Global Mechanical Assessment

Understanding (Assessing) the Nervous System of Athletes

Dr. John Downes
drjohndownes@pflmethod.com
jdownes@life.edu

© GMA all rights reserved PFLM, Inc.
“The process of discovery is seeing what others have seen before and thinking something new.”

Albert Einstein
Goals for the presentation

- Demonstrate global assessment
- Propose ‘What ifs’ and ‘Whys’
- Discuss possible implications: F, C, P
- Leave you interested in further investigation
Components of movement

- Neurology
- Soft tissue
- Joint movement

- Neuromechanics – the combining of neurology and biomechanics
Components of Neuromechanics

- Feedforward APAs
  - 100 ms prior – 50+ms post
- Feedback CPAs
  - 75-100 ms post
- Neural Plasticity
- Task Specificity

- NM>Neural Control>APAs / CPAs>
  Muscle Synergies>SAID
General Adaptation Process / Homeostasis

- **Specific**
- **Adaptation**
  - to
- **Imposed**
- **Demand**
‘An intact motor system can adapt via central nervous system control and muscle system activity. The adaptations of the motor system are represented by muscle imbalances’

Craig Liebenson, DC
Presumption(s)?

• An intact nervous system free of pathology or injury performs as a neutral conduit of signals.
• The mechanical indicators of techniques are a direct indicator of change in the nervous system.
• The changes in the horizontal stay changed in the vertical
Where did this come from?

- Clinical observation that seemingly minor injuries were persistent despite quality care by ATCs, DCs, PTs, MDs.
- Noting that asymmetrical dorsiflexion was prevalent in many cases.
- Testing extremities prior to adjusting the spine indicated a tendency towards a pattern of contralateral dysfunction of UE and LE.
Process of GMA

- Use the extremities as long levers to challenge the CNS to properly anchor and operate.
- Compare sides via isometric mirror image tasks.
- Observe quality of anchoring and operation.
- Determine if reciprocal limb coupling inefficiency is involved. RLS
Starting Point
Abduction LE / LLNC
Abduction LE / LLNC Oblique
Adduction LE / LLNC Oblique
Adduction UE / LLNC Oblique
Scapular SLNC
Flexion UE / LLNC
## Glossary

- **PFLM** – Performance for Life Method
- **GMA** – Global Mechanical Assessment
- **GPD** – Global Proprioceptive Deficit
- **RLS** – Reciprocal Limb Syndrome
- **FFA** – Feed Forward Activation
- **FB** – Feed Back
- **APAs** – anticipatory postural adjustments
- **CPAs** – compensatory postural adjustments
- **SAID**-specific adaptation to imposed demand
## Prevalence of GPD

<table>
<thead>
<tr>
<th>Group / Team</th>
<th>Gender Total</th>
<th>GPD Number</th>
<th>GPD Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Y</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td><strong>Non-athletes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>29</td>
<td>23</td>
<td>6</td>
</tr>
<tr>
<td>Female</td>
<td>25</td>
<td>22</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>54</td>
<td>45</td>
<td>9</td>
</tr>
<tr>
<td><strong>Athletes Diving</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>7</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Female</td>
<td>19</td>
<td>17</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>26</td>
<td>23</td>
<td>3</td>
</tr>
<tr>
<td><strong>Track &amp; Field</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>14</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Female</td>
<td>9</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
<td>18</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>21</td>
<td>16</td>
<td>5</td>
</tr>
<tr>
<td>Female</td>
<td>28</td>
<td>25</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>49</td>
<td>41</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total Subjects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>50</td>
<td>39</td>
<td>11</td>
</tr>
<tr>
<td>Female</td>
<td>53</td>
<td>47</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>103</td>
<td>86</td>
<td>17</td>
</tr>
</tbody>
</table>
Theory of GPD

- Because it has nothing to do with pain the patient is not aware of its’ presence.
- Because it appears to change the efficiencies within the NMS instantaneously the potential for injury may increase or decrease without perception.
- If you don’t check for it pre and post you don’t really know if a change has occurred.
Cycle of Injury – Lephart, Fu, Scott

