**Functional Biomechanics of the Spine and Pelvis**

In spinal functional biomechanics the motion of movement is named by the superior vertebrae. Be careful of this as this is the opposite to the LEX where the movement is named by that of the distal bone.

The eyes try to remain horizontal therefore the spine and pelvic movements are relative to each other.

The relative motions of the pelvis and Ls pint he 3 different planes are laid out below:

**Sagittal plane**

<table>
<thead>
<tr>
<th>Anterior rotation</th>
<th>Posterior rotation</th>
<th>Extension</th>
<th>Flexion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pelvis</td>
<td>+</td>
<td>Lsp</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Frontal**

<table>
<thead>
<tr>
<th>Left lateral flexion</th>
<th>+</th>
<th>Right side bending</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pelvis</td>
<td></td>
<td>Lsp</td>
</tr>
<tr>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Transverse**

<table>
<thead>
<tr>
<th>Left rotation</th>
<th>+</th>
<th>Right rotation</th>
</tr>
</thead>
<tbody>
<tr>
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The Lsp and pelvis go through all 3 plane of motion during the gait cycle. However, there is not a pure movement - there is torsion as in gait one side of the pelvis moves faster / with more rotation than the other – the side of the front leg.

For example, if stepping forward with the Right foot:

- The pelvis drops on the opposite side, creating left lateral flexion in the pelvis and right side bending in the Lsp. Therefore the LS facet on the right is loaded in the frontal plane.
- As you push your centre of gravity towards the front foot in the sagittal plane, creating anterior rotation of the pelvis and extension of the Lsp, so both LS facets are loaded.
- In the swing phase of gait, the motion is in the transverse plane, creating right rotation of the pelvis and left rotation of the Lsp, which off loads the right LS facet and loads the left LS facet.

There is a delay in movement of the sacrum after the innominate due to the SI joint which creates a load / unload motion of nutation / counter nutation. This also happens at the other junctional areas of LS, TL, CT and OA.

Hip extension and internal rotation are coupled. Therefore, working on piriformis and glute medius can improve hip extension as well as psoas and rectus femoris.

When looking to rehab patients with low back pain it is helpful to use movements where the pelvis and Lsp don’t disassociate and aggravate LBP – same leg and same arm unlike in gait.
**Lunge Matrix**

Sagittal $\uparrow$

Frontal $\leftrightarrow$

Transverse $\swarrow \searrow$

With the patient in a hip width apart stance the patient steps in all 3 planes of motion to identify their areas of comfort and difficulty. Think of the static hip as the back foot and active leg as front foot. In this example the right foot is active and the left foot is static:

<table>
<thead>
<tr>
<th>Plane of motion</th>
<th>Pelvis</th>
<th>Lsp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sagittal – forward $\uparrow$</td>
<td>Anterior rotation</td>
<td>Extension</td>
</tr>
<tr>
<td>Sagittal – back $\downarrow$</td>
<td>Posterior rotation</td>
<td>Flexion</td>
</tr>
<tr>
<td>Frontal – step across $\leftrightarrow$</td>
<td>Left lateral flexion</td>
<td>Right side bending</td>
</tr>
<tr>
<td>Frontal – step wide $\Rightarrow$</td>
<td>Left lateral flexion</td>
<td>Right side bending</td>
</tr>
<tr>
<td>Transverse – step across &amp; rotate $\swarrow$</td>
<td>Left rotation</td>
<td>Right rotation</td>
</tr>
<tr>
<td>Transverse – step wide &amp; rotate $\searrow$</td>
<td>Right rotation</td>
<td>Left rotation</td>
</tr>
</tbody>
</table>

Look for range / quality of movement and focus particularly on end of range control.

Use lunges to improve ROM within the successful range. Then use the recoil to move back into the unsuccessful range.

**Spinal Motion**

Csp movement translates down to T4-7

UEX movement translates to T4

**Dr Lovett’s Principals:**

<table>
<thead>
<tr>
<th>Coupled motion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lsp: Side bend then rotate towards concavity</td>
</tr>
<tr>
<td>Tsp: Side bend then rotate towards convexity</td>
</tr>
<tr>
<td>Csp: Side bend then rotate towards concavity</td>
</tr>
</tbody>
</table>

**Direct and indirect manipulation**

Direct = into the restriction. More bang for buck!

Indirect = away from the restriction. Has the same benefits of manipulation but with less discomfort. Very useful for acute patients.

**Table work**

You can take these principals onto table work – doesn’t need to be static.

