Spondylolisthesis

What is it?

Spondylolisthesis is a fracture and slippage of a spinal vertebra (usually lower Lumbar). It can develop for a range of reasons and can vary in severity the majority fall into one of two categories: Traumatic or degenerative. Whatever the underlying reason, the result is that the vertebrae literally slip either forward on the one below (Anterolysthesis) or backwards (Retrolysthesis). This can sometimes be felt as a palpable 'step' as you run your fingers down the patients' spine.

Types of Spondylolisthesis:

☐ Type I Congenital spondylolisthesis
☐ Type II Isthmic spondylolisthesis
☐ Type III Degenerative spondylolisthesis

☐ Type IV Traumatic spondylolisthesis
☐ Type V Pathologic spondylolisthesis
☐ Type VI Postsurgical

1

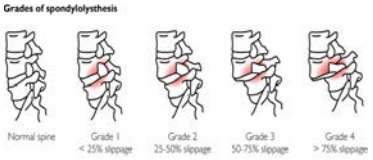
How would you manage:

- **16 y/o male**
- **6'8" tall, lean, tends towards hypermobility**
- **Grade 1 spondylolisthesis, bilateral pars #**
- **Asymptomatic**
- **Keen basketball and soccer player**

2

Spondylolisthesis Facts (Nabil Al Ali et al 2005)4:

- The L4-L5 interspace is affected 6-10 more times than any other level
- Approximately 82% of cases of isthmic spondylolisthesis occur at L5-S1
- Another 11.3% occur at L4-L5
- Degenerative spondylolisthesis occurs more frequently with
- increasing age especially after 40
- Congenital/dysplastic spondylolisthesis has been documented in children as young as 3.5 months
- Heavy athletic activities requiring predispose some athletes to developing pars defects5
- Isthmic spondylolytic defects affect roughly 1.1% of black females
- The most commonly affected group is the white male with an incidence of 6.4%
- Arkara Plains Indians and Aleut people groups have a very high
- incidence of spondylolytic defects, due to a combination of genetic and environmental factors6
- Degenerative spondylolisthesis affects black females more commonly than white females (females more affected than males)



3

Types of Spondylolisthesis

Congenital

- Congenital spondylolisthesis is due to dysplastic sacral or lower lumbar segments. Dysplastic facets or abnormal orientation of the facet joints are the cause for spondylolisthesis

Traumatic/Isthmic

- Isthmus Spondylolisthesis is rare – often due to displacing a small fracture in the pars interarticularis (spondylolysis). Pars interarticularis defect often occurs because the bone didn't fully form from its infantile cartilage (this can be due to a lack of folic acid during pregnancy amongst other things). Traumatic Spondylolisthesis usually affects the lower part of the spine, most commonly the 5th lumbar vertebra (82%), but sometimes the 4th lumbar vertebra3.
- The usual mechanism is that a child or youth falls heavily onto the coccyx region and the cartilaginous pars splits. This type of fracture usually occurs around 5-7 years of age, however the symptoms may not be felt until adulthood. Usually a traumatic slippage is a grade I or II and is well adapted and compensated for by the body over time. However, it is not uncommon to see young boys (mainly) of 14/15 years old coming to you with acute spondylolisthesis-induced low back pain. Younger patients are at higher risk than older patients for **developing progressive spondylolisthesis**. The risk for progression in **adults** is **rare** when the main problem is at L5

Degenerative

- Usually due to aging, a degenerative spondylolisthesis happens where the spine's support system (bones, joints and ligaments) weaken and are no longer able maintain alignment.
- Degenerative spondylolisthesis is most common in the 5th decade onwards and usually occurs at the L4/5 zone because that's mechanically weaker due to the maximal angle of the lumbar lordosis. This is sometimes also called a 'stress fracture'. It occurs more commonly in **females** with a **5:1 female to male ratio.** The incidence increases after age 40 years.

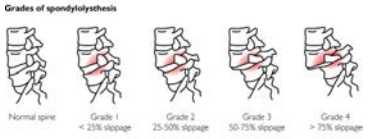
Pathologic spondylolisthesis

- Can occur as a result of any bone lesion that might weaken the posterior bony structures. Generalized skeletal diseases including osteomalacia, syphilitic disease, and Von Recklinghausen disease are some reported causes. Bony destructive lesions, including tumor or infection, are other potential causes

4

Symptoms of Spondylolisthesis may include:

