

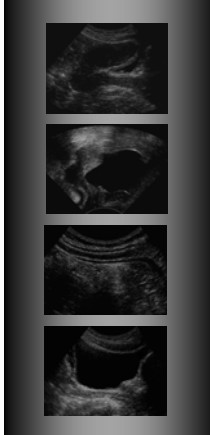
MOTOR CONTROL OF THE LUMBOPELVIC REGION: IMPLICATIONS FOR PELVIC ORGAN PROLAPSE

MOTOR CONTROL OF THE LUMBOPELVIC REGION;

IMPLICATIONS FOR PELVIC ORGAN PROLAPSE

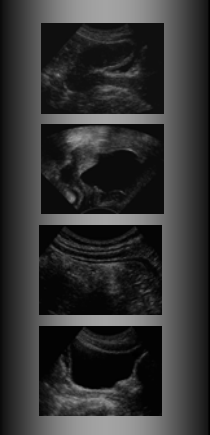
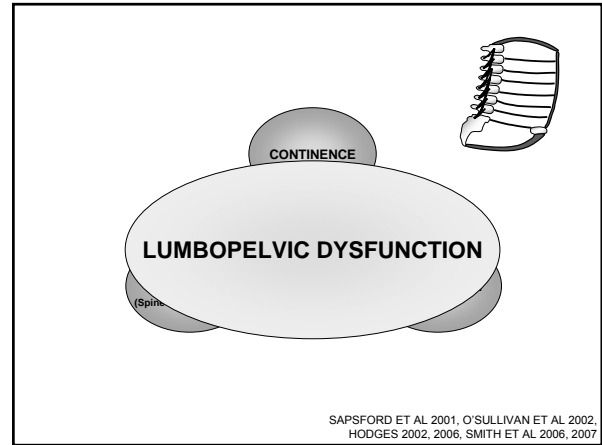
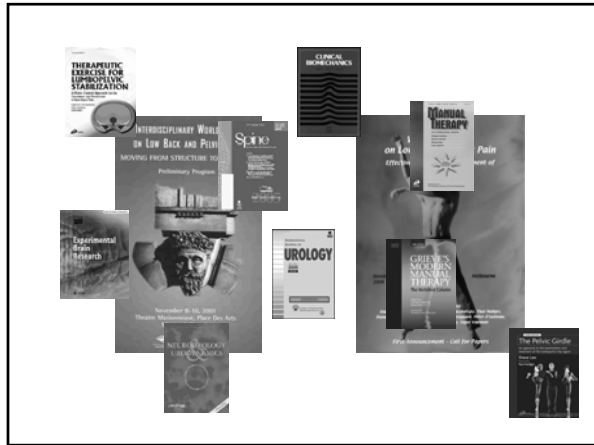
CSM – SECTION ON WOMAN'S HEALTH
FEBRUARY 14, 2007

Jackie Whittaker
BScPT, FCAMT, CGIMS, CAFCI



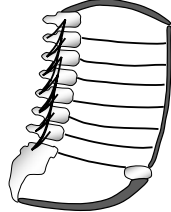
OUTLINE;

- ^ Current concepts of neuromuscular control in the lumbo-pelvic region
 - continence, postural control & respiration
- ^ Discuss how altered motor control may be an underlying factor for POP.
- ^ Demonstrate some of these concepts with the help of USI.
- ^ Outline some basic principles for conservative intervention.

DEEP / LOCAL MUSCLE SYSTEM;

- ^ Deep 'Canister' of muscles that line the abdominal cavity
- ^ Attach to pelvis, lumbar vertebrae & fascial stocking.
- ^ Anatomically / neurologically suited to influence joint stiffness * & ↑ IAP prior to loading.
 - Unable to control spinal orientation or produce motion.
- ^ TrA, Pelvic Floor, dMF & diaphragm.
 - PF – continence
 - Diaphragm, TrA - respiration
- ^ Medial QL, Post. Psoas?
- ^ Evidence suggests that the control of these muscles is impaired with LBP, SUI & respiratory disorders.





RICHARDSON ET AL 2004

HOW DOES THIS DEEP CANISTER CONTRIBUTE TO POSTURAL CONTROL?

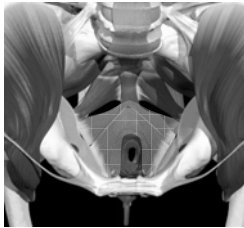
HODGES 2ND PHD.

