# Assessment of interaction with breathing, posture, abdominal muscle activation

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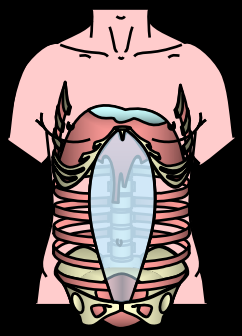
## Breathing

## Normal breathing pattern

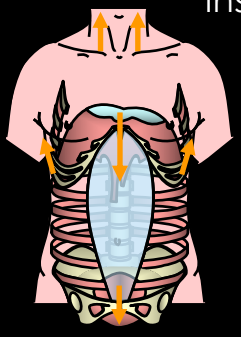


## Inspiration

Scalenes

Diaphragm

External Intercostals + Diaphragm

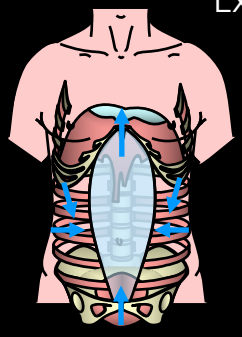


Erector spinae

Pelvic floor muscles (ecc)

## Expiration

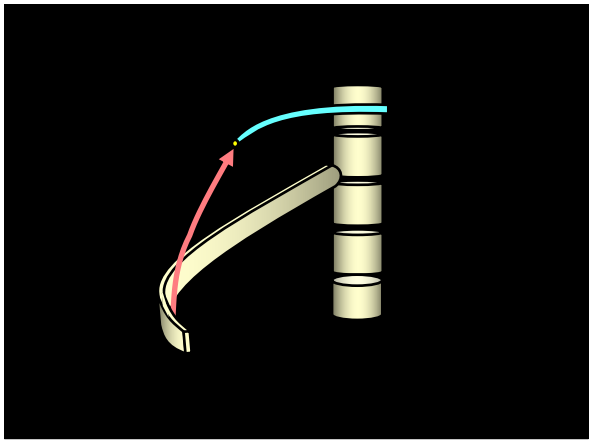
Obliquus externus & Internus + internal intercostals

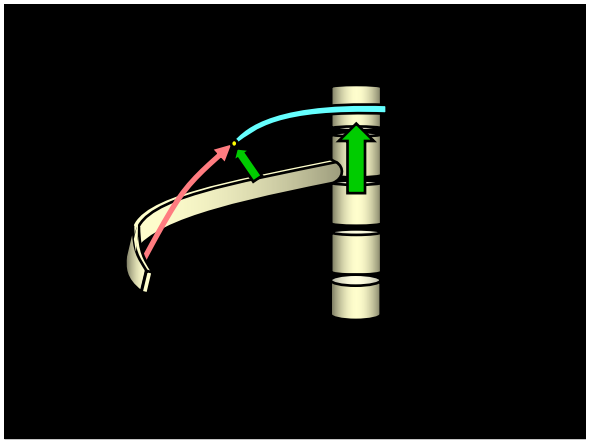


Erector spinae

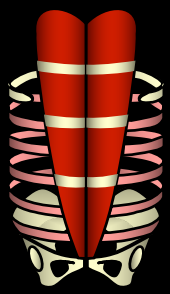
Transversus abdominis + superficial abdominals

Pelvic floor muscles (conc)





## Rectus abdominis

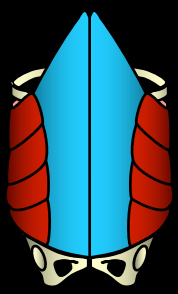


- Caudad displacement of sternum
- ↑ AP rib cage diameter
- Small ↓ in transverse diameter

## Obliquus externus abdominis

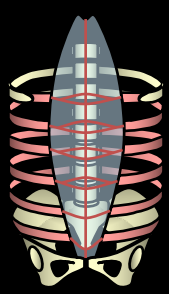
- ↓ transverse rib cage diameter
- Small caudad sternum displacement

## Obliquus internus abdominis



- ↓ transverse rib cage diameter
- Small caudad sternum displacement

## Transversus abdominis



- ↓ Smallest insertional expiratory action
- Expiratory action through elevation of diaphragm
- ↑ transversus diameter of rib cage via ↑ IAP

## Breathing and pelvic floor

- Pelvic floor muscle activation is necessary for breathing
- Breathing may drive changes in pelvic floor muscle activation
  - e.g. forced expiration – greater PFM acitvation
- Breathing training may aid modification of pelvic floor muscle activation
  - e.g. relaxed breathing may reduce PFM tone
- Specific challenges from respiratory disease – breathing pattern and coughing

