THE ROLE OF THE PELVIS IN GAIT

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OBJECTIVES

• Upon completion of the course the participant will be able to:
  • explain the kinematics of the pelvis in gait
  • discuss the changes noted in gait as a result of pain, in particular, low back pain
  • describe the PNF diagonal patterns of the pelvis
  • discuss the 3-dimensional role of the pelvis in gait
  • discuss how to address pelvic motion to optimize its role in gait and decrease pain while improving function
NORMAL GAIT

Normal Gait

Normal Kinematics
Temporal and Spatial Components of Gait
EFFICIENT GAIT

Normal and Efficient…
Are these the same?

DOES PAIN AFFECT GAIT?
DOES PAIN AFFECT GAIT?

• Low Back Pain (LBP) & Gait:
  • Individuals with LBP tend to walk slower
    Keefe & Hill, 1985; Lamoth & Meijer, 2002; Spenkelink et al, 2002
  • Individuals with LBP have:
    • decreased hip extension range
    • decreased stride time
    • altered onset of firing of hip extensor muscles
    • altered onset of the firing of lumbar erector spindle muscles
      Vogt, Pfeifer & Banzer, 2003

• Individuals with LBP have compromised energy mechanisms
  Carvalho, Andrade & Peyre-Tartaruga, 2015

• Patients with LBP have increased EMG activity in lumbar paraspinals during swing phase when these muscles are supposed to be silent. There is also an increase in EMG activity in the rectus abdominals
DOES PAIN AFFECT GAIT?

• Sagittal plane coordination of the lower extremities, pelvis and trunk are affected by LBP – the patterns and variability of the coordination across these segments is altered by low back pain

   Ebrahimi et al, 2017

• In individuals with LBP, the pelvis-thorax coordination is less out of phase when walking at higher speeds (in normals, horizontal thorax and pelvis rotations are in phase at slower speeds but become anti-phase when walking at higher speeds)

   Muller, Ertell & Blickhan, 2015

• LBP reduces (or eliminates) the adaptation of trunk-pelvis coordination necessary with changes in gait speed. This is believed to affect gait stability. It is possible that the altered coordination and motor control occur as a result of an effort to stabilize the pelvis and spine and prevent unexpected perturbations

   Lamoth et al, 2006; Seay et al, 2011; van den Hoorn et al, 2012
DOES PAIN AFFECT GAIT?

- Patients with chronic LBP have less pelvis rotation and unchanged thorax rotation while walking and running on level and uneven ground
  Muller et al, 2015

- Individuals with LBP show significantly less overall lumbar rotation
  Gombatto et al, 2015

So...

What does it all mean to us as PTs?
A question I want to answer…

What is the role of the pelvis in gait?

and…

What is the role of the pelvis in gait?

Can we affect gait, and therefore pain, through neuromuscular re-education of the pelvis?
What is the role of the pelvis in gait?

“During each stride the pelvis moves asynchronously in all three directions. The site of action is the supporting hip joint. All the motion arcs are small, representing a continuum of postural change. Motion at the junctions of the pelvic bones and sacrum has not been noted during walking.”


What is the role of the pelvis in gait?

Pelvic Tilt (sagittal plane): 2.79° to 4°

Pelvic drop/list (frontal plane): 4° to 7.72°

Pelvic rotation (transverse plane): 10° to 10.4°

WE DON’T WALK IN ONE DIMENSIONAL PLANES!

PELVIS - PNF

• Anterior Elevation (AE)
• Posterior Depression (PD)
• Anterior Depression (AD)
• Posterior Elevation (PE)
PELVIS DURING GAIT

- Heel strike
- Loading Response to Mid-Stance to Terminal Stance
- Pre-Swing (Toe-off)
- Initial to Mid-Swing
- Terminal Swing into HS

PELVIS DURING GAIT

- Heel strike: *pelvis AD*
- Loading Response to Mid-Stance to Terminal Stance: *pelvis PD*
- Pre-Swing (Toe-off): *relative pelvis PE (PE & AE)*
- Initial Swing to Mid-Swing: *pelvis AE*
- Terminal Swing into HS: *pelvis AD*
PELVIS DURING GAIT

- Heel Strike: pelvis anterior depression

PELVIS DURING GAIT

- Loading Response to Mid-stance to terminal stance: pelvis posterior depression
PELVIS DURING GAIT

• Pre-swing (Toe-off): relative pelvis PE with possible co-contraction of PE & AE.

PELVIS DURING GAIT

• Initial to mid-swing: pelvis anterior elevation
PELVIS DURING GAIT

• Terminal swing into HS: pelvis anterior depression

PELVIS DURING GAIT

• Heel strike: pelvis AD
• Loading Response to Mid-stance to terminal stance: pelvis PD
• Pre-swing (Toe-off): relative pelvis PE (PE & AE)
• Initial Swing to Mid-swing: pelvis AE
• Terminal Swing into HS: pelvis AD
RECIPROCITY DURING GAIT

- Pelvis Anterior Elevation
- Scapula Posterior Depression

- Pelvis Posterior Depression
- Scapula Anterior Elevation

Current study...

- Phase 1:
  - The role of the pelvis in gait – normal vs chronic LBP?
    - Kinematics of gait – Zeno mat
    - Motion of the pelvis – G-Walk sensor
    - EMG activity – hip extensors (g.max) and hip abduction (g.med)

- Phase 2:
  - The effect of pelvic PNF patterns on gait and pain in individuals with chronic LBP compared to a core stabilization program
GAIT OBSERVATION

• **Trunk walker:** efficient gait
  • Movement of the extremities is initiated by the scapula and pelvis on a dynamically stable trunk. Proximal stability allows for efficient distal mobility

• **Pelvic walker:**
  • Movement of the pelvis occurs mostly on the frontal plane or the transverse plane

• **Hip walker:**
  • Movement of the limbs is driven by the hip

PNF INTERVENTION FOR PELVIS

• **PNF patterns:**
  • Pelvic & Scapula patterns:
    • Anterior elevation
    • Posterior depression
    • Anterior depression
    • Posterior elevation

• **PNF techniques:**
  • Rhythmic Initiation
  • Combination of Isotonics
  • Repeated Stretches
  • Dynamic Reversals
Research Plans/Ideas…

- Examination of the three dimensional role of the pelvis in gait:
  - Video analysis, including accelerometers on the pelvis and EMG on trunk musculature in:
    - Children who have not had a traumatic incident and are pain free
    - Adults 20-50 yo who have no c/o LBP
    - Adults 20-50 yo who have chronic LBP
  - Evaluate role of pelvis on efficiency of gait in terms of temporal and spatial components of gait. COM displacement during ambulation, as well as cardio-pulmonary function.

- Gait analysis of individuals with chronic LBP before and after PNF interventions aimed at re-establishing efficient pelvic function.

- Role of the pelvis in gait in individuals with other diagnosis – MS & NM

- Role of the pelvis in walking vs running

Questions…
References