- ^ DIA & TA (bi) = ↑IAP & ↑flex/ext stiffness
- ^ Hole in canister = no Δ ↑IAP or stiffness
- ^ Intact canister, no crura = ↑IAP, ↑flex, & ↓ext stiffness
- ^ Intact canister, no crura, no TLF = ↑IAP no Δ in flex & ↓ext stiffness

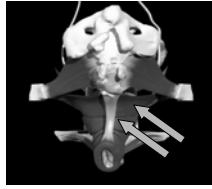



MOTOR CONTROL OF THE LUMBOPELVIC REGION: IMPLICATIONS FOR PELVIC ORGAN PROLAPSE

ANATOMICAL;



Anterior - Superior view



Posterior - Inferior view

ASHTON-MILLER ET AL 2001

MECHANICAL;



- ^ Influence the stiffness of the pelvic ring.
 - In vitro study demonstrated the capability of the PFM's to stiffen the joints of the pelvis (POOL & GUDZWAARD ET AL 2004)
- ^ Influence on intra-abdominal pressure
 - PFM activity is seen during activities that result in an increase in IAP (DEINDL ET AL 1993, SMITH ET AL 2006, 2007)
 - Activities that ↑ IAP result in ↑ PFM activity (NEUMANN & GILL 2002, SHAFIK ET AL 2003, SMITH ET AL 2006, 2007, HODGES ET AL 2007)

NEUROPHYSIOLOGY;

- ^ PFM's behave similar to the deep regional muscles
 - ↑ activation in anticipation of load.
 - PFM activation in anticipation of trunk perturbation, regardless of direction. (HODGES ET AL 2006, SMITH ET AL 2006)
 - ↑Urethral pressure precedes ↑bladder pressure by 200ms (cough). (CONSTANTINOU & GOVAN 1982)
 - PFM activation 25 ms before a cough. (BARBIC ET AL 2003)
 - PFM activation with ↑IAP (cough / valsalva). (DEINDL ET AL, 1993)



ALTERED ACTIVATION;

- ^ Sacro-iliac Joint dysfunction
 - ↑Bladder & pelvic floor descent with ASLR (O'SULLIVAN ET AL 2002)
- ^ Urinary Incontinence
 - Asymmetrical & uncoordinated activation pattern (DEINDL ET AL 1994)
 - PFM activation 150 ms after a cough (BARBIC ET AL 2003)
 - Altered resting PFM activity (↑) (THOMPSON ET AL 2006, SMITH ET AL 2007)
 - Altered response to postural challenge (delayed yet ↑ PF & EO activity) (SMITH ET AL 2006, 2007)

Smith M et al. Postural activity of the PFM is delayed during rapid arm movements in women with stress urinary incontinence. Int Urogynecol J 2006 epub ahead of print.

- Onset (timing & amplitude) of PF, EO & IO with rapid arm motion
 - Onset of PFM activity was preceded by a period of reduced activity (SUI).
 - Onset of PFM activity was delayed (SUI).
 - Amplitude of PF activity was greater (SUI).

Smith et al. Postural responses of the PF & abdominal muscles in women with & without incontinence. Neurourol Urodynam 2007 epub ahead of print

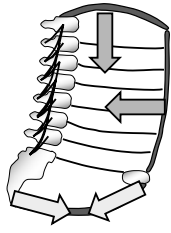
- Amplitude of PF, EO & IO activity prior to & during expected & unexpected trunk loading.
 - Amplitude of PF activity was > with SUI at rest & with loading.
 - Amplitude of EO activity was > with SUI (moderate > mild) = detrimental to continence.
 - Highlights the relationship of PF & abdominal muscles

EPIDEMIOLOGY;

- ^ Established link between LBP & PF disorders
 - 38% of women with SUI have low back pain (LBP).
 - 66% with recurrent SUI post-surgery present with LBP. (KJOLHEDE & RYDEN 1997)
 - 52% of patients presenting with either LBP & Pelvic floor dysfunction have a both.
 - In 82% the complaints started as LBP. (POOL & GUDZWAARD 2004)
 - Disorders of continence are strongly related to frequent back pain. (SMITH ET AL 2006)

MOTOR CONTROL OF THE LUMBOPELVIC REGION: IMPLICATIONS FOR PELVIC ORGAN PROLAPSE

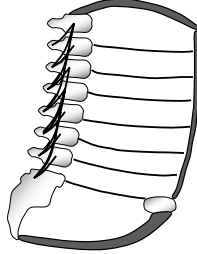
RESPIRATION & PFM's




- ^ When the diaphragm descends, it ↑'s IAP & there is a corresponding increase in PFM activity
- ^ When the abdominal wall contracts (Valsalva maneuver, expiratory or postural activity of TrA) there is an associated increase in PFM activity
- ^ Therefore ↑ PFM activity with inspiration & expiration.

THOMPSON 2004, 2005, 2006, HODGES ET AL 2007

OPTIMAL FUNCTION



OPTIMAL FUNCTION



↑↓
ABILITY OF A REGION TO TRANSFER LOAD & THEN RETURN TO A STATE OF EQUILIBRIUM
 (continue to breath & remain continent)
 ↑↓
STABLE SYSTEM / BEHAVIOR = STABILITY

HODGES 2005, REEVES ET AL 2006

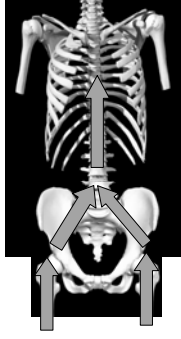
STABLE BEHAVIOR

A system that can be perturbed & then return to behaving in a way indistinguishable from its behavior prior.