## Assessment of breathing

## Breathing pattern: Assessment

- Movement
  - Observation & Palpation of breathing movements
    - 3 components – evenly distributed with no dominance
      - Upper chest
      - Basal chest expansion
      - Abdominal displacement
    - Symmetry
- Muscle activity
  - Observation, Palpation, electromyography, ultrasound imaging
- Chest wall flexibility
- Effect of motor control correction
- Effect of posture correction
- Effect of loading

## Breathing pattern: Assessment

- Respiratory movements
  - Abdominal movement
  - Bibasal rib cage expansion
  - Upper chest breathing
  - Objective
    - Even distribution of movement between regions
    - No region dominating
    - Consider effect of position
      - Reclined – less basal expansion (less abdominal muscle activation)

## Breathing pattern: Assessment

- Respiratory movements
  - Look before touching
  - Do not indicate that you are evaluating breathing
  - Assess natural breathing
  - Consider
    - is movement is equal in each region?
    - Consider what movement is dominant?
    - Common abnormalities in breathing pattern
      - Hyperinflation
      - Vertical motion
      - Upper chest breathing

## Breathing pattern: Assessment

- Respiratory muscle activity
  - Abdominal muscle activity
    - Palpation
    - Observation
    - EMG biofeedback
    - Ultrasound imaging

## Breathing pattern: Assessment

- Respiratory muscle activity
  - Abdominal muscle activity
    - Consider
      - Is the muscle activity modulated with breathing?
      - Is there activity that is compromising respiratory movements?

## Breathing pattern: Assessment

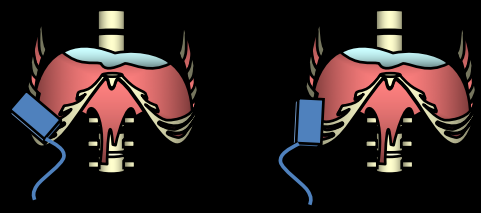
- Respiratory muscle activity
  - Diaphragm muscle activity
    - Palpation – rib cage and abdominal movement
    - Observation – rib cage and abdominal movement
    - Ultrasound imaging

## Breathing pattern: Assessment

- Respiratory muscle activity
  - Diaphragm muscle activity
    - Consider
      - Does the diaphragm shorten (rib/abdo movement)?
        - » Tight/short/overactive diaphragm
        - » High IAP with abdominal brace - prevent diaphragm descent
      - What is the quality of shortening/thickening – Is it smooth and slow?

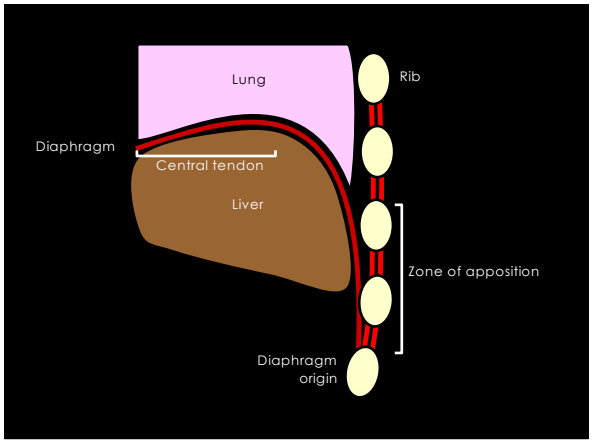
## Ultrasound imaging

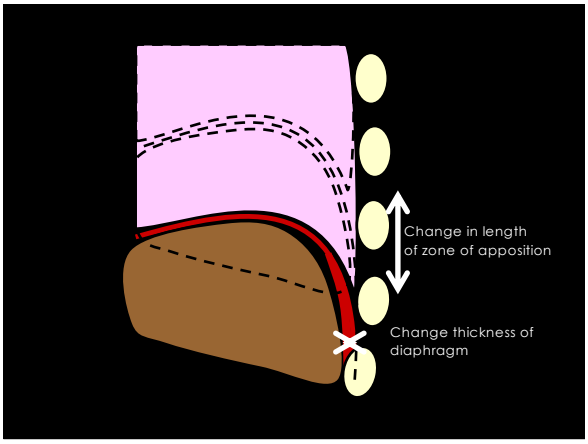
## Diaphragm ultrasound imaging



## Diaphragm ultrasound imaging

- Thickening of costal diaphragm
- Displacement of central tendon
- Change in length of zone of apposition