1. Ligamentous injury
2. Structural Instability
3. Functional Instability
4. Reinjury

Proprioceptive Deficit
Decreased Neuromuscular Control

Mechanical Model
Neuromechanical Model
Cycle of Injury – Chiropractic / Neuromechanical Model

- Potential for Injury/Reinjury
- Functional Instability
- Structural Instability
- Ligamentous Injury
- Decreased Neuromuscular Control
- Proprioceptive Deficit
- Subluxation – Corrupted Signal

Mechanical Model

Neuromechanical Model

Downes 2002
Panjabi’s article / implications

Efficient Performance

From Panjabi 2006
Subfailure Injury of Ligaments in the Spine

From Panjabi 2006

Diagram showing the relationship between injured mechanoreceptors, neuromuscular control unit, chronic back pain, tissue inflammation, and adverse consequences such as higher stresses/strains and injuries in ligaments, mechanoreceptors, and muscles, muscle fatigue, and higher facet loads. Feedback loops are indicated in the diagram.
Global Proprioceptive Deficit Model – Downes 2000

- Interference
  - Proprioceptive Deficit
  - Corrupted Signal
  - Feedforward deficit

- Functional Instability
  - Adverse Consequences

- Feedback
  - SAID

- Decreased Neuromuscular Control
  - Corrupted Muscle Response Pattern

- Global Compensatory Effect
  - Altered Coupling patterns
  - Reciprocal Limb Syndrome
  - Feedforward alterations
  - Functional Inefficiencies
  - Altered Movement Patterns
  - Layering of CMRP
Patterns of GPD

- Complaint patterns, right LB / left shoulder – neck
- Lower extremity and contralateral upper extremity
- Layering – starts with all one side, then after adjusting a different pattern is seen, then after adjusting another pattern appears.
- Proper approach to management with a different sequencing of tools.

The role of head position and prior contraction in manual aiming.

Sidaway B¹, Bonenfant D², Jandreau J², Longley A², Osborne K², Anderson D³.

Copyright © 2014 Elsevier B.V. All rights reserved.
Head position sense
Practical application

- Elbow position under shot with head rotation towards
- Over shot with head rotation away
- Undershot with core activation
- What if it was due to CNS corruption?
- What if you could demonstrate it and correct it?
Who’s safe? Who’s Injured?
Abstract

Traumatic minor cervical strains are common place in high-impact sports (e.g. tackling) and premature degenerative changes have been documented in sports people exposed to recurrent impact trauma (e.g. scrummaging in rugby) or repetitive forces (e.g. Formula 1 racing drivers, jockeys). While proprioceptive exercises have been an integral part of rehabilitation of injuries in the lower limb, they have not featured as prominently in the treatment of cervical injuries. However, head and neck position sense (HNPS) testing and re-training may have relevance in the management of minor sports-related neck injuries, and play a role in reducing the incidence of ongoing pain and problems with function. For efficacious programmes to be developed and tested, fundamental principles associated with proprioception in the cervical spine should be considered.

Hence, this article highlights the importance of anatomical structures in the cervical spine responsible for position sense, and how their interaction with the CNS affects our ability to plan and execute effective purposeful movements. This article includes a review of studies examining position sense in subjects with and without pathology and describes the effects of rehabilitation programmes that have sought to improve position sense. In respect to the receptors providing proprioceptive information for the CNS, the high densities and complex arrays of spindles found in cervical muscles suggest that these receptors play a key role. There is some evidence suggesting that ensemble encoding of discharge patterns from muscle spindles is relayed to the CNS and that a pattern recognition system is used to establish joint position and movement. Sensory information from neck proprioceptive receptors is processed in tandem with information from the vestibular system. There are extensive anatomical connections between neck proprioceptive inputs and vestibular inputs. If positional information from the vestibular system is inaccurate or fails to be appropriately integrated in the CNS, errors in head position may occur, resulting in an inaccurate reference for HNPS, and conversely if neck proprioceptive information is inaccurate, then control of head position may be affected. The cerebellum and cortex also play a role in control of head position, providing feed-forward and modulatory influences depending on the task requirements.