Stability is about *controlling* motion in a variety of conditions not about how much motion is available

Stability ≠ Stiffness

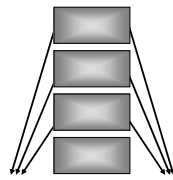
> Stiffness is not always ideal
Stability is a dynamic process



HODGES 2005, REEVES ET AL 2006

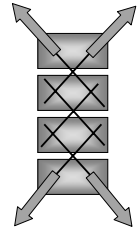
STABILITY MECHANISMS;

Euler Model




Control through compression

Motor Control Model



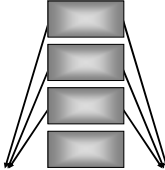
Control through modulated tensegrity

STABILITY – Euler Model



Muscle Capacity Model

- ^ Considers only control of buckling compressive forces
- ^ Antagonistic muscle activity, guy wires
- ^ Translation & rotary control comes from compression
- ^ Static definition
- ^ Create high compressive loads & high IAP
- ^ Biomechanists



RICHARDSON ET AL 2002

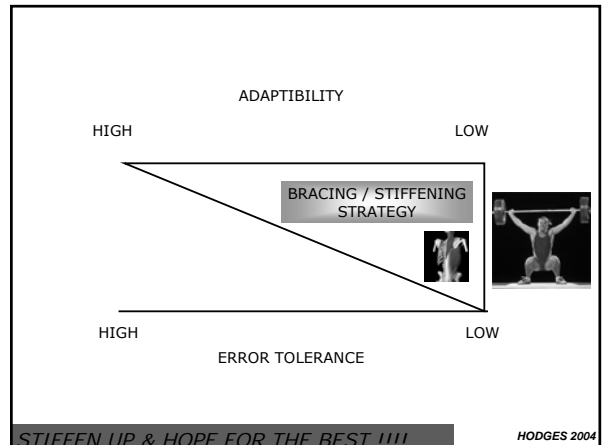
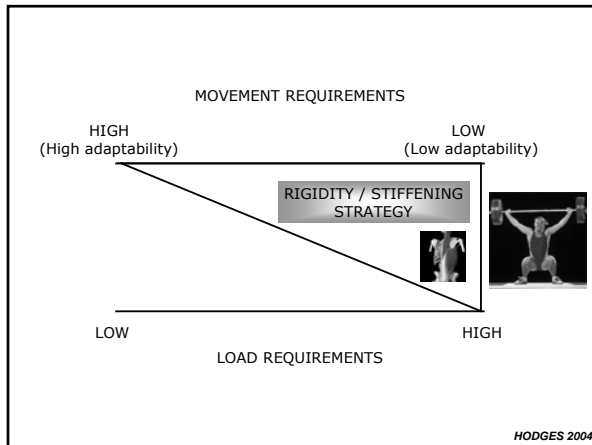
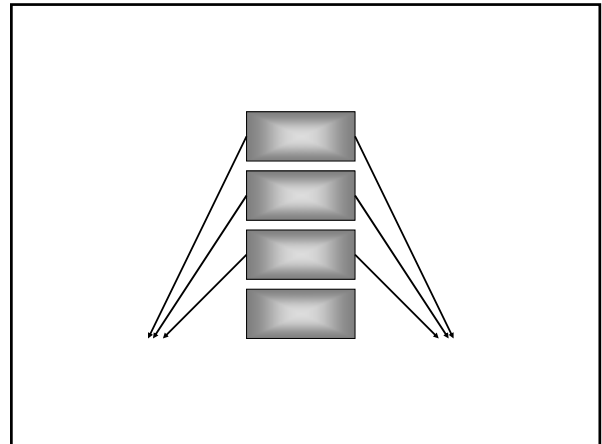
MOTOR CONTROL OF THE LUMBOPELVIC REGION: IMPLICATIONS FOR PELVIC ORGAN PROLAPSE

SUPERFICIAL MUSCLE SYSTEM;

- ^ Large muscles linking pelvis & thorax
- ^ Capable of moving the spine & balancing external loads
 - Control inter segmental motion only through compression
- ^ Create large compressive loads (victim = L. Spine)
- ^ EO, IO, RA, sMF, Erector Spinae, Lattissimus, Quadratus Lumborum



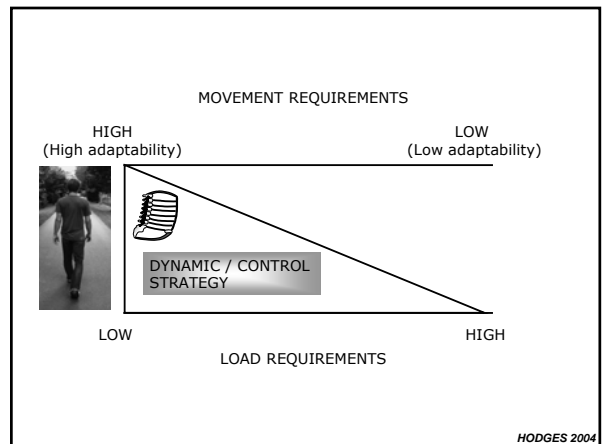
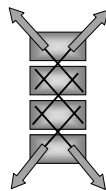
RICHARDSON ET AL 2004