## Thickening of the diaphragm

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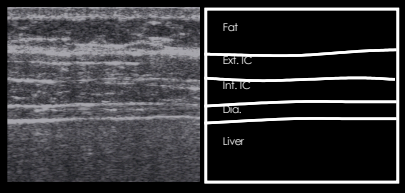
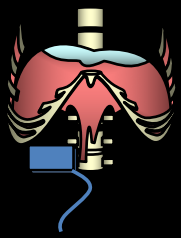



## Thickening of the diaphragm

- Subject position: Supine with head on pillow
- Transducer: 12 MHz
- Transducer placement:
  - Identify 8th & 9th intercostals space (find 12th rib and count up)
  - Place the transducer along the IC space
  - Place the transducer in the anterior axillary line then optimize
    - Too far back the muscle will peel away and you will loose the image
    - Too far forward the muscle will not thicken much with contraction
  - Check both spaces and pick the one with the best image
  - Optimise the image
    - Select the depth that optimizes the size

## Diaphragm displacement



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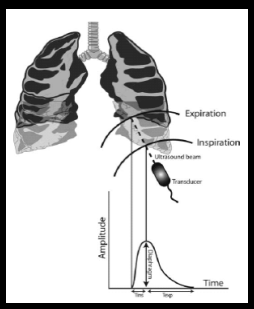
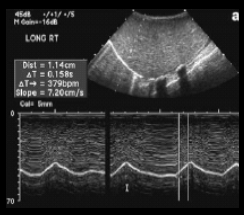
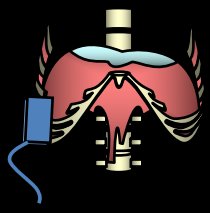


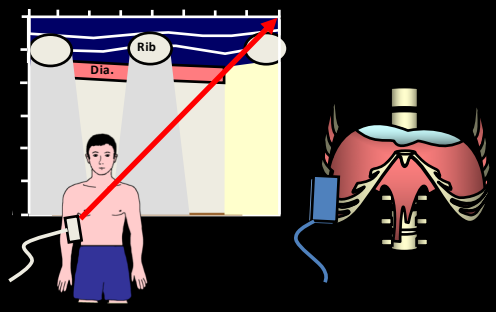

## Diaphragm displacement

- Subject position: Supine with head on pillow
- Transducer: 3 MHz (set to 4 MHz)
- Transducer placement:
  - Place the transducer in the anterior axillary line, below the rib cage
  - Angle the transducer craniodorsally to image through the liver
  - Identify the posterior aspect of the diaphragm
  - Too horizontal you will not see the diaphragm
  - Too vertical it may be hard to see the edge
  - Optimise the image
    - Select the depth that optimizes the size
  - Use m-mode

## Length of zone of apposition



## Diaphragm ultrasound imaging




## Length of zone of apposition

- Subject position: Supine with head on pillow
- Transducer: 12 MHz and 3 MHz
- Transducer placement:
  - Identification of the origin of the diaphragm
    - Place 12 MHz transducer longitudinally in the anterior axilliary line at approx the 8-9th IC space
    - Identify the landmarks (ribs, liver, diaphragm).
    - Ask the subject to breathe and move the transducer caudally until you can see the origin this will be indicated by
      - In rib space below the origin the muscle in the location of the dia will not thicken with inspiration (TrA)
      - Slip of TrA may be noticeable deep to diaphragm
      - Muscle will thin a little and the Dia will not increase in thickness as much with inspiration
      - The rib at which this transition occurs is the origin of the diaphragm
    - Mark the rib with a pen to use as a landmark for the imaging of the zone of apposition (Lzapp)
  - Measurement of the length of the zone of apposition
    - Identify the rib of origin and the superior border of the diaphragm (identified by the white shadow from the lung).
  - Use b-mode and make a cine movie

## Breathing pattern: Assessment

- Pelvic floor muscle activity
  - Activation of PFM during breathing
  - Tonic hold with subtle lengthening (exp) & shortening (insp)

➔Assess breathing pattern and activation of abdominal muscles during breathing

## Assessment: Breathing

- Evaluate breathing pattern during:
  - Quiet breathing
- Breathing movements
  - Abdominal displacement
  - Lateral rib cage expansion
  - Upper chest elevation
- Muscle activation
  - Abdominal muscles
  - Diaphragm muscle

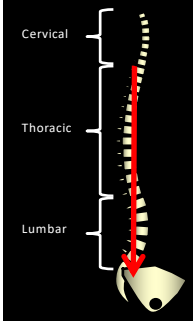
## Breathing pattern: Assessment

- Postural assessment
  - Neutral spine
    - Optimal breathing pattern
    - Slump – upper chest
    - Thoracolumbar ext – basal expansion
    - Rotated – decreased basal, increased abdo.