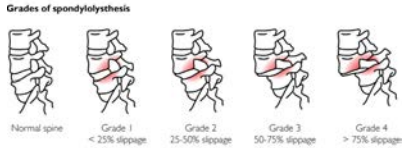
- Difficulty standing straight
- Back or buttock pain
- Pain that runs from the lower back down one or both legs (Sciatica) • Numbness or weakness in one or both legs
- Difficulty walking
- Leg, back, or buttock pain that gets worse on bending over or twisting
- Loss of bladder or bowel control, in rare cases
- Pain getting up from a chair
- Morning pain and stiffness
- Back pain getting worse as the day goes on
- Pain usually is provoked by activity, particularly back extension activities
- Poor tolerance of activities requiring excessive spine loading, including running and jumping
- Sitting usually is better tolerated
- A large percentage of patients with spondylolysis are asymptomatic. Progression of a spondylolisthesis also may occur without symptoms



5

Symptoms

- Patients typically have complaints of pain in the back with intermittent pain to the legs. Spondylolisthesis can often cause muscle spasms, or tightness in the hamstrings.
- Symptoms will depend on a number of factors, age, chronicity and the degree/grade of slippage. We grade slippage from I-IV according to the percentage of slippage and as the bone slips it can also pull on the intervetbral disc, which can be a source of pain.
- Remember that most spondylolisthesis' occur at the L5/S1 level. Anatomically, most of the spinal nerves have exited to the lower extremities by the L3/4 zone (the cauda equina starts at L2/3) so any nerve damage or symptoms will tend to be less serious than if the slippage was higher up. It can affect one side (unilateral) or both sides (bilateral) and often presenting as sciatica or pseudosciatica. If severe it can also cause **cauda equine syndrome** (CES). CES is potentially very serious and may present as a loss of bladder or bowel control/regulation, in which case you must urge the patient to seek **immediate medical/surgical intervention**.



6

What are the symptoms telling us?

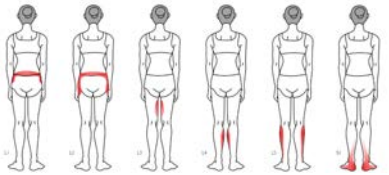
- **Pain** is a signal that something is wrong – it's part of our 'protect and defend mechanism'. In a spondylolisthesis back pain is the most common symptom; this is mainly due to overloaded lumbar erector spinae and or multifidus muscles.
- The muscles are being asked to do two jobs at the same time, the normal job of maintaining posture (multifidus) and extending the flexed spine (erector spinae) **PLUS** the job of stabilizing around the fracture site. This is also one of the reasons why the low back pain is often worse as the day goes on, the muscles fatigue and cause low grade constant aching. As the muscles fatigue, the pressure on the spinal cord and or its neuro-vascular structures may increase and cause more leg pain and or hamstring tension.
- Patients often present with slight forward (flexion) bending (the **Phalen-Dickson sign**).
- This posture leads to buttock pain as the **gluteus maximus** and **medius** and hamstring muscles become similarly engaged in protecting and stabilizing the lower back and hips through their myofascial attachments. Over time this leads to a 'chronic tight clenched buttocks' often with spasms and pain this buttock clenching tension can be seen clearly during examination. Gluteal muscle spasm and tension can in turn lead to tension in the Piriformis muscles, which engorge and then press upon the sciatic nerve (causing sciatica) or its blood supply (pseudosciatica).

7

What are the symptoms telling us?

Numbness

- May be one sided (unilateral) or bilateral. It is usually felt down the back of the legs but this depends on where the spondylolisthesis is located. Each nerve that exits the spine has a specific radiating pattern or dermatome. See chart below. Often the leg pain is not directly related to pressure
- on the nerves but may be coming from muscular trigger points and associated tight muscles. Tight muscles can press on the delicate blood supply to the nerves and mimic nerve pain (myogenic neuropathy). In these cases, trigger point (NAT) therapy can be very, very effective.



8

- **Can trigger points help?**
  - **How?**
  - **Evidence?**
  - **Theory?**
- **Reflexes and proprioception**
- **Other pathways to stability**

9

EXAMINATION AND TESTING

PALPATION

- In most cases it is not possible to see visible signs of spondylolisthesis by examining the patient, however there are a few tests you can do. The patient may present with a waddling gait. This may be noted secondary to hamstring tightness producing a shortened stride length. The patient also often presents with tight clenched buttocks. A step or bump in the spinous processes can sometimes be felt as you stroke down the spine.

POSTURE

10

EXAMINATION AND TESTING

The Phalen-Dickson sign

One-legged hyperextension test (stork test):

A positive one-legged hyperextension test while standing on one leg and bending backward, pain is experienced in the same side (ipsilateral) of the low back.