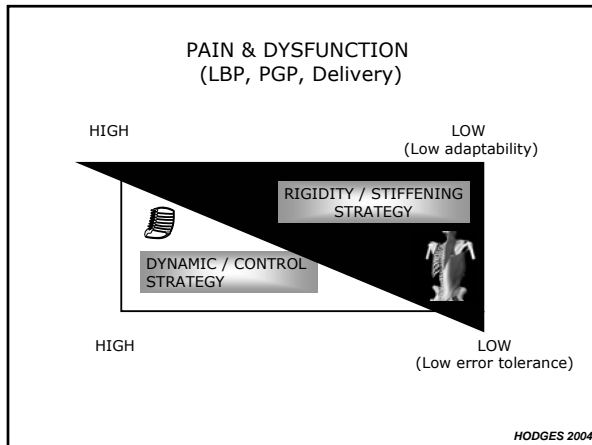
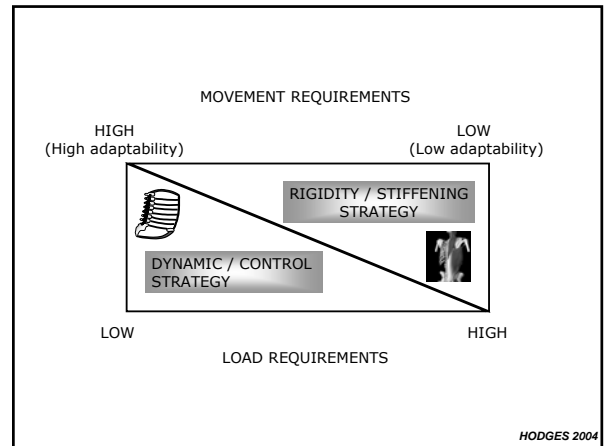
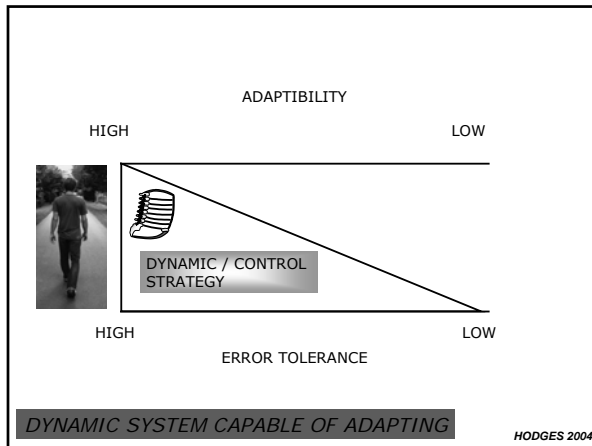
STABILITY – Dynamic control

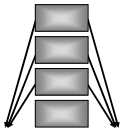
Neurophysiological Model

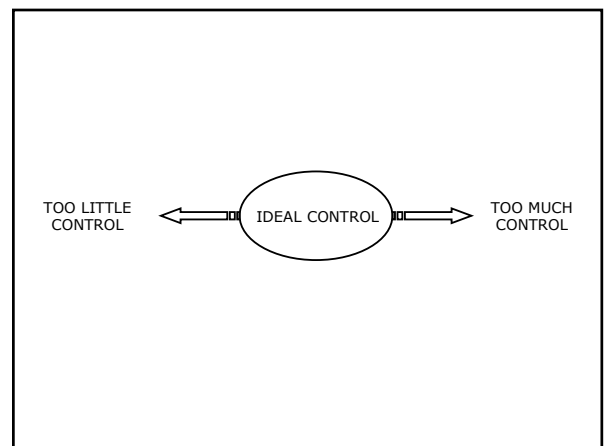
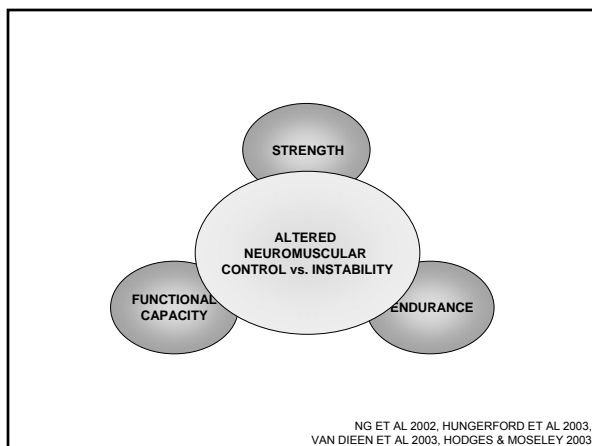
- ^ Capable of controlling both dynamic & static loads
- ^ Allows for control at 3 levels of motion;
 - spinal motion, e.g. keep COG over BOS
 - spinal orientation
 - intervertebral motion – required for spinal control
- ^ Considers the controller or neural drive
 - Orchestrated recruitment
- ^ Dr. Paul Hodges, Dr. Jacek Cholewicki