Lee & Hodges 2006

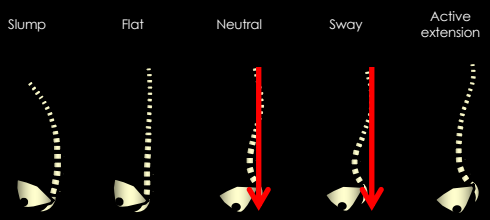
  - Assess impact of posture correction

## "Neutral spine"



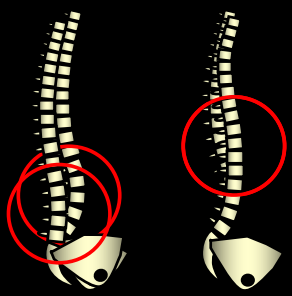

- Aim:
  - Cervical lordosis
  - Thoracic kyphosis
  - Lumbar lordosis
  - Neutral pelvic tilt
  - Sagittal balance/alignment
  - Frontal alignment
- Benefits:
  - Optimal loading
  - Avoid creep
  - Reduce global muscle overactivity
  - Increase local muscle activity
- Consider:
  - Pathology (e.g. stenosis)
  - Spinal mobility
  - Not static – functional range

## Posture/alignment




## Key

- Control of
  - Lumbar lordosis/pelvic tilt
  - Thoracolumbar junction
  - Thoracic kyphosis
  - Sagittal/frontal alignment

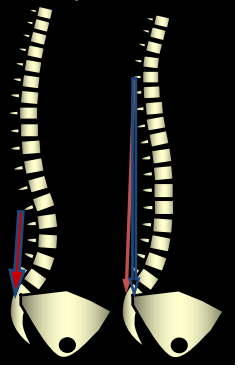


## Muscle activity in different postures

- Lumbar lordosis - greater multifidus, greater low TrA/OI
- Thoracolumbar ext - greater TL ES
- Slump – minimal activity of extensors

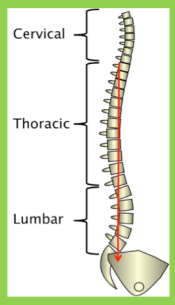
Claus et al, 2010

- Sway – "hang" on OE



## Assessment: Postural alignment

- *Evaluation of sagittal and frontal alignment*
- *Evaluation of spinal curvature*
- *Evaluation of muscle activity*

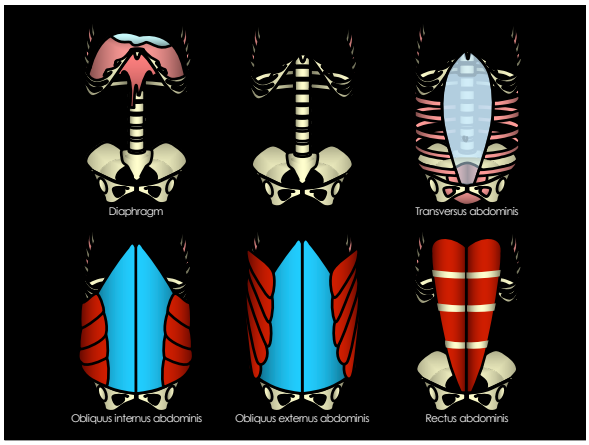



## Breathing pattern: Assessment

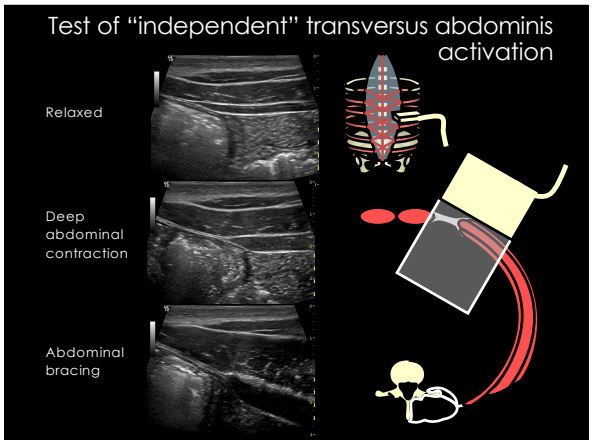
- Muscle activation
  - Assess impact of motor control correction
    - Activation of local muscles
    - Relaxation of global muscles

