ISM Certification Case Report
Mr. COP

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The Story:

Mr. COP was first referred for a physiotherapy assessment at Diane Lee & Associates – Consultants in Physiotherapy by his massage therapist. He was initially assessed on August 26, 2014.

Mr. COP is a 29-year-old RCMP officer who presented to the initial assessment with complaints of chronic low back pain and newer onset right hip pain. He reported that the low back pain initially started 6 years prior during his Basic Training for the RCMP. He had an incident during defensive training where his back was hyper-extended while he was lying in a prone position. He reported feeling a "crack" in the back with immediate pain that persisted for several days. He did not receive any sort of formal treatment at that time. Ever since that initial incident, Mr. COP describes frequent flare-ups of his low back pain with the symptoms worsening over the past 2.5 years. He was also concerned with a new and insidious onset of right hip pain approximately 6 months prior to the initial physiotherapy assessment. He felt this hip pain was also related to a recent onset of paraesthesia (pins and needles) in the anterior aspect of the right thigh. Mr. COP has not taken any time off of work for these injuries.

Mr. COP has had past treatment, which has included massage therapy and chiropractic, both which seemed to only provide temporary benefit. He had also tried training with kinesiologists (Innovative Fitness) but found that the training only worsened the right hip pain so he had stopped with all training at the time of the initial assessment. He had never tried physiotherapy. At the time of the initial assessment he was still routinely

receiving treatment from his chiropractor and massage therapist. His goals for physiotherapy treatment were to decrease his pain symptoms and to rehabilitate his low back and hip to eventually return to working out with a trainer.

Past medical history was unremarkable for any previous injuries or health concerns/issues. He was occasionally taking Robax for his pain. X-ray of his lumbar spine done prior to the initial assessment was negative. At initial intake, Mr. COP completed a Patient Specific Functional Scale (PSFS) questionnaire where he was asked to identify activities and then rate them (0 equals unable to perform the stated task, 10 equals able to perform stated task at pre-injury levels). He identified the following: sitting – 5, static standing – 6, walking up stairs/inclines - 4. During the course of physiotherapy treatment, Mr. COP also had a MRI of the lumbar spine and MR arthrogram of the right hip (as prescribed by his family physician), both of which were normal.

<u>Meaningful Complaint:</u>

At the initial assessment, Mr. COP complained of 2 areas of pain:

1. Localized low back pain; aggravated with driving and sitting
2. Right buttock pain which radiated to the lateral and anterior aspects of the right hip; aggravated with stairs, steep inclines, and lunges (left foot forward)

He also reported "tingling" in the right anterior thigh. He was unsure what aggravated the tingling but he could especially notice it when he lightly brushed his thigh with his hand. His pain was the least intense in the mornings and worsened throughout his day, most notable on his workdays.

Clinical Reasoning Question #1:

Since his pain experience is now well over the time for soft tissue healing, the pain science suggests that his subjective symptoms may be related to altered perception in his brain or central sensitization. From his story, what characteristics suggest that this pain is peripherally mediated vs. centrally mediated?

Answer:

Pain science research suggests that, over time, there is the possibility for central sensitization to occur. In other words, the nervous system becomes hypersensitive and can be over-reactive to normal stimulus, instead interpreting them as threats. The brain interprets these threats as "danger messages" and will prioritize these signals and prepare the body for "fight or flight". In other words, the nervous system becomes the primary driver.

In the case of Mr. COP, his symptom presentation was more mechanical peripherally mediated than that of centrally mediated pain. His subjective reports were mechanically based in that there were obvious aggravating (e.g. sitting) and easing (e.g. Robax) factors for his symptoms. Even though the pain has been long-standing, the areas and intensity of pain reported were in line with the inciting event (hyperextension injury 6 years ago) and were not constant in nature. Mr. COP had some definite cognitive beliefs about his pain (e.g. worsened by work activities and uniform) but his belief systems were not a barrier to his rehabilitation and he was very willing to actively participate in his treatment program. Although he was frustrated given the length of time since the initial injury, there did not appear to be significant psychological/emotional overlay to his pain presentation. All of these observations/findings point toward a peripherally mediated, nociceptive pain presentation.

Cognitive Beliefs:

Mr. COP has been working as an active duty RCMP officer since the onset of his low back pain. He strongly believed that the gear he is required to wear when on duty (vest and duty belt which he estimated weighed approximately 20 lbs combined) aggravated his symptoms as he was more sore during work shifts and at the end of his typical 4 consecutive (12 hour shifts) workdays.

