THE PREDICTABLE EFFECTS OF
ABERRANT SAGITTAL PELVIC POSITION AND CONTROL
IN THE DEVELOPMENT AND PERPETUATION OF LOW BACK AND PELVIC PAIN

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purpose:

We attempt to further **the understanding of the *nature* of movement problems** in back pain, by proffering a model of posture and related movement dysfunction. This describes the common neuromusculoskeletal dysfunctions of the lumbopelvic and related regions observed in clinical practice.

relevance:

Many clinicians and researchers dealing with lumbopelvic pain do not appear to fully appreciate **the important contribution that appropriate spatial position and control of the pelvis affords in optimising control of trunk posture and movements** (1, 3, 6, 11, 12, 29, 32, 54).

It is important that the clinician can **'see' and understand** what is important to address in the patient in front of him. The functional paradigm offered provides a clinically useful framework and working hypothesis to help understand why the back and /or pelvic pain may have developed and persists.

It provides a **simple clinical classification system** and so, also **facilitates assessment, functional diagnosis** and hence improved treatment interventions – both manual and prescriptive exercise in the management of lumbo-pelvic pain syndromes.

proposal:

1. The central role of the pelvis in postural and movement control of the axial spine

2. The functional interdependence of the hips, pelvis and spine.

3. Control of posture is basic to movement control.

Evidence is emerging that people with back pain have problems with postural control (49, 30, 33) including defects in postural position sense. (39, 52, 4, 5, 10).

Uprightness and all movements in the body emanate from and are supported by, a **preceding 'postural set'** – the quality of which will determine the quality of the ensuing movement. Complex neuromuscular mechanisms are involved in axial control. Building upon the work of others (3, 16, 17, 18, 19, 20, 21, 46, 51) we have proposed the concept of two systemic muscle systems being involved in this complex control (28).

In essence:

- **The Systemic Local Muscle System (SLMS)** or deep system – its actions akin to the functions of the "postural reflex mechanism" – 'intrinsic' actions such as antigravity support, breathing, segmental alignment and control, small shifts and adjustments necessary for equilibrium control.
- **The Systemic Global Muscle System (SGMS)** or superficial system – providing the more 'extrinsic' movements, large perturbations and actions involving effort. This system is **dependent upon adequate preceding activation of the SLMS** to provide a flexible, adjustable yet stable base of support for their actions and optimal postural and movement control.

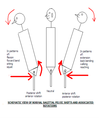
THE DYSFUNCTIONAL STATE.

Clinical evidence, increasingly supported by research (15, 16, 22, 23, 35) reveals that in the dysfunctional state, there is **imbalanced activity between the two systems and within each system.** Postural and movement control of the torso is attempted via consistent though variable **underactivity in the SLMS with variable and consistent over activity in the SGMS.**

The person begins to move in a ***more primitive, coarse and less ideal way***. This will be reflected in the consistent tendency for **certain typical, habitual 'preferred' patterns of postural and movement control.**

THE PELVIC CROSSED SYNDROMES.

- Clinically, we have distilled **two primary pictures of postural and related movement dysfunction** predicated upon the position and control of the pelvis. These have utilised and extended Janda's concept of The Pelvic or Lower Crossed Syndrome (24, 25, 26).



SCHEMATIC VIEW OF NORMAL, ANATOMIC PELVIC SHIFTS AND ASSOCIATED MUSCLING

Observing the person's preferred standing posture from the side, the neutral sagittal alignment and position of the pelvis as described by Kendall (27) is deviated – **expressed as either a posterior or anterior shift with an associated sagittal rotation.** This creates the two principal Pelvic Crossed Syndromes. Most patients will not demonstrate the 'pure' form; however will readily demonstrate strong features of either tendency.

- These two primary pictures provide a ***simple clinical classification system based on altered function.***

I. THE POSTERIOR PELVIC CROSSED SYNDROME (PPXS)

the pelvis is back!

This fairly much equates to Janda's original Pelvic Crossed Syndrome.

Here the neuromuscular system is "more switched on" but in an abnormal manner of **relative SGMS 'overdrive' with patchy axial extensor hyperactivity and related underactivity of the deep system**. In its purest form it may be more common in males. The patient looks "up" – the pseudo warrior, although he is tense, unyielding, generally tight and stiff, with poor selective control of movement within the torso. Clinically this does not appear to be the dominant presentation.

