

Osteopathie Kongress  
**Gelenke & Manipulation**  
 International osteopathy conference on joints & manipulation  
 09.-11.06.2023  
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**Revisited lumbar roll using  
 the latest research on  
 diaphragm, IAP, and rehabilitation**

Kongress OSD Berlin 2023  
 By Lucia Pereira




Maintain an open mind, because what you are doing and teaching today you will have to modify in view of new facts. The task is enormous, there is a generation's work. Go step by step

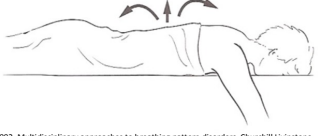
Prof. Karel Lewit

**Respiratory wave from K Lewit**

Optimal respiratory wave



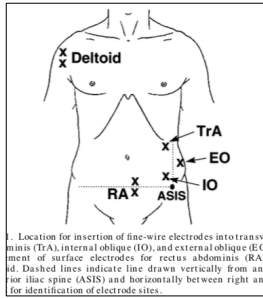
Dysfunctional respiratory wave



Chaitow L, Bradley D, Gilbert C 2002, Multidisciplinary approaches to breathing pattern disorders, Churchill Livingstone  
 Lewit K 1999 Manipulative therapy in rehabilitation in the locomotor system, 3<sup>rd</sup> edn Butterworths, London

- The spine is inherently unstable due to its proper structure. So muscles co-activation is essential:
  - To maintain a well stabilised and up-righted trunk posture
  - To control intervertebral disc and joints
  - Particularly during phasic limbs motion

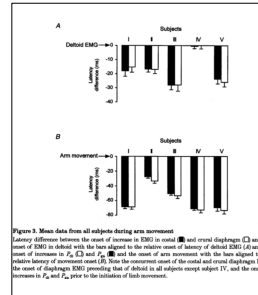
## Articles information



Co-activation of the diaphragm and the abdominal wall muscles during upper extremities movements: in proportion to the movement & force

Figure 3. Contractions of specific abdominal muscles in postural tasks are affected by respiratory maneuvers. Hodges PW, Gandevia SC, Richardson CA. *J Appl Physiol* (1985). 1997 Sep;83(3)/753-60

## Articles information



Eccentric contraction of the diaphragm, during co-activation including pelvic floor

Feedforward mechanism

Figure 3. Contraction of the human diaphragm during rapid postural adjustments. Hodges PW1, Butler JE, McKenzie DK, Gandevia SC. *J Physiol.* 1997 Dec 1;505 ( Pt 2)/539-48

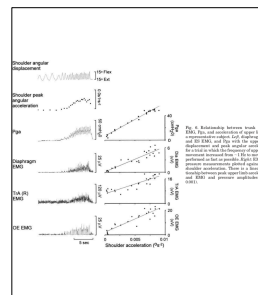
## Articles information

[illegible]

Feedforward mechanism  
also for Lower Extremities  
motion not influence par  
direction of movement

Table, Contraction of the Abdominal Muscles Associated With Movement of the Lower Limb Paul W Hodges, Carolyn A Richardson Author Notes  
Physical Therapy, Volume 77, Issue 2, 1 February 1997, Pages 132-142

## Articles information



Co-activation of diaphragm and abdominal wall muscles causes a sustained increase in IAP.

Breathing activities vary the shape of the pressurized abdominal cavity.

Figure 6. Changes in intra-abdominal pressure during postural and respiratory activation of the human diaphragm. Paul W Hedges, Simon C Gandevia. *J Appl Physiol*.(2000)89:967-976



## Articles information

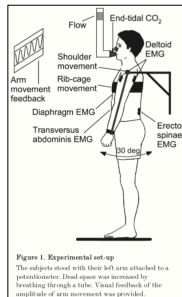


Figure 1. Postural activity of the diaphragm is reduced in humans when respiratory demand increases. Paul W. Hodges, Inger Heijnen and Simon C. Gandevia. *Journal of Physiology* (2001), 537, 3, pp.999–1008

Stability of the spine may be compromised when respiratory demand is increased, (by exercise or by respiratory disease).