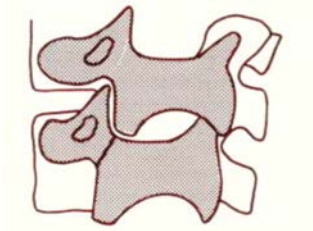
11

Diagnostic Tests

1- Radiography:

- Spondylolisthesis is easily identified using plain radiographs **A/P**, **lateral and oblique**. Lateral (side) view of lumbar spine is especially useful in the detection of Spondylolisthesis.
- **Oblique** x-ray also clearly shows the appearance of bilateral pars defects - this resembles a **Scottie** dog with a collar (the collar is the pars defect).

Scottie Dog



12

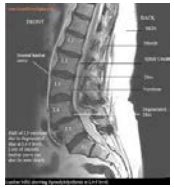
Diagnostic Tests7

2- Computed Tomography:

- CT SCANNING axial or sagittal image of the lumbar spine can be performed with or without contrast enhancement.

3- Magnetic Resonance Imaging (MRI):

- Has the distinct advantage of imaging the spine in any plane. Typically, the axial (up/down) and sagittal (side view) planes are used.



13

DIFFERENTIAL DIAGNOSIS

PATHOLOGICAL SIEVE	
SPONDYLOLISTHESIS	
CONGENITAL	Spondylolisis, anomalies of the lumbar or sacral vertebrae such as sacralization or lumborization
DEGENERATIVE	Spinal bulging or prolapsed disk, Spinal stenosis (narrowing of the vertebral nerve exits), Arthritis of the spine pressing (bars and/or osteophytes) on the nerves or ligaments, Spinal fracture (or crush fracture)
FUNCTIONAL	Sacroiliac joint injury/dysfunction/derangement, Overuse/sitting/cross-legged/high heeled shoes, Piriformis syndrome, Ischial tunnel syndrome
INFECTIVE	Tuberculosis, Osteomalacia, syphilitic disease, and Von Recklinghausen disease
METABOLIC	
NEOPLASTIC	Primary Neoplastic, Secondary Neoplastic - Spinal fracture (or crush fracture)
RETICULO-ENDOTHELIAL	Neuropathy: e.g., Mononeuropathy monoplex, Systemic Lupus (SLE) - Erythematosis, Multiple myeloma
TRAUMATIC	Fracture, Accident

14

RED FLAGS

- Pain that develops gradually, and slowly gets worse and worse over days or weeks
- Constant back pain that is not eased by lying down or resting
- Pain that travels to the chest, or is higher in the back behind the chest
- Weakness of any muscles in a leg or foot
- Lack of feeling (numbness) in any part of your bottom or leg
- If you have taken steroid tablets for more than 3 months
- Numbness around the back passage (anus) - the saddle area
- Bladder symptoms such as loss of bladder sensation loss of bladder control, incontinence, loss of sensation when passing urine
- Incontinence (faeces, stools, or motions)

15

WHICH MUSCLES ARE AFFECTED BY SPONDYLOLISTHESIS?

- Piriformis
- Lumbar Erector Spinae
- Multifidus
- Gluteus Medius
- Gluteus Maximus
- Hamstrings

16

Erector Spinae

Interestingly and contrary to what some of us have been taught the erector spinae, don't hold the spine erect! Most fibres are electrically silent during postural work (Kippers 1984)8. This muscle group is designed to activate during extension from flexion – i.e. standing upright from bending forward. Because most patients with a spondylolisthesis have a permanently slightly bent forwards posture – there is increased load on erector spinae muscle fibres that can lead, over time, to trigger point formation.

17

Multifidus

- Similarly, the Multifidus muscle, which has a deeper and a more superficial arrangement. Gluteus Maximus and Medius also demonstrate increased loading and can develop trigger points for the same reasons.

18

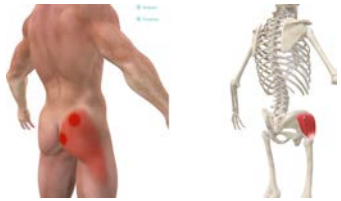
Piriformis

- The Piriformis takes its origin from the lower part of the sacrum but it also often gets involved with the protective spondylolisthesis pattern. When the Piriformis gets tight it can squash the sciatic nerve, or even the blood vessels to the nerve (vaso nervorum) which can lead to (pseudo) sciatica.