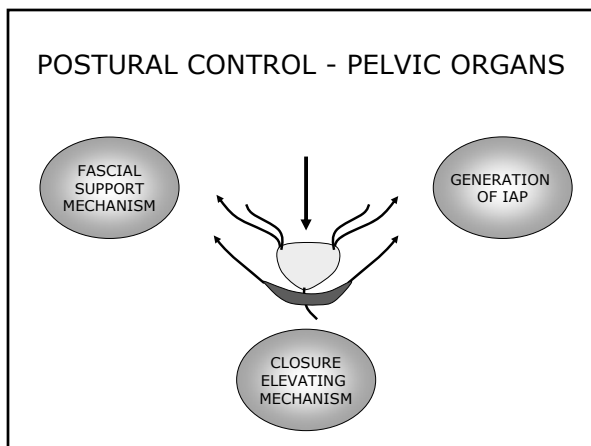
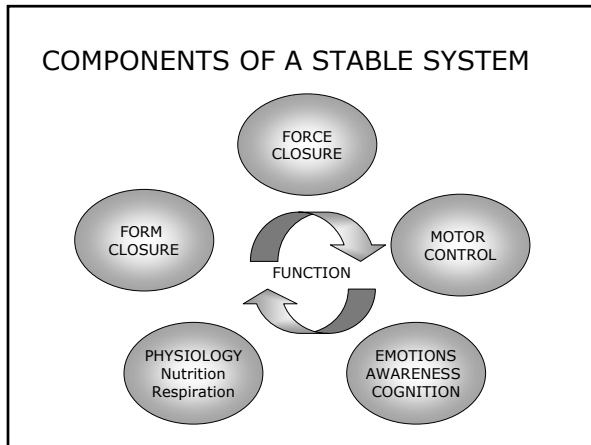
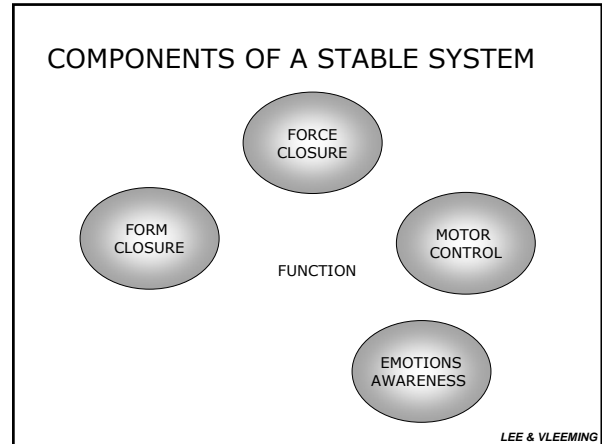
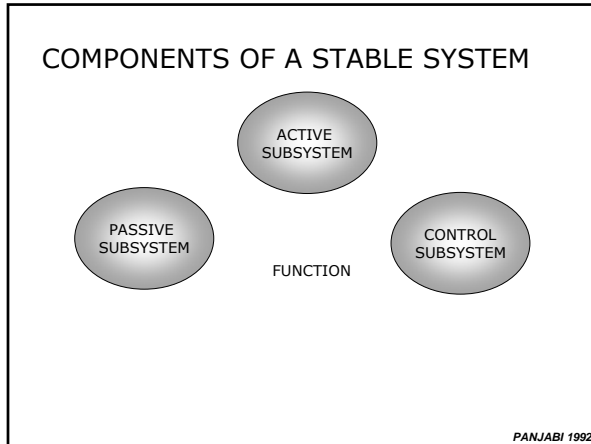
MOTOR CONTROL OF THE LUMBOPELVIC REGION: IMPLICATIONS FOR PELVIC ORGAN PROLAPSE



- ### CONSEQUENCES - RIGIDITY STRATEGY;
- ^ ↑ Compressive loading, ↓ ability to dissipate load
 - DDD, Facet joint degeneration
 - ^ ↑ Metabolic cost of antagonist co-contraction
 - Trigger points, fatigue, weakness
 - ^ Compromise of respiration & continence
 - Altered chemistry, ↑IAP leading to incontinence
 - ^ Chronically pressurized canister
 - SUI, pelvic organ prolapse, hernia
 - ^ Decreased motion / mobility
 - Rigidity vs. mobility
 - ^ Diminished postural control / response
 - Rigid structure is easy to perturb.
 - ^ Inhibition of deep muscle system.
 - Redundancy of control.
- 



MOTOR CONTROL OF THE LUMBOPELVIC REGION: IMPLICATIONS FOR PELVIC ORGAN PROLAPSE



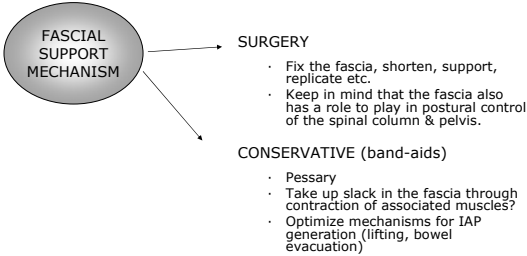
SUCCESSFUL INTERVENTION - POP;

Depends upon;

1. Identifying the mechanism (s) at play.
 - Poor *fascial* integrity (resilience) or presence of defects
 - Deficits of the *closure & elevating mechanism*
 - altered response or timing vs. strength & endurance
 - Habitually larger increases in *IAP* associated with postural control
2. Constructing an intervention specific to an individuals needs.

