ABSTRACT

Ms. R. is well aware of her flat back posture and the accompanying limited lower back mobility. Recently however, she has complained of persistent lower back pain. She works as a thoracic surgery lead medical assistant, which requires her to stand for long hours with head, neck and shoulders flexed forward while performing a micro movement. This can last for up to six hours at a time without a break. This static positioning and repetitive motion often leads to muscle imbalances causing postural weaknesses referred to as Fatigue Posture (or Sway-Back posture). This paper utilizes the Body Arts Science International Block System and principals of Joseph Pilates to structure a Pilates training program that addresses both physical and mental conditioning (“as a whole”). The objective of the conditioning program is to reduce or eliminate lower back pain by restoring proper spine alignment, improving posture, overall strength, and mobility, all the while ensuring the client is working within her anatomical and structural range of motion (ROM).
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ANATOMICAL DESCRIPTION

A brief anatomical description of the spine and its supporting musculature is presented here as background for the case study that follows after the Introduction.

The human spine has natural curvatures. When the back is viewed from behind, the spine should be straight and centered over the pelvis. However, when the spine is viewed from the side, curvature is now apparent. This curvature is designed to maintain balance as the spine is located behind organs in the chest and abdomen. The spine has two alternating curves to create an “S”-like shape. In the neck and lower back there is normally an inward curvature or sway back known as lordosis. In the thoracic spine and sacrum there is an outward curvature known as hunchback or kyphosis. Refer to Figure 1.

Figure 1 – Anatomy of spine

These curves normally balance each other so that when a patient stands they are well balanced when the head is straight above the hips when viewed from the side. Standing in this position minimizes the effect of gravity and allows the patient to stand with the best posture, using the
least energy when moving or walking. The natural curves of the spine act as shock absorbers for
the body. Poor alignment compromises this action; hyperlordosis and kyphosis, which refer to
increased curves of the lumbar and thoracic spine, are examples of poor alignment. In order to
maintain its natural curves, good alignment and stability, the spine needs to be supported by a
robust and balanced musculature, especially that of the core. These abdominal core muscles
will support and protect the lower spine, while mid-and upper-back extensors will support and
protect the upper spine.

There are four paired abdominal muscles: the rectus abdominis, external oblique,
internal oblique, and transversus abdominis. All of the abdominals attach into a tendinous
band that runs vertically down the center of the abdomen (linea alba). These muscles are
responsible for holding the organs inside the abdomen and maintaining integrity between the
rib cage and the pelvis. Spinal flexion occurs when these muscles are contracted bilaterally.
Spinal rotation and lateral flexion occur when they are contracted unilaterally. Refer to Figure 2
of the four paired abdominal muscles.

Figure 2 – Abdominals
The abdominal muscles are further described below:

**Rectus Abdominis**-Origin: external surfaces of ribs 5-7, xiphoid process, costal cartilages and linea alba Insertion: superior surfaces of the pubic symphysis - Action: torso flexion and lateral flexion.

**Internal Oblique** (the internal oblique lies deep to the external oblique,) Origin: cartilage of ribs 10-12, linea alba, lumbodorsal fascia; Insertion: iliac crest, lateral one third of the inguinal ligament; Action: torso flexion ipsilateral rotation, lateral flexion.

**External Oblique** - Origin: linea alba and outer surfaces of the ribs 5-12 intergigitating with the serratus anterior; Insertion: iliac crest one third of the inguinal ligament; Action: torso flexion, contra lateral rotation, lateral flexion.

**Transversus Abdominis** (is the deepest abdominal muscle) - Origin: interior surfaces on the costal cartilage of ribs 7-12, linea alba, lumbodorsal fascia; Insertion: interior surface of the iliac crest, lateral third of the ingunal ligament; Action: compresses the contents of the abdomen, stabilizes the lumbar spine. The transversus abdominis plays an important role in protecting the spine, automatically contracting to help stabilize the healthy spine and pelvis just before movement of the limbs. It can also aid with respiration and is recruited with forced expiration.