This lead to increase potential for injury to spinal structures and reduces postural control.

During strenuous exercise = increase of physical stress on the spinal = probable injury

## Articles information



Figure 1. Inspiratory muscles fatiguing protocol. Patient consent obtained.

IMF test (inspiratory ms fatigue) for control and LBP groups.

Control subjects use a rigid proprioceptive postural control (rather than their normal multi-segmental control) which is similar to people with LBP = decreased postural stability.

Results suggest that FMI might be a factor in the high recurrence rate of LBP

Figure 1. The effect of inspiratory muscles fatigue on postural control in people with and without recurrent low back pain, Janssens L, Brumagne S, Polspoel K, Troosters T, McConnell A. 2010 *Spine* 2010 May 1;35(10):1088-94

## Articles information

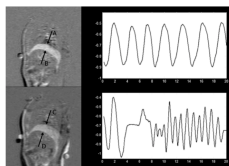


Fig. 7. Comparisons of DfEs and spirometric records (tidal volumes) in TB (upper graph) and LE conditions (lower graph) in a representative subject.

Similar study using MRIF instead of EMG

Similar diaphragmatic motion/activation during UE and LE motion

Figure 7. Stabilizing function of the diaphragm: dynamic MRI and synchronized spirometric assessment, Kolar P, Sulc J, Kyncl M, Sanda J, Neuwirth J, Bokariou AV, Kriz I, Kobesova A. *J Appl Physiol*. 2012;42(4):552-62

## Articles information

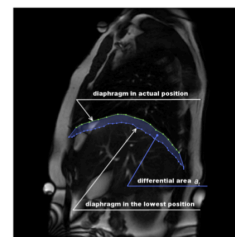


Figure 1. Differential area definition. Figure shows t-th image from a sequence with corresponding diaphragm contour. The t-th diaphragm contour together with the lowest placed diaphragm contour in the sequence form the differential area  $a_t$ . doi:10.1371/journal.pone.0056724.g001

Changes in diaphragm motion and shape during LE flexion (2 groups) :

LBP group: mostly not able to maintain respiratory diaphragm function during effort.

Control group: diaphragm respiratory and postural changes were slower, bigger, and better balanced

Figure 1. Diaphragm Postural Function Analysis Using Magnetic Resonance Imaging. Pavel Vostatek, Daniel Novak, Tomas Rychnovsky, Sarka Rychnovska, PLoS One. 2013;8(3):e56724. doi: 10.1371/journal.pone.0056724. Epub 2013 Mar 14



## Articles information

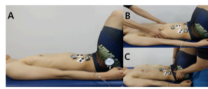


Fig. 2. Exercises were implemented with participants lying supine with 90° hip and knee flexion, with the PBU under the lumbar spine. Three positions were used – A: resting position (crook lying), B: DNS, C: NDT.

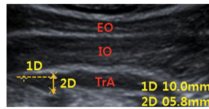


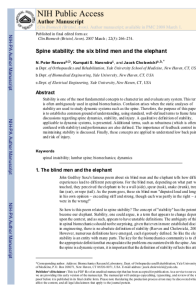
Fig. 3. Ultrasound muscle thickness data of the TrA muscle. TrA: transversus abdominis; IO: internal oblique; EO: external oblique.

2 groups; control and hemiparetic stroke, therapeutic effect of NDT (NeuroDevelopmental Treatment) and DNS (Dynamic Neuromuscular Stabilization) care stabilisation exercise, using EMG + ultrasound imaging + PBU (pressure biofeedback unit).