MOTOR CONTROL OF THE LUMBOPELVIC REGION: IMPLICATIONS FOR PELVIC ORGAN PROLAPSE

PRINCIPLES FOR INTERVENTION



IAP GENERATION – LIFT STRATEGY

Hagins et al. The effects of breath control on maximum force & IAP during a maximal isometric lifting task. Clin Biom 2006 epub ahead of print.

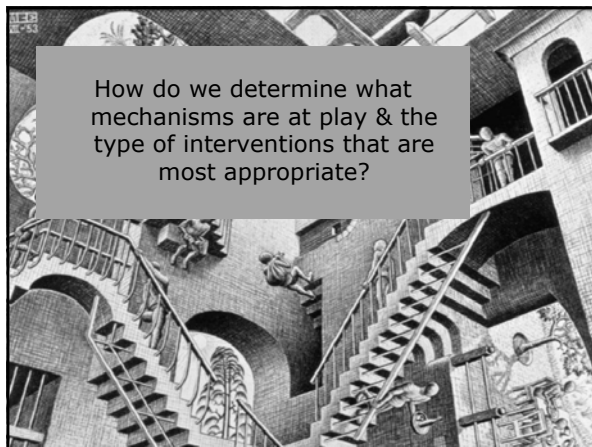
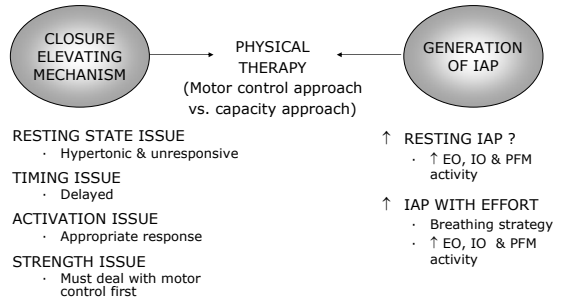
- Compared the max. force & amount of IAP generated with a max. lifting task (3 different breathing conditions).
 - Inhale & hold with lift
 - Exhale & hold with lift
 - Inhale prior & exhale with lift
- RESULTS**
 - Breath control had no effect on the max. force generated
 - The exhale & hold as well as the inhale prior & exhale during breathing conditions generate significantly less increases in IAP. With exhale & hold being resulting in the lowest generation of IAP.



SURGICAL CURE RATES of POP

- Tergerstedt & Hammarstrom 2004
 - 10 year f/u, 128 individuals
 - Subjective cure rate = 46%
 - Objective (anatomical) cure rate = 56%
- Blanchard et al 2006
 - 2 year f/u, 40 individuals
 - 45% had a reoccurrence of significant prolapse.

PRINCIPLES FOR INTERVENTION



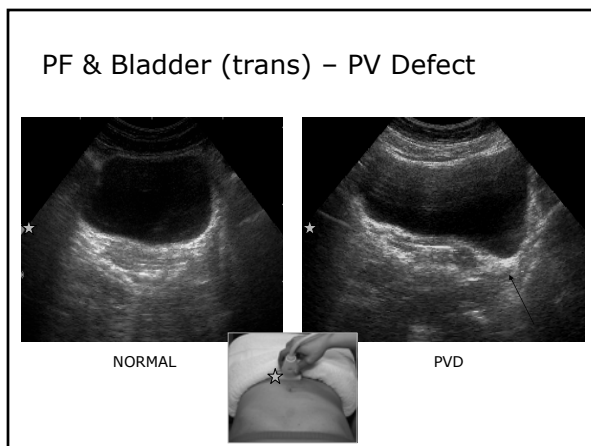
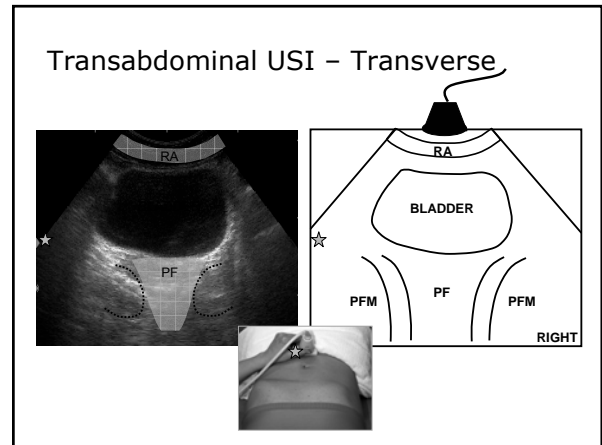
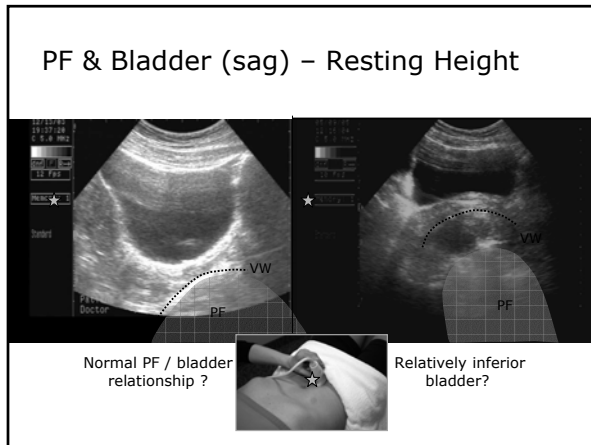
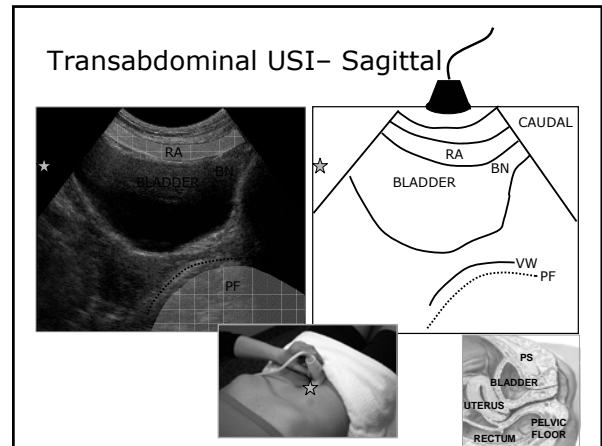
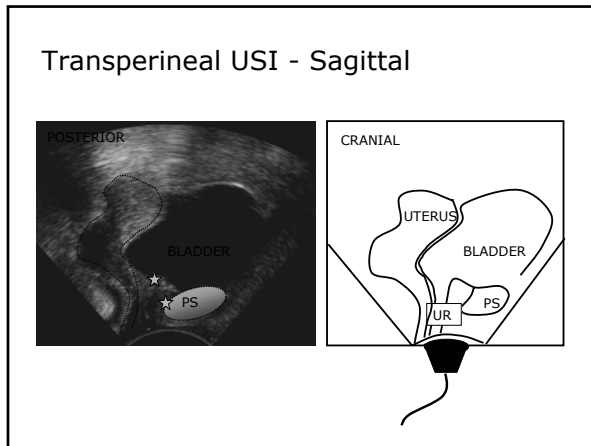
How do we determine what mechanisms are at play & the type of interventions that are most appropriate?