Clinical Reasoning Question #2:
What tests would you consider to support or negate this cognitive belief?

Answer:
Through the course of treatment, we were able to have meaningful discussions regarding Mr. COP's cognitive beliefs about his work and his perpetuating pain symptoms. During his work shifts (12 hours), he is required to wear both his safety vest and duty belt, which he estimated to weigh about 20lbs. He is an RCMP officer on active duty but a significant amount of time during a shift is spent sitting/driving in his vehicle. He cannot work on active duty without the safety vest, and the various equipment (e.g. gun, handcuffs, baton etc.) he carries on his duty belt have a fixed location on the belt for safety purposes.
Mr. COP's subjective reports of his pain symptoms and activity levels (during work shifts and non-work days) were used to help support his cognitive belief. Consistently during the course of treatment, Mr. COP reported his symptoms would gradually increase over the course of his 4-day shift, worst by the end of the four days. He would then feel better during his 4 days off, only for the cycle to start again when he returned for his next shift. At one point during treatment, Mr. COP took 1 month off for vacation (but continued to work out at the gym) and there was a noticeable improvement in his symptoms (less low back and hip pain and less paraesthesia in the right thigh).
Mr. COP has always responded well to treatment and this cognitive belief did not pose as a barrier to his rehabilitation so no further tests were conducted. *If* we felt that further

testing of this cognitive belief was necessary, an assessment with a compressive load similar to his work uniform could be done (for safety reasons when off duty, Mr. COP is not able to bring in his work vest and duty belt with all the attached gear to the clinic). In this case, a backpack loaded with 20lbs could be worn in the clinic and an assessment could be done while wearing this pack.

Meaningful Tasks:

Based on the activities identified in the PSFS and Mr. COP's subjective story, the meaningful tasks identified at the initial assessment included:

1. Sitting/driving
2. Working out with a trainer (running, lunges)

The screening tasks that were chosen to further assess were derived from the requirements to perform the above meaningful tasks. They included: standing postural screen, squat, right one leg stand (OLS), and seated trunk rotation.

Screening Tasks:

Standing Postural Screen:

The standing postural screen is an important screening task as it provides useful information on how a person habitually stands. Rarely will you find an individual without any habitual asymmetries or torsions in standing. The key to proper movement (in whatever screening task is chosen) is that the individual can move out of these asymmetries/torsions in order to move with good alignment, biomechanics, and control for that specific task. We can only know if a finding during a screening task is relevant if we know the starting position for that task. In other words, is the finding just an unwinding of a torsion to an aligned position or is it an actual site of failed load transfer?

There were no reported symptoms during evaluation of the static standing postural screen. Mr. COP stood with his pelvis rotated to the left in the transverse plane (TPR) with a congruent left intrapelvic torsion (IPT). The right hip appeared slightly anterior relative to the right acetabulum, a finding that was congruent to the positional finding of his pelvis (left TPR). The mid thorax appeared rotated to the right. Specific segmental ring shifts were noted with the 6th and 7th thoracic rings in a left translated/right rotated position in standing. These mid thoracic ring shifts were incongruent to the positional finding of the pelvis (left TPR) and right hip.

Clinical Reasoning Question #3:
Can you explain further what you mean by "these mid thoracic ring shifts were incongruent to the positional finding of the pelvis (left TPR) and right hip" and how you interpret this finding?

Answer:
As noted above, a standing postural screen provides information on how a person habitually stands. It is common to find body regions that are rotated in standing (e.g. pelvis TPR to the left) and these positional findings do not necessarily correlate with dysfunction *if* the person can move out of these rotations/torsions during different movements. However, if there is an incongruency in positional findings (two body regions rotating in opposite directions) during a standing postural screen, this can place unnecessary stress/load through different body regions that can result in pain and dysfunction over time.
In the case of Mr. COP, the 6th & 7th thoracic rings were translated left/rotated right in standing but the pelvis (and hip) is rotated left in the transverse plane; these rotations are incongruent in that they are not in the same direction. The result of these opposite direction rotations (thorax to the right, pelvis to the left) can create unnecessary stress in the body regions in between, the lumbar spine in this case. The lumbar spine becomes the symptomatic "victim" of these 2 incongruent body regions. When an incongruency between body regions is found in a standing postural screen, there is likely a vector

between the two areas creating the incongruence. This is an important finding to keep in mind when determining which body region is the primary driver for a screening task as there is a more likely chance the primary driver is the incongruent body region. This will help prioritize the remainder of the assessment (i.e. which body region to test first to assess the impact of a correction on the alignment, biomechanics, and control of other body regions) in order to improve the efficiency of the assessment.