19

Glutes and Hamstrings

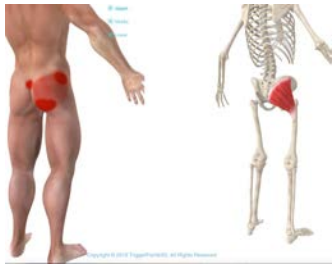
- Along with the tight Glutes and Piriformis the lower back muscles form a triangle of tight, spastic and fatigued tissues. Postural changes also cause tension in the hamstring muscles, which also often manifest trigger points and can ache after exercise. Trigger points make their host muscles shorter, fatter and less efficient. Also over time and if untreated, trigger points can have a host of unwanted effects such as **peripheral and central sensitization**.



20

Glutes and Hamstrings

- Along with the tight Glutes and Piriformis the lower back muscles form a triangle of tight, spastic and fatigued tissues. Postural changes also cause tension in the hamstring muscles, which also often manifest trigger points and can ache after exercise. Trigger points make their host muscles shorter, fatter and less efficient. Also over time and if untreated, trigger points can have a host of unwanted effects such as **peripheral and central sensitization**.



21

Glutes and Hamstrings

- Along with the tight Glutes and Piriformis the lower back muscles form a triangle of tight, spastic and fatigued tissues. Postural changes also cause tension in the hamstring muscles, which also often manifest trigger points and can ache after exercise. Trigger points make their host muscles shorter, fatter and less efficient. Also over time and if untreated, trigger points can have a host of unwanted effects such as **peripheral and central sensitization**.

22

TNAT

- Intentionally stimulating mechanoreceptors embedded within and around the trigger points (and joints) generates a novel "neural signature," which affects the spinal cord and the somatic cortices. NAT deliberately utilizes some of the automatic reflexes associated with trigger points, including:

- Co-coordination
- Reciprocal inhibition
- Post-isometric relaxation
- Post-activation depression
- Pure facilitation
- Co-facilitation
- Autonomic (ANS) responses
- "Pain gate"
- Spinal cord reflex responses
- Neuroplasticity

23

TNAT Algorithm for Spondylolisthesis

- The sequence and the depth of pressure are key to getting the most effective results. In terms of depth, the deep stroking massage should be experienced like squeezing toothpaste out of a tube. Slow and luxurious stroking in one direction only; this leads to a type of neurological stimulation of the muscles. It is important to visualize the muscles you are working on, see the fibers - how do the feel? What is the fiber direction?
- You may well note the spondylolisthesis step or anomaly that as you get near the lower lumbar spine you can pause on it gently and then finish the stroke all the way to the buttock. You can use your hands, fingers or even gently and respectfully with your elbow.
- Rather than simply generally massaging the area NAT involves a deliberate algorithm of trigger point stimulation. This may be a little different to the way you normally treat but give it a go it works. Trigger points are to be thought of as INPUTS to the nervous system rather than just painful knots. We utilize the pain to change the neurology and feedback from the tissues, which, in turn, alters and attenuates sensation.
- NAT and trigger point therapy has proven successful in the vast majority of patients for treating and managing spondylolisthesis and we sincerely hope you will find it a valuable addition.

24

Treatment frequency

What creams or lotions can I use?

- In general, it is better to avoid oils, as they may cause you to slide off from the pressure points once you have found them. We use plain blue Nivea Creme. Alternatively, arnica cream or plain aqueous cream mixed with some vitamin E oil (with a wooden spoon) may be sufficient. Petroleum gel, talcum powder, or massage oil may also be used if you have a lanolin allergy.

How often should I treat?

- Stabilizing and helping the patient come out of the acute phase usually takes 3-5 sessions these should be performed between five to 10 days apart. After this we usually recommend maintenance sessions anywhere from 6-12 weeks apart. The exact frequency of these visits will vary from patient to patient but as a rule, they should come back when they start to feel those telltale symptoms. This also means you will have time to build a relationship with your patient and can advise them on their general health, wellbeing and lifestyle factors.

25

TNAT Algorithm

Step 1 - one sided (prone ipsilateral) - erector spinae - deep stroking massage – Work 3 times in 1 direction only working down the spine towards the coccyx. Here we start by working down the center of the back for a few strokes just to get a feel of the tissues. After introducing your hands with slow rhythmic glide start focusing on **one side only**.

26

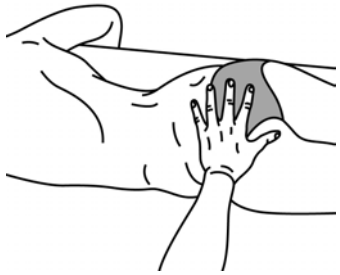
STEP 1

27

TNAT Algorithm

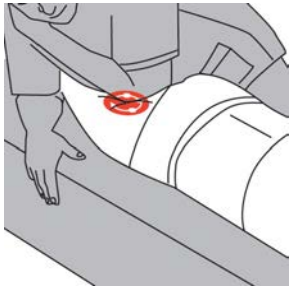
Step 2 – same side (prone – ipsilateral) – gluteus inhibition compression technique – Hold the point until it fatigues then move around the point to check there's not another gluteal trigger point. Approach the trigger points with respect, building the pressure up slowly, holding it until you feel the tissues yield and then slowly come away – you should hold the points for up to four minutes.