Example of Lsp decompression of a facet:

- Position pt sidelying with the affected side uppermost.
- Create a lose wind up
- Introduce motion by asking the pt to reach back and forwards (open and close) with their arm at 45° to their body
- Hold back on the pelvis and reinforce the end of range “open” position of the arm with operator’s cephalad arm against pecs
- NB not a thrust but an exaggeration of the patient’s natural range in a harmonic rhythm.

**Transformational zone**

This is the “book-ends” of the patient’s natural movement or action. We need to focus on quality of movement in all 3 planes at that point, both with movement driven from the top down and the bottom up, firstly static and then dynamically.
Active session
Using the previous lunge matrix and adding in other components to create coupled movements and fully test functional movement.

Arms follow a sequence of down & up, side to side, rotation left and rotation right.

Lunge matrix plus arms:
- Step forward + arms down
- Step back + arms up
- Step forward + arms to the side and step back
- Step forward + arms to the others side and step back
- Step forward + arms rotate left and step back
- Step forward + arms rotate right and step back
- Continue for side lunge and rotational lunge with each combination of arms.

Take the simple lunge matrix and add in
- No step, just touch with toe to floor + arms
- No touch of toes to floor, just above + arms
- Jump + arms
- Hop + arms

These can be used as both progressive testing once the patient is no longer acute and for homework exercises.

Classical osteopathic texts
Google the classical institutes and see what you get – this is one I found: http://www.classical-osteopathy.org/index.html
Theory of a pyramidal support base at the pelvis which overlap at approx T4 and then span out again towards the base of the skull.

Focus on keystones: T4, L3, C7 & T9(functional), central arch and the sympathetic map as shown in NMS.
**Thoracic Spine**
Patient takes a static, wide-based stance and keeps the head looking forward:
- Reach down & right / left (point across the body to the bottom corner of the room)
  Type 2 movement
- Reach up & right /left (point across the body to the upper corner of the room)
  Type 1 movement

**Tsp table work:**
- Pt sits straddled over the plinth with the end lifted up towards them.
- One hand is on the raised section of the table across the body to create rotation.
- The other hand is on their head to create side-bending.
- Can assess using Type one and Type two movements to find the restriction (side bending the patient towards or away from operator) and then either mobilise using direct or indirect reinforcement of the movement.
- Direct is Type one in Tsp as this is its preferred movement.

If going to use a Tsp manipulation (aka dog) then ensure you “preload” the arms to create additional flexion for extended Tsp.

**Cervical Spine**
The OA uses a Type one motion with a scoop at the end of range. This is the same as the Tsp, so if you have a restricted OA you can relieve it by manipulating the Tsp to free up other Type one movement in the body.

**Top down assessment:**
- Look at tip of shoulder Type two
- Look 45° upwards Type one

**Bottom down assessment:**
- Arm down and behind Type two
- Arm up and behind Type one

Coupled movement is created by the head being kept still rather than the movement of the thorax and arms. Therefore you can use the Tsp to reinforce or mobilise by controlling the head position when moving in the frontal and transverse planes:
- Head goes with body / head stops at 45° / head stays still directly forward

**General**
- The body will always choose stability over mobility therefore keeping patient stabilised during early phases of rehab create focus on mobility, then you can progress to remove the stability and focus on balance.
- Use of translation (side shift) in Csp manipulation to reduce the need for rotation as a lever – very good for acute patients.
- Reinforced mobilisation of the Cps or OA: using the arms – one into transverse and the other into extension, then reinforce end of range point. More dynamic if you abduct and drop the other arm and add traction of the OA.

**Leg length difference**
You can use a hip hike test – ask the standing patient to hitch up their hips in turn and you will see that it is harder for them to do on the side with the longer leg (already hitched so not able to do much more). The LLD will have caused a sidebend in the Tsp, so a temporary correction under the shorter leg will allow more transformational zone movement – eg test with rotation.

Ben advises to use a full length lift of up to 5mm rather than a heel lift. Good material is “spenco” [http://www.simplyfeet.co.uk/m-12-spenco.aspx?gclid=CPORo4Ctu6sCF5NtAodoWeRfQ](http://www.simplyfeet.co.uk/m-12-spenco.aspx?gclid=CPORo4Ctu6sCF5NtAodoWeRfQ)

Or from Boots you can buy blue full length insoles with bubbles in them – if you flip one on top of the other and place in one shoe it gives you a lift of approx 4mm.