## Breathing pattern: Assessment

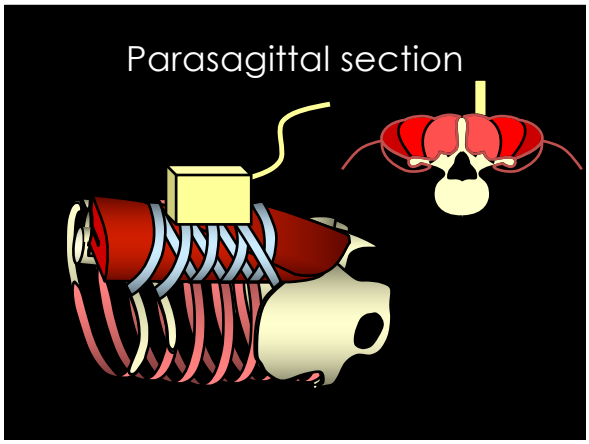
- Muscle activation & correction
  - Are muscle activation deviations present?
  - Is muscle activation affecting breathing?
  - What is the effect of contraction of transversus abdominis?
  - What effect does muscle activation correction have on breathing pattern?



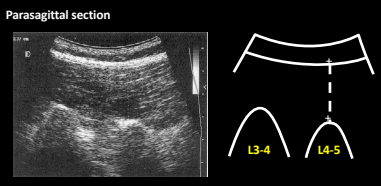

## Test of "independent" transversus abdominis activation




## Parasagittal section



## Parasagittal section




## Breathing presentation #1

- Prominent expiratory activity of abdominal muscles in supported positions
  - NORMAL
    - Supported positions – relaxed abdo. muscles
    - Upright positions – Standing +/- respiratory activity of abdo. muscles
  - ABNORMAL
    - Pronounced abdo. Muscle activity in supported postures

## Breathing Presentation #2

- Tonic activity of abdominal muscles that limits respiratory motion of chest wall
  - Restrict - bibasal expansion/diaphragm motion
  - Enhance - Upper chest breathing

## Interpretation

- Increased OE activity
  - Consequence of pain?
  - Increased resistance to expiration (COPD/Asthma)
- Decreased upper chest movement
  - OE holding rib cage down – decreased basal expansion & abdominal wall displacement
  - Vertical motion only strategy left
  - Posture – thoracolumbar extension – change rib motion

## Breathing Presentation #3

- Inability to maintain deep muscle contraction with breathing
  1. Loss of deep muscle (including PFM) contraction during inspiration
     - Inability to hold during inspiration
  2. Upper chest breathing
     - Restrict abdominal movement
  3. Shallow breathing
  4. Increase activity of global muscles

## Interpretation

- Inability to hold PFM
  - Unable to ecc. contract PFM
  - Inc. pelvic floor descent due to compromised basal expansion

## Breathing Presentation #4

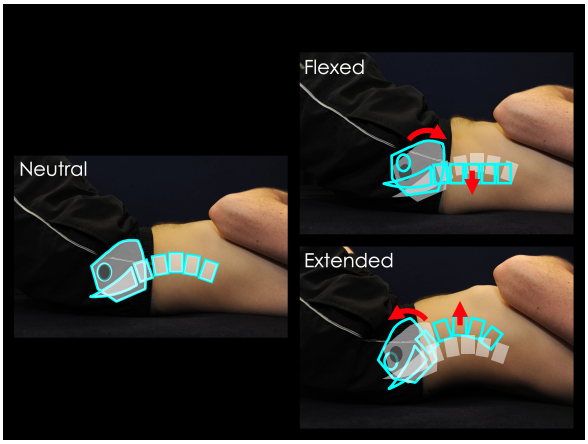
- Reliance on abdominal/pelvic floor displacement for breathing
  - Challenge to hold PFM contraction with large change in muscle length

## Assessment: Muscle control

- *Evaluation of deep abdominal activation*
  - *Which muscles?*
  - *What sequence?*
  - *What quality*

## Breathing pattern: Assessment

- Effect of loading
  - How does addition of load affect breathing?