The spinal extensors can be divided into three groups consisting of the erector spinae, semispinalis, and deep posterior spinal group. They are shown in Figure 3.
The most powerful of the spinal extensors is made up of three columns, which are the spinalis, longissimus, and the iliocostalis. When contracted bilaterally, the action is to extend the spine. Spinal lateral flexion and contralateral (semispinalis) or ipsilateral rotation (longissimus and iliocostalis) occur when the extensors are contracted unilaterally. Strengthening this muscle group can help prevent the common tendency toward slumped upper back posture. The deep posterior spinal group of intrespinales, intrtransversales, rotatores and multifidus – is parallel in function to the transversus abdominis. Its primary role is stabilization of the spine and small movements of one vertebra relative to an adjacent vertebra. Multifidus lies deep along the spinal column and pans from the cervical region of the spine down to the base of the lumbar. The multifidus and transverse abdominis offer support and stabilization and are recognized to be particularly vital for stabilization and rehabilitation of the spine. All these long muscles of the back, together with those of the pelvic floor, the gluteal muscles, the adductors of the thigh, and the muscles of the torso all help the erector spinae to stabilize the vertebral column and so provide the foundation of safe, effective movement of the
whole body. When muscle is not recruited regularly, it loses its ability to contract, resulting in strength reduction over time. Refer to Figure 4.

**Figure 4 – Flat Back Posture**

**INTRODUCTION**

**FLAT BACK:** Head: forward head position; **Upper thoracic spine:** an exaggerated thoracic kyphosis; **Lumbar spine:** a markedly reduced lumbar lordosis; **Pelvis:** if not in a neutral position, sways forwards with a posterior pelvic tilt (as in sway back posture); **Hip and Knee joints:** hyperextended; **Body alignment:** the whole body leans forward slightly so that the line of gravity is shifted toward the front of the feet.

Flat Back is an abnormal condition where the spine loses its natural low back curve to become flat, with the pelvis generally tilted posteriorly. Patients with flat back syndrome typically notice troubles standing upright or experience ongoing back or leg pain. Symptoms usually worsen as the day goes on; patients may feel they lean further and further forward the
longer they try to stand upright. The severity of the symptoms usually depends on the amount of curvature present and difficulties with standing erect. In patients with flat back syndrome, a loss of normal lumbar curvature causes an imbalance of the spine. The spine provides the primary movement of the axial skeleton. The movement, stability, and alignment of the spine are an essential focus in a Pilates approach to treatment.

CASE STUDY

Ms. R. is 56 years of age. She works as a thoracic surgery operating assistant. Her hours are long and most of her work is spent performing micro movements during the surgery. At times surgery can last for six hours with minimal movement and no break. Ms. R. habitually stands on one leg or the other to shift her weight and attain a bit of movement. While she has no injuries, dating back over a period of four years she has routinely experienced a small discomfort in her lower back. Her symptoms are not triggered by overloading, rather they start slowly and become worse with prolonged standing. She then experiences low back pain and tightness in her neck and shoulders. To release stress and muscle tightness she has undergone physiotherapy and massage therapy, which has provided her with only temporary relief. Her doctor suggested that she takes exercises to strengthen her abdominals in order to promote improved posture and spine alignment. Previously the client had participated in a basic Pilates group mat class before deciding to take a one-on-one tailored Pilates program.

Restrictions: Due to her flat back condition (the source of her current pain) Ms. R. will avoid exercises with excessive trunk flexion, loaded spinal flexion, or combined flexion/rotation movements that may aggravate her current back condition. Client’s goal/objective of the
**program:** is to restore proper spine alignment, thus reducing or eliminating low back pain, improving posture and overall strength, and increasing mobility through a full range of motion.

