieve inhalation!**

SCAPULAR POSITION AND HYPERINFLATION



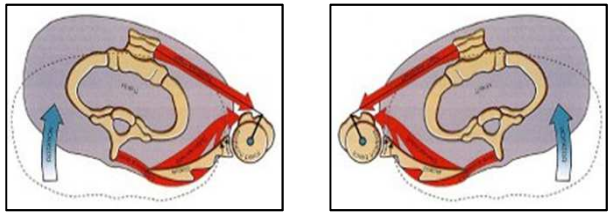
- ABDUCTED, DEPRESSED, UPWARDLY ROTATED, ANTERIORLY TILTED & INTERNALLY ROTATED (WINGING) ON THORAX
- (Burkart et al., 2003) has found very similar findings in that there will be an apparent "dropped"scapula in the dominant shoulder compared to the opposite shoulder. The scapula protracts with the upper scapula rotating antero-inferiorly. The inferior medial scapular border appears more prominent, with the superior medial border of the acromium appearing less prominent A.K.A "SICK "scapula.

THORACIC SCAPULAR MOVEMENT

Right Trunk Rotation
Right Thoracic Scapular (TS) Retraction
Left Scapular Thoracic (ST)Protraction

Left Trunk Rotation
Left Thoracic Scapular (TS)Retraction
Right Scapular thoracic (ST) Protraction

(Neumann,D., 2009)



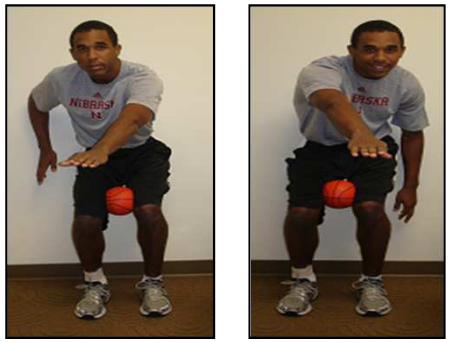
CLINICAL CONSIDERATIONS

(THORACIC-HUMERAL MOVEMENT)

- Thoracic Flexion/Ribs IR
- "EXHALATION"
- Thoracic Scapular (TS) retraction
- Scapular Thoracic (ST) protraction

CLINICAL CONSIDERATIONS

(HUMERAL-THORACIC MOVEMENT)



Exhalation with Flexion (Ribs Down)

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The Value of Blowing Up a Balloon

NAJSPT

CLINICAL SUGGESTION

THE VALUE OF BLOWING UP A BALLOON

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Cynthia Lewis PT, PhD[3]

Abstract: Suboptimal breathing patterns and impairments of posture and trunk stability are often associated with musculoskeletal complaints such as low back pain. A therapeutic exercise that promotes optimal posture (diaphragm and lumbar spine position), and neuromuscular control of the deep abdominals, diaphragm, and pelvic floor (lumbar-pelvic stabilization) is desirable for utilization with patients who demonstrate suboptimal respiration and posture. This clinical suggestion presents a therapeutic exercise called the 90/90 bridge with ball and balloon. This exercise was designed to optimize breathing and enhance both posture and stability in order to improve function and/or decrease pain. Research and theory related to the technique are also discussed.

North American Journal of Sports Physical Therapy | Volume 5, Number 3 | September 2010 | Page 179

CLINICAL CONSIDERATIONS

(RIBS DOWN, PECTORAL FLEXIBILITY & HUMERAL-THORACIC MOVEMENT)

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CLINICAL CONSIDERATIONS

(THORACIC-HUMERAL MOVEMENT)

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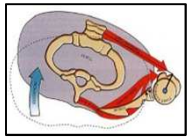
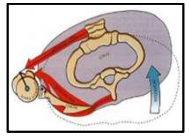
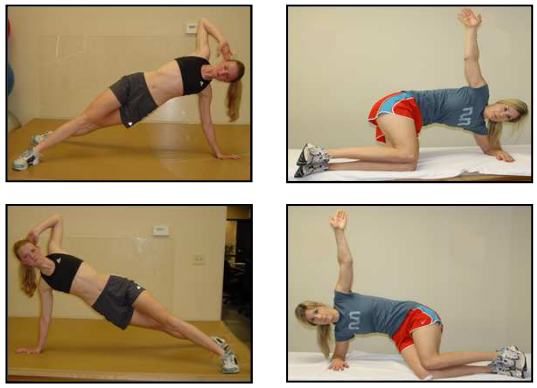


(Neumann, D., 2009)



CLINICAL CONSIDERATIONS

(HUMERAL-THORACIC OR THORACIC-HUMERAL MOVEMENT)



CLINICAL CONSIDERATIONS

(THORACIC-HUMERAL MOVMENT)

CLINICAL CONSIDERATIONS

(THORACIC-HUMERAL/ HUMERAL-THORACIC MOVEMENT)

CLINCAL CONSIDERATIONS

(HUMERAL-THORACIC MOVEMENT)

TAKE HOME MESSAGE

- OFTEN TIMES, WE AS CLINICIANS CONSIDER THE POSITIONAL IMPORTANCE OF THE SCAPULA AS IT RELATES TO HUMERAL FUNCTION.
- YET WE NEGLECT TO CONSIDER THE POSITION OF THE THORAX AS IT RELATES TO SCAPULAR POSITION TO PROVIDE HUMERAL-SCAPULAR MOVEMENT!
- THORACIC POSITION ULTIMATELY AFFECTS SCAPULAR POSITION AND HUMERAL FUNCTION!
- PLEASE CONSIDER THE POSITION OF THE THORAX AS IT RELATES TO RESPIRATORY FUNCTION BEFORE PROCEEDING WITH SCAPULAR-HUMERAL STABILIZATION.

THANK YOU!!
QUESTIONS?

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