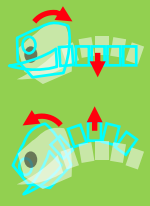



## Breathing pattern: Assessment

- Effect of loading
  - How does addition of load affect breathing?
    - Breath holding +/- Poor control of alignment when instructed to breathe
    - Excessive abdominal bracing/excessive intra-abdominal pressure
    - Increased vertical motion

## Assessment: Muscle control

- *Evaluation of bracing and control of loading*
  - Quality of control
  - Methods for feedback
  - Threshold for loss of control
  - Asymmetry of control



## Breathing pattern: Assessment

Basic assessment - sequence
- Observe breathing pattern
  - 3 components
- Palpate movements
- Assess muscle activity
  - Palpation
  - EMG
  - US imaging – abdominal wall, diaphragm
- Consider posture and muscle activation strategy
- Assess affect of correction of posture and muscle activation
- Assess affect of loading
- Assess chest wall flexibility

## Training of breathing

## Breathing: Training goals

- Optimise respiratory movements
  - Encourage even distribution of movement between regions
  - Change breathing pattern to simplify spine control
  - Train symmetry
- Optimise respiratory activity of trunk muscles
  - Reduce tonic muscle activity compromising respiratory motion
  - Reduce excessive respiratory activity of trunk muscles
- Optimise posture to optimise breathing
- Optimise thorax dynamic control (thoracic spine & rib cage) to optimise breathing
- Optimise efficiency of breathing pattern in disease
- Train breathing pattern with motor control progressions

## Breathing pattern: Techniques

- Optimise respiratory movements
  - Respiratory training techniques
    - Manual facilitation
    - Quick stretch
    - Positioning
    - Feedback – manual, elastic
  - Need motion of upper chest, basal rib cage and abdomen
    - If high abdominal movement – difficult to sustain TrA contraction
    - If low bibasal – often large OE to compress
    - If high upper chest – OE prevent other motion

## Breathing pattern: Techniques

- Optimise respiratory activity of trunk muscles
  - Reduce tonic/excessive activity
  - Maintain deep muscle activity during respiration
    - Feedback
    - Gradually increase inspiratory volume to threshold
    - Optimise breathing pattern
    - Commence with expiration

## Muscle activation: Techniques

- Increase activity of TrA/ MF/ PFM
  - Whole body posture (stretch on muscle)
  - Spinal posture (greater activity in neutral)
  - Instruction
  - Co-contraction with other muscles
  - Manual facilitation
  - Imagery
  - Feedback (Observation, palpation, US)
  - Taping

## Muscle activation: Techniques

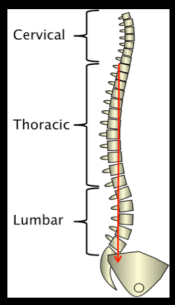
- Reduce activity of OE/OI/RA/TL ES
  - Whole body posture (more activity, more support
  - Spinal posture (less activity of global in neutral)
  - Instruction
  - Breathing techniques
  - Feedback (EMG, palpation)
  - Decrease effort
  - Connective tissue techniques, trigger point, dry needling
  - Inhibitory taping
  - imagery

## Breathing pattern: Techniques

- Optimise posture to optimise breathing
  - Retrain neutral posture

## Assessment: Postural alignment

- *Evaluation of sagittal and frontal alignment*
- *Evaluation of spinal curvature*
- *Evaluation of muscle activity*




## Postural correction: Techniques

Cognitive correction

- Instructions
  - e.g. roll forwards on tailbone, breathe into base of ribs
- Imagery
  - e.g. lengthen spine
- Manual guidance
  - e.g. hand on sacrum to facilitate anterior rotation of pelvis
- Manual cues
  - e.g. finger on xiphoid and navel to control T-L junction
- Dissociation tasks
  - e.g. separate L/T-L motion
- Muscle activation
  - e.g. palpation, observation, EMG biofeedback
- Cues/reminders
  - e.g. taping

## Breathing pattern: Techniques

- Optimise thorax dynamic control (thoracic spine & rib cage) to optimise breathing
  - Thoracic spine mobility/motor control – exercise, manual therapy
  - Rib cage mobility/motor control – exercise, manual therapy

## Breathing pattern: Techniques

- Optimise efficiency of breathing pattern in disease
  - Optimise breathing movements & muscle activity
  - Increase fitness – pulmonary rehabilitation
  - Flexibility – muscle length & thorax dynamics

## Breathing pattern: Techniques

- Train breathing pattern with motor control progressions