**PROGRAM DESIGN**

To structure a program, the main objective is to assist the client in finding relief from current persisting back pain associated with her occupation. The initial focus is to familiarize the client with basic element of Pilates and to build a strong foundation from which to achieve the long term goals. Emphasis on breathing technique is critical as the client’s breathing is very shallow; proper breathing technique will also promote the proper muscle recruitment needed to build functional abdominal strength and control. In particular, the focus will be on the lower abs, specifically maintaining a consistent contraction of the abdominals. The program will focus on working from a neutral spine position (while moving the upper and lower extremities) in order to increase pelvic lumbar stability. Correcting spine alignment and stability, strengthening her weak muscles (abdominal muscles TA and obliques) and stretching her tight muscles hip flexors (iliopsoas, rectus femoris, tensor fasciae latae) including lower back extensors (erector spinae) are key. To correct a kyphosis will involve strengthening the thoracic extensors (erector spinae, latissimus dorsi and deep extensors (interspinalis and multifidi) and the scapulae adductors (rhomboids, trapezius), and stretching the anterior shoulder muscles (pectoralis major) to prevent shoulders rolling forward. From observations of the client’s body during movement was noted that there is limited forward flexion; this requires assisted roll-ups, where assists and modifications are used for supine exercises to help her open the shoulders. A foam cushion will be useful during the seated exercises to align the rib cage over the pelvis.
Taking into consideration Ms. R.’s condition and her main short, intermediate and long term goals, she committed to one-on-one sessions for one hour, two days a week over the course of 4 months. The below chart’s represents examples of exercises used during sessions 1-21+

**CONDITIONING PROGRAM**

Sessions: 1-10

<table>
<thead>
<tr>
<th>BLOCK</th>
<th>EXERCISE</th>
<th>MUSCLE FOCUS (MF)</th>
<th>NOTES/Desired results</th>
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<tbody>
<tr>
<td>Warm Up</td>
<td>M: <strong>Roll Down</strong> (modified roll down against the wall) <strong>Pelvic Curl</strong> -focus on lateral breathing to warm up; MF: abdominals, hamstrings <strong>Note:</strong> use ball to encourage inner thigh activation and alignment. Objective spinal articulation pelvic lumbar stabilization. <strong>Spine Twist supine</strong> – abdominal; control w/oblique, spinal rotation - <strong>Note:</strong> feet are on the floor to increase stability through the lower back. - <strong>Chest Lift</strong>-MF: abdominal strength; - <strong>Note:</strong> pelvic stability; focus on maintaining neutral pelvis while flexion of the upper back and engaging abdominal. <strong>Leg Lifts/Leg Changes:</strong> focus movement in a hip joint.</td>
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<tr>
<td>Foot Work</td>
<td>R: <strong>Foot Work</strong> -Parallel heals/ toes, V position toes, Open V-heals/ toes, Calf Raises, Prances, Single Leg heel/ toes. MF: Hamstrings, quadriceps, hip/knee extensor strength. <strong>Note:</strong> head rest up; assess her gait; emphasis on the concentric and eccentric contraction; stabilization; alignment (proper positioning of the feet throughout).</td>
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<tr>
<td>Abdominal Work</td>
<td>R: <strong>Hundred Prep/Hundred</strong> (in table top/modified) MF: abdominal strength, trunk stabilization, shoulder flexion/extension control. <strong>Note:</strong> Modification – light spring to lessen the arm work so primary focus placed on TA engaged throughout. <strong>Coordination</strong> MF: ab control, pelvic lumbar stabilization, shoulder extension control. <strong>Note:</strong> movement added for the challenge; imprinting the lower back into the mat when lifted in to truck flexion; maintain stability and strengthen the abs.</td>
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<tr>
<td>Hip Work</td>
<td>R: <strong>Frog</strong> MF: Hip adductor strength, hip extensor control; focus on hip disassociation, head rest up; <strong>Circles Down/Up</strong> MF: Hamstrings, hip adductor strength, extensor control, <strong>Openings</strong> MF: Hip adductor strength and stretch. <strong>Note:</strong> used to explore the hip joint functional range of motion (ROM) while maintaining integrity of the pelvis and spinal alignment.</td>
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<tr>
<td>Spinal Articulation</td>
<td>Not teaching this yet</td>
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<tr>
<td>Stretches</td>
<td>R: <strong>Standing Lunge</strong> (Hamstring stretch series) MF: Hip flexor&amp; hamstrings stretch <strong>Note:</strong> with goal to maintain spinal alignment gain flexibility while stretching these tight areas. <strong>Teach:</strong> posterior tilt of pelvis during hip flexor stretch &amp; anterior tilt of pelvis during hamstring stretch. Maintain contraction of back extensors (mid back) Move pelvis along a horizontal line when straightening front leg.</td>
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<tr>
<td>Full Body Int. F/I</td>
<td>Not teaching this yet</td>
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### Equipment:
- **M**: Mat;  
- **R**: Reformer;  
- **C**: Cadillac;  
- **WC**: Wunda Chair;  
- **LB**: Ladder Barrel