static picture characterised by:-

pure posterior pelvic crossed syndrome: anterior, lateral and posterior view

SCHEMATIC VIEW POSTERIOR PELVIC CROSSED SYNDROME

- **Pelvis: posterior shift with increased anterior sagittal rotation** or tilt.
- **Trunk: anterior translation** of the thorax via thoraco-lumbar 'shunt' from increased thoraco-lumbar extensor muscle activity creates a forward loaded trunk and associated compensatory anterior pelvic rotation.
- They look 'extended' with an **increased lordosis** but this is principally **high lumbar** and over the **thoraco-lumbar junction**. Examination usually reveals relative flexion and poor segmental control over mid-low lumbar levels.
- **Hips in relative flexion** with adaptively tight anterior structures.
- Quick appraisal reveals big belly, bottom and calves and bulky T/L extensor groups. Puffy superficial tissues and poor definition over the low lumbar levels and lumbo-sacral junction.

muscle hypo-activity/ lengthened:-

- Entire abdominal wall and? pelvic floor
- Lumbo-sacral multifidus
- Iliacus in controlling anterior pelvic rotation AT the lumbo-sacral junction
- Glutei – medius +.
- Inefficient diaphragm activity

muscle hyperactivity / adaptive shortness:-

- **Thoraco lumbar erector spinae +++**
- Anterior hip flexor groups primarily **psoas.**
- Piriformis.
- ? Hip internal rotators ‹ external rotators

as a consequence we can expect or predict that in movement:-

- **Poor control of the pelvis in space** – ***particularly anterior shift/posterior rotation; and also on the hips and lumbar spine*** in posture and movement because of **reduced Systemic Local Muscle System (SLMS) activity.**
  Dysfunction has been demonstrated in some of the SLMS muscles involved in important patterns of pelvic control: the lower abdominals - TrA; IO; (16, 17, 19, 23, 50); lumbar multifidus (15, 23).
  Sagittal posterior rotation is poor due to underactive abdominal wall.
  Sagittal anterior rotation control is indirectly attempted by abnormal SGMS activity via a synergy of thoraco-lumbar extensors and the anterior pelvic-femoral muscles – particularly **psoas**. ***The apparent anterior pelvic rotation is not controlled at the lumbo-sacral junction as iliacus and abdominals and SLMS muscles are underactive in the synergy.***
- ***Patchy axial extensor synergies*** tend to dominate in most movements – ***particularly thoraco-lumbar (T/L) extensors.*** Inhibition of the overactive muscles is difficult e.g. in standing, forward bending, T/L extensor muscle groups keep holding. Research has shown a lack of the flexion relaxation phenomenon in some. (32). **Balanced co activation of the axial flexors and extensors (6, 13) in patterns of movement to control the spine suffers.**
- **Trunk extension is generally reduced *particularly through the thorax.*** In attempting extension, both **poor spatial pre-positioning of the pelvis** (anterior shift /posterior rotation) and **poor hip and thoracic extension** leads to further over activation of the extensor muscle groups over thoraco-lumbar junction (T/L/J) and upper lumbar levels.
- **Thoraco-lumbar region becomes hyperstabilised** by overactive erector spinae groups / serratus posterior inferior ***producing a "Central Posterior Cinch" (CPC)*** - over-anchors the lower thorax, further reducing movement within the thorax and over the thoraco lumbar junction to the upper lumbar spine. A compensatory functional "break" in the mid /low lumbar spine occurs.


central posterior cinch: static and active

- **Decreased hip extension** from tight /overactive psoas/ anterior hip muscles and related underactive antagonists – the glutei. ***Active hip extension movements are associated with increased thoraco-lumbar activity*** (CPC) and abdominals are underactive in the synergy.
- ***Important standing forward bending pattern.*** The pelvis is already posteriorly shifted and anteriorly rotated, and so reasonable contribution of hip flexion unless 'butt gripping" (29). However **reduced control of anterior pelvic rotation** and sacral nutation at lumbo-sacral junction from reduced coactivation of Iliacus with low lumbar flexors and extensors (6, 13) is compensated for by **increased thoraco-lumbar extensor activity.** This leads to…
- ***Relatively increased intersegmental flexion over the mid/low lumbar levels*** during forward bending) as the thoraco-lumbar contribution to movement is reduced from **overactive CPC**. This is exacerbated by the frequent therapeutic misdirective to 'tuck the tail under'. Abdominal exercises which stipulate 'flattening the low back' and not controlling the pelvis also further entrench the dysfunction.
- ***Altered control of sitting postures*** – **poor control of the pelvis on the femora** as well as **reduced coactivation of the axial flexors and extensors** to provide balanced upright alignment of the torso. Rely on thoraco-lumbar extensor hyperactivity (CPC) instead (44, 8, 9).
- Similar patterns play out when on all fours, squatting etc.
- ***Abnormal axial rotation*** – **lack of general and rotary mobility in the thorax and over the thoraco-lumbar junction** because of CPC and a 'dome' (refer to our paper (28), part A), plus poor spatial pelvic control, means any rotation imposed on the system is forced to occur abnormally in the mid/low lumbar spine.
- ***Dysfunctional breathing patterns*** – **inefficient diaphragm** activity because of CPC which also reduces posterior basal expansion.