INDICATORS FOR SURGERY

- Evidence of fascial laxity
 - Actual prolapse
 - Indicators of fascial laxity or defects with USI



MOTOR CONTROL OF THE LUMBOPELVIC REGION: IMPLICATIONS FOR PELVIC ORGAN PROLAPSE



INDICATORS FOR SURGERY

- ^ Evidence of fascial laxity
 - Actual prolapse
 - Indicators of fascial laxity or defects with USI
 - Palpable increase in mobility
 - Increased mobility with PFM contraction seen with USI

FASCIAL SUPPORT MECHANISM

MOTOR CONTROL OF THE LUMBOPELVIC REGION: IMPLICATIONS FOR PELVIC ORGAN PROLAPSE

Preferential Act. (trans); ↑mobility?

NORMAL ↑ MOBILITY ?

Bladder stability with a loading task- ASLR

NORMAL LAXITY ?

INDICATORS FOR SURGERY

- ^ Evidence of fascial laxity
 - Actual prolapse
 - Evidence of fascial laxity with ultrasound imaging
 - Palpable increase in mobility
 - Increased mobility with ultrasound imaging
- ^ Failure with conservative treatment
 - Consider the type of treatment.
 - Was it appropriate?
 - Did it address IAP generation & PF hypertonicity.

FASCIAL SUPPORT MECHANISM

INDICATORS FOR PT - ↑ IAP

- ^ ↑ Resting IAP
 - Resting activity in the lateral abdominal wall muscles.
 - Behavior, observation, palpation, ultrasound imaging

GENERATION OF IAP

Lateral Abdominal Wall - Transverse

LATERAL

Lat. Abdominal Wall - Resting activity

NORMAL RESTING ACTIVITY

MOTOR CONTROL OF THE LUMBOPELVIC REGION: IMPLICATIONS FOR PELVIC ORGAN PROLAPSE

INDICATORS FOR PT - ↑ IAP

- ^ ↑ Resting IAP
 - Resting activity in the lateral abdominal wall muscles.
 - Behavior, observation, palpation, ultrasound imaging
 - Resting activity in the pelvic floor muscles
 - Behavior, palpation, ultrasound imaging

GENERATION OF IAP

PF & Bladder (trans) – Resting Activity

NORMAL RESTING ACTIVITY

INDICATORS FOR PT - ↑ IAP

- ^ ↑ Resting IAP
 - Resting activity in the lateral abdominal wall muscles.
 - Behavior, observation, palpation, ultrasound imaging
 - Resting activity in the pelvic floor muscles
 - Behavior, palpation, ultrasound imaging
- ^ ↑ IAP with effort
 - Breath holding, closed glottis
 - Distention of the abdomen
 - Abdominal hernia, ↑Intra-rectus distance
 - Palpation , ultrasound imaging
 - ↑ abdominal bracing resulting in bladder descent
 - Palpation, observation, ultrasound imaging

GENERATION OF IAP

Anterior Abdominal Wall

EO Fascia
RA
TrA Fascia

Lateral abdominal wall with an ASLR

SUFFICIENT EXCESSIVE / TIMING

Bladder stability with a loading task- ASLR

NORMAL EXCESSIVE ↑IAP ?