Squat:

A squat is a useful screening task to assess a patient's habitual movement patterns when moving through a squat to sit. If a patient has a non-optimal squat then they are likely to sit with poor alignment (e.g. an increase in right pelvis transverse plane rotation during a squat will likely result in a patient sitting in a non-optimal right TPR of the pelvis); therefore, a squat is an important screening task when sitting is a meaningful task for a patient.

In an optimal squat, there should be no loss of control of either sacroiliac joints (SIJ). Both innominates should remain posteriorly rotated relative to the sacrum throughout the movement. There should be no transverse plane rotation of the pelvis; the pelvis should just anteriorly tilt as a unit. In the optimal squat, the hips should remain centered in the acetabulum (seated) of the pelvis, the lumbar vertebrae should remain in neutral, there should be no thoracic rings shifts, and the hips/knees/ankles should symmetrically flex during the squat movement. Any deviation from the above would constitute a site of failed load transfer.

During Mr. COP's squat, the following relevant findings were observed:

- Further left translation/right rotation of the 6th and 7th thoracic rings
- Loss of control of the right SIJ during the mid range phase of the squat
- Anterior translation of the right hip (relative to the acetabulum) in the earlier stages of the squat
- L5 rotated left during mid to later stages of the squat

Manual correction of the 6th and 7th thoracic ring resulted in restoration of control of the right SIJ and L5 and an improvement (but not full correction) in the alignment/biomechanics of the right hip. When the thoracic rings and the right hip were concurrently corrected, Mr. COP noticed an improvement in his squat in that he did not feel "twisted" and there was a greater ease to the movement. Based on these findings, it was determined that the 6th and 7th thoracic rings were the primary driver and the right hip was the secondary driver for the squat screening task.

Clinical Reasoning Question #4:
In terms of priority, what role does the patient's experience play in determining driver(s) for any task?

Answer:
The ISM is centered around the patient's story and takes into consideration their meaningful task, cognitive beliefs, and perception of their pain experience. So, in determining the primary driver(s) for any task, the patient's perception of change (e.g. in symptoms, effort, performance etc.) in response to a correction of a body part is very important. However, a patient's perception is not the key piece in determining the primary driver. The primary driver(s) should be determined by which correction (of a body part) results in the best objective overall change to the body. In other words, which correction results in the best improvement in alignment, biomechanics, and control of the other areas of failed load transfer during the chosen screening task. Although a patient's experience is important, there are many factors that may impact a patient's ability to accurately perceive any change, positive or negative, in their body. These include:

- Longstanding symptoms: patients who have chronic mechanical issues/postural bad habits have adapted to the many compensations in their body and they cannot always provide accurate feedback when trying to find the primary driver(s) for a screening task. They feel "straight" in their body and

when a correction is made they often feel "crooked" even though alignment is better.

- Patients on some medications (e.g. neuromodulators such as Gabapentin and Lyrica; opioids) are often more disconnected from their physical bodies and frequently have difficulty in perceiving any change to their body.
- Any inflammatory component to the pain presentation can also impact a patient's perception of any change to their experience when determining the primary driver. Frequently, a patient may have a longstanding mechanically driven issue that creates stress on certain tissues and over time this can result in an inflammatory issue in those tissues (for example: a marathon runner with hip driven knee pain with running – the anterior hip (relative to the acetabulum) is the primary driver and can create an internal rotation of the femur, thus creating a non-optimal torsion at the knee; over time, this can create an inflammatory reaction at the knee as the local tissues there become inflamed). In these cases, any correction may improve the mechanical presentation but there will be no immediate change to the local inflammatory response so the patient may not be able to perceive a significant change in response to a correction when determining the primary driver.

The key to determining the primary driver(s) lies in finding the correction that results in optimal alignment, biomechanics, and control. In many cases, when an objective improvement in failed load transfer (alignment, biomechanics, control) occurs during a correction there is also a positive impact on the patient's experience (e.g. in pain intensity, effort to perform the task, performance of the task).