- **Repeat steps 1& 2 - 3 times**



28

STEP 2

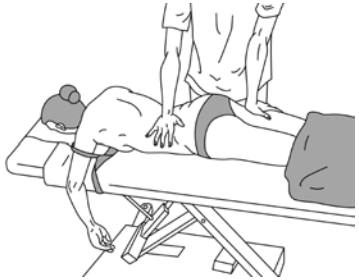


29

TNAT Algorithm

Step 3 – (prone) End the session with 'cool down' move - using gentle leaning/compression technique on the opposite Lumbar flank and hamstring, balancing your weight between the two of them and then pushing until you feel equal resistance. Come away really slowly then repeat rhythmically three to four times changing hand positions. As you move up the back, move down the leg. Don't forget to change sides

Finish with sacral hold if you want



30

REMEMBER

- NAT is about stimulating a neural sequence rather than making sure you have stretched out every single muscle in pain.
- In the case of a Spondylolisthesis it's not a good idea to completely relax all the muscles – they are doing the important job of holding and protecting the spine.
- We are aiming to use the trigger points as feedback inputs to change the relationship between the brain and the holding pattern around the Spondylolisthesis.

31

Surgery

Whilst the majority of patients will respond to conservative management, surgery might be necessary if the vertebra continues to slip or if the pain is not relieved by conservative treatment and begins to interfere with daily activities.

I believe it is important to have a good understanding of the surgical option so we can support, reassure and inform patients if surgery is needed. It may well be they come back to you after surgery for more therapy.

The main goals of surgery for spondylolisthesis are:

1) to relieve the pain associated with an irritated nerve,
2) to stabilize the spine where the vertebra has slipped out of place,

3) to increase the person's ability to function.

32

Surgery

The main surgical techniques used are (Longo 2014)29:

1) Laminectomy

a. When the vertebra slips forward, the nearby nerves that exit the spine can become pinched or irritated. In addition, the size of the spinal canal in the problem area shrinks, placing pressure on the nerves inside the canal. **The goal is remove the lamina and release pressure on the nerves**

i. Traditional open lumbar laminectomy :

1. The two laminae and spinous process of a vertebra are removed to relieve excess pressure on the spinal nerves.

ii. METRx Minimally Invasive Hemilaminectomy:

1. It involves removing part of one of the two laiminae on a vertebra to relieve excess pressure on the spinal nerve(s).

2) Fusion

a. **A spinal fusion is normally done immediately after laminectomy for spondylolisthesis.** It is designed to fuse the two vertebrae into one bone and stop the slippage from worsening. The fusion is used to lock the vertebrae in place and stop movement between the vertebrae.

i. Traditional Fusion

1. The vertebrae are affixed to one another using surgical instrumentation.

2. Bone graft is then placed between the vertebrae allowing them to "fuse" together over time.

3. This idea behind this is that the fusion stabilizes the painful joint segment and relieves pressure from the painful spinal nerves

33

Surgery

ii. Minimally invasive surgical spine fusion

1. Posterolateral fusion **(PLF)** is the grandfather of fusion technique as it was developed just over 100 years ago.
2. In a posterior approach to lumbar fusion, the surgeon makes an incision down the middle of the lower back.
3. One of the criticisms of PLF is that it involves an extensive dissection (the stripping of muscle and fascia off the bone) of the adjacent transverse processes, facet(s) and sometimes lamina.
4. After the decompression, the surgeon will place graft material along the sides of the vertebrae to stimulate bone growth.
5. Titanium screws and rods are often used to provide immediate stability to the spine until a solid fusion has been achieved.

iii. Posterior Lumbar Interbody Fusion (PLIF):

1. In this procedure, the problem vertebrae are fused from the *anterior* (front) and *posterior* (back).

2. The surgeon works from the back of the spine and removes the disc between the problem vertebrae.

3. Bone graft material is inserted from the back of the spine into the space between the two vertebrae where the disc was removed (the *interbody* space)

4. Transpedicular instrumentation is attached to stabilize the motion segment while fusion occurs.

- **Risks of surgery**
- • Implant failure
  • Pseudoarthrosis
  • Nonunion
  • Foot drop
  • Spinal compression
  • Acute bowel ischaemia