2. ANTERIOR PELVIC CROSSED SYNDROME (APXS)

the pelvis is forward!

Here, **the neuromuscular system is *"more switched off"* – both the deep and the superficial systems.** However, while less dominant, **the superficial system is still abnormally used though *more intermittently.*** Those with generally low muscle tone fall into this group. In its purest form, it is probably more common in females. The patient appears somewhat collapsed and exhausted while 'up'.
This presentation appears to be more common clinically.

static picture characterised by:-

Pure Anterior Pelvic Crossed Syndrome: anterior, lateral and posterior view

SCHEMATIC VIEW ANTERIOR PELVIC CROSSED SYNDROME

- **Pelvis: anterior shift with increased posterior rotation** or tilt.
- **Trunk:** (thorax) backward loaded – **posture that of more general flexion**; adaptive shortening and / or over activity of the upper abdominals. Flexion of lumbar spine.
- **Hips in relative extension** with adaptively tight posterior hip structures
- Quick appraisal shows no buttocks, forward loaded head posture, thoracic kyphosis - thorax collapsed / pulled down towards pelvis, poor calf development
- **Rely more on passive structures** for upright support – hang on iliofemoral ligaments, adopt wide base of support, knees hyperextended.

muscle hypo activity/lengthened:

- o Lower abdominal group and? pelvic floor
- o Lumbar multifidus – particularly over lower levels.
- o Diaphragm – reduced excursion ++
- o Iliacus; Psoas.
- o Glutei - reduced postural and movement demand and often adaptively shortened

hyperactivity / adaptive shortness:

- o **Hamstrings**
- o Piriformis
- o Upper abdominal group including lateral internal oblique
- o Hip external rotators ‹ internal rotators
- o +/- T/L erector spinae

As a consequence we can expect or predict that in movement:-

- ***Poor spatial control of the pelvis*** – ***particularly control of posterior shift/anterior rotation; and on the hips and lumbar spine.*** SLMS synergies are underactive as pelvis is placed forward in spatial relationship of **'reduced SLMS demand'** as they hang off the iliofemoral ligaments. Under-activity of Psoas and Iliacus, Multifidus, Lower IO and Transversus, pelvic floor creating **difficulty in anteriorly rotating the pelvis and controlling the low lumbar lordosis.** So called "instability" syndromes of the lumbar spine and S.I.J. become predictable
- ***Patchy axial flexor synergies tend to dominate*** in movement – e.g. **upper abdominals** with pectorals. Balanced co activation of the SLMS axial flexors and extensors in synergistic patterns of movement and control of axial alignment suffers.
- ***Generalized loss of extension through spine is marked*** – more in the thorax followed by lumbar spine. **Poor axial intersegmental and general extensor control.** Loss of lordosis is marked through lumbar spine with poor activity of LM. **Extension is achieved by intermittent thoraco-lumbar extensor activity** and / or further swaying pelvis forward and extending hips to compensate.
- ***Thoraco lumbar junction hyperstabilised in flexion.*** Upper abdominal over activity or cinch ***creates a "Central Anterior Cinch" (CAC)*** which holds the anterior thorax down, inhibiting good descent of the diaphragm, increasing the thoracic kyphosis and 'dome' and further reducing contribution of thorax in movement.
- ***Decreased hip flexion*** from tight posterior pelvic / hip muscles and hamstrings **because of poor control of anterior pelvic rotation.** Compensated **by further increased lumbar flexion in movement.** Relevant studies (12, 31, 48) would have been more compelling had they sub classified their subjects into PPXS and APXS.
- ***Important pattern of forward bending in standing.*** Initiated more from **over activity of the upper abdominals (CAC)** because of **poor posterior shift and anterior rotation of pelvis on hips into flexion with associated controlled lumbar lordosis.** Resultant increased thoraco-lumbar 'folding' and repeated over flexion of lumbar segments.


central anterior cinch: (left) Acute presentation; (Centre and right) chronic picture