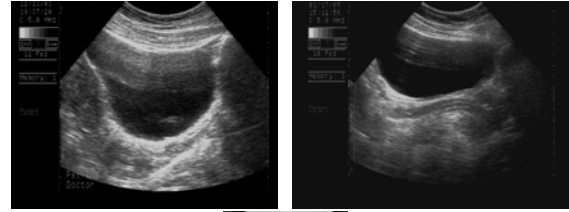
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INDICATORS FOR PT – CLOSURE

- ^ Altered resting activity (PFM & EO)
 - Associated with ↑ IAP & altered responsiveness to further ↑ IAP.
- ^ Inappropriate activation of PFM or EO.
- ^ Inability to perform an elevating PFM contraction.
 - 'USI is more specific than intra-vaginal palpation for assessing elevating and support roles of the PFM's'.
DEITZ 2004, FRAWLEY ET AL 2005
- ^ Inappropriate timing of elevating contraction
- ^ Deficit in strength
 - Must restore motor control first

CLOSURE
ELEVATING
MECHANISM

PF & Bladder (sag) – PFM Contraction



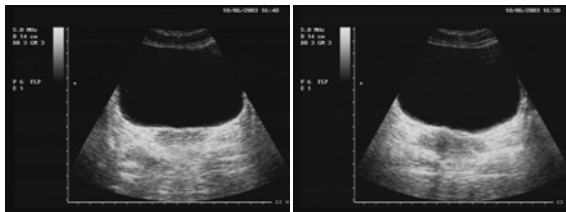
ELEVATING

DEPRESSING



Repeated strain = ↑ IAP
POP??

PF & Bladder (trans) – PFM Contraction



CORRECT

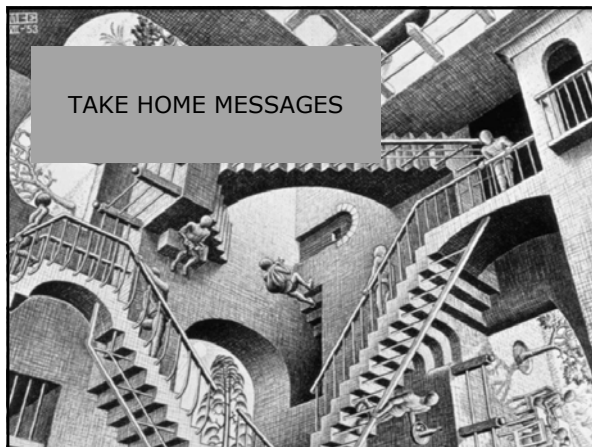
STRAINING



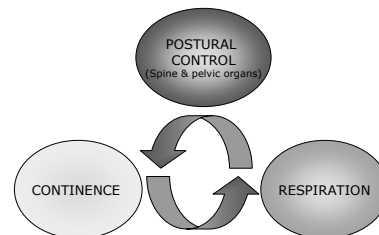
INTERVENTION FOR PT – CLOSURE

- ^ RE-TRAIN ELEVATING FUNCTION
 1. Normalize resting activity (PF & Obliques)
 2. Restore ability to perform an elevating contraction
 3. Restore appropriate motor control (timing) - cannister
 - Activities resulting in ↑ IAP
 - Functional activities
 4. Restore strength / function

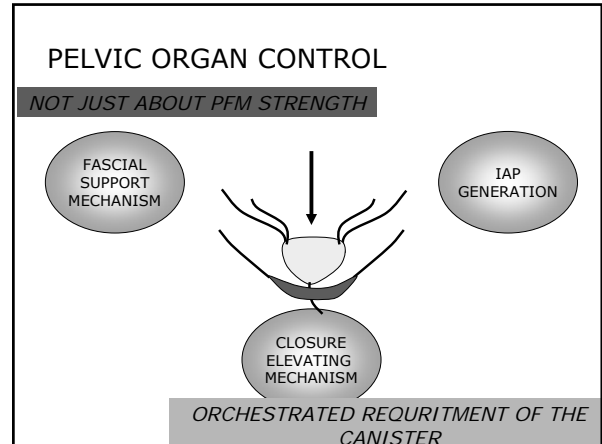
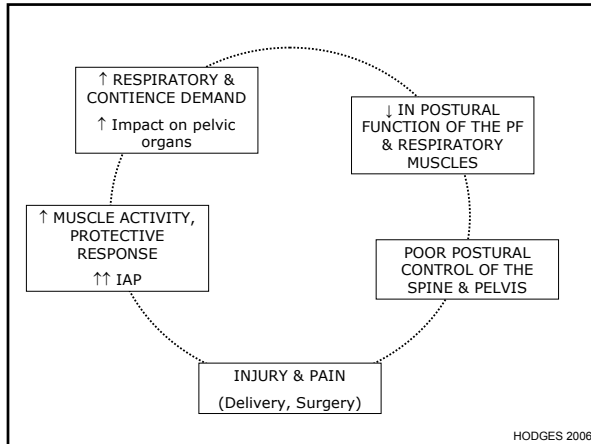
TAKE HOME MESSAGES



INTERDEPENDENT MOTOR CONTROL;



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World Physical Therapy
2007

Thank-you !!

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