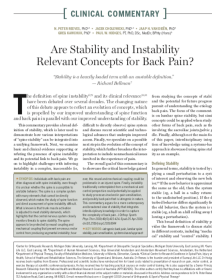
Results: clinical evidence that DNS is more effective for hemiparetic stroke subjects over NDT exercise than control group.

Figure 2 et 3, Reflex-mediated dynamic neuromuscular stabilization in stroke patients/ EMG processing and ultrasound imaging, Hyun S. Yoon, Joshua (Sung) H. You. *Technology and Health Care*, 25 (2017) 599–6106

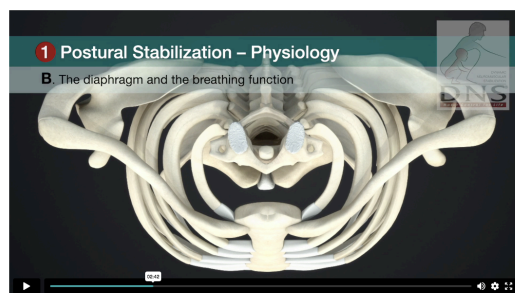
## Articles information



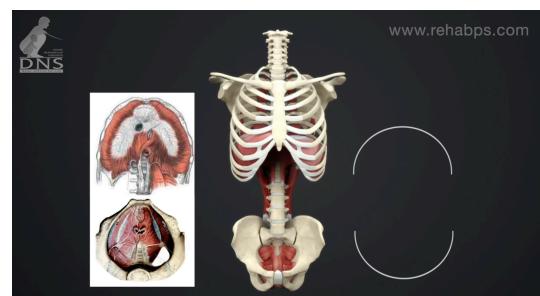
Reeves NP, Narendra KS, Cholewicki J, 2007, Spine stability : the six blind men and the elephant, Clin Biomech (Bristol, Avon). 2007 March ; 22(3): 266-274  
Reeves NP, Cholewicki J, van Dieën JH, Kawchuk G, Hodges PW, 2019, Are Stability and Instability Relevant Concepts for Back Pain ? J Orthop Sports Phys Ther . 2019 Jun;49(6):415-424

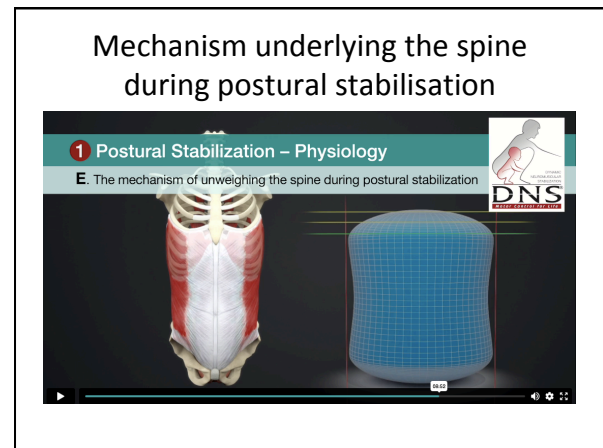
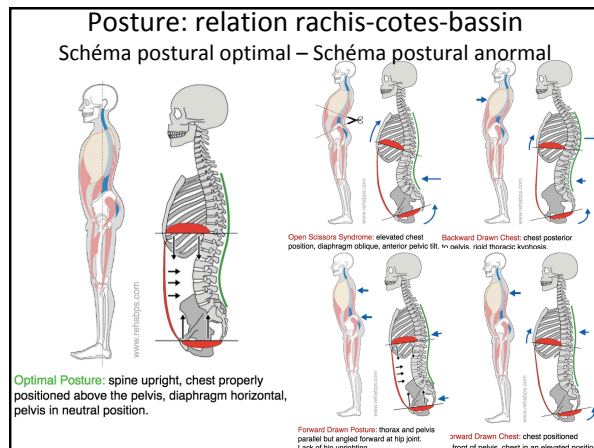