- ***Relatively increased intersegmental flexion over low lumbar levels*** from **poor lumbopelvic control as well as compensation** for associated posterior hip and pelvic tightness. Lumbar structures are subjected to untenable, more unstable and vulnerable end range flexion. Disc, facet and a plethora of other various **"diagnoses" become a predictable consequence** over time.
- ***Altered control of sitting postures.*** Generally relax/**collapse** because of poor axial SLMS activity (44, 45, 7, 8, 9,) as well as **difficulty in anteriorly rotating pelvis on femora at hips and finding an effective base of support through the ischia.** In attempting 'to sit up' they will **employ 'central cinch strategies'** both posteriorly (44) and anteriorly.
- ***Similar patterns play out when all fours, squat etc.***
- ***Abnormal axial rotation*** – a general **reduction in extension and rotation** because of CAC and thoracic 'dome', plus deficient lumbo- pelvic control, means **any imposed rotation will abnormally occur in the lumbar spine.**
- ***Dysfunctional breathing Patterns*** – CAC hampers diaphragmatic breathing and basal expansion - **increasing upper chest breathing** with sympathetic dominance. Related upper body tension and cervical pain syndromes occur.

3. MIXED SYNDROME (MS)

Display features of both APXS and PPXS with a dominant tendency towards one.

Appreciating each syndrome separately helps see and understand the composite presentation and the relative dominance of one.
The static standing view may not be remarkable; however dynamic movement analysis will demonstrate the prevailing patterns.
Control of the pelvis is defective and tends to be indirectly attempted from the habitual Central Cinch Patterns rather than by local muscle system activity. Here we see the combined features of a CPC in PPXS with a CAC seen in APXS which creates a ***"Central Conical Cinch" (CCC)*** whereby the anterior, posterior and lateral thoraco-lumbar junction becomes hyperstabilised.

Common to all 3 syndromes is the tendency to:-

- Posturally align and move predominantly utilising more primitive, patchy, gross, bilateral flexion / extension synergies which disallow
  - The important rotary and lateral shifts and adjustments needed for weight shift, to maintain axial alignment, equilibrium and control
  - Appropriate patterns of axial setting and control to support limb movement

Iliacus and Psoas function "at" the centre of gravity of the body. Currently, neither muscle appears to be 'fashionable', particularly Iliacus. However clinically, they are functionally important. The function of psoas is debated in the literature (47). Andersson et al (2) showed individual and task specific activation patterns between Iliacus and Psoas.
Clinically, we see that both psoas and iliacus are under active in APXS or show imbalanced activity between the two in PPXS (psoas over active; iliacus under active).
Future primary research should help confirm this.

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Ideally, adequate antigravity support for the torso comes from below via effective control of the pelvis on the legs.
In the dysfunctional state, muscle activation patterns appear somewhat upside down. The lower torso including the pelvis is underactive and poorly controlled on the legs while excess SGMS activity occurs in the upper body, as the patient attempts to compensate for this lack of support and control and "hold himself up" via the SGMS. (see 34, 55). Similarly, the breathing pattern is upside down – inadequate diaphragmatic excursion and central expansion with an excess of accessory muscle respiration and upper body tension.

discussion:

Van Wingerden et al (53) presented a study which lends support to the concept of the two Pelvic Crossed Syndromes.

O'Sullivan proposes (41, 42) clinical subgroups of chronic low back pain based on the mechanism underlying the disorder. He defines five clinical directional patterns based on subjective history and symptom behaviour. (36, 40, 41, 7)

We suggest that movement and control impairments coexist though in different proportions, depending on the primary underlying pelvic postural and movement syndrome and the presenting stage of the disorder.

Importantly however, we observe similar patterns of clinical presentation (37, 8, 9) namely:

- **APXS shows features in common with his Flexion Pattern** (43).
- **PPXS shows features in common with his Extension Pattern** (41, 7)
- We see that O'Sullivan's other directional patterns (41, 7) are **variations on these basic two patterns at differing stages of neuro-musculo-skeletal dysfunction.**

Postural and movement dysfunction occurs in a continuum over time. The two primary pelvic syndromes provide a simpler yet integrated understanding of the more common ***patterns of motor control dysfunction.*** It appears ***we all have an inherent tendency to these patterns, which become magnified in CLBP.***

conclusion:

Understanding the **two primary pictures of altered postural and movement response provides a simple clinical classification system.** This facilitates the clinician in arriving at **diagnoses based on functional deficits** and paves the way for more appropriate interventions.

implications:

This model poses a certain paradigm shift in our understanding and approach to the management of lumbopelvic pain disorders. Without a practical clinical framework for understanding functional motor control, many of the research findings risk being misunderstood and misapplied in clinical practice e.g. much of the current approach to "core control" in addressing so called 'instabilities' of the pelvis and lumbar spine – a lot of which further imprints dysfunction around the body's centre of gravity.
"Core control" is control of the pelvis in space, on the legs and the lumbar spine. Appreciation of this model also has large implications for research design and helps explain the inconsistent findings in many studies.

*** The work presented here is part of a two part paper in press with The Journal of Body Work and Movement Therapies
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