Right One Leg Stand:

The ability to transfer load during a right one leg stand (OLS) is an important screening task for any meaningful task that requires single leg loading, such as walking, running, and hiking. It can be used to assess motion control of the weight-bearing side as well as

intrapelvic mobility on the side of hip flexion. Optimally, during a right OLS (weight-bearing side), the ipsilateral SIJ should remain controlled (innominate posteriorly rotated relative to the sacrum), the right head of femur should remain centered (no anterior translation or rotations) relative to the acetabulum, there should be good alignment/biomechanics/control through the right lower extremity/ankle/foot, and the thorax.

Mr. COP had greater difficulty with single leg loading on the right. During a right OLS, the following relevant findings were noted:

- 6th and 7th thoracic rings remained in left translation/right rotation throughout the task
- Poor control of the right SIJ occurred during mid range of the task
- The right femoral head translated anterior relative to the acetabulum early on in the task
- L5 rotated left during mid range of the task (at approximately 20 degrees of left hip flexion and therefore was not related to the left IPT created by this task)

Manual correction of the thoracic rings 6 & 7 resulted in full control of L5 and the right SIJ. Correction of thoracic rings 6 & 7 only *improved* the alignment/biomechanics of the right hip in that it continued to translate anteriorly during the task, but much later during the task. Full correction of the right hip did not occur with correction of the thoracic rings 6 & 7. Manual correction of both the 6th and 7th thoracic rings and the right hip simultaneously resulted in the best change, with no sites of failed load transfer noted. Mr. COP also felt the most "stable" in this task with both the 6th & 7th thoracic rings and right hip corrected concurrently. Based on the findings, it was determined that the 6th and 7th thoracic rings were the primary driver and the right hip was the secondary driver for the screening task of a right OLS.

Seated Trunk Rotation:

For the purpose of this case, seated trunk rotation serves two purposes. First, it is a valuable screening tool for any thoracic dysfunction in that a more detailed examination of the biomechanics and control of the individual thoracic rings can be assessed. Second, trunk rotation is important for Mr. COP as it is essential for running (for the meaningful task of returning to gym workouts with a trainer).

During a seated trunk rotation screen, Mr. COP reported greater effort to turn to the left, as compared to the right. He was also unable to rotate to the left to the same degree as he could to the right. During left seated trunk rotation there was failed load transfer of the 6th and 7th thoracic rings in that they remained in a left translated/right rotated position throughout the trunk rotation task. Optimal left seated trunk rotation requires right translation/left rotation of the segmental thoracic rings (ipsilateral rotation, contralateral translation). Manual correction of the 6th and 7th thoracic rings (create space between rings, posteriorly rotate the left 6th and 7th ribs and wait for them to auto-correct to neutral) resulted in a reported improvement in ease of left trunk rotation and an increase in the amount of left seated rotation. Based on these findings, it was determined that the 6th and 7th thoracic rings were the primary driver for the screening task of left seated trunk rotation.

Screening Tasks Summary:

In summary, findings from the above screening tasks helped guide further assessment and treatment. The primary driver is the body area, that when corrected, results in the best total body response. In some instances, there can be a situation with a primary driver/secondary driver for a screening task. In other words, the primary driver, when corrected, will improve (> 50%) the alignment/biomechanics/control (ABC's) of the suspected joint/body region. There will be an improvement, but not full correction of the other area(s) of failed load transfer. This scenario suggests a primary (> 50%) and secondary driver (< 50%) situation. This knowledge then helps improve efficiency in that it allows one to prioritize what body area needs to be addressed in subsequent treatment.

The following is a quick summary of Mr. COP's findings:

1. Squat: primary driver – 6th and 7th thoracic rings; secondary driver – right hip
2. Right OLS: primary driver – 6th and 7th thoracic rings; secondary driver – right hip
3. Seated trunk rotation: primary driver – 6th and 7th thoracic rings

Motor Control:

In both the squat and right OLS screening tasks, there was non-optimal alignment, biomechanics, and control of L5 during the mid to later stages of the task. In both cases, correction of the 6th and 7th thoracic rings (primary driver) resulted in full correction in control of L5 during these tasks. Because full control of L5 was restored with the thoracic ring correction, a more detailed assessment of the motor control system (deep core muscle recruitment, strategy, capacity) was not assessed during the early stages of Mr. COP's rehabilitation.