34

Lifestyle changes to discuss with patient

• Reduce the amount of long period sitting – stand up during the course of the day, walk around, stretch and then resume working

• **Don't rest excessively** – keep moving - Avoid standing for long periods
• Sit on an ergonomically correct chair for office area
• Sit with **correct posture**
• Place a **small pillow** in the curve of the lower back – pillows can be purchased at orthopedics stores that are specific to lower back support
• Sleep with a **pillow under knees** when sleeping on back

• Sleep with a **pillow between legs** whilst sleeping on side – preventing pelvic rotation
• **Weight loss**
• Stress management - stress can cause muscle tension which in turn can cause back pain - this can be done through counseling, yoga, breathing techniques
• Modify your environment – adjust mattress to sleep on a softer mattress, prevent sleeping on stomach, reduce amount of time walking in high heel shoes, use softer chair

• **Quit smoking** – smoking contributes to the degeneration of spinal disks
• Discontinue with any activities that **aggravate symptoms** such as bending over, heavy lifting and any quick twisting or jerking motions. Avoid standing or sitting (e.g. driving) for extended periods as it will increase strain to the spine and aggravate disc pain. At home, keep away from overstuffed and low furniture, because it is difficult to stand back up after sitting in them

35

Sports

Recommended sports

• Swim, swim, swim – an excellent way to look after your back and strengthen your core muscles without putting to much strain on the back

• Pilates and Yoga

• Feldenkries
• TRX training
• Crosstraining

Not recommended sports/activities

- • Avoid mountain biking
  • Excessive weight lifting
  • Golf
  • Running on hard or uneven surfaces
  • Tennis
- • Skiing

36

EXERCISES

Stretch 1: Two Knee Twist

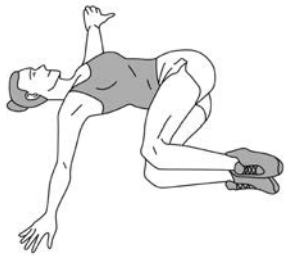
Technique

• Lying on your back, bend your knees into your chest and bring your arms out as a T

• As you exhale, lower your knees to the ground on the right
• Keep both shoulders pressed down firmly
• If the left shoulder lifts, lower your knees further away from the right arm
• Hold for 1-2 minutes each side

How Often?

3 times each side, twice daily



37

EXERCISES

Technique

Adopt position as shown

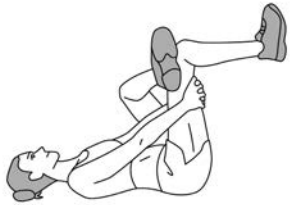
• Lying on your back, bend both knees with your feet flat on the ground • Bend the right knee like a figure four, with the outer left ankle to the

right thigh
• Lift the left foot into the air, bringing the left calf parallel to the ground • Thread your right hand between the opening of the legs and interlace

your hands behind your left thigh
• Hold 2-3 minutes and then repeat on the other side

How Often?

Twice Daily



38

EXERCISES

Technique

Adopt position as shown

• As soon as you get up in the morning you should lie prone - on your stomach

• By getting into this position, your lower back curves/arches
• The increased arch pushes on the disk helping to bring the nucleus

forward into the correct position

How Often?

Hold for 1 min, twice daily

39

Stretch 4: Knee to chest stretch

Adopt position as shown

Technique Start position:

• Lie on your back on a mat or carpet
• Place a small flat cushion or book under your head
• Bend your knees and keep your feet straight and hip-width part

• Keep your upper body relaxed and your chin gently tucked in

Action:

• Bend one knee up towards your chest and grasp your knee with both hands
• Slowly increase this stretch as comfort allows
• Hold for 20-30 seconds with controlled deep breaths

How Often?
Repeat three times, alternating legs, twice daily

40

Stretch 5: Sciatic mobilizing stretch

Technique Start position:

• Lie on your back
• Place a small flat cushion or book under your head
• Bend your knees and keep your feet straight and hip-width apart
• Keep your upper body relaxed and your chin gently tucked in

Action:

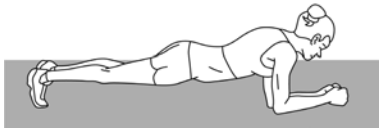
• Bend one knee up towards your chest and grasp your hamstring with both hands below the knee
• Slowly straighten the knee while bringing your foot towards you
• Hold for 20-30 seconds, taking deep breaths
• Bend the knee and return to the starting position

How Often?

Repeat two or three times, alternating legs, twice daily

41

Exercise 1: Plank



Technique:

Adopt position as shown

The basic plank exercise, also called a hover, is the starting place if you want to improve your core strength and stability.