### Block | Exercise | Muscle Focus (MF) | Notes/Desired Results
--- | --- | --- | ---
**Arm Work** | **R**: Arm Supine Series | Extension; Adduction; Up/Down Circles; Triceps | **Notes**: lats., and serratus for shoulder stability; focus on keeping neutral spine and pelvis.
**Full B.I A/M** | Not introducing this yet | --- | ---
**Leg Work** | **WC**: Hamstring Curl | MF: Hamstrings. **Note**: exercising each leg independently (unilaterally) because client shows significant imbalance in the strength of the hamstrings.  
**Hip Opener** | MF: Hip external rotators. **Note**: focus hip external rotator and hip abductors, extensor control, pelvic lumbar stabilization. | --- | ---
**Lateral Flex/Rotation** | **LB**: Side Over Prep | MF: Ab with oblique emphasis, Strengthen the obliques, Stretch lateral flexors. **Note**: In this position she can find neutral spine in diagonal orientation and strengthen the core (bilateral bend). | --- | ---
**Back Extension** | **M**: Back Extension | – at this beginning stage exercise is performed with a slim pillow placed under the hips to reduce lumbar lordosis.  
**M**: Kat Stretch | – used to promote lumbar spine stability elongation and segmental mobilization (the pelvic flor and TA); to improve vertebral column mobility in flexion/extension (rectus abdominis and the oblique abdominals); Pectoral girdle stability – activation of the middle and lower fibres of trapezius, latissimus dorsi and teres major. | --- | ---
**Rest Position** | **Session End** | **Roll Down** - with a standing (assisted) | --- | ---

### Sessions: 11-20 and 21+

### Warm Up - Intermediate
- **M**: Roll-Up – wit support under her back (work toward unsupported Roll-up)  
- **Spine Twist Supine** - use variations for added challenge  
- **Double Leg Stretch** - Modified: supporting the head with the hands; reach elbows toward the knees to begin, open elbows out to sides as the legs reach up toward the ceiling. **Single Leg Stretch** – support the head and neck with the hands  
- **Criss Cross** - focus on true rotation (avoiding flare of the ribs) contracting the internal obliques on the bent-knee side, drawing the lower ribs towards the pelvic crest. **Note**: alternate with Cadillac Warm-up Series