As his function improved through the course of treatment, higher load/more challenging screening tasks were used as part of his ongoing assessment (e.g. left lunge). It was during these higher load screening tasks that a motor control issue (neural system impairment) was noted. At this point, correction of the primary driver (thoracic rings 6 & 7) did not fully restore control at L5. As a result, further analysis of the motor system was done and atrophy was then noted on palpation of the segmental fibers of deep multifidus. It was likely that there was not enough capacity in these muscles at these higher load screening tasks to fully control L5.

Vector Analysis:

Vector analysis is a technique used to further analyze the driver in order to determine the underlying system impairment (articular, neural, visceral, myofascial) for the driver. A "listening" approach to vector analysis was used to determine system impairments for Mr. COP. This specific skill involves correcting the primary driver to the point of first resistance (R1) and then letting go and feeling (passive listening) for the location, direction, and length of the first vector that pulls the driver back into non-optimal alignment.

There was an underlying neural system impairment that was causing the failed load transfer in the 6th and 7th thoracic rings. During the vector analysis, it was evident that both these rings were correctable, suggesting that the joints of these rings were neither stiff nor fixated; the articular system was not impaired. Upon release of the correction, the "feel" (passive listening) of the vector was on the right posterior aspect of the ring and the resultant pull on the right side was inferior and long. Over-activation was palpable in the fibers of the right longissimus muscle that attach to the transverse processes and adjacent ribs of the 6th and 7th rings.

Clinical Reasoning Question #5:
When two thoracic rings are found to have non-optimal alignment, biomechanics and/or control it is important to differentiate rings that are "glued" vs. "compressed". In this case, both the 6th and 7th rings were behaving in a non-optimal manner. What tests did you do to differentiate whether they were glued or compressed and why is this clinically important to determine in all situations where adjacent rings are impaired?

Answer:
When two adjacent thoracic rings are found to have non-optimal alignment, biomechanics, and control it is very important clinically to know if the two rings are either "glued" or "compressed". This helps determine the relationship between the two adjacent thoracic rings. This is done by correcting one of the thoracic rings on its own and seeing the impact this one ring correction has on the other ring.
If correcting one thoracic ring results in the adjacent ring worsening in alignment (and vice versa when you correct this 2nd ring and the adjacent 1st ring gets worse) then the ring is likely glued. Glued rings result when there is a vector (usually a fascicle of the intercostals) that runs between the two adjacent rings. Correcting one of these rings on its own is not sufficient as the adjacent ring will then worsen in alignment.
The difference between glued and compressed rings lies in the relationship between two adjacent thoracic rings. In the glued rings, correction of one ring worsens the alignment of the adjacent ring (and vice versa), which implies that glued rings cannot move

independent of one another. In the case of compressed rings, one thoracic ring can be corrected and move independently of the adjacent rings. As a result, a compressed ring can be corrected on its own as there will be no worsening (in alignment) of the adjacent thoracic rings.

It is important clinically to differentiate between glued and compressed thoracic rings to prevent any unnecessary aggravation of symptoms following treatment. In the case of glued rings, if a correction of one thoracic ring (e.g. left translated/right rotated 6th ring) results in worsening of the adjacent ring (e.g. right translated/left rotated 5th ring), then there is the risk of "flossing" of the dural-neural system. This can create a very unpleasant immediate or latent sympathetic nervous response for the patient (e.g. nausea, heart racing, feeling foggy). In these cases of "glued" thoracic rings, it is imperative to release the vector that is between the two rings (with ring stack and breathe technique) to avoid this reaction.

Vector analysis helps determine the most dominant vector that needs to be addressed. As is common in more persistent pain situations, release of the dominant vector of over-active muscle will reveal other vectors. It is like peeling back all the layers of an onion. Once the right longissimus (to 6th and 7th rings) was released with a dry needling technique, over-activation (neural system impairment) was noted in the left latissimus dorsi and left serratus anterior muscles.

Clinical Reasoning Question #6:
What test determined this finding?