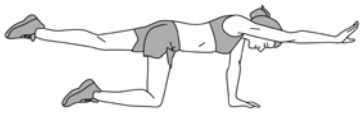
• Begin in the plank position with your forearms and toes on the floor
• Keep your torso straight and rigid and your body in a straight line from ears to toes with no sagging or bending
• Your head is relaxed and you should be looking at the floor
• Hold this position for 10 seconds to start
• Over time work up to 30, 45 or 60 seconds

How Often?

Repeat 4 times, twice daily

42

Exercise 2: Birddog



Technique:

Adopt position as shown

• Begin on all fours, hands directly under your shoulders and knees directly under your hips
• Keep head aligned with spine (to help avoid tilting head, look at floor)
• Keep buttocks and abdomen tight. Do not arch the back
• Lift one arm up and forward until it is level with torso simultaneously lift the opposite leg in the same manner
• Keep arm, spine, and opposite leg aligned as if they are forming a tabletop
• Balance yourself for 10-15 seconds then slowly return to starting position
• Switch sides and repeat
• Remember to breathe

How Often?

Do ten repetitions each side, twice daily

43

Exercise 3: Bridge

Technique:

Adopt position as shown

To improve core strength of several muscles in combination, try a bridge

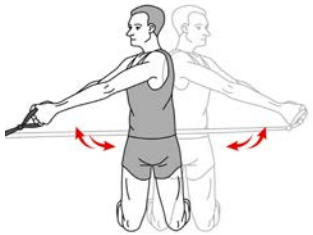
• Lie on your back with your knees bent
• Keep your back in a neutral position, not arched and not pressed into the floor. Avoid tilting your hips
• Tighten your abdominal muscles
• Raise your hips off the floor until your hips are aligned with your knees and shoulders.
• Hold for 20 to 30 seconds
• Return to the start position and repeat

How Often?

30 times, twice daily

44

Exercise 4:



Technique:

Adopt position as shown

• Begin this exercise kneeling or standing with your back straight, holding the resistance band as demonstrated. (Band should be attached to something fixed at waist height)

• Slowly rotate your body keeping your arms and back straight

• Perform 3 sets of 10 repetitions as far as possible provided it is pain free

How Often?

Repeat on opposite side, twice daily

45

Exercise 5: Heel taps

Technique

Adopt position as shown

• Begin this Pilates exercise lying on your back in neutral spine with your hands by your side and your hips and knees bent to 90 degrees as demonstrated

• Maintain activation of your deep stomach muscles and pelvic floor muscles throughout the exercise

• Slowly lower one leg until your heel touches the ground and then return to the starting position

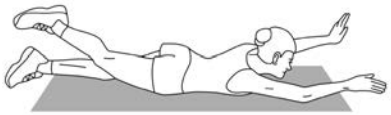
• Keep your spine and pelvis completely still and breathe normally

How Often?

Perform 30 times alternating between legs, twice daily

46

Exercise 6: Alternating leg and arm raises (Superman)



Technique

• Lie on stomach, arms reached out past your head with palms and forehead on the floor

• Tighten abdominal muscles

• Lift one arm (as you raise your head and shoulders) and the opposite leg at the same time, stretching them away from each other

• Hold for 5 seconds and then switch sides

How Often?

Repeat 5 - 10 times each side, twice daily

47

References

1 T Rothman RH, Simeone FA. *Spondylolisthesis*. 1992. vol 1 913-69 2Wiltse LL. Spondylolisthesis classification and etiology. Symposium of the Spine. *Am Acad Orthop Surg*. 1969. 143.

3 Oh JY, Liang S, Louange D, Rahmat R, Hee HT, Kumar VP. Paradoxical motion in L5-S1 adult spondylolytic spondylolisthesis. *Eur Spine J*. 2011 Jun 15

4 Beth B Froese, MD Lumbar Spondylolysis and Spondylolisthesis, http// emedicine.medscape.com/article/310235-overview#a6

5 Bono CM. Low-back pain in athletes. *J Bone Joint Surg Am*. 2004 Feb. 86- A(2) 382-96

6 Simper LB. Spondylolysis in Eskimo skeletons. *Acta Orthop Scand*. 1986 Feb. 57(1) 78-80

7 Wynne-Davies R, Scott JH. Inheritance and spondylolisthesis a radiographic family survey. *J Bone Joint Surg [Br]*. 1979 Aug. 61-B(3) 301-5

8 Kippers et al 1984 – Spine Vol. 9. No.7

9 Dommerholt J Bron, C. Franssen J. Myofascial Trigger Points An Evidence- Informed Review. *J Manual and Manip Ther* 2006 Volume 14, Issue 4, pp. 203-221

10 Travell, J.G., & Simons, D.G. 1992. Myofascial Pain and Dysfunction. The Trigger Point Manual, Vol. 2. Lippincott Williams & Wilkins□ Baltimore, MD.