Position-matching tasks have been the most popular means of testing position sense in the cervical spine. These allow the appreciation of absolute, constant and variable errors in positioning and...
Neural Plasticity and Task Specificity

- High-Performance Vision Training Improves Batting Statistics for University of Cincinnati Baseball Players
  Joseph F. Clark, James K. Ellis, Johnny Bench, Jane Khoury, Pat Graman
  Published: January 19, 2012 http://dx.doi.org/10.1371/journal.pone.0029109
Head position changes coupling

- Effect of head and limb orientation on trunk muscle activation during abdominal hollowing in chronic low back pain
  Kevin Parfrey1, Sean GT Gibbons2, Eric J Drinkwater1,3 and David G Behm1*

- Parfrey et al. BMC Musculoskeletal Disorders 2014, 15:52 http://www.biomedcentral.com/1471-2474/15/52
Practical Demo / Application

- After history
- After questions of joint stability are resolved
- Included in pre-treatment assessment
- Utilized as a post-treatment assessment
Exploring the Neuromodulatory Effects of the Vertebral Subluxation and Chiropractic Care

- Haavik, Holt, Murphy 2010
The Theory

- Vertebral Subluxation
  - Altered Afferent Input
    - Altered somatosensory processing
      - Altered sensorimotor integration
        - Altered Motor Control
          - Altered function (pain and disability)
The Adjustment

- Normal Afferent Input
- Appropriate somatosensory processing
- Appropriate sensorimotor integration
- Good function
- Accurate Motor Control

- Spinal Adjustment
- Appropriate Joint Movement
Cervical spine manipulation alters sensorimotor integration: A somatosensory evoked potential study

Haavik Murphy 2006
Cortical responses to adjustment

- N 2O / N 30 excitation
- Lasts for 20+ minutes post adjustment
- Possible window of opportunity for neural integration and increased plasticity
The role of spinal manipulation in addressing disordered sensorimotor integration and altered motor control

Heidi Haavik a,1, Bernadette Murphy b,*,2

a New Zealand College of Chiropractic, Auckland, New Zealand
b Faculty of Health Sciences, University of Ontario Institute of Technology, 2000 Simcoe St North, Oshawa, Ontario, Canada L1H 7K4
The Role of the Core Stability in Athletic Function  Kibler & Press

• ‘Core stability’ is the ability to control the position & motion of the trunk over the pelvis to allow optimum production

• Core muscle activity is best understood as the pre-programmed integration of local, single-jt muscles and multi-jt muscles to provide stability and produce motion.

• Proximal stability for distal mobility
<table>
<thead>
<tr>
<th>muscles of the inner core of the spine</th>
<th>muscles of the outer core of the spine</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Spinal extensors (multifidus) muscles</td>
<td>1. External Olique</td>
</tr>
<tr>
<td>2. Deep neck flexors (longus capitas, longus colli)</td>
<td>2. Rectus abdominis</td>
</tr>
<tr>
<td>3. Abdominal wall (transverse abdominis)</td>
<td>3. Erector Spinae</td>
</tr>
<tr>
<td>4. Diaphragm</td>
<td>4. Lattissimus Dorsi</td>
</tr>
<tr>
<td>5. Pelvic floor</td>
<td></td>
</tr>
</tbody>
</table>
So what does it mean?

- If you find apparent inequality in the mirror image isometric tests … the patient has a neurological deficit.
- If you find that there is a contralateral upper or lower extremity demonstrating a similar inequality … the patient has reciprocal limb syndrome RLS.
- If you don’t find anything then there is no global imbalance … maybe … check head position.
Pitching mechanics

- Balance counterbalance critical
- Power developed with cervical rotation
- Deceleration occurs with opposite cervical rotation
- Scapular Dyskinesis?
Shoulder Injuries

- Multifactorial
- Power is generated from the opposite lower extremity
- Scapulothoracic area has the greatest ability to adapt
- It requires a global assessment
Parting Thought

“You cannot solve the problems you now have at the same level of thinking you used to create them.”

Albert Einstein
Thank you for your attention!