Answer:
Once the over-active fascicle of right longissimus was released, vector analysis of the 6th and 7th thoracic rings was repeated to determine if there were any other system impairments continuing to impact this primary driver. A "listening" approach was repeated and there was a new vector that pulled the left side of the thoracic rings (lateral

aspect) and the resultant pull was shorter and slightly superior towards the scapula. There was over-activation of muscle palpable in the left serratus anterior and left latissimus dorsi muscles. Once these muscles were released (through a combination of dry needling and release with awareness) the vector analysis of the 6th and 7th thoracic rings was repeated. This process was continued until all the "layers of the onion" (dysfunction) were released and the 6th and 7th thoracic rings were in optimal alignment.

As for the right hip, there was non-optimal anterior translation of the head of the right femur in the screenings tasks of right OLS and squat (secondary driver). Vector analysis of the right hip again showed a neural system impairment in that there were over-active fascicles in right rectus femoris and right vastus lateralis muscles (dominant vectors). Once these muscles were released through a dry needling technique, over-active fascicles (neural system impairment) was noted in the deep external rotators of the right hip (piriformis, gluteus medius).

Clinical Reasoning Question #7:
On listening during vector analysis of the right hip, what was the location, direction, and length of the listening (feel) that suggested the rectus femoris and vastus lateralis were the first vectors to address? Similarly, please describe the location, direction and length of listening suggesting the piriformis and gluteus medius were the next vectors to release and how does the listening differ when the obturators are over-active?

Answer:
"Listening" involves using your hands to gently take a joint/body part to R1 of resistance and upon release feel the direction, length, and location that the first vector takes you as the joint/body part is pulled back into non-optimal alignment.
In the case of Mr. COP, vector analysis of his right hip showed the first vectors (neural system impairment) were over-active fascicles in right vastus lateralis and right rectus femoris. The listening for rectus femoris was felt as the femoral head was centered (into

the acetabulum) to R1 and then released; this felt like a medium length (to about mid thigh) anterior/inferior pull down the middle of the right thigh. As for vastus lateralis, the pull once the centered femoral head was released was a short to medium length pull anterior/lateral to the proximal ½ of the thigh. In both cases, painful over-active fascicles were palpable in both muscles.

Once the dominant vectors were released, the hip was re-positioned to a point where the femoral head was just starting to move into a non-optimal anterior position (relative to the acetabulum). In this specific case, that was a hip position greater than 60 degrees. At this hip position, vector analysis was repeated and over-activation (neural system impairment) was noted in gluteus medius and piriformis (both muscles are hip abductors when hip flexion is greater than 60 degrees). In both these cases, the vector of pull was again felt upon releasing the centered femoral head as the hip was pulled back into a non-optimal alignment. However, this time the pull felt more superficial and was relatively short in a lateral direction around the lateral part of the hip and around towards the back of the right innominate and sacrum. The vector direction for both gluteus medius and piriformis were similar; however, the gluteus medius vector was slightly more superior in location than piriformis. Again, palpable over-active fascicles were noted in both these muscles.

The obturator internus muscle is also an external rotator of the hip and runs in a similar orientation to piriformis. The proximal attachment for obturator internus is the pelvic surface of the obturator membrane and the surrounding bone. The listening for this muscle is different to that of piriformis in that it is a slightly shorter vector and the direction goes deeper and more directly into the pelvis (rather than the more superficial listening for piriformis that runs laterally along the hip towards the sacrum).

Hypothesis:

Mr. COP's story began 6 years ago during Basic Training with the hyper-extension injury to his low back. At that time, there was a probable localized joint/ligament sprain with subsequent disuse/pain limited inhibition/atrophy of the deep fibers of multifidus, most

notable at L5/S1. At the time of the initial assessment, there remained marked atrophy of these muscles. Given that he had no formal treatment and our understanding that there is no spontaneous recovery of core muscles post-injury, it is unlikely he ever regained proper motor control of these deep fibers of multifidus, resulting in control issues at L5/S1.

Clinical Reasoning Question #7:
Full control of L5/S1 was obtained with the manual correction of the thoracic rings 6 & 7. If the deep fibres of multifidus were atrophied with "no spontaneous recovery" how do you explain the complete restoration of control at L5/S1 with correction of the thorax?