## The diaphragm and the breathing function



## The diaphragm and the breathing function





### Articles conclusions

- Diaphragm/abdominal wall/pelvic floor & paraspinal co-contraction is related to trunk control/stabilisation
- Feedforward mechanism of the diaphragm prior any motion if the extremities
  - Regardless of the direction of the movement of the UE and LE
- These muscles provides for the CNS a mechanism to coordinate breathing and control the spine during motion

### Articles conclusions

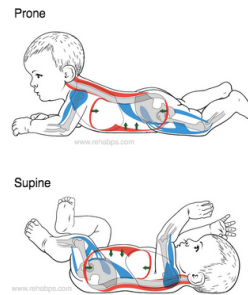
- The diaphragm and abdominal muscles act in opposing direction on the rib cage and abdomen, to pressurise the abdominal cavity and to stabilise the spine
- Every respiratory stress compromises the spinal stability and probably increases the risk of spinal injuries and reoccurrences
- With the studies on perturbations, the definition of dynamic stabilisation need to be review

## DNS approach

Dynamic Neuromuscular Stabilization which is based on developmental kinesiology, emphasises core stabilization through the co-activation of the diaphragm-TrA/IO-pelvic floor-multifidus muscles in coordination with the superficial core muscles, which generates sufficient IAP to dynamically stabilise the spine

As the diaphragm contracts it stimulates eccentrically and proportionally the entire abdominal wall.

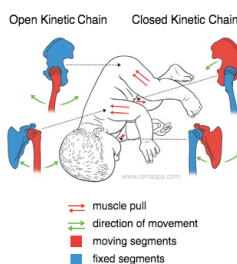
## Developmental kinesiology and stabilisation of the spine



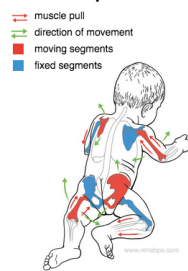
- Stabilisation of the spine is established at 3 month old
  - Isolated movements of the cervical vertebrae start
- From 4½ month, limbs differentiation starts to develop
  - Ipsilateral pattern develops from supine (turning motion)
  - Contralateral pattern develops prone (stepping forward motion)

## Differentiation of limbs and trunk muscles

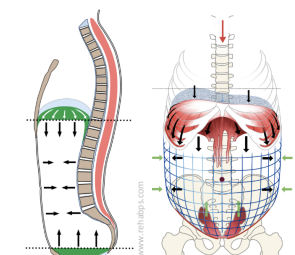
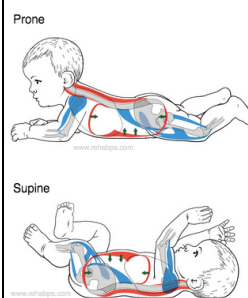
### Ipsilateral pattern



### Contralateral pattern



## Transcription to adulthood



Proper chest and pelvis alignment: supine upright, optimal coordination of the stabilizers, paraspinal muscles: not hyperactive  
Proper Postural Stabilization: diaphragm descends, costal diaphragmatic attachments fixed, contraction of the diaphragm pull the central tendon caudally, proportional eccentric activation of the entire abdominal wall. Lower ribs expansion.

### Turning over

Two different positions for the lower extremities according to the following activity of the baby

Open Kinetic Chain    Closed Kinetic Chain

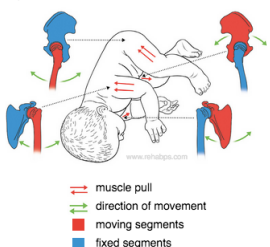




Figure 4, Rintala M, Ulin R, Jeskova M, Kobesova A, Czech Get-up, NSCA Coach, 31(2)/50-58, 2376-0982  
Figure 5A, Frank C, Kobesova A, Kolar P, 2013. Dynamic neuromuscular stabilization & sports rehabilitation, Int J Sports Phys Ther. 2013, 8(1):62-73

### Evolution since graduation



After graduation    Now days

### Vidéo L's



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