### Foot Work
- **WC**: Foot Work - Parallel heals, P toes, V position toes, Open V-heals, Open V-toes, Calf raises, Prances, Single Leg Heal/Toe | MF: Hamstrings, quadriceps, hip extensor control/strength. **Note**: used to challenge - co-contracting of abdominal and back extensor muscles to hold stable upright truck; as well as pelvic floor activation; In Single Leg Heal modification (ball) used to hold leg straight. Depending on how client fells we may do Foot work on the Reformer.
<table>
<thead>
<tr>
<th>BLOCK</th>
<th>EXERCISE</th>
<th>MUSCLE FOCUS (MF)</th>
<th>NOTES/Desired results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominal Work</td>
<td>WC: Standing Pike- abdominals</td>
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<td><strong>Pike Sitting</strong> – MF: ab and latissimus dorsi; spine in flexion</td>
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<td><strong>Note:</strong> Standing Pike chosen because this exercise lays the foundation for the abdominal exercises that follow; aim to maximum lumbar flexion and stabilize the scapula.</td>
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<tr>
<td>Hip Work</td>
<td>R: Frog; Circles Down/Up; Openings</td>
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<td><strong>Note:</strong> focus on hip disassociation, head rest up; work on hip adductor activation, strength and control with pelvic stabilization.</td>
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<tr>
<td>Spinal Articulation</td>
<td>R: Bottom Lift/Bottom Lift w Extension</td>
<td>Abdominals, Hamstrings, Spinal articulation, hip extensor control. <strong>Note:</strong> Chosen because client had mastered pelvic stabilization and spinal articulation, more work on because hamstrings act as a hip extensors and as a knee flexors in order to keep carriage in place; more ab strength and control.</td>
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<tr>
<td>Stretches</td>
<td>LB: Hamstrings; alternate with LB: Gluteal Stretch</td>
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<tr>
<td>Full Body Int. F/I</td>
<td>R: Up Stretch 1. MF: Abdominals, Back extensors</td>
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<td>C: Sitting Forward PTB MF: Abdominals; C: Side Reach PTB MF: Ab with obliques focus. <strong>Note:</strong> modified-seated on a foam cushion to align rib cage over pelvis; -this exercise gives client a good shoulder extension together with work of spinal flexors.</td>
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<tr>
<td>Arm Work</td>
<td>C: Arm Standing Series Chest Expansion, Hug-a-Tree, Circles Up/Down, Punches, Biceps; MF: Scapula control, shoulder strength and control, symmetry left to right, functional postural awareness. <strong>Note:</strong> Chosen to reinforce correct standing posture and spinal stabilization while working arms.</td>
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<tr>
<td>Full Body Int. A/M</td>
<td>Not Introducing this yet</td>
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<tr>
<td>Leg Work</td>
<td>C: Squats MF: Quadriceps &amp; Bicep Strength. <strong>Note:</strong> keeping the body upright as it moves up/down a wall, resisting the urge to posteriorly tilt the pelvis, encourage a slight anterior tilt to line the hips up over the heels.</td>
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<tr>
<td>Lateral Flex/Rot.</td>
<td>WC: Side Pike MF: Abdominals, with oblique emphasis; deltoids</td>
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<tr>
<td>Back Extension</td>
<td>WC: Basic Swan MF: back extensors strength; scapula stabilization; back extensor strength, shoulder extensor control. <strong>Note:</strong> Modified to reduce challenge, placing feet on a large ball so the alignment is still parallel to the floor, assist in creating a long, evenly distributed arc though the trunk. Maintains ab engagement to protect the spine. Work toward Swan on the Floor.</td>
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<tr>
<td>Session End</td>
<td>Roll Down – Standing</td>
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This Pilates program was performed twice a week for a period of four months. Feeling the improvement Ms. R. was so excited that she purchased a reformer for her home, because of
her unpredictable work schedule she did not wish to miss her regular practice, so we continued once a week one-on-one sessions in her home applying appropriate progressions on a reformer and mat exercises using various assists/accessories, including she takes a dual Pilates session using other apparatus in a studio setting every Thursday. Ms. R. had taken 30 plus Pilates lessons overall.

CONCLUSION
Due to gains in segmental articulation and dynamic stability, with a great emphasis being placed on breath, alignment, precision, stretching and her positive alterations in posture in her everyday movements, Ms. R. no longer suffers from back pain, and has overall improved her posture strength and have better range of motion. Although it will still take some time for some movements/positions to come more easily and naturally, looking back from the very start. Ms R is an example and a proof of as once Joseph Pilates quoted: “In 10 sessions you'll feel the difference, in 20 you'll see the difference, and in 30 you'll have a new body”.

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