Answer:
In the initial assessment and early on in treatment, the screening tasks used for Mr. COP were squat and right OLS. During these specific tasks, the manual correction of the primary driver (6^{th} & 7^{th} thoracic rings) did fully correct the alignment, biomechanics, and control of L5/S1. Given that the lower thorax (lower 6 thoracic nerves) innervates the abdominal wall, any thoracic dysfunction such as thoracic ring shifts can impact the neural drive to the abdominal wall and thereby create dysynergies. In the case of Mr. COP, correcting the thoracic dysfunction (6^{th} & 7^{th} ring shifts) was sufficient to allow full control of L5/S1 in the tasks of squat and right OLS.
As Mr. COP improved functionally with treatment, the screening tasks also changed. With treatment, he was able to learn to fully control all sites of failed load transfer in the right OLS task. Given that a goal was to return to the gym, a left lunge (left foot forward) screening task was later introduced. The left lunge screening task proved to be a higher load/more challenging task for Mr. COP. The primary driver for this task continued to be the 6^{th} and 7^{th} thoracic rings but manual correction of these rings was no longer sufficient to have full control at L5/S1. The manual ring correction only *improved* L5 control during the left lunge. An underlying motor control issue became evident in these higher load tasks as Mr. COP did not have enough *capacity* (as noted with the palpable

segmental muscle atrophy) in the segmental fibers of deep multifidus (L5/S1) to fully control the lumbar spine during the lunge. This finding also correlates with Mr. COP's story – he was able to function well enough to work but any higher load exercises, such as he did when he first started training with a kinesiologist, only resulted in symptom aggravation (given the lack of adequate motor control in the lumbar spine during higher load tasks).

As a result of this loss of segmental L5/S1 control during higher load tasks (e.g. lunge, gym workouts), Mr. COP likely learned to brace with the more superficial extensor muscles in his back (right longissimus). This resulted in an over-active fascicle of the right longissimus (fibers to 6th and 7th thoracic rings), which created the left translated/right rotated position of the 6th and 7th rings.

The right longissimus muscle attaches from the heads of the ribs and transverse processes and runs caudally with fibers attaching to the sacrum. Over-activation of this muscle can create the incongruent torsion between the left translated/right rotated mid thorax (rings 6 and 7 specifically) and left rotated pelvis, as was the case with Mr. COP.

Clinical Reasoning Question #8:
Given that the fascicles of longissimus from the 6th and 7th thoracic rings insert into the spinous processes of L5 and S1, over-activation is likely to extend L5/S1 and nutate the sacrum relative to the innominate (increase the position of control or stability of the SIJs). However, in both the squat and right OLS Mr. COP's right SIJ lost control (sacrum counternutate or innominate anteriorly rotate). What is the likely mechanism for this loss of control?

Answer:

If the 6th & 7th thoracic rings were the *only* driver (primary driver) for the screening tasks of squat and right OLS then one would expect that the right SIJ would remain controlled throughout the movements, given the distal attachment of longissimus to the spinous processes of L5 and S1. In the case of Mr. COP there is also a secondary driver (right hip) that is playing a significant role during the squat and right OLS screening tasks. As noted above, the vector analysis for the right hip identified a neural system impairment in the form of over-active fascicles of both rectus femoris and vastus lateralis (first layer). Rectus femoris will play a significant role during Mr. COP's squat and right OLS because the proximal attachment for rectus femoris is the anterior inferior iliac spine and ilium superior to the acetabulum of the pelvis. Over-activation of this muscle can then induce an anterior rotation of the right innominate (relative sacral counter-nutation), thereby destabilizing the right SIJ during the squat and right OLS tasks.

Mr. COP has two vectors creating opposite pulls through the right SIJ – the over-active fascicle of right longissimus will pull the sacrum into nutation (relative posterior rotation of the innominate) while the over-active fascicle of the right rectus femoris will create an anterior rotation of the right innominate (relative counter-nutation of the sacrum). His deep stabilizers, mainly deep fibers of multifidus in this case, are insufficient (in control or capacity) to balance out these opposing vectors/pulls, which results in the loss of control of the right SIJ during the squat and right OLS screening tasks.

Clinical Reasoning Question #8:

Given that the lower thorax supplies the abdominal wall, were any dysynergies noted in either resting tone or recruitment of the various layers of abdominal muscles?

Answer:

As noted above, there was palpable atrophy in the segmental fibers of deep mulitifidus at L5/ S1. When re-training of these muscles started, Mr. COP had difficulty initially with

finding the right cue to properly engage these muscles with asymmetry noted in that contraction of the right multifidus was delayed. The cue "draw PSIS's together gently" was the best cue for Mr. COP and with lots of repetitions his recruitment strategy improved with a more symmetric contraction palpable.