11 Reitinger, A., Radner, H., Tilscher, H., et al. 1996. Morphologische Untersuchung an Triggerpunkten. Manuelle Medizin 34 256–262.

12 Grinnel, A.D., Chen Kashani, A., Lin, J., et al. 2003. The Role of Integrins in the Modulation of Neurotransmitter Release from Motor Nerve Terminals by Stretch and Hypertonicity. J Neurocytol 32 (5–8) 489–503.

13 Shah, J.P., Phillips, T.M., Danoff, J.V., & Gerber, L.H. 2005. An In Vivo Microanalytical Technique for Measuring the Local Biochemical Milieu of Human Skeletal Muscle. *J Appl Physiol* 99 (5) 1977–1984.

14 Bengtsson, A., Henriksson, K., & Larsson, J. 1986. Reduced High Energy Phosphate Levels in the Painful Muscles Patients With Primary Fibromyalgia. *Arthritis and Rheumatism* 29 817–821.

15 Hong, C.-Z. 1996. Pathophysiology of the Myofascial Trigger Point. J Formosan Med Assoc 95 (2) 93–104.

16 Gunn, C. 1997. Radiculopathic Pain, Diagnosis and Treatment of Segmental Irritation or Sensitisation. *J Musculoskel Pain* 5 119–134.

17 Quintner, J., & Cohen, M. 1994. Referred Pain of Peripheral Nerve Origin: An Alternative to the Myofascial Pain Construct. *Clinical J Pain* 10 243–251

18 Kawakita, K., Itoh, K., & Okada, K. 2002. The Polymodal Receptor Hypothesis of Acupuncture and Moxibustion, and its Rational Explanation of Acupuncture Points. International Congress Series Acupuncture – Is There a Physiological Basis? 1238 63–68.

48

References

19 Chen Q, Bensamoun S, Basford J, et al. Identification and quantification of myofascial taut bands with magnetic resonance elastography. *Arch Phys Med Rehabil* 2007 88 1658-1661.

20 Sikdar S, Shah JP, Gilliams E et al. Assessment of myofascial trigger points (MTrPs) a new application of ultrasound imaging and vibration

21 Niddam DM, Chan RC, Lee SH, et al. Central modulation of pain evoked from myofascial trigger point. *Clin J Pain* 2007 23 440-448.

22 Hong CZ, Simons DG. Pathophysiologic and electrophysiologic mechanisms of myofascial trigger points. *Arch Phys Med Rehabil* 1998 79 863-872.

23 Shah JP, Phillips TM, Danoff JV, et al. An in vitro microanalytical technique for measuring the local biochemical milieu of human skeletal muscle. *J Appl Physiol* 2005 99 1977-1984.

24 Lucas K, Rich PA, Polus BI. Muscle activation patterns in the scapular positioning muscles during loaded scapular plane elevation the effects of latent myofascial trigger points. *Clin Biochem* 2010 25 765-770.

.

24 (3 refs)

a) Wang C, Ge HY, Ibarra JM et al. Spatial pain propagation over time following painful glutamate activation of latent myofascial trigger points in humans. *J Pain* 2012 13(6) 537-545.

b) Xu YM, Ge HY, Arendt-Nielsen L. Sustained nociceptive mechanical stimulation of latent myofascial trigger point induces central sensitization in healthy subjects. *J Pain* 2010 11(12)1348-1355 c) Affaitati G, Constantini R, Fabrizio A, Lapenna D, Tafuri E, Giamberardino MA. Effects of treatment of peripheral pain generators in fibromyalgia patients. Eur J Pain 201113 61-69

26 Mense S, Gerwin RD. *Muscle Pain: Understanding the Mechanisms*. Springer, Heidelberg, 2010

27 Schaible, H. 2006. Peripheral and Central Mechanisms of Pain Generation. Handbook Exp Pharmacol 1773–28. 28 Weis, J.T., Niel-Asher, S., Latham, M., et al. 2003. A Pilot Randomised Placebo Controlled Trial of Physiotherapy and Osteopathic Treatment for Frozen Shoulder. *Rheumatol* 42(Suppl. 1) 146.

29 Longo UG, Loppini M, Romeo G, et al. Evidence-based surgical management of spondylolisthesis reduction or arthrodesis in situ. *J Bone Joint Surg Am*. 2014 Jan 1. 96(1) 53-8.

49