He also presented with dysynergies in the anterior abdominal wall on real-time ultrasound with a dominant internal oblique strategy (increased resting tone in internal obliques was also noted on layer palpation of the anterior abdominal wall, more so on the right). This finding correlates with the finding of the over-active fascicle of right longissimus that was creating the 6th and 7th thoracic ring shifts (primary driver). The increased tone in the right internal oblique is a "reactor" to the right longissimus vector ("actor").

As treatment progressed and Mr. COP moved on to higher load tasks (e.g. lunge), the focus of his motor control training was on deep fibers of multifidus. Correction of the driver(s) during a left lunge, in conjunction with the verbal cues for multifidus ("draw PSIS's gently together") resulted in full control of L5/S1.

Loading in this non-optimal pattern likely created altered biomechanics in the lumbar spine during the functional tasks of sitting and driving, which is a likely source for the persistent low back pain symptoms. Over time, the right anterior femoral head position (congruent to the positional finding of the left rotated pelvis) likely compressed the right lateral femoral cutaneous nerve as it passes under the right inguinal ligament in the groin. The compression of this sensory nerve can create the paraesthesia in the right anterior thigh, consistent with a diagnosis of Meralgia Paraesthetica.

Mr. COP's duty belt could have also contributed to some compression of the lateral femoral cutaneous nerve. During the course of the physiotherapy treatment, Mr. COP had a consultation with a neurologist, who confirmed the diagnosis of Meralgia Paraesthetica; he felt the nerve compression was directly from wearing the duty belt.

Treatment Plan:

The principles of Integrated Systems Model (ISM) treatment are first to release and align the drivers and then teach a new strategy for connect or control, and move according to the patient's goal(s) and their cognitive belief. The outline of the treatment early on was as follows:

> **R:** Primary driver – 6th & 7th thoracic rings: right longissimus fascicle, left latissimus dorsi, left serratus anterior; Secondary Driver – right hip: right rectus femoris, right vastus lateralis
>
> **A:** Align thoracic rings 6 & 7 – best cue was to "create space in between the middle ribs in the mid-axillary line, like a fish hook pulling to the ceiling"; seat the right hip with the cue "create space for the back of the hip by relaxing the buttock muscles and allowing the sitz bones to widen away from each other"
>
> **C:** Given that correction of the 6th & 7th thoracic rings resulted in full control of L5 and the SIJ, no specific "connect" cue was needed during the earlier stages of rehabilitation (focus was placed on the "align" and "move" pieces)
>
> **M:** Incorporate the above align cues into the following movement training exercises: start with standing with weight shift to the right, progress to right OLS, progress to squat (10 x 3 each, daily)

Mr. COP responded very well to this initial treatment and was able to learn the proper "align" cues and incorporate them in the lower load movements of weight shift to the right, right OLS, and squat. As his symptoms became less intense and irritable, the movement exercises were progressed to the higher load movements of left lunge (moving from a high to low lunge) and eventually to a left lunge position with added thoracic rotation. It was at these higher load tasks/movements that a motor control deficit (neural system impairment) was noted. Correction of the primary driver at these higher load tasks (6th & 7th thoracic rings) was no longer sufficient to fully control L5; a "connect" cue ("gently draw PSIS's together") was needed at this time in order to build up the capacity of deep fibers of multifidus in order to allow full control of L5/S1 during these more challenging tasks/movements.

Treatment, which began as once per week, was slowly decreased to once every 2 weeks as Mr. COP improved. He was eventually able to start training again with the kinesiologists (Innovative Fitness) with concurrent physiotherapy treatment. Subjectively, he noticed a slow but gradual improvement in the right anterior thigh paraesthesia (less intense, less irritable). He was able to return to workout out with the kinesiologists with no pain or aggravation of his symptoms. He continued to have some symptoms, primarily right hip/buttock pain, during his work days especially towards the end of a 4 day block of shifts.

Mr. COP continued to work full time/duties throughout the course of the treatment. This complicated treatment given that his job required him to wear a heavy vest (that compressed through the thorax) and duty belt at all times and he regularly sat/drove for extended periods of time. As a result, Mr. COP continued to require occasional dry needling/release of the above over-active muscles in order to move with more optimal alignment, biomechanics, and control. As he continues to improve with regards to his symptoms and activity tolerance, the frequency of physiotherapy treatments will decrease as new and healthier movement patterns are established and the align/